SOLAR PANELS MANUAL

Table of Contents

What can the sun do for you?

The sun is a large body in space that is 150 million kilometers away from earth, yet its energy makes life possible on earth. The sun, an average star, is a fusion reactor that has been burning over 4 billion years. It provides enough energy in one minute to supply the world's energy needs for one year.

In one day, it provides more energy than our current population would consume in 27 years. In fact the amount of solar radiation striking the earth over a three-day period is equivalent to the energy stored in all fossil energy sources.

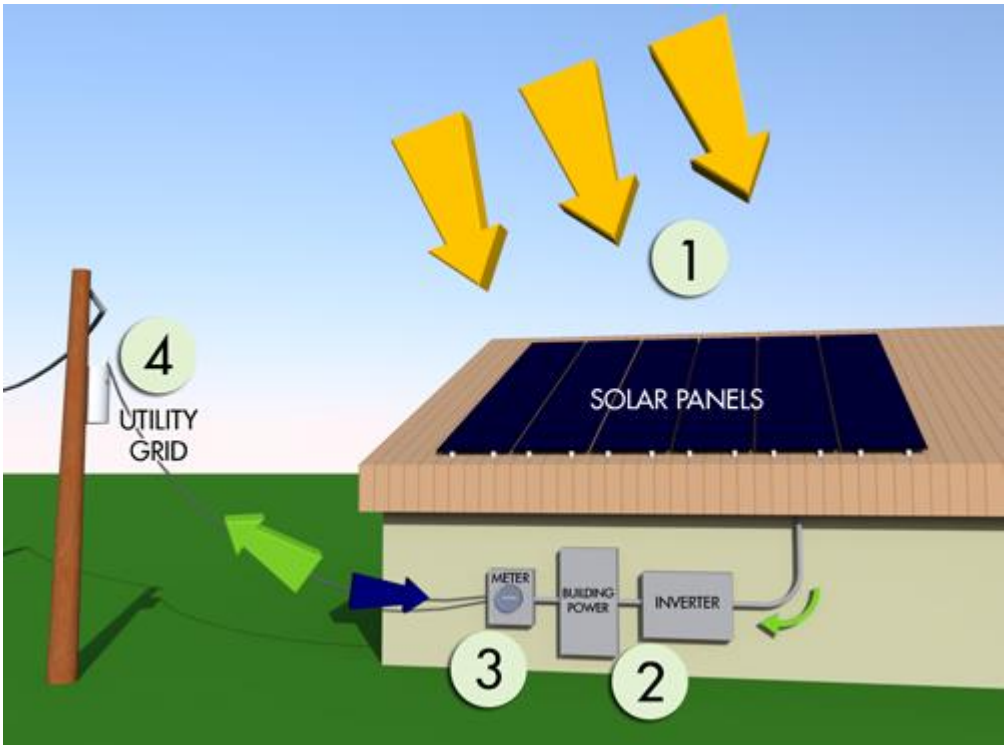
Using the power of the sun to provide energy to power your home or business is an amazing and incredible concept. It can be mind-blowing when you actually consider that

The sun produces enough energy everyday to sustain the average household's electricity needs.

If it were not for the technological and financial limitations of solar energy systems, it is quite conceivable that we could be using solar power for the majority of our energy needs right now. Unfortunately, historically high costs have prevented most people from benefitting from the Sun's energy. YOU, by purchasing this book have taken the first steps to alter that trend.

Take a moment to think about the value of the sun and its role as a renewable resource. What exactly does renewable mean? The amount of solar energy we use today in no way effects the amount of energy that will be available for use tomorrow or in 20 years. What is even better about solar energy is that we are not borrowing from our children's future or creating greater problems for their children.

How solar power works?



The concept of solar energy is the process of collecting the energy produced by the sun over a specified surface area and then converting that collected energy into usable electricity for our homes and buildings. Many people think that Photovoltaic (PV) energy is a relatively new technology.

The facts are that in 1839, Edmund Becquerel discovered the photovoltaic effect while experimenting with metal plates. He discovered that some materials were photoconductive and could create small electrical charges when exposed to light. In 1887, Heinrich Hertz observed much the same effect when creating a spark-generating apparatus.

Then in 1905, Albert Einstein described mathematically how the photovoltaic effect was caused, and in the process defined "quanta of light," which are now called photons. He posited that the absorption of discrete quanta of light explained the observations of the effect thus far. His paper on the topic won him the Nobel Prize in Physics in 1921 and was one of his greatest discoveries.

In the early 1950's, Bell Laboratories developed a silicon-based cell that achieved a six percent efficiency compared to solar cells manufactured today that are close to 20% efficient.

The first non-laboratory use of photovoltaic technology was to power a telephone repeater station in Georgia in the late 1950's. NASA (National Aeronautics and Space Administration) installed a PV system consisting of 108 cells on Vanguard I which was the United States' first satellite. By the early 1960's, PV systems were being installed on most satellites and spacecraft.

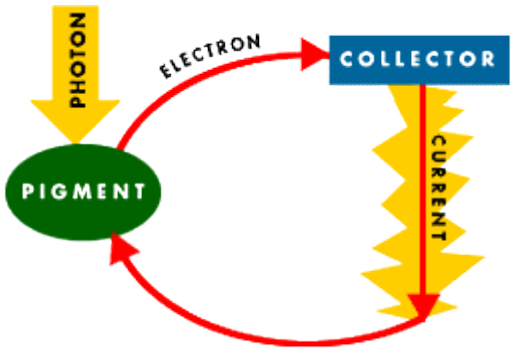
Solar energy systems use solar panels made up of photovoltaic (photo means light and voltaic means electricity) cells to collect and convert the sun's energy into electricity that we can use. Most photovoltaic (PV) cells are made from very thin layers of silicon and then impregnated with tiny amounts of elements like boron and phosphorus.

Energy is produced when the sun's rays contact the photovoltaic cells and a "reaction" occurs. The semiconductors absorb the sun's energy. This causes electrons to break free from their atoms and push through the cell's substrate to create electricity.

It is hard to believe that the internal components of age-old transistor radios helped create the world of solar power. There have been advancements made in the world of photovoltaic cells in recent years and most solar panels manufactured today are able to absorb an ever increasing percentage of the sun's energy and convert it to electricity. Some even operate with limited sun exposure, whereas the original panels only produced electricity in full and direct sunlight.

Today, PV solar modules supply electrical power to more than 1 million homes worldwide. This technology supports thousands of jobs and creates sustainable economic opportunities. The applications for solar PV energy today include communications, refrigeration for health care, crop irrigation, water purification, lighting, utility power and other residential and commercial applications.

Photovoltaic Cells: Converting Photons to Electrons



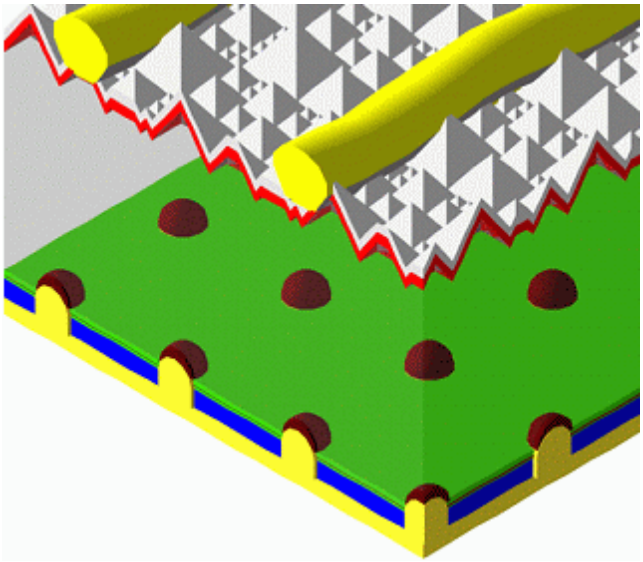
The solar cells that you see on calculators and satellites are also called photovoltaic (PV) cells, which as the name implies (photo meaning "light" and voltaic meaning "electricity"), convert sunlight directly into electricity. A module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays, like the one operating at Nellis Air Force Base in Nevada.

Photovoltaic cells are made of special materials called semiconductors such as silicon, which is currently used most commonly. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely.

PV cells also all have one or more electric field that acts to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off for external use, say, to power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce.

That's the basic process, but there's really much more to it. On the next page, let's take a deeper look into one example of a PV cell: the single-crystal silicon cell.

