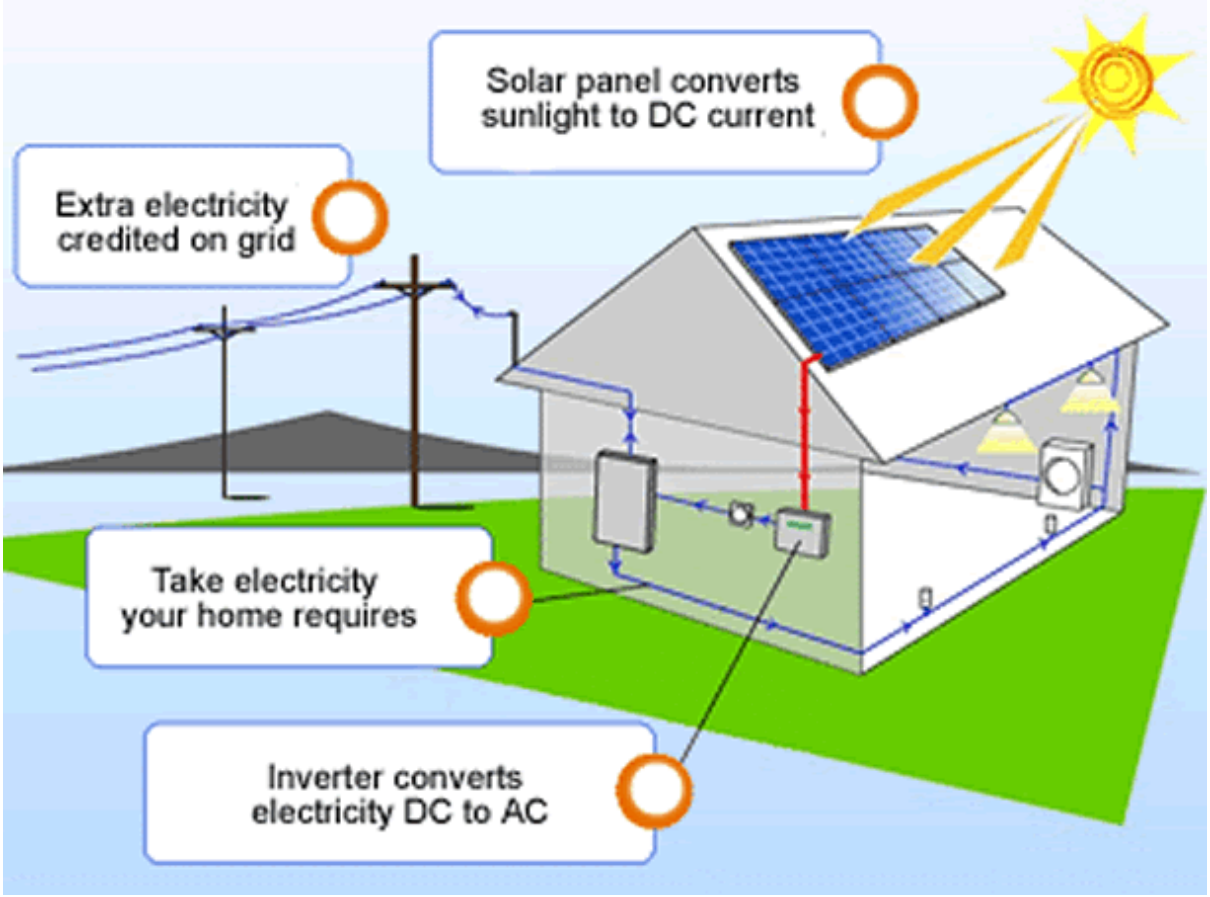
Solar Power for Home and Office Use



The definition of solar energy is simple: solar energy is the energy emitted from the sun. Most people understand that the sun gives life to all things on this planet through its energy, seen as light and felt as heat, but the sun also produces many other things. The source of solar energy is the nuclear reaction in the center of the sun, continuing for billions of years. Photons are created through the fusion of two Hydrogen atoms to form one Helium atom in the sun's core. They will eventually be what generates solar power, but not until they are able to escape from the sun.

It generally takes a photon over a million years to escape from the center of the sun to the sun’s surface. Once at the surface, the photons are sent hurtling out into space in all directions, and some of them are intercepted by the Earth.

