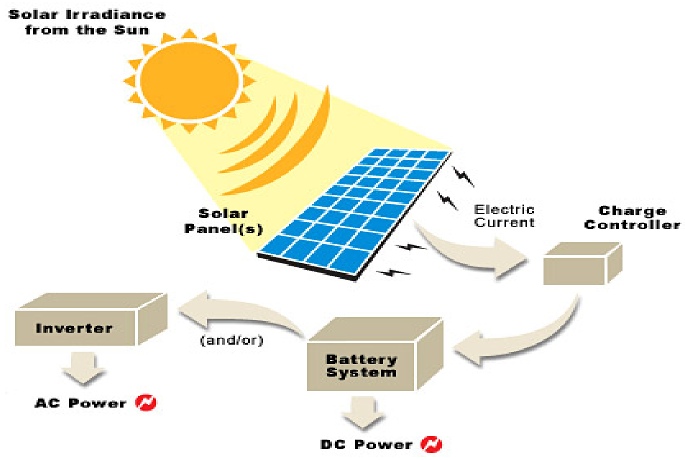
The Use Of Solar Energy In Electricity Production

Definition of solar energy

Electromagnetic energy (solar radiation) transmitted by the sun (approximately one billionth of which reaches the earth) that is the basis of all terrestrial life.

It amounts to about ٤٢٠ trillion kilowatt-hours, and is several thousand times greater than all the energy used by all the people. Solar energy is harnessed by capturing the sun's heat (through solar heaters) or light (through photovoltaic cells).

It is estimated that one square kilometer (about ٠.٤ square miles) of land area receives some ٤٠٠٠ kilowatts (٤ megawatts) of solar energy every day enough for the requirements of a medium-sized town.



Solar energy technologies:

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies.

Solar energy technologies include solar heating , solar photovoltaics , solar thermal electricity, solar architecture and artificial photosynthesis, which can make considerable contributions to solving some of the most urgent energy problems the world now faces.

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

In ٢٠١١, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared".

The Earth receives ١٧٤ petawatts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately ٣٠% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.

Earth's land surface, oceans and atmosphere absorb solar radiation, and this raises their temperature. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapor condenses into clouds, which rain onto the Earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection, producing atmospheric phenomena such as wind, cyclones and anti-cyclones.

Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of ١٤ °C. By photosynthesis green plants convert solar energy into chemical energy, which produces food, wood and the biomass from which fossil fuels are derived.

The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately ٣,٨٥٠,٠٠٠ exajoules (EJ) per year. In ٢٠٠٢, this was more energy in one hour than the world used in one year. Photosynthesis captures approximately ٣,٠٠٠ EJ per year in biomass.

The technical potential available from biomass is from ١٠٠–٣٠٠ EJ/year. The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined .

Solar energy can be harnessed at different levels around the world, mostly depending on distance from the equator.

History of solar energy

How long have people been using solar energy?

It depends what you mean by "solar energy." Humans have always used solar energy in some sense: to warm themselves, to grow food, etc. However, I'm assuming that's not really what you mean (although it is important to realize that all energy on earth, with the exception of nuclear fission and geothermal, is ultimately driven by the sun's energy - even fossil fuels, which after all were plants that grew with sunlight millions of years ago). Solar power has been used directly in various forms for over ١٠٠ years. See the link to below this answer for a nice review of the history of solar power, starting from the beginning. Early on, focused sunlight was used to heat water, which was converted to steam and used to turn a turbine. (This is still very commonly used today and known as "solar thermal" energy although instead of water a fancy high temperature molten salt is used instead to reach very high temperatures).

If you are referring to the type of solar panels that you commonly see on rooftops of homes, etc. those are called photovoltaic solar cells. Those panels take sunlight and directly make electricity using semiconductors. Those are a relatively modern invention.

In ١٨٣٩, Becquerel observed photoelectrochemical processes for the first time, but wasn't until ١٩٥٤ that the first silicon-based photovoltaic solar cell was made by Bell Labs with an conversion efficiency of ٦%. I'm not sure when the first commercial photovoltaic solar panels were available for sale. It was probably sometime in the mid- to late-١٩٦٠'s solar panels started to become commercially available. It wasn't until the ١٩٧٠'s with the oil embargo and energy crisis that they were sold on any significant scale.