How Silicon Makes a Solar Cell



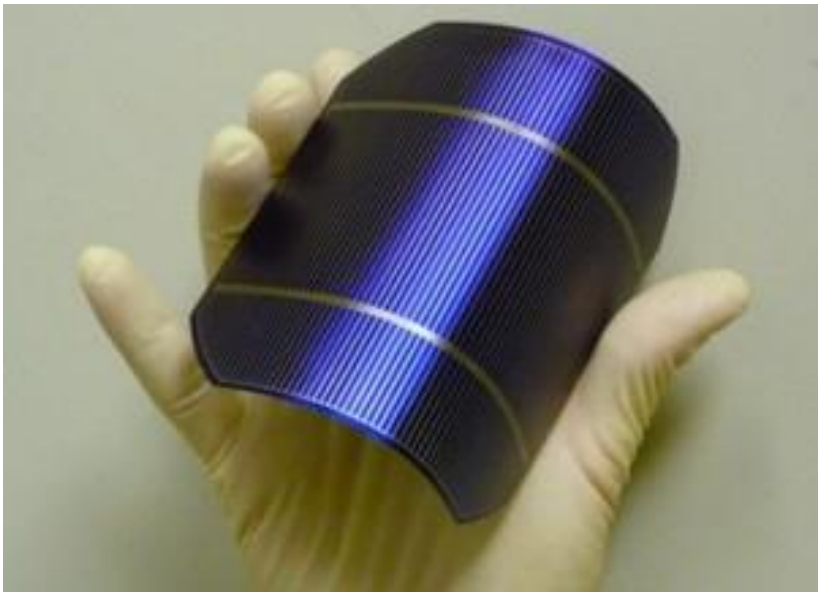
Silicon has some special chemical properties, especially in its crystalline form. An atom of sili-con has 14 electrons, arranged in three different shells. The first two shells, which hold two and eight electrons respectively, are completely full. The outer shell, however, is only half full with just four electrons.

A silicon atom will always look for ways to fill up its last shell, and to do this, it will share electrons with four nearby atoms. It's like each atom holds hands with its neighbors, except that in this case, each atom has four hands joined to four neighbors. That's what forms the crystalline structure, and that structure turns out to be important to this type of PV cell.

The only problem is that pure crystalline silicon is a poor conductor of electricity because none of its electrons are free to move about, unlike the electrons in more optimum conductors like copper. To address this issue, the silicon in a solar cell has impurities - other atoms purposefully mixed in with the silicon atoms - which changes the way things work a bit. We usually think of impurities as something undesirable, but in this case, our cell wouldn't work without them.

Consider silicon with an atom of phosphorous here and there, maybe one for every million silicon atoms. Phosphorous has five electrons in its outer shell, not four. It still bonds with its silicon neighbor atoms, but in a sense, the phosphorous has one electron that doesn't have anyone to hold hands with. It doesn't form part of a bond, but there is a positive proton in the phosphorous nucleus holding it in place.

When energy is added to pure silicon, in the form of heat for example, it can cause a few electrons to break free of their bonds and leave their atoms. A hole is left behind in each case. These electrons, called free carriers, then wander randomly around the crystalline lattice looking for another hole to fall into and carrying an electrical current. However, there are so few of them in pure silicon, that they aren't very useful.



But our impure silicon with phosphorous atoms mixed in is a different story. It takes a lot less energy to knock loose one of our "extra" phosphorous electrons because they aren't tied up in a bond with any neighboring atoms. As a result, most of these electrons do break free, and we have a lot more free carriers than we would have in pure silicon. The process of adding impurities on purpose is called doping, and when doped with phosphorous, the resulting silicon is called N-type ("n" for negative) because of the prevalence of free electrons. N-type doped silicon is a much better conductor than pure silicon.

The other part of a typical solar cell is doped with the element boron, which has only three electrons in its outer shell instead of four, to become P-type silicon. Instead of having free electrons, P-type ("p" for positive) has free openings and carries the opposite (positive) charge.

On the next page, we'll take a closer look at what happens when these two substances start to interact.

Anatomy of a Solar Cell

Before now, our two separate pieces of silicon were electrically neutral; the interesting part begins when you put them together. That's because without an electric field, the cell wouldn't work; the field forms when the N-type and P-type silicon come into contact. Suddenly, the free electrons on the N side see all the openings on the P side, and there's a mad rush to fill them.

Do all the free electrons fill all the free holes? No. If they did, then the whole arrangement wouldn't be very useful. However, right at the junction, they do mix and form something of a barrier, making it harder and harder for electrons on the N side to cross over to the P side. Eventually, equilibrium is reached, and we have an electric field separating the two sides. This electric field acts as a diode, allowing (and even pushing) electrons to flow from the P side to the N side, but not the other way around. It's like a hill -- electrons can easily go down the hill (to the N side), but can't climb it (to the P side).

When light, in the form of photons, hits our solar cell, its energy breaks apart electron-hole pairs. Each photon with enough energy will normally free exactly one electron, resulting in a free hole as well. If this happens close enough to the electric field, or if free electron and free hole happen to wander into its range of influence, the field will send the electron to the N side and the hole to the P side.

This causes further disruption of electrical neutrality, and if we provide an external current path, electrons will flow through the path to the P side to unite with holes that the electric field sent there, doing work for us alo-ng the way. The electron flow provides the current, and the cell's electric field causes a voltage. With both current and voltage, we have power, which is the product of the two.

There are a few more components left before we can really use our cell. Silicon happens to be a very shiny material, which can send photons bouncing away before they've done their job, so an antireflective coating is applied to reduce those losses. The final step is to install something that will protect the cell from the elements, often a glass cover plate. PV modules are generally made by connecting several individual cells together to achieve useful levels of voltage and current, and putting them in a sturdy frame complete with positive and negative terminals.

Types of Solar Energy Systems

1.A portable photovoltaic system is a simple power supply that can operate just about anything you can think of. It is a great system for camps and camping trips and the best part is that it costs between $200 - $500.00 to assemble at home. This system easily pays for itself in a few short months.

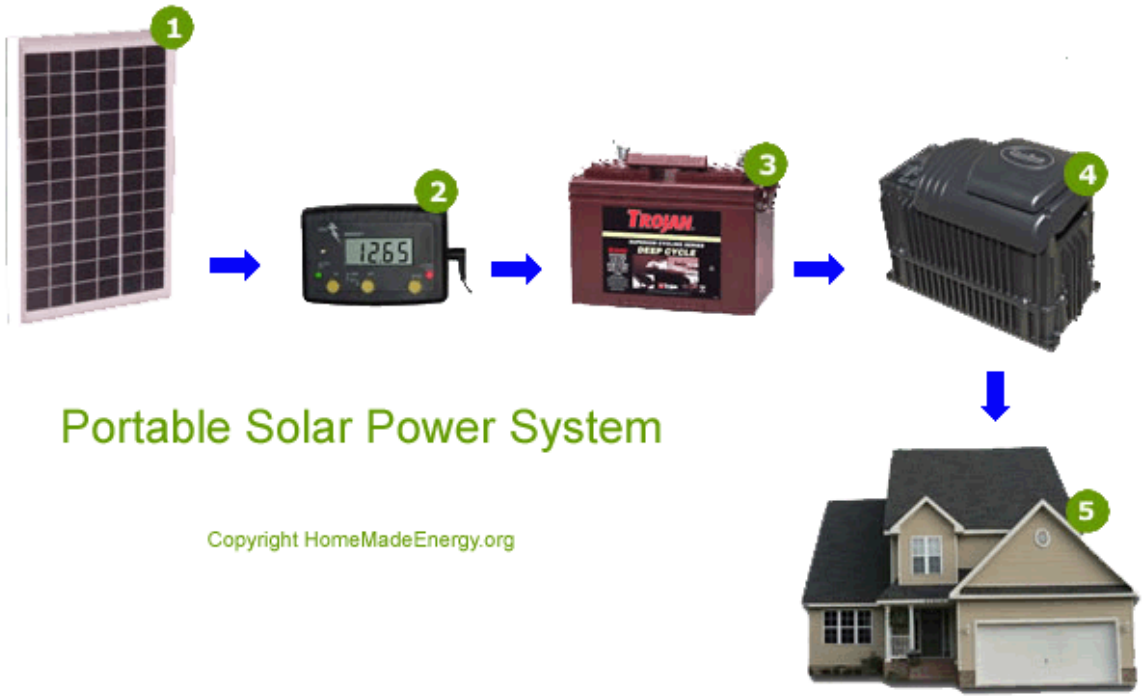
The components and the order of their connections for this simple system are:

1. Energy source or PV Panels

2. Charge controller

3. Deep Cycle Battery

4. Inverter



2. An on-grid solar power system is what most households that are already tied to commercial grid power opt to use. This utility interactive solar electric system can actually pay back in some energy efficient households where the solar system generates more electricity than is being used by the home through net metering. It is also important to mention that with this system, if your power from the commercial grid is interrupted, you will not have power in the home.

