Some reasons for solar power

The First is TO SAVE THE EARTH by reducing carbon emissions which will greatly affect yours and your next generations' life quality.

With a solar power system on your roof you replace other energy sources such as gas, coal or uranium and thereby reduces ecological damage by eliminating CO_2 emissions. Every kilowatt hour generated by solar energy means a reduction in pollutants.

Please do also take into consideration also all of the emissions which are incurred along the way, ranging from extracting the raw material to burning the fossil fuels in furnaces. Among the polluters contributing to such emissions can be counted crude oil vessels used for the transport, refineries for processing the oil, road tankers for transporting heating oil to consumers and any material related emissions which are incurred during the production of the different conversion systems.

Solar energy is infinitely renewable: The sun is guaranteed to be available as the largest and most reliable source of clean and free of cost energy for some billions of years to come. Solar energy is used directly on location. There are no transport costs and no appreciable conduction losses.

There are two types of systems:

1. Solar Photo Voltaic Systems
2. Solar Thermal System

SOLAR PHOTO VOLTAIC SYSTEMS

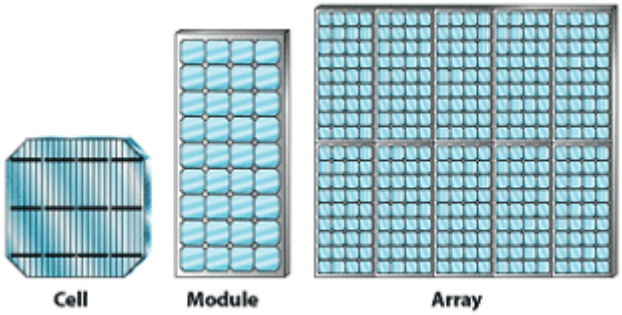
Solar cells, also called photovoltaic (PV) cells by scientists, convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the*PV effect*. The PV effect was discovered in 1954, when scientists at Bell Telephone discovered that silicon (an element found in sand) created an electric charge when exposed to sunlight. Soon solar cells were being used to power space satellites and smaller items like calculators and watches. Today, thousands of people power their homes and businesses with individual solar PV systems. Utility companies are also using PV technology for large power stations. Solar panels used to power homes and businesses are typically made from solar cells combined into modules that hold about 40 cells. A typical home will use about 10 to 20 solar panels to power the home. The panels are mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight. Many solar panels combined together to create one system is called a solar array. For large electric utility or industrial

applications, hundreds of solar arrays are interconnected to form a large utility-scale PV system.

Traditional solar cells are made from silicon, are usually flat-plate, and generally are the most efficient. Second-generation solar cells are called thin-film solar cells because they are made from amorphous silicon or nonsilicon materials such as cadmium telluride. Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Because of their flexibility, thin film solar cells can double as rooftop shingles and tiles, building facades, or the glazing for skylights.

Third-generation solar cells are being made from a variety of new materials besides silicon, including solar inks using conventional printing press technologies, solar dyes, and conductive plastics. Some new solar cells use plastic lenses or mirrors to concentrate sunlight onto a very small piece of high efficiency PV material. The PV material is more expensive, but because so little is needed, these systems are becoming cost effective for use by utilities and industry. However, because the lenses must be pointed at the sun, the use of concentrating collectors is limited to the sunniest parts of the country.

(Solar cells are devices that convert sunlight directly into electricity. Solar cells are made of layers of semiconductor materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity.)



Solar cells are generally very small, and each one may only be capable of generating a few watts of electricity. They are typically combined into modules of about 40 cells; the modules are in turn assembled into PV **arrays** up to several meters on a side. These *flat-plate* PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight. For utility-scale electricity generating applications, hundreds of arrays are interconnected to form a single, large system.