Solar Panels and Sun's Energy

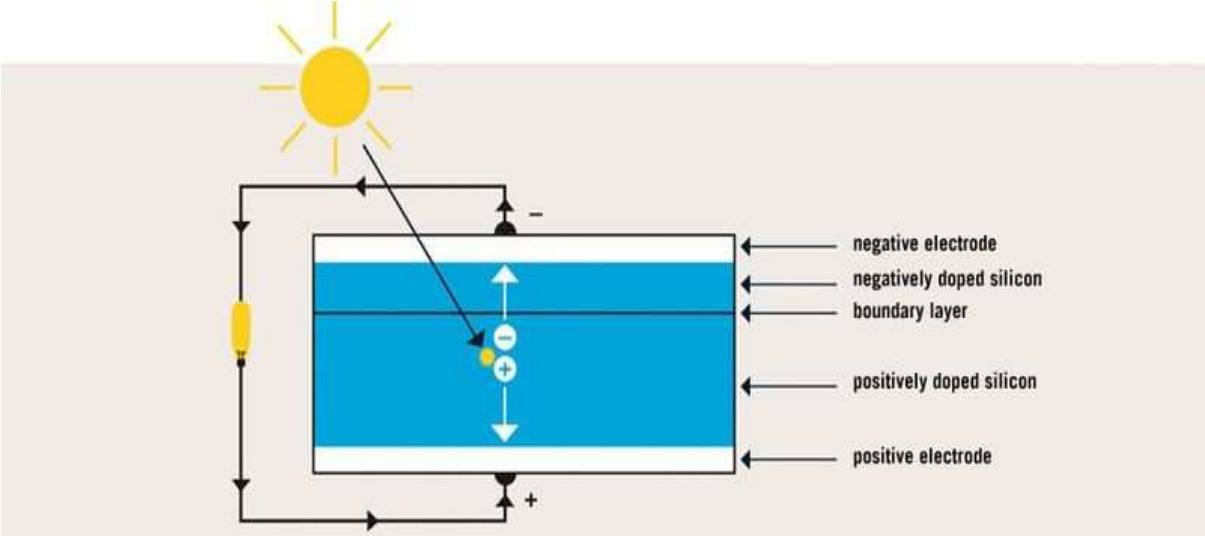
The basic explanation is that solar panels use a network of Photo-Voltaic (PV) cells to capture the sun's energy, which is then converted to electricity and used to power pretty much anything you want. However, that doesn't really explain the science behind the panels or what all these terms mean. Firstly, let's look at just what PV cells are. Photovoltaic (from 'photo' meaning light and 'voltaic' meaning electricity) cells are manufactured from layers of semi-conducting material, usually silicon – this is because striped down silicon is ideal for the transmission of electrons, which is essentially how solar panels operate.

Sunlight contains photons which are absorbed by the silicon, or other semiconducting material, when they hit the solar panel. The electrons in the silicon's atoms are then displaced and a number are released, allowing electric fields in the cells to pull the free electrons into a current. The metal contacts on the top and bottom of the PV cell are then able to channel these electrons to a load, generating electricity. That's the science bit but there's more to a successfully functioning solar panel than that.

Silicon is a particularly shiny material, which would ordinarily reflect the photons rather than absorb them. An anti-reflective coating is therefore applied to the surface to encourage as much absorption as possible – the more photons, the more electricity can be generated. This is also why the panels themselves are generally installed on a roof, preferably south sloping in the northern hemisphere and north sloping in the southern hemisphere.

Solar panels could very well be the future of energy for the globe. Every household and business utilizing the free, inexhaustible and green energy from the sun for their power needs is a dream shared by many. The technology is there, it just needs to be developed to increase its efficiency and to bring down costs, something which is happening in labs across the world right now.

How Does Silicon Produce Energy?



Silicon is the **most common conductor** used in PV cells nowadays, for several reasons. The main reasons lie in the extremely low price of silicon and the fact that it's widely available worldwide. However, pure silicon is not an excellent conductor due to its crystalline structure. A silicon atom has 14 electrons in three different layers (or shells), with 2 electrons in the first, 8 in the second, and 4 in the third layer. This third layer is only half full and the atoms always seek to fill up their layers with electrons by sharing them with other atoms around them.

However, because of the even number of electrons, each silicon atom will have a full share, which leaves less room for free electrons to go. When energy is added to silicon, some of these electrons break free and look for holes left by other free electrons.

This movement of electrons is what actually generates electricity. The photons strike the PV cell and ideally, each photon will knock one electron free and send it searching for a hole to fill, thus conducting electricity. Because silicon has an even number of electrons, all modern solar cells use impure silicon as a way to free up extra electrons to conduct energy better.

All solar companies have a patented crystalline structure that they use in their own panels, and these are made by adding other atoms into the silicon, although usually only a few parts per million. The two main types of atoms that are added to silicon to form solar cells are usually phosphorous and boron**.**

Solar Inverters

Most all appliances and electronics use alternating current or AC power, which differs from the direct current or DC power that is generated by solar panels. In order to transform this DC power into AC power, it is necessary to have a solar power inverter connected to your solar panels. This inverter allows the energy generated to be consumed, fed back into the grid, or used to charge a battery depending on what type of solar Inverter, energy-generating unit you use.