You will need to consult your local electricity provider and state regulatory agency for more information on net metering in your area. The components and the order of their connections for this solar power system are:

1. Energy source or PV Panels

2. Array DC Disconnect

3. Inverter

4. AC Breaker Panel

5. Kilowatt Per Hour Meter

6. Grid tie in

3. **An on-grid system with battery back-up** is the same as the grid system, but has additional battery elements for storing energy. This stored battery power will be used in times when the sun is not available such as a cloudy or rainy day or when power from the grid is interrupted. The components and the order of their connections for this solar power system are:

1. Energy Source or PV panels

2. Array DC Disconnect

3. Charge Controller

4. Deep Cycle Battery

5. System Meter

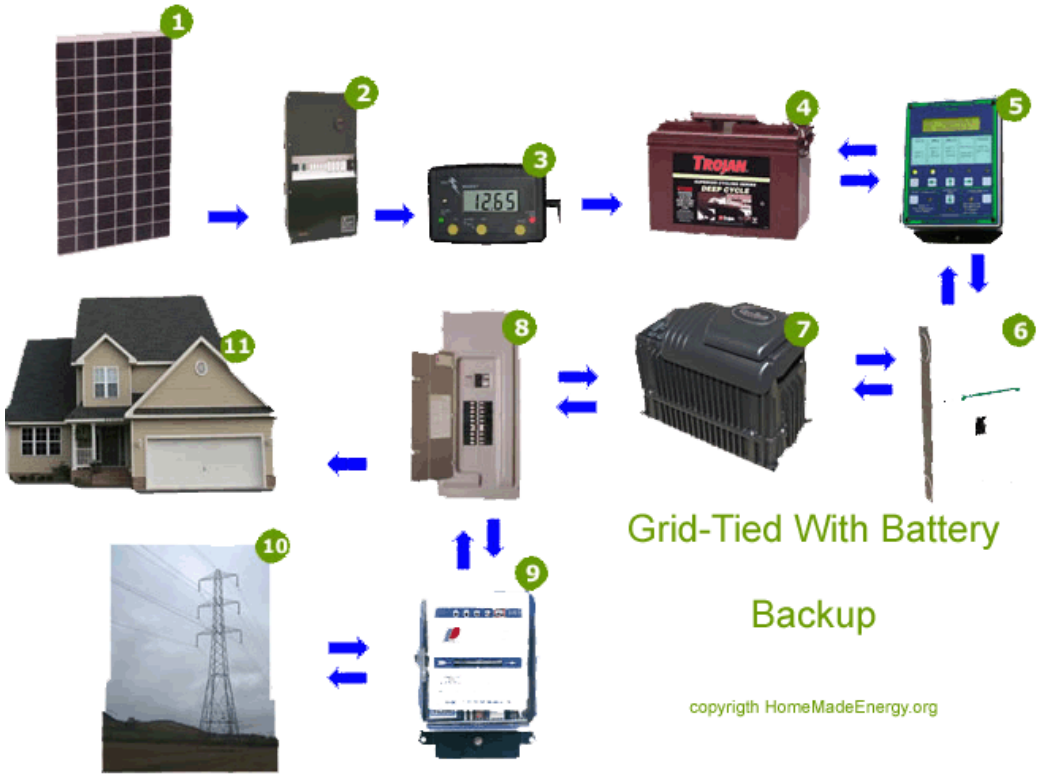
6. Main DC Disconnect

7. Inverter

8. AC Breaker Panel

9. Kilowatt Per Hour Meter

10. Grid Tie In



4. **The off-grid solar energy system** is a popular choice for remote locations where the cost of running commercial electricity would be too great or too intrusive on the landscape. This is also the option chosen by those individuals who do not wish to see that monthly electric bill in their mailboxes. The generator is included in this system to charge batteries in situations when there is not enough sun exposure to produce the home or business' electricity needs.

The components and the order of their connections for this solar power system are:

1. Energy Source or PV Panels

2. Array DC Disconnect

3. Charge Controller

4. Deep Cycle Battery

5. System Meter

6. Main DC Disconnect

7. Inverter

8. Generator

9. AC Breaker Panel

Your solar potential

Depending on where you live geographically — the orientation and exposure of your particular house or business — you get more or less usable sunshine. Even within small, localized regions, weather patterns vary due to topography and landscape details like trees and ponds. So two identical solar systems separated by a few miles, but otherwise built and operated identically, may yield different energy outputs averaged over a period of time.

Here's a look at how climate can affect your solar system:

Sunlight: Climate dictates how much sunlight you can expect annually. That the Southwest gets the most sunshine per day — and that Canada and the northern states get the least — should come as no surprise. The sun is higher in the sky in the southern states, so the days are longer.

Snowfall: You want to locate your panels so they avoid being inundated with heavy layers of snow. For example, some locations on your roof will experience very shallow snow buildups as compared to other parts of your roof. Also, some parts of your roof may be warmer than others due to proximity to heaters, exhausts, chimneys, and so on.

Cloud cover: If you're living in a cloudy region, you still have solar energy, and it's generally diffused (spread out). As a result, collector panel orientation isn't so critical because light will be coming in at many different angles rather than just directly overhead from the sun.

Smog: Air pollution and smog affect the amount of sunlight you can expect to receive. If you do live in an area with heavy air pollution, expect less system output over an extended period of time.

Air density: You get better solar exposure in the mountains than near sea level simply because the air is thinner and scatters less sunlight. You can make an approximate estimate of how clear your air is by simply observing how blue the sky is on a clear day. Thick air scatters more red light, and so the appearance of the sky is less blue and more white.

Temperature: With PV systems the lower the temperature, the happier the semiconductors, and the greater the output. You can get more system output on a cold, clear day than a sunny day.

Frequent fog: If you're living in an area that's foggy and misty in the morning (in the San Francisco Bay Area, for example) but the mist burns off into a clear sky by noon, you want to orient your solar panels more westward to optimize the amount of sunlight you can achieve over the course of a day.

Wind: If you have a lot of wind, you need to consider where you mount your solar equipment for a couple of reasons:
• Wind can tear equipment off of its mounting hardware and result in expensive repairs, not to mention dangerous conditions. If you're in a windy climate, you need to make sure that you specify, heavy duty mounting equipment. Mounting schemes all have wind speed specifications; pay close attention because mishaps are expensive.

In addition to how much direct sunlight you get, sunlight intensity is important. When the sun is lower in the sky, solar radiation must pass through more atmosphere, and it's therefore reduced by scattering and absorption.
The sun is the most intense when it's directly overhead. And summer sunlight is much stronger than winter.

Determining Your Energy Needs

Determining your average energy needs is as simple as looking at your previous electric bills. Each bill supplied by the utility company will identify how many ***Watts*** or ***Kilowatts*** of power you used in the last billing period. Many utilities will offer information on the previous year's consumption. Use this to determine just how much energy your alternative energy system is going to have to produce.
Just to give you an idea, before you start building or buying your alternative energy system, let's get a little better understanding of the energy you are about to produce and what it will power in your home.

Electric Load Requirements

Remember basic formula: *watts = volts x amps*–If not listed on device, read manufacture's label. Look for voltage and amps consumed.
For Example - A small toaster may consume:
120 volts AC x 8.33 amps = 1,000 watts

Let's start by looking at 1,000 Watts of power or 1KW of power. This is the average power that is consumed by small appliances such as lights, TVs, DVD players, a microwave or toaster oven. Essentially you could eliminate the cost of running these appliances daily by producing 1KW of power yourself with a ***solar*** or ***wind*** energy system. Approximately 12 solar panels generating 80 watts each can produce the 1,000 watts necessary to run these appliances).

Example: A toaster consumes 1,600 Watts when operating; toaster operates for 15minutes per day = **.25** hours per day; 30 days = 1 month; Total Watt Hours (Wh) / 1,000= KWh.