Types of Solar Modules

1. Monocrystalline
2. Poly crystalline
3. Thin film solar (Amorphous)

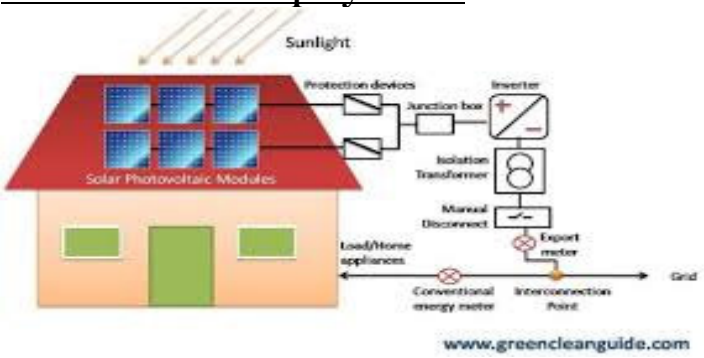
Efficiency of Solar Panels

Solar panel efficiency is the ratio of the electrical output of a solar panel to the energy incident on it in the form of sunlight. In simple words, Solar panel efficiency or conversion rate refers to how much of the incoming solar energy is converted into electrical power. Thus, if 10 kWh equivalent solar system is considered with 20 % efficiency ,sunlight is falling on solar panels will generate 2 kWh of electricity. Typically, the efficiency of commercial solar panels operates in therange11-15%.

Solar PV generates electricity in well over 100 countries and continues to be the fastest growing power-generation technology in the world.

India is endowed with rich solar energy resource. It receives the highest global solar radiation on a horizontal surface. In most part clear sunny weather is experienced 300 days per year. The average intensity of solar radiation received on India is 200 MW/km square

Solar PV Roof Top Systems:



A typical roof top photo voltaic solar system

Requirements:

The shadow-free area required for installation of a rooftop solar PV system is about 10 m2 / 100 sft per kW (kilowatt). This number includes provision for clearances between solar PV array rows. The solar panels may be installed on the roof of the building with a south facing tilt angle from 11 – 13 degrees depending on the latitude of the location. Sufficient area shall be available for servicing the system. The minimum clearance required for cleaning and servicing of the panels is 0.6m from the parapet wall and in between rows of panels. In between the rows of solar panels sufficient gap needs to be provided to avoid the shading of a row by an adjacent row. The solar grid inverter shall be placed indoor in a safe and easily accessible place.

Benefits:

- Lower electricity bills
- Increase the value of your property
- Create new revenue from unused roof space
- Hedge against rising utility rates

- Reduce dependence on foreign oil
- State & Local - Rebates and Tax Incentives
- Extend roof warranty
- Reduce carbon footprint
- Positively affect your community by producing clean energy

Cost and Revenue Generated:

A solar PV plant costs approximately Rs. 1 Lakh per kW with installation without batteries or subsidies, and will last 25 years 1 kW of solar plant generates about 4.5 kWh of electricity per day on average over a year The inverter is the only major component likely to need replacement If you are considering solar to save on your Electricity bills, we recommend evaluating solar only if your residential Electricity Bill tariff is Rs. 5.00/kWh or greater.

Other applications:

Solar PV Parking

Photovoltaic wall at MNACTEC Terrassa in Spain

Solar powered Traffic signal

Trough Systems

• **Trough systems** use large, U-shaped (parabolic) reflectors (focusing mirrors) that have oil-filled pipes running along their center, or focal point, as shown in Figure 1. The mirrored reflectors are tilted toward the sun, and focus sunlight on the pipes to heat the oil inside to as much as 750°F. The hot oil is then used to boil water, which makes steam to run conventional steam turbines and generators.

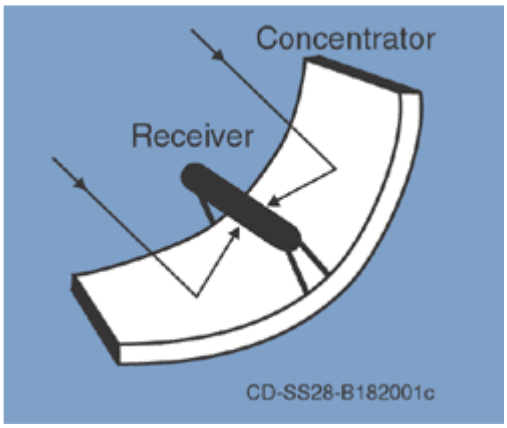


Figure 1: Parabolic Trough System Schematic Diagram

Figure 2: Parabolic trough system.