The Use Of Solar Energy In Electricity Production

Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light into electric current using the photoelectric effect.

Commercial CSP plants were first developed in the ١٩٨٠s. Since ١٩٨٥ the eventually ٣٥٤ MW SEGS CSP installation, in the Mojave Desert of California, is the largest solar power plant in the world.

Other large CSP plants include the ١٥٠ MW Solnova Solar Power Station and the ١٠٠ MW Andasol solar power station, both in Spain. The ٢٥٠ MW Agua Caliente Solar Project, in the United States, and the ٢٢١ MW Charanka Solar Park in India, are the world’s largest photovoltaic plants.

Solar projects exceeding ١ GW are being developed, but most of the deployed photovoltaics are in small rooftop arrays of less than ٥ kW, which are grid connected using net metering and/or a feed-in tariff.

Concentrated solar power

Concentrating Solar Power (CSP) systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated heat is then used as a heat source for a conventional power plant.

A wide range of concentrating technologies exists; the most developed are the parabolic trough, the concentrating linear fresnel reflector, the Stirling dish and the solar power tower. Various techniques are used to track the Sun and focus light. In all of these systems a working fluid is heated by the concentrated sunlight, and is then used for power generation or energy storage.

Photovoltaics

Commercially available since the ١٩٧٠s, photovoltaic (PV) technology converts energy from solar radiation directly into electricity using semiconductor materials. It has no mechanical moving parts, so it lasts for decades and requires only minimal maintenance. Photovoltaic projects range from small-scale projects for lighting and pumping to large-scale projects for whole buildings and even utility-scale photovoltaic "farms."

A solar cell, or photovoltaic cell (PV), is a device that converts light into electric current using the photoelectric effect. The first solar cell was constructed by Charles Fritts in the ١٨٨٠s. In ١٩٣١ a German engineer, Dr Bruno Lange, developed a photo cell using silver selenide in place of copper oxide.

Although the prototype selenium cells converted less than ١% of incident light into electricity, both Ernst Werner von Siemens and James Clerk Maxwell recognized the importance of this discovery.

Following the work of Russell Ohl in the ١٩٤٠s, researchers Gerald Pearson, Calvin Fuller and Daryl Chapin created the silicon solar cell in ١٩٥٤.

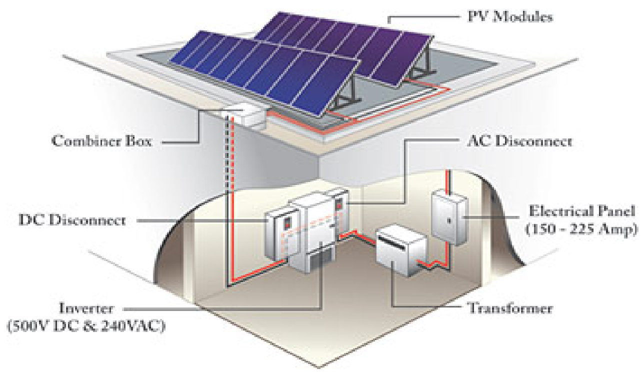
These early solar cells cost ٢٨٦ USD/watt and reached efficiencies of ٤.٥–٦%. By ٢٠١٢ available efficiencies exceed ٢٠% and the maximum efficiency of research photovoltaics is over ٤٠%.

In general, solar electricity is more expensive per kilowatt (kW) than many other sources of electricity, but it has a number of advantages. Because a photovoltaic system can be located at the user site, it can often offset the full retail electricity rate of the facility, rather than the wholesale power price. In addition, photovoltaic electricity often matches peak demand very well, especially in warmer climates, and can offset peak electricity rates. It is modular and can be installed in any size necessary, with the only limitation being the availability of a sunny roof or ground space. Additionally, photovoltaic technology often qualifies for more incentives than other renewable energy technologies. For example, in states that have a "solar set-aside" in their renewable energy requirements, the renewable energy certificates can be much higher than those provided for other technologies.

Description

A photovoltaic system is made up of several major components including:

- Modules
- Mounting racks
- Inverter(s)
- Electric panel
- Battery bank (optional).



