

Solar Energy

What is Solar Energy?

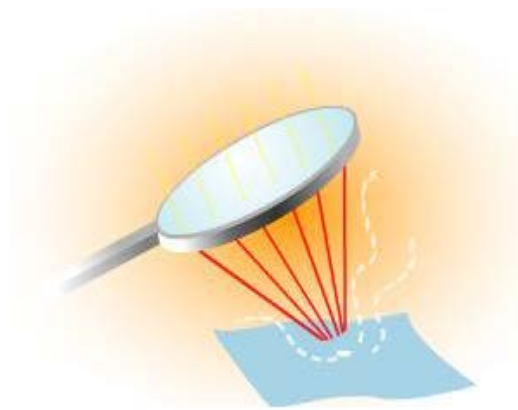
- The radiation from the sun gives our planet heat and light. All living things need energy from the sun to survive.
- More energy from sunlight strikes the earth in one hour (4.3×10^{20} J) than all the energy consumed on the planet in one year (4.1×10^{20} J).*
- However, solar electricity currently provides just one millionth of