Power Tower Systems

• **Power tower systems** also called central receivers, use many large, flat heliostats (mirrors) to track the sun and focus its rays onto a receiver. As shown in Figure 3, the receiver sits on top of a tall tower in which concentrated sunlight heats a fluid, such as molten salt, as hot as 1,050°F. The hot fluid can be used immediately to make steam for electricity generation or stored for later use. Molten salt retains heat efficiently, so it can be stored for days before being converted into electricity. That means electricity can be produced during periods of peak need on cloudy days or even several hours after sunset.

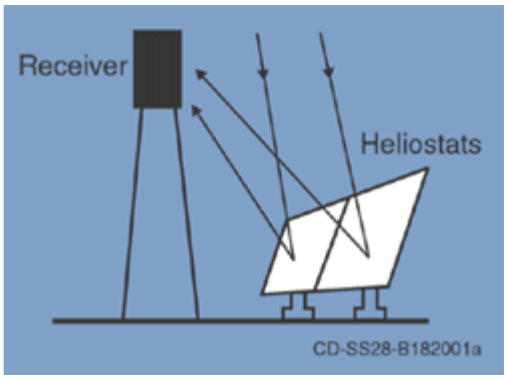


Figure 3: Power Tower Schematic Diagram

Figure 4: Power tower system

Dish Engine Systems

- **Dish/engine systems** use mirrored dishes (about 10 times larger than a backyard satellite dish) to focus and concentrate sunlight onto a receiver. As shown in Figure 5, the receiver is mounted at the focal point of the dish. To capture the maximum amount of solar energy, the dish assembly tracks the sun across the sky. The receiver is integrated into a high-efficiency "external" combustion engine. The engine has thin tubes containing hydrogen or helium gas that run along the outside of the engine's four piston cylinders and open into the cylinders. As concentrated sunlight falls on the receiver, it heats the gas in the tubes to very high temperatures, which causes hot gas to expand inside the cylinders. The expanding gas drives the pistons. The pistons turn a crankshaft, which drives an electric generator. The receiver, engine, and generator comprise a single, integrated assembly mounted at the focus of the mirrored dish.

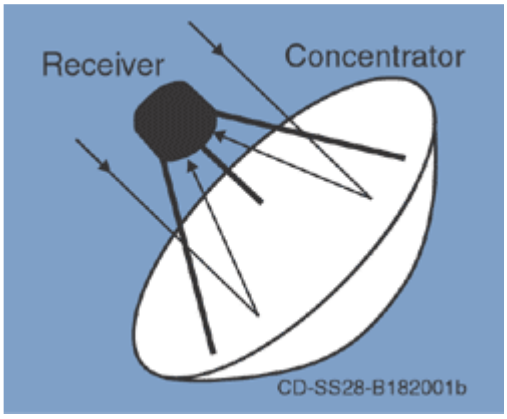
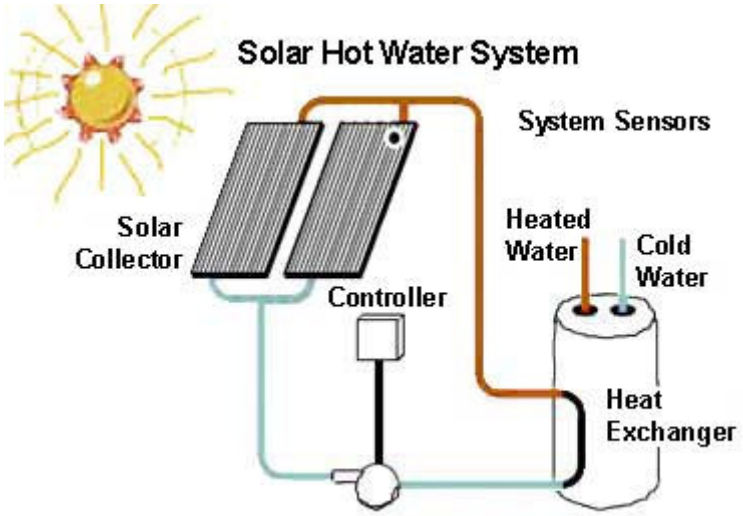


Figure 5: Dish/engine System Schematic Diagram

Figure 6: Solar dish-engine system.