How do it works :

When light energy, or photons, strikes a photovoltaic cell, electrons are "knocked" loose from a layer in the cell designed to give up electrons easily. The charge difference that is built into the cell pulls the loose electrons to another cell layer before they can recombine in their originating layer. This migration of electrons creates a charge between layers in the photovoltaic cell. Electrically connecting the positively and negatively charged layers of a photovoltaic cell through a load (e.g. a light bulb) will produce electricity as the electrons flow through the circuit, thus, lighting the light bulb as they are attracted back to the positive layer of the cell.

Photovoltaic cells integrated into a system, or photovoltaic module, create electricity. This energy is then converted through the inverter to be used by electric machines, appliances, lights, and so on

Operation and Maintenance

Operations and maintenance (O&M) is an important procedure to ensure that a system operates optimally and safely and extends the life of the system components. Typical O&M procedures can be applied to a photovoltaic system. For example, major system components should be scheduled for a regular inspection and maintenance to ensure mounting racks and connectors are tight and there is no sign of corrosion. Facility personnel should fully understand the system operation and safety whether the O&M is performed by the facility personnel or a third-party contractor.

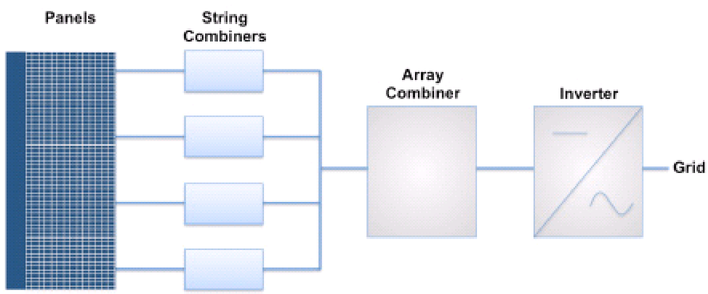
Photovoltaic Modules

Photovoltaic modules normally come with an excellent manufacturer warranty for any manufactured defects. A regular visual inspection is a simple way to check for any damage that may have been caused by severe weather. Also, since dust build up on the photovoltaic module surface can dramatically decrease system performance, it is recommended that a module cleaning be performed one to two times per year or as needed.

Security

Solar photovoltaic systems consist of expensive components such as solar panels and inverters, with solar panels being the most expensive components of the entire system. Frequently located at a highly visible location, the solar photovoltaic system can be educational for the public and offer good publicity for an agency or institution. As a result, this visibility can lead to vandalism or theft in certain situations. If this is a concern, particularly for a facility with little security or no security for extended periods of time, theft-prevention techniques should be set up accordingly.

Typical solar energy electrical system



Typical solar energy electrical system.

In a typical solar energy electrical system, individual solar panels or modules are connected in series to increase output voltage, which in turn increases efficiency. Multiple strings are connected in parallel to obtain the required output current and resulting power. Depending on the system size and design details, parallel strings can be connected in string-combiner boxes, which can be connected in parallel within array-combiner boxes, then connected to an inverter

In most cases, multiple strings and arrays are connected using combiner boxes in accessible locations. These common connection points help simplify assembly and maintenance of the system. Wherever they are used, it is necessary to analyze the circuit to determine the available fault current (that is, the short-circuit current) of the system in comparison to the over-current capabilities of the components and then install appropriate circuit protection devices to prevent damage to PV modules, disconnects, wiring, and wiring devices.

Circuit design at the cutting edge

Responsibility for practical PV electrical system development eventually falls on the shoulders of electrical circuit designers, including those who work for companies that create complete solar energy systems, system integrators who provide turnkey systems to end customers, and designers of various solar energy subsystems. Many of these designers are charged with creating electronics that optimize the performance and cost of PV installations. These engineers are typically involved with the design of electrical circuits for solar arrays, DC combiner boxes, or inverters.

Solar energy systems involve relatively new technology, so PV system designers often have greater experience in working on different types of electrical and electronic systems. For example, a company that is now producing small solar inverters may have previously focused on building power conversion or UPS systems. In their new positions, these new PV system designers may be called on to design solar energy circuits on a scale of ١MW DC for connection to the electrical grid. Designing circuits and specifying components for these high voltage solar energy applications is very different from the same tasks when applied to other DC power systems or even high power AC applications.

Basic circuit protection needs

The selection of circuit protection devices for solar energy circuits is one area where designers can get into trouble. These circuits may be used in systems ranging from residential-scale applications to those intended for large industrial facilities and grid-connected solar farms. On all of these systems, circuit protection devices are needed in many locations . Many application notes are available to provide guidance on selecting circuit protection devices for AC power and digital communication systems used for monitoring and control. Those areas are beyond the scope of this article, which focuses on the DC side of solar energy systems, where circuit designers are more likely to encounter unanticipated problems.