Toaster at 1,600 Watts X **.25** hours per day = 400 Watt hours consumed per day; 400Wh / day X (30 days) = 12,000 watt hours / month = 12KWh/month 1,000 watts (1KW)

Typical Wattage Requirements Table for Common Appliances

Air Conditioner (room) 1,000
Blender 300CD Player 35
Air Conditioner (central) 3,500
Can Opener 100
Stereo 25–50

Blow Dryer 1,000
Dishwasher 1,500
19” TV 60
Ceiling Fan 10-50
Microwave 1,400
32” TV 300
Clock Radio 2
Range (Large Burner) 2,100
DVD Player 11
Clothes Washer 1,450
Range (Small Burner) 1,250
Clothes Dryer (Electric) 4,000
Toaster 800–1,500
Table Fan 10 –25
Mixer 120
Energy Star 110 Refrigerator
Incandescent bulb (100W) 100
14” Band Saw 1,100
Older Refrigerator/ Freezer475
Incandescent bulb (60W) 60
Electric Drill ¼” 300
Standard Freezer 400
Compact Flour (CFL) (60W equiv.) 16
Electric Drill ½” 600
Incandescent (40 W) 40
Electric Drill 1” 1,000
Compact Flour (CFL 40 W equiv.) 11
Computer–Desktop 80 -450
Printer (Inkjet) 50 -75
Printer (Inkjet) 600 –1,000
Fax (Stand-by) 15–45
Fax (Printing) 120 -350

So, if you use the formula shown above, you can compute the load for your home using the spread sheet we have supplied for you.

How Long Do Solar Panel Systems Last?

Photovoltaic (PV) cells and panels are a great investment because they last a long, long, time. The oldest units in use, on earth that is, are around 45 years old and still operating well. As the technology behind solar cells advances, the longevity of panels is increasing and degradation rates are decreasing. Because transistor technology was the basis for most solar cell development, many early researchers believed that solar cells would have a similar 20-year life span. However, the cells that were placed in space in the 1960's, to power the early communication satellites, are still functioning today.

Solar energy and solar panels are a sound investment in your future both in terms of lower utility bills today and in the future as the cost of electricity will surely rise in the years to come. Another financial aspect to consider is that the depreciation of your system will be minimal. In fact, the "estimated life span" of solar cells/solar panels is 20 years and longer.

Advantages of PV Technology	Disadvantages of PV Technology
Reliability: even in harsh conditions PV systems are extremely reliable	**Initial Costs**: historically high but due to technology and government incentives more affordable today
Durability: most PV cells/modules are guaranteed by the mfg. for 25 years or longer	**Weather Dependence**: lack of sun, cloudy, rainy weather can affect PV energy production
Low Maintenance Cost: PV systems usually only require periodic inspections and occasional maintenance	**Cost of Batteries**: if used to store PV system power, can significantly add to cost of PV system
Modularity: modules may be added incrementally to increase system power	May need to replace old, inefficient electrical appliances within one's home
Allows Energy Independence	**Lack of Education**: PV systems represent new and unfamiliar technology that requires education

Building your solar system

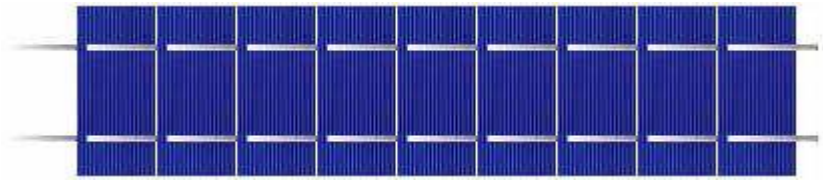
The cost of purchasing a commercial solar generator or a solar energy system at a retail value is not a pleasant thought for members of the average income household. However, building your own solar generator is a cost effective way to introduce alternative energy into your home or business and it is a lot easier than you probably imagined. The photovoltaic (PV) cell life span usually includes a manufacturer's warranty which may last for 20 years or more.

There are actually different applications for solar power that you can use within your home or business to reduce your commercial energy dependence and reduce your energy costs. But, before we can start describing the various systems, let's look at the individual parts of most solar energy systems and their functions. Your familiarity with these elements will make understanding the designs presented later in this book, easier to understand.

Photovoltaic System Parts & Their Functions

Solar Cell: The key ingredient of the Photovoltaic (PV) system is the Photovoltaic (PV) cell. PV cells are connected together to create PV panels.

Stringer: When the individual PV cells are connected together in a "string", they are referred to as a "stringer". Four (4), 9 cell stringers make up a 36 cell panel.



Solar Panels: Otherwise known as PV (or photovoltaic) panels are the "heart" of a solar electric system. These panels capture the sun's energy and convert it into direct current or DC electricity.

Each PV cell produces approximately .55 volts DC and from 1 to 8 amps per PV cell (depending on surface area of cell). As the graphic above shows, the PV cells are connected together to create PV panels and then the panels are connected together to create a Photovoltaic (PV) System referred to as a PV Array.

Most solar panels are rated with wattage information and you will need to determine your electricity usage needs to find the best panels for your project. You can combine multiple panels into an Array to meet your system requirements. Standard panels usually have either 36 or 72 cells per panel. (36 PV cells per panel X .55 VDC per PV Cell = approx. 20 Volts DC per panel x 4 Amps/cell = approx 80watts of power).

You will create your first PV module from individual solar cells. As you create additional PV modules you will connect them together to create the necessary sized array for your individual electricity needs for your home.

Once you have built the number of PV panels necessary for your home's energy needs, then you can install the Array on the ground (see graphic below) or on the roof (see graphic below) to generate electrical power.

An example of a “ground mount” PV System is shown here:

An example of a “roof mount” PV System is shown here:

Other components:

Array DC Disconnect. The DC Disconnect is an important maintenance element of any solar panel system. The DC disconnect makes shutting off power from the solar panels easy and safe. Please Note: The disconnect MUST be DC "rated" and not AC "rated"!

Charge Controller: A Charge controller is a "must", if batteries are to be utilized in a PV system. Utilizing a charge controller will greatly benefit the life and charge of your battery system (if one is in use). The charge controller protects the batteries from becoming overcharged by interrupting the charging process once the batteries are fully charged. Many charge controllers incorporate features that will prevent the battery from discharging at night.

Deep Cycle Batterie are the best and safest battery to use with any alternative energy system. This battery will store the energy produced by the solar panels. It is possible to find free deep cycle batteries from suppliers of other machines that utilize deep cycle batteries such as golf carts, forklifts and fishing boats. However, perhaps the best and least troublesome action is to purchase new batteries with a manufacturer's warranty.

System Meter: A system meter can be used in coordination with your battery bank to monitor how fully charged your system is. You can also use the system meter to determine how much energy is being consumed at any given time. Many system meters allow the homeowner to *"go online"* with their system through the system meter to monitor their PV System.

Main DC Disconnect: The main DC disconnect allows you to easily and safely disconnect the inverter for maintenance. It is installed between the battery bank and the inverter.

Inverter: An inverter is an integral element in any alternative energy system. This unit converts the DC energy generated by your solar panels into alternating current or AC current. As we explained earlier, AC current is the type of electricity used by household appliances. If you wish to operate only DC appliances, then no conversion from DC to AC power is necessary.

Generator: A generator is not a necessary element for all alternative energy systems. It is most beneficial in "off-grid" systems which you will learn more about later. Some individuals decide to include a generator in their alternative energy system as a "back-up" source of power. It can be used to generate energy on days when there is not enough sun exposure to produce electricity. In addition to providing power when there is not enough sunshine to operate the

PV System, the generator may and will be used to recharge the Deep Cycle Batteries in the PV System's battery backup system.

AC Breaker Panel: Almost every home, except maybe those with no existing electricity, has a breaker panel located somewhere on the premises. It is the point where all of the home's electrical wiring meets with the electricity provider. The electricity can be provided via a commercial grid system (AC), through an alternative system (PV) or through a hybrid system that combines both (AC + PV). Another alternative is to operate a hybrid PV system which is a PV system plus a grid tied system.

Every state and/or local governmental agency has their own set of guidelines and codes regarding the ways that alternative energy sources are connected to the AC breaker panel. It is the Recommendation of HME that you always employ a qualified, licensed electrician, who is knowledgeable about PV systems, to connect your alternative energy system to the AC breaker panel.
It is possible to run your appliances directly from your inverter. This would eliminate the cost of hiring an electrician and tapping into the commercial grid system. "HME" recommends connecting to your commercial utility (electrical company) as opposed to only utilizing the Inverter.
HME strongly recommends: Always check with your local jurisdiction for rules and regulations regarding having a "grid-tied" electrical system BEFORE you attempt to connect your PV system to the local utility!