SOLAR THERMAL SYSTEMS:



Solar water heater is a better choice for heating water than a Solar PV Plant

advantages:

- they use solar energy which is a free, renewable source of energy

- by using solar energy they help reduce our dependence on fossil fuels

- in sunny and warm places with high insolation values solar water heating systems are highly cost effective

- relatively good payback period, in average between 5-10 years

- low maintenance costs

Three types of Solar Collectors are used for residential applications:

- **Flat-plate collector**
  Glazed flat-plate collectors are insulated, weatherproofed boxes that contain a dark absorber plate under one or more glass or plastic (polymer) covers. Unglazed flat-plate collectors -- typically used for **solar pool heating** -- have a dark absorber plate, made of metal or polymer, without a cover or enclosure.
- **Integral collector-storage systems**
  Also known as ICS or *batch* systems, they feature one or more black tanks or tubes in an insulated, glazed box. Cold water first passes through the solar collector, which preheats the water. The water then continues on to the conventional backup water heater, providing a reliable source of hot water. They should be installed only in mild-freeze climates because the outdoor pipes could freeze in severe, cold weather.

- **Evacuated-tube solar collectors**
  They feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin. The fin's coating absorbs solar energy but inhibits radiative heat loss..

Solar water heating systems almost always require a backup system for cloudy days and times of increased demand. **Conventional storage water heaters** usually provide backup and may already be part of the solar system package. A backup system may also be part of the solar collector, such as rooftop tanks with thermosyphon systems. Since an integral-collector storage system already stores hot water in addition to collecting solar heat, it may be packaged with a **tankless or demand-type water heater** for backup.

Advantages:

A 100 litre per day capacity system suitable for 3-4 people can save upto 1500 units of electricity in a year, depending on hot water used. It can also save around 140 litres of diesel in an establishment using oil fired boiler besides reducing green house gas emissions in the atmosphere. Higher capacity systems will save higher amount of electricity/fuel oil besides reducing higher amount of GHG emissions.

Electricity is expensive and is not available due to power cuts in many areas when required for heating water. Solar Water Heater, since it stores hot water in an insulated tank, provides water all the time when required. Fuel oil is also expensive and creates pollution. Storing the fuel oil for long term use in commercial establishments is another problem.

The table below gives approximate likely electricity and money savings for a typical 100 liters per day system located in different parts of the country.

What happens on cloudy/rainy day? Do I still get hot water?

On cloudy days also, if it is for a day or two, you still get warm water as water gets heated due to diffused radiation available in the atmosphere. The system, however, is either connected to an electric geyser in the house or an electrical back-up is provided in the storage tank of the system which is switched on when water is not sufficiently hot. So, you get hot water all the time even on rainy days.

How do I decide about the size/capacity of the system to be installed?

For a house with one bathroom and 3 to 4 members, 100 liter per day capacity system should be sufficient. For more numbers of bathrooms, the capacity will increase accordingly due to pipe losses & more number of family members. Generally the capacity is decided based on hot water required in mornings for bathing. If the usage is in evening & at other times also, the capacity is decided accordingly. Some useful thumb rules for estimating the hot water requirement are given below:

A rule of thumb for sizing collectors: allow about 20 square feet (about 2 square meters) of collector area for each of the first two family members and 8 square feet (0.7 square meter) for each additional family member

Application Typical Requirement of Hot Water at 60 degree centigrade.

1. **Household bathing using buckets 10-20 liters per person per bath.**
2. **Household bathing using shower with a mixing tap 20-30 liters for 10-15 minute Bath**
3. **Shaving, while a tap runs 7-10 liters Household bathing in bathtub(one filling)**
4. **50-75 liters Wash basin with a mixing tap (hand wash, brushing of teeth, etc.) 3-5 liters per person per day.**
5. **Kitchen washing 2-3 liters per person per day.**
6. **Dishwasher 40-50 liters per wash cycle**
7. **Clothes washing machine 40-50 liters per cycle.**