Some other uses of solar energy

١. Architecture and urban planning

Darmstadt University of Technology in Germany won the ٢٠٠٧ Solar Decathlon in Washington, D.C. with this passive house designed specifically for the humid and hot subtropical climate.

Sunlight has influenced building design since the beginning of architectural history. Advanced solar architecture and urban planning methods were first employed by the Greeks and Chinese, who oriented their buildings toward the south to provide light and warmth.

٢ . Transport

Solar vehicle, Solar-charged vehicle, Electric boat, and Solar balloon

Australia hosts the World Solar Challenge where solar cars like the Nuna٣ race through a ٣,٠٢١ km (١,٨٧٧ mi) course from Darwin to Adelaide.

In ١٩٧٥, the first practical solar boat was constructed in England. By ١٩٩٥, passenger boats incorporating PV panels began appearing and are now used extensively.

Helios UAV in solar powered flight.

A solar balloon is a black balloon that is filled with ordinary air. As sunlight shines on the balloon, the air inside is heated and expands causing an upward buoyancy force, much like an artificially heated hot air balloon. Some solar balloons are large enough for human flight, but usage is generally limited to the toy market as the surface-area to payload-weight ratio is relatively high.

٣ . Solar thermal

Solar thermal technologies can be used for water heating, space heating, space cooling and process heat generation.

٤. *Water heating*

Solar hot water systems use sunlight to heat water. In low geographical latitudes (below ٤٠ degrees) from ٦٠ to ٧٠% of the domestic hot water use with temperatures up to ٦٠ °C can be provided by solar heating systems. The most common types of solar water heaters are evacuated tube collectors (٤٤%) and glazed flat plate collectors (٣٤%) generally used for domestic hot water; and unglazed plastic collectors (٢١%) used mainly to heat swimming pools.

Future of solar energy

In the ٢١st century, solar power has already become part of daily life. From solar heated swimming pools to sun powered homes, there are many examples that demonstrate the useful application of the clean, safe, sustainable power of the sun. As concern grows about the effects of burning fossil fuels, and the possibility of exhausting non-renewable energy sources, the future of solar energy looks bright. As of ٢٠١٣, the technology is not without its problems, and so far, applications have mostly been relatively small scale, but a great deal of research is going on in this area, and there have been a number of very promising developments.

١٢ percent of EU energy demand by ٢٠٢٠

Current developments in Europe underline both the strength and growth potential of PV solar energy. The European Union (EU) has already set a goal of meeting ٢٠ percent of energy demand through the use of renewable sources by ٢٠٢٠. The European Photovoltaic Industry Association (EPIA), of which REC is a member, has conducted a study, "SET for ٢٠٢٠", which shows that assuming basic improvements to regulatory conditions, PV solar power could satisfy as much as ١٢ percent of EU electricity demand by ٢٠٢٠.

Why Solar Energy is Good?

Solar energy is definitely the future trend of energy. Nowadays, many households have converted their home to be powered by solar power system to take advantage of free and renewable energy from the sun.

Here are some good reasons for using solar energy to power your home.

١. Cut-down electricity bill

The key reason that most households convert their power source to solar energy is to cut down their electrical bill because the electrical usage generated from the sun is free. By converting as many home appliances as possible to use solar energy, you can save a significant savings in your utilities expenses.

٢. It is a renewable energy source

Typical electricity is generated from fossil fuel that will run out one day. Solar energy is a good alternative to replace fossil fuel as the major energy source because solar power is renewable at absolutely no cost to supply energy infinitely.

٣. Environment friendly

The world pollution is getting worse. Any effort that can reduce the pollution to the environment helps to save the earth. Solar panels are able to harness the energy from the sun and convert it to electricity. Therefore, the use of solar panels is environment friendly. Therefore, solar energy that is harmless to the environment will be the major energy source for future - starting today.

٤. Low / no maintenance needed

Once you have installed the solar power system, it can last twenty to thirty years without major maintenance needed. You may need to do system check once a year, just to make sure everything is performing as it should. Since it requires very minimum maintenance cost, your cost should be minimal.

..The End ....