Features You Need In A Solar Inverter

Maximum Power Point Tracking (MPPT)

Maximum Power Point Tracking is an electronic control system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are potentially capable of. Because of this feature, the inverter acts as the "brains" of a solar electric system. PV cells have a single operating point where the values of the current (I) and Voltage (V) of the cell result in a maximum power output, under a certain solar irradiation level. MPPT is capable of changing the impedance experienced by the solar PV array to match the ideal voltage for the particular solar irradiation level. When the sun shine increase, the impedance is changed again, to move the voltage to the new maximum power point. MPP trackers utilize control circuits or logic to search for this point to maximize electricity production.

Types of Solar Power Inverters

There are three distinct types of solar energy inverters, each of which serve a different function and are used for a different type of solar energy system, although each inverter still converts DC into AC:

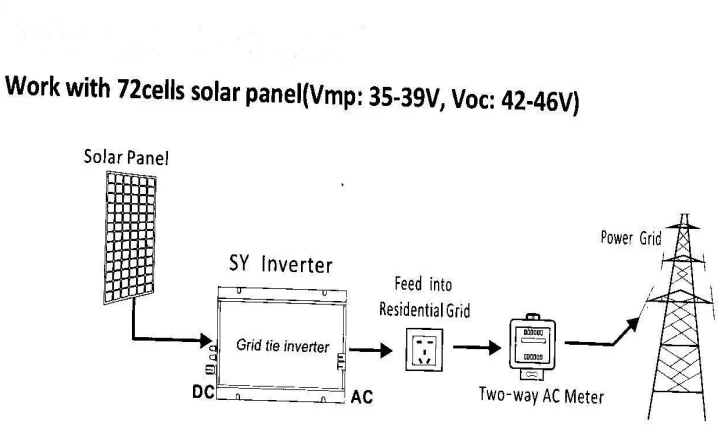
- Stand Alone Inverters
- Grid tie Inverters
- Dual Inverters

Stand alone inverters are used for off-grid solar arrays and independent of the utility power grid. In off-grid arrays, the solar panels generate direct current energy which is then connected to a Charge Controller to charge a set of batteries and stored in those rechargeable batteries. When energy is required, the direct current is sent from the battery to the stand alone inverter and then converted into alternating

current which can then be used to power a home or for any other electricity needs. These inverters are necessary for locations where no local power grid is available, or for anyone who wishes to remain completely independent of energy companies. It must be kept in mind that these systems are very expensive option compared to the grid served electricity, and comes up with a significant maintenance burden from the battery bank. With a stand-alone system, you will be unaffected by power outages because your system will be completely independent from the power grid. You will be free to consume electricity whenever you wish, provided your batteries are charged or your solar array is currently producing electricity.

If you wish to run any large appliances or equipment off your stand-alone solar system, then it is necessary that you purchase a **surge compliant inverter**. These inverters are also necessary for most any residential or commercial off-grid solar application.

Grid tie inverters are for use in any situation where your solar array is connected directly to your local power grid. These systems, known as **grid tie solar systems**, are more common in urban areas and are much cheaper than stand alone or off-grid systems because of the lack of need for a battery. In grid tie solar systems, direct current is generated by the solar panels, which then send to the grid tie inverter. This energy is then converted into 240 volt alternating current by the inverter, and finally sent directly into the local power grid. If this system is generating more power than the house can use, the excess is sent out over the grid thus ensuring that you receive credit from the power company.



If the house needs more power than the power of Grid Tie Inverter system, then the extra is drawn from the grid as usual. Grid tied systems only work when the grid is up. If the grid power goes out, the grid tie inverter is required to shut down immediately. Sri Lanka is among the first few nations in the region to introduce this system, known as the net metering scheme. Launched in June 2010, the scheme

has now accumulated few megawatts of systems all over the urban areas of the country.