Solar-powering a House

What would you have to do to power your house with solar energy? Although it's not as simple as just slapping some modules on your roof, it's not extremely difficult to do, either.

First of all, not every roof has the correct orientation or angle of inclination to take full advantage of the sun's energy. Non-tracking PV systems in the Northern Hemisphere should ideally point toward true south, although orientations that face in more easterly and westerly directions can work too, albeit by sacrificing varying degrees of efficiency. Solar panels should also be inclined at an angle as close to the area's latitude as possible to absorb the maximum amount of energy year-round.

A different orientation and/or inclination could be used if you want to maximize energy production for the morning or afternoon, and/or the summer or winter. Of course, the modules should never be shaded by nearby trees or buildings, no matter the time of day or the time of year. In a PV module, if even just one of its cells is shaded, power production can be significantly reduced.

If you have a house with an unshaded, southward-facing roof, you need to decide what size system you need. This is complicated by the facts that your electricity production depends on the weather, which is never completely predictable, and that your electricity demand will also vary. Luckily, these hurdles are fairly easy to clear.

Meteorological data gives average monthly sunlight levels for different geographical areas. This takes into account rainfall and cloudy days, as well as altitude, humidity and other more subtle factors. You should design for the worst month, so that you'll have enough electricity year-round. With that data and your average household demand (your utility bill conveniently lets you know how much energy you use every month), there are simple methods you can use to determine just how many PV modules you'll need. You'll also need to decide on a system voltage, which you can control by deciding how many modules to wire in series.

You may have already guessed a couple of problems that we'll have to solve. First, what do we do when the sun isn't shining?

Solving Solar Power Issues

The thought of living at the whim of the weatherman probably doesn't thrill most people, but three main options can ensure you still have power even if the sun isn't cooperating. If you want to live completely off the grid, but don't trust your PV panels to supply all the electricity you'll need in a pinch, you can use a backup generator when solar supplies run low.

The second stand-alone system involves energy storage in the form of batteries. Unfortunately, batteries can add a lot of cost and maintenance to a PV system, but it's currently a necessity if you want to be completely independent.

The alternative is to connect your house to the utility grid, buying power when you need it and selling it back when you produce more than you use. This way, the utility acts as a practically infinite storage system. Keep in mind though, government regulations vary depending on location and are subject to change. Your local utility company may or may not be required to participate, and the buyback price can vary greatly.

You'll also probably need special equipment to make sure the power you're looking to sell the utility company is compatible with their own. Safety is an issue as well. The utility has to make sure that if there's a power outage in your neighborhood, your PV system won't continue to feed electricity into power lines that a lineman will think are dead. This is a dangerous situation called islanding, but it can be avoided with an anti-islanding inverter -- something we'll get to on the next page.

If you decide to use batteries instead, keep in mind that they'll have to be maintained, and then replaced after a certain number of years. Most solar panels tend to last about 30 years (and improved longevity is certainly one research goal), but batteries just don't have that kind of useful life [source: National Renewable Energy Laboratory]. Batteries in PV systems can also be very dangerous because of the energy they store and the acidic electrolytes they contain, so you'll need a well-ventilated, nonmetallic enclosure for them.

Although several different kinds of batteries are commonly used, the one characteristic they should all have in common is that they are deep-cycle batteries. Unlike your car battery, which is a shallow-cycle battery, deep-cycle batteries can discharge more of their stored energy while still maintaining long life. Car batteries discharge a large current for a very short time -- to start your car -- and are then immediately recharged as you drive.

PV batteries generally have to discharge a smaller current for a longer period of time (such as at night or during a power outage), while being charged during the day. The most commonly used deep-cycle batteries are lead-acid batteries (both sealed and vented) and nickel-cadmium batteries, both of which have various pros and cons.

On the next page, we'll dig a little deeper into the components that'll be needed for the sun to start saving you some cash.

Finishing Your Solar Power Setup

The use of batteries requires the installation of another component called a charge controller. Batteries last a lot longer if they aren't overcharged or drained too much. That's what a charge controller does.

Once the batteries are fully charged, the charge controller doesn't let current from the PV modules continue to flow into them. Similarly, once the batteries have been drained to a certain predetermined level controlled by measuring battery voltage, many charge controllers will not allow more current to be drained from the batteries until they have been recharged.

The use of a charge controller is essential for long battery life.

The other problem besides energy storage is that the electricity generated by your solar panels, and extracted from your batteries if you choose to use them, is not in the form that's supplied by your utility or used by the electrical appliances in your house.

The electricity generated by a solar system is direct current, so you'll need an inverter to convert it into alternating current. And like we discussed on the last page, apart from switching DC to AC, some inverters are also designed to protect against islanding if your system is hooked up to the power grid.

Most large inverters will allow you to automatically control how your system works. Some PV modules, called AC modules, actually have an inverter already built into each module, eliminating the need for a large, central inverter, and simplifying wiring issues.

Throw in the mounting hardware, wiring, junction boxes, grounding equipment, overcurrent protection, DC and AC disconnects and other accessories, and you have yourself a system. You must follow electrical codes (there's a section in the National Electrical Code just for PV), and it's highly recommended that a licensed electrician who has experience with PV systems do the installation. Once installed, a PV system requires very little maintenance (especially if no batteries are used), and will provide electricity cleanly and quietly for 20 years or more.

Tips to maintain solar panels

Overall, a solar power system is not dangerous or too complex for most people to maintain. It doesn't require any supervision from any government agency because it presents no risks. All the same, there are still a few safety tips you should follow when working on a solar power system..

To use solar power panels safely in practical applications, they must be:

Protected from physical damage during manufacture, transport, and installation.

Protected from extreme weather conditions such as hailstones, wind and weight caused by a build up of snow. This is particularly important for wafer-based silicon cells which are fragile.

Sealed so as to protect them from damp, which will corrode metal contacts,particularly the transparent conductive oxide layer found in thin-film cells. Not doing this will inevitably result in attenuated performance and their corresponding lifespan.

After reading that, you should know that you do not work on solar panels whenever there is rain about.

Just like car batteries, the batteries for a solar power system contain extremely corrosive battery acid. If you should get acid on your skin, in your eyes, or just on your clothes, it is vital to get it off right away. When you are working around the batteries of your solar power system,it is a good idea to make sure that someone can hear you if you ever need to shout for aid. You might need another

person nearby in case you have an accident of some sort.

Making sure you have water and soap nearby will help to clean any spillages of battery acid off you. If you get it on your clothes, remove them before it soaks through to your skin. For your eyes, you need running water to flood your eyes, and after that you will need to visit a hospital right away.

It is foolish to smoke or allow any source of ignition anywhere near a battery. Not only that though, metal instruments may make a spark, which can cause an explosion. You should always be mindful that sparks may happen when you ever have to work on the panels. The risk of sparks is the main reason why you should never have any incendiary gases anywhere near the panels.

You must always make sure that, if you have a hybrid system, your backup generator is switched off so it it's impossible for it to start while you are working with the battery.

And you must not have anything made of metal such as jewelry or watches when you are around the battery. A short circuit can produce enough electrical current to melt the metal onto the other metal. The heat from this occurrence could easily cause you severe burns.

There are also a couple of other sensible precautions you should take when you are working with solar panels. For instance, you should cover the outward face of the panels to make sure sunlight cannot reach them. This keeps them from generating electricity whilst you are working.

You have to be careful what you touch when you are installing solar panels. It is hazardous to touch the terminals if they are exposed to light. You should also work with insulated tools to protect yourself from shock.

If you are working on a solar panel make sure it is secured or it can fall and break. No only will you lose an expensive solar panel, but you will have the hazard of broken glass all around besides. This is one good reason children should never be left to play nearby whenever solar panels are being installed.

All the above safety precautions for working on solar power panels are mainly for installation and maintenance. Solar power is extremely safe when you compare it to most other forms of energy. It only calls for a couple of precautions and a small amount of know-how to keep the project functioning correctly with no chance of danger to you or anyone else.

How to Add Solar Panels to an Existing Solar System

If you already have an existing solar panel system to provide energy at home, then providing extra power is a task which is easily accomplished. This can be achieved by the process of adding more solar panels to the roof and connecting it up to the existing solar panel system.

In other words you can start by setting up a small solar power panel and then later upgrade the system by adding more solar panels at a later date. However there are certain guidelines to be followed while adding more solar panels to an existing solar system.

You should first of all ensure that you have sufficient space on the roof to add more solar panels. It is important that all the panels receive the same amount of sunlight when they are connected to the same inverter.

The solar panels that are added on to the existing solar power system should be compatible with it.

As far as possible, the new panels should be of the same type and voltage of the panels that are already installed. In case this is not the case, there will be the

need to install a Maximum Power Point Tracker (MPPT) solar controller which would help to draw different amounts of current from the solar panel array.

This system would help to continuously adjust the current so as to obtain the maximum current that is available.

If the inverter does not have the capacity to cope with the extra power load, then it needs to be changed to a more powerful one. A small inverter would lead to a loss of energy while a large inverter would be under-utilized and may not perform to its optimum efficiency.

The best situation is to have an inverter that would function up to a maximum of 80% power rating of the Photovoltaic's system as these systems do not generally perform at 100% capacity.

When the new panels are wired care must be taken to ensure that the panels are wired positive to positive and negative to negative charges. This is called parallel wiring. Though it does not change the voltage it increases the current capacity.

The new photovoltaic modules must have similar type and the same number of cells in the same series.

Safety Precautions

When working with solar panels you need to consider some safety precautions:

- Exercise caution when wiring or handling modules exposed to sunlight.

- When disconnecting wires connected to a photovoltaic module that is exposed to sunlight, an electric arc may occur. Arcs can cause burns, start fires or otherwise create safety problems. Exercise caution when disconnecting wiring on modules exposed to sunlight.

- Photovoltaic solar modules convert light energy to direct-current electrical energy, and are designed for outdoor use. Proper design of support structures is the responsibility of the system designer and installer. Modules may be ground mounted, pole mounted, or mounted on rooftops.

- Do not use mirrors or other hardware to artificially concentrate sunlight on the module.

- When installing modules, observe all applicable local, regional and national codes and regulations. Obtain a building and/or electrical permit where required.

- Only connect modules with the same rated output current in series. If modules are connected in series, the total voltage is equal to the sum of the individual module voltages.

- Only connect modules or series combinations of modules with the same voltage in parallel. If modules are connected in parallel, the total current is equal to the sum of individual module or series combination currents.

- Keep children well away from the system while transporting and installing mechanical and electrical components.

- Do not wear metallic rings, watchbands, ear, nose, or lip rings or other metallic devices while installing or troubleshooting photovoltaic systems. Use appropriate safety equipment (insulated tools, insulating gloves, etc) approved for use on electrical installations.

- Observe the instructions and safety precautions for all other components used in the system, including wiring and cables, connectors, DC-breakers, mounting hardware, inverters, etc.

- Use only equipment, connectors, wiring and mounting hardware suitable for use in a photovoltaic system.

- Always use the same type of module within a particular photovoltaic system. Under normal operating conditions, PV modules will produce currents and voltages that are different than those listed in the date sheet. Data sheet values are applicable at standard test data. Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions.

- Drainage holes must not be covered with parts of the mounting system. The junction box has a breather port which must be mounted facing downward and cannot be exposed to the rain. The junction box should be on the higher side of the module when it is mounted in order to orient the breather port correctly.

- Do not lift the module by grasping the module's junction box or electrical leads.

- Do not stand or step on module.

- Do not drop the module or allow objects to fall on the module.

- Do not place any heavy objects on the module. Inappropriate transport and installation may damage the module glass or frame.

- Select a suitable location for installation of the module. For optimum performance, the module must be facing true south in northern latitudes and true north in southern latitudes. For detailed information on optimal module orientation, refer to standard solar photovoltaic installation guides or a reputable solar installer or systems integrator.

- The module should not be shaded at any time of the day.

- Do not install the module near equipment or in locations where flammable gases can be generated or collected.

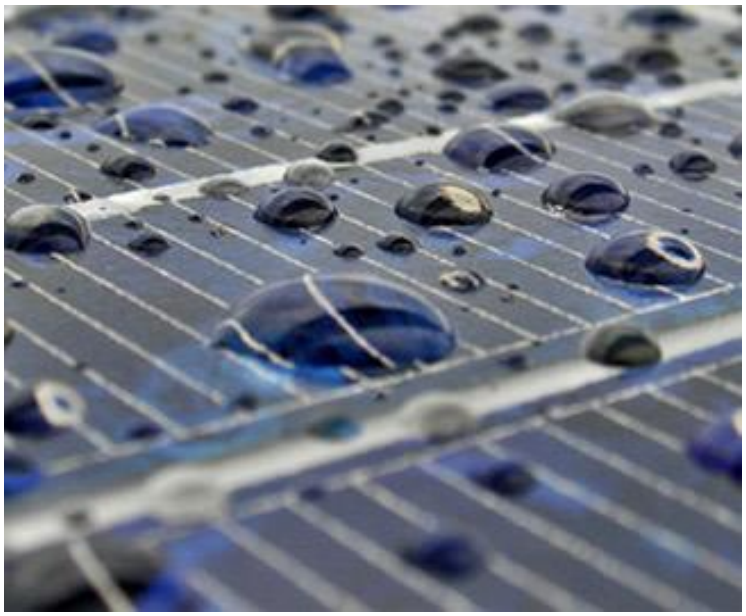
- Clean the glass surface of the module as necessary. Use water and a soft sponge or cloth for cleaning. A mild, non-abrasive cleaning agent can be used if necessary. Do not use dishwasher detergent.

- Electrical and mechanical connections should be checked periodically by qualified personnel to verify that they are clean, secure and undamaged.

- Problems should only be investigated by qualified personnel.

- Observe the maintenance instructions for all other components used in the system.

- Artificially concentrated sunlight shall not be directed on the module.



Interesting Facts about Solar Energy

There are lots of interesting facts about solar energy. Educating yourself about this will prove to be beneficial in the long run. You can share the information to your loved ones. You can teach them of ways on how they can help to conserve the energy. You can also do your share to help this method to advance if you are a genius in the field.

But if you are an ordinary citizen who only wants to enjoy, then feast on. But remember that you also have responsibilities to the environment that you must accomplish in order to do your part in the whole scheme of things.

1. Solar radiation makes it possible for the energy coming from the sun to be used as power source and energy that can in turn be used for many purposes. The technology on this aspect is characterized in two ways. They can either be

passive or active. This will depend on the methods that are used to get, convert and allocate sunlight.

What are active solar techniques? These utilize pumps, photovoltaic panels and fans to renovate sunlight into useful resources. These aim to increase the energy supply that is why these can also be referred as supply side technologies.

The passive solar techniques, on the other hand, use only selected resources with constructive thermal properties, utilize the kind of spaces that can circulate air naturally and apply the position of buildings and structures towards the sun. These will lessen the need for other sources and can also be referred as the demand side technology.

2. Solar energy has influenced many factors that surround people. This can be referred in planning and designing buildings. This process can be rooted back at the early days of the architectural history. The Greeks and the Chinese first used such factor in building and constructing their architectural pieces and on their planning methods.

3. Solar energy is also being utilized by the agricultural sector because they rely heavily on its benefits in order to gain more harvest. They developed ways in order to plant the kind of crops that will grow according to the amount of sun that they will be getting for the season. This can also be used to dry the crops, pump water, brooding of chicks and to dry animal manures that can later be used as fertilizers.

4. On seasons like the Little Ice Age, fruit walls were used by French and Chinese farmers to be able to collect and store solar energy to help them keep the plants warm and to speedy up the process of ripening of fruits.
These walls serve as the thermal masses. The fruit walls that were first developed were perpendicular to the ground and faced the south direction. Over time, innovations were done and slopping walls were used to gain more advantage from the sun.

5. To convert the solar light into heat, people have developed greenhouses. These enable the production and cultivation of specialty crops all year round. Such innovation made it possible for crops to be produced in untimely seasons and in places where you think that those plants won’t grow.

And these are only some of the interesting facts about solar energy. These give you a good peek at how wonderful nature is and how people have developed ways to use it to advance in many aspects of their lives.

The benefits of solar energy

We all know that using solar energy is a good thing to do. We have heard, and there are quite a number of them, all about the benefits of solar energy and we can't agree why we can't turn this alternative form of energy source to a primary one. But despite the advantages, solar power has yet to fully make it in the mainstream. Let's go back and discuss a couple of the advantages of solar energy and see why keep going back to fossil fuels for energy resource.