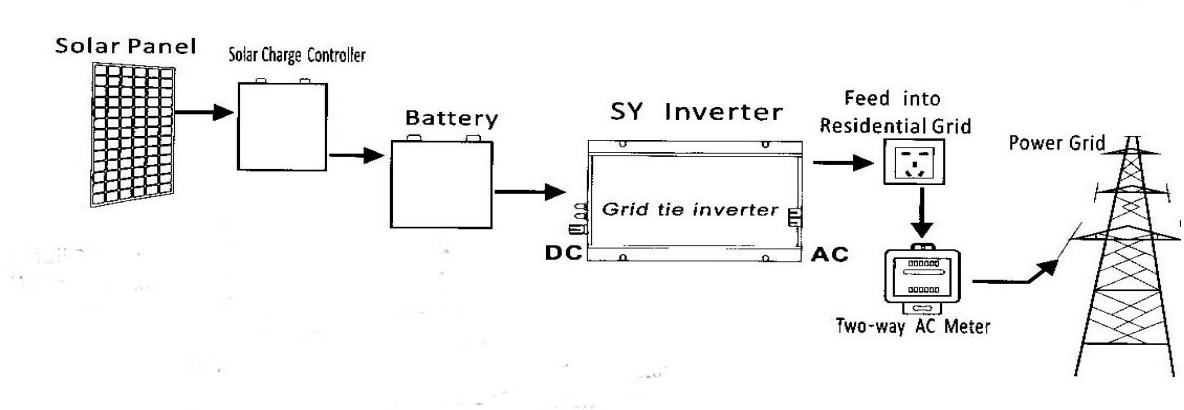
All grid tie systems are required to have a solar energy inverter with **anti-islanding protection** which forces them to shut down in case of power outages. Without anti-islanding protection, your solar system would continue to generate electricity and send small amounts back into the electric grid during power outages. This energy would stay in the local power grid and is referred to as an island. These islands can be extremely dangerous for utility workers who are trying to repair the gird during a power outage. This safety feature known as anti-islanding protection, is governed by UL 1741 and IEEE 1547 standards since 1999.

Please Note:

Before purchasing a grid tie solar power inverter - always make sure to check that the inverter is compliant with the net metering standard of the country, which is included in the distribution grid code of Sri Lanka. This standard ensures that it has anti-islanding protection, and many other grid friendly features and it is **illegal** and can be extremely dangerous to install a grid tie system without the necessary compliance. You probably won't find any grid tie inverters on the market without it, but checking to make sure is still a great way to ensure you are purchasing the correct inverter for your particular solar system.

Grid-Tied with Batteries:

A grid tied with batteries system is kind of a mix of the two systems. It basically operates like a grid tied system when the grid is up, but it also charges a set of batteries. If the grid goes down, the inverter disconnects from the grid (to protect line workers), but it continues to supply power to the house from the batteries and inverter essentially behaving like an off-grid system when the grid is down.



Design your solar power system

How to Select the Right Inverter for your House

Selecting the right inverter for your home has become a tough task these days. There are so many terms we need to understand. Power or the installed capacity of the inverter measured in Watts and the amount of electricity produced by the system during a particular period, measured in kilo Watt hours. So I did some research and study before buying an inverter for my home and I'm sharing the details of same so that you don't have to go through the same problems while buying an inverter.

What Capacity of Inverter is Good for Your Home?

Once you are sure that you are looking for an Inverter, it's important to calculate the capacity of Inverter that will suit your requirement. It is entirely depended on your monthly electricity use, given in kWh or units. As a rule of thumb, a location in Colombo will have solar irradiation which can give you 120kWh of electricity in a month, with an installed system capacity of 1,000 Watts or $1kW_p$. Following table will give you brief idea about the power consumed by various equipments, but it is advisable to refer to your past bills to know the annual variations of electricity use.

10 Liights (Each 10watts)	= 100W x operating for 4 hours/day = 0.4kWh
2 Fans (75w each)	= 150W x operating for 8 hours/day = 1.2kWh
Television = 100W	= 100W x operating for 4 hours/day = 0.4kWh
Fridge = 250W	= 250W x operating for 16 hours*/day = 4kWh

*effective compressor 'ON' hours

Total electricity use per day = 6kWh/day – 180kWh/month. Using the rule of thumb of $120kWh/kW_p$ the ideal size for the inverter will be $180/120\ kW_p$ or $1.5kW_p$.

Eliminating Your Electric Bill

By installing solar Systems in your home or Office, you can save a large amount of money on your electric bill, or possible even eliminate your electric bill altogether. It is an investment decision, which is depended on complex interplay of many factors. The sizing tool developed by the Sri Lanka Sustainable Energy Authority will take this burden off your shoulder. Please follow the link; http://www.energy.gov.lk/sub_pgs/events.html for a firsthand experience. The tool can be found in the 'Events' page of the website, and is titled ***'Do you want a net***

metered solar system in your home?' and is based on a simple spreadsheet application. Make sure you enable 'macros' in the spreadsheet, before you start on your solar PV system sizing problem.

Maintenance Free Energy Production

Once installed, solar panels require almost no maintenance, and because the energy is being produced directly from the sun's rays, they also require no additional costs to keep them functioning. A properly installed solar panel can last for about two decades without the need for expensive repairs, albeit the loss of efficiency by around 15% at the end of the two decades. However, inverter life, especially in lightning prone areas could be a serious matter for consideration.

E N D

If mankind truly wants to step into the future, it will be necessary to use the free, clean forms of energy that nature provides us. The increased research and funding of solar power is starting to make a pollution free future a real and tangible goal. By switching to solar powered devices and products even you, can play a small but crucial role in helping to make this future a reality for future generations. We will help you take your first steps along the way !

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