In the long run, solar power saves money. Initial costs of installation and operations may be more expensive that other energy forms but after settling the expenses, you have an energy resource that is free. Nobody charges for using sunlight, right?

The return of investment can also be shorter depending on how much energy you use. You won't spend too much on maintenance either plus those photovoltaic cells can last for 15 to 20 years. There are no mechanical or moving parts to oil and maintain nor are there parts that need to be replaced yearly.

Of course solar power is environmental friendly. First its renewable not like fossil fuels which according to studies will be gone in four to five decades. The process of converting energy to usable electricity does not involve the release of toxic chemicals which can harm the environment. Carbon dioxide, nitrogen oxide, sulphur dioxide, lead, and mercury emissions will.

The alternative energy home

As people become more aware of the environmental changes occurring today and watch as energy prices soar to new level, they are learning to build homes that are free from the costs of a fossil fuel driven world. “Off-grid” living is becoming more popular in new home construction and home renovations as well.

The benefits of creating a renewable energy home or business should be obvious, but just the idea of spending less on electricity peaks most people’s interest in such a change. Building a renewable energy lifestyle has far more rewards, like the reduced consumption of fossil fuels and the reduction in carbon footprints and environmental impacts.

Many home and business owners are actually increasing the value of their properties by converting to renewable energy sources to supply their electricity needs. Buyers are looking for more ways to save money and mortgage lenders and government agencies are adding incentives and tax breaks for energy efficient upgrades.

The opportunities for using different types of renewable energy vary depending on location, but almost every residence has the ability to utilize one form of alternative energy whether it is the sun, wind or some form of moving water. Most homes that are completely self-sufficient run off multiple alternative power sources.

It is also important to remember that reducing your dependency is just as honorable as eliminating it. In many instances, even a combination of renewable energy resources is not enough to maintain a home or business’ power consumption. Doing what you can is better than doing nothing at all.

The cost of going completely “off-grid” can be close to $100,000. This is a huge investment that may take generations to realize a return on your investment. Making alternative upgrades does however increase the value of your home and this should be considered when deciding to go completely energy independent. If you are interested in learning more about self-sustaining homes or to see if it is the right option for you, we are providing a list of resources that will help you learn more and make an educated decision.

Large scale renewable energy

Environmental change has historically started with the people and the changes we see necessary in our culture today are much the same. They will come from the bottom up. Unfortunately, it is not likely that we will see the environmental impact of this change until large corporations and governments become involved.

Realistically, our alternative energy systems still need to advance in their technology and the only way to get the funding for this to happen is with big business and government involvement. Until they are on board 100% to break free of our fossil fuel dependence, the cost of the most efficient of these technologies will remain out of the reach of the average household.

That is one of the reasons we have created this resource. Although you may not be able to afford the very best technology, you can still build your own systems and show our "leaders" that we won't wait for them to destroy our planet.

This is not to say that our government is not doing anything. In recent years, we have seen millions of dollars spent on the research of ethanol fuels derived from corn, tax rebates for energy efficient home upgrades and hybrid vehicle purchases. There are even government incentives now in place to encourage big businesses to invest in renewable energy sources. When you look at the big picture and what other spending takes place, the attention needs to become more focused on renewable energy.

The cost of energy affects the cost of everything. Our food, our clothes, the cost of transportation, is all affected by the cost of fuel and energy. It is not just a problem for individuals; it is a problem for the world as a whole.
As we said previously, this kind of movement builds from the bottom up. The public has focused more of their attention on large energy industries and many of these big corporations are taking steps to develop more environmentally responsible practices.

Large-scale wind farms are popping up in more states across the country.
Energy efficient appliances are replacing older models on store shelves.
Each of these small changes is having an impact. We have to be patient and wait for it to grow to a global level.
Taking responsibility for your own energy needs is the best start for a world of change. The people are the leaders and we need to show the government and big business just how important renewable resources, our planet and renewable energy are to us.

Solar Panels Really Increase Home Resale Value

To increase property value and make a home more appealing to potential buyers, many homeowners immediately assume they should invest in some trendy remodeling projects. Most homeowners think renovations to their kitchens or bathrooms will do the trick.

Others think making additions to their homes (i.e. a new deck, room, or pool) will increase the likelihood that their home will sell faster. However, many of these pricey home improvements do not get homeowners much return on their investment. They also may not get a home to sell any faster.

Adding solar panels is one of the only home improvements that continues to become more profitable over time, according to solar experts. Updates to your kitchen can become outdated over the years. And making additions like adding a pool actually yield very little return on investment because of long-term maintenance issues.

Many sources and studies have continuously found that adding solar panels to a home increases its property value. They have also found that solar powered homes sell much faster and for substantially more money.

Arizona solar energy experts state that home buyers highly desire solar powered homes because they enjoy the idea of living in a home that will save them money.

Solar authorities state that homes with solar panels have long-term fixed energy rates. The energy rates are locked in for approximately 25 years. This means that the homeowners save more and more money on their electric bills over time. It's simple math.

The nation's energy rates have been steadily increasing by about 6 to 7 percent annually. So your energy rates are fixed while homes without solar panels are continually subjected to constantly increasing energy rates. This means that every year you save more and more money.

The U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy released information stating that homes with solar panels sell twice as fast.

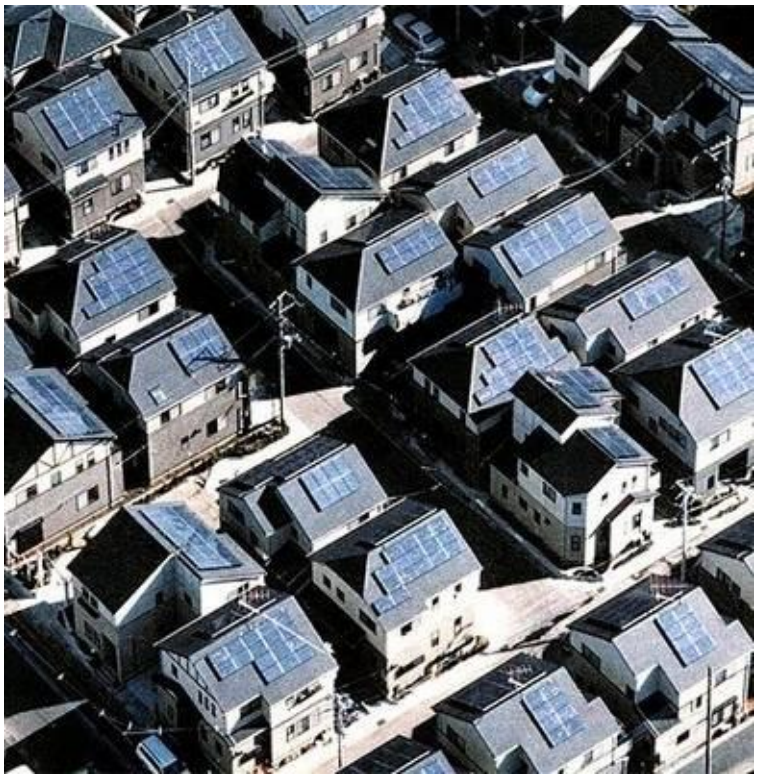
Solar experts believe again that this is because, today more than ever, home buyers are seeking out green homes. Solar panels are attractive to home buyers because they will also have increased property values and energy bill savings as time passes.

The U.S. Department of Housing and Urban Development stated that solar powered homes sell much faster than the average home because "they make your house more affordable to more people" and they "attract attention in a comparative market."

Solar officials also say that energy efficient homes are attractive to home buyers because it gives them more borrowing power. They can potentially get an Energy Efficient Mortgage for up to $20,000 more than on an average home.

Lastly, McGraw Hill actually conducted a study which showed that home buyers have been buying green homes for approximately $18,000 more than average homes. This is a lot of incentive for homeowners who would otherwise invest in pricey home remodeling projects. With a green home you can potentially have more money in your pocket.

Solar power of the future

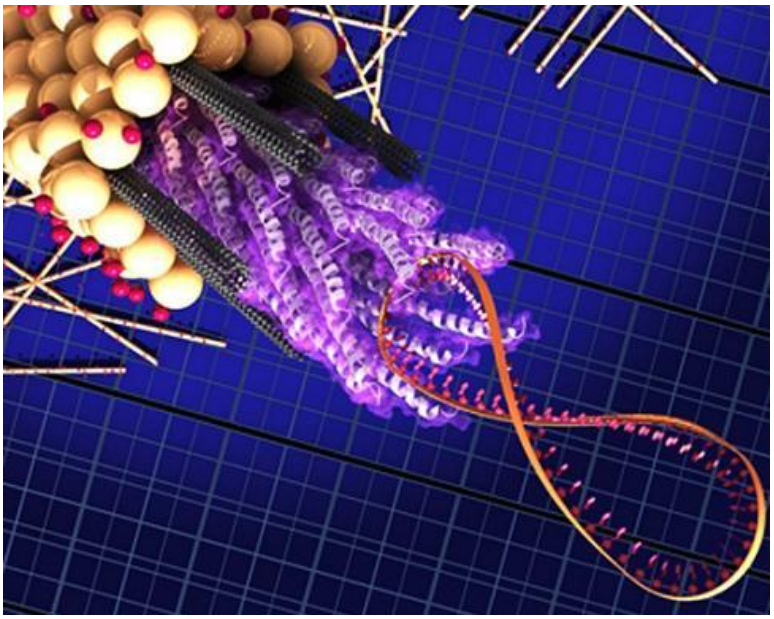


Of all the sources of renewable energy available to mankind in its pursuit of a sustainable future, solar power is a pivotal one. Plentiful, free and absolutely clean, the main challenge to fully tap its huge potential is to harness and distribute it. We have made considerable progress with solar power, but future uses of solar energy will be spawned by innovations still to come.

The technology of trapping the Sun's energy by using solar cells has been around for some time. Each solar cell has the capability to produce just a small amount of energy; hence the cells are usually arranged in a large area on rooftops to get the required amount of energy.

Unfortunately, space limitations mean that some houses cannot get the required power because there is insufficient space for the necessary solar cells. It is therefore great news to hear that scientists have discovered a new technology of concentrating more solar energy in a relatively small space.

The chemical engineers at MIT are using carbon nanotubes to concentrate solar energy as much as 100 times more so than it is possible to achieve with regular photovoltaic cells. The carbon nanotubes are hollow carbon atom tubes that can be used as antennas that concentrate light energy, effectively creating more powerful yet relatively smaller solar arrays.



These antennas can be used to focus the concentrated energy on photovoltaic cells, which means that you will not need to cover your entire roof with photovoltaic cells to get enough energy. Basically, solar panels convert photons into electric current. The nanotube antenna concentrates more photons that can be directed to the solar panels, enabling the generation of more current.

The researchers refer to the antenna as ‘solar funnel’. These ‘funnels’ can be used in various places where a concentration of light is required, such as in night-vision goggles.

The nanotube antenna funnel is made of a fibrous rope that is just 10 micrometers long and 4 micrometers thick, which contains around 30 million carbon nanotubes. The team of researchers made a fiber with two nanotube layers, each having different electrical properties – bandgaps.

Electrons can be found at different energy levels in any material. A photon striking a surface excites electron to higher level of energy. The energy level difference between the electron and the hole it leaves behind is called bandgap.

The inner layer of the antenna has lower bandgap while the outer layer has a higher bandgap. The researchers have not used the antenna to develop a photovoltaic cell but they intend to. In such a device, the ‘solar funnel’ would focus the photons before solar cells convert them to electricity.

Such devices would create a better alternative to the conventional solar panels. They will be cheaper because the prices of nanotubes are getting lower.

Lasers – the future of solar cells

Solar panels have long been flat and solid, limiting their placement and usage over the years. But thin-film solar cells are rapidly gaining ground in the market, as the flexible cells can be used as rooftop shingles and tiles, building facades, or glazing on skylights.

The problem with thin film so far has been manufacturing costs and efficiency, both of which are the direct result of the "microchannels" in solar cells. The microchannels, which interconnect solar panels with one another to generate usable amounts of electricity, have traditionally been created using a mechanical stylus – a slow process that often creates imperfect, inefficient cells.

Production costs of solar cells have been greatly reduced by making them out of thin films instead of wafers, but it is difficult to create high-quality microchannels in these thin films.

The mechanical scribing methods in commercial use do not create high-quality, well-defined channels. Although laser scribing has been studied extensively, until now we haven't been able to precisely control lasers to accurately create the microchannels to the exacting specifications required.

But the ultrashort pulse laser and its "cold ablation" process has overcome that boundary. The laser uses pulses that only last a quadrillionth of a second, creating precise microchannels very quickly without causing enough heat to damage the film.

It creates very clean microchannels on the surface of each layer. You can do this at very high speed, meters per second, which is not possible with a mechanical scribe. This is very tricky because the laser must be precisely controlled so that it penetrates only one layer of the thin film at a time, and the layers are extremely thin. You can do that with this kind of laser because you have a very precise control of the depth, to about 10 to 20 nanometers.

The efficiency of solar cells depends largely on how accurate your scribing of microchannels is. If they are made as accurately as possibly, efficiency goes up.

Thin-film solar cells account for about 20 per cent of watts generated in the photovoltaic market globally and are expected to account for 31 per cent by 2013. Though, that number may rise quickly once the pulse-laser technique is refined and commercialized over the course of their study.

At present, solar power is used in three main ways, that is, to heat air, water and space. Photovoltaic cells are also one of the most popular forms whereby sun energy is converted into power.

According to the U.S. Department of Energy's Energy Efficiency and Renewable Energy arm, there will be more breakthroughs in new materials, cell designs, and novel approaches to product development in photovoltaic research and development.

Future uses of solar energy could include our mode of transportation and even clothing, which will be equipped to produce clean, safe electric power.

The department believes that in the future, use of solar energy will be ubiquitous because concentrating solar power will be fully competitive with conventional power-generating technologies within a decade.

"Concentrating solar power, or solar thermal electricity, could harness enough of the sun's energy to provide large-scale, domestically secure, and environmentally friendly electricity, especially in the southwestern United States", it says. In theory, the electricity needs of the United States could be met by a photovoltaic array within an area 100 miles on a side.

Those researching future uses of solar energy are also looking at the ocean for clues. That is because the ocean is a natural reservoir of solar power. Therefore it could be used as a source for thermal energy. The challenge is to devise a way to extract warm water from the surface and cold water from the depths so that an ocean thermal plant could operate 24 hours a day.

According to ENTER SOURCE, George Claude tested this hypothesis as early as 1930 in Cuba. Cold water from the pipe and warm water from the surface were pumped into a plant on shore. It produced 22KW when the water temperatures were optimum and 12KW when seasonal current fluctuation reduced the efficiency.

George Claude tested this hypothesis as early as 1930 in Cuba. Cold water from the pipe and warm water from the surface were pumped into a plant on shore. It produced 22KW when the water temperatures were optimum and 12KW when seasonal current fluctuation reduced the efficiency.

Another exciting possibility in terms of future uses of solar energy is that it will be used in an electrolysis process that separates the hydrogen and oxygen in water so the hydrogen can be used in fuel cells for transportation and in buildings. That would be a true double-whammy for the two of the cleanest types of renewable energy.

Final thoughts

The current energy and environmental situations of the world may not look promising, but we hope that the information provided in this book has given you the view of change and how you can start to make it happen.

Global change will have to start with the people and thanks to individuals like you; more people are starting to realize the value of alternative energy sources in their everyday lives. Imagine your homemade solar or wind energy system attracting attention locally and more of your neighbors and friends taking the same action. This is how change starts.

Save your own valuable resource of money by being smart and conservative with your energy usage. Turning off lights and electronics today will give you the money to replace your bulbs with compact fluorescents, which will give you the money to start building up parts for your own alternative energy system and that in turn will help you save the money for more energy efficient appliances and so on down the line. In the end, you are going to save more money and waste less energy, helping the world and your wallet.

Don't forget to take the bus, carpool or ride a bike if possible. What you save in gas during that time can be used as a down payment on a hybrid, water or electric powered car. Global change is not going to happen without an effort from you and many others like you.

It is important to remember that you are not alone. This book and information about solar and wind alternatives is available worldwide. People the world over are starting to see the effects of our neglected planet, the world's environment and understanding the importance of the problems we are all facing. The people are taking action and governments and big business will have no choice but to follow.

Let our current energy crisis be the catalyst for change, but more importantly, you now have the tools to be the catalyst for change as well. Future generations will look back on this time and thank our generation.

Change is coming. Thank you for reading, learning and becoming part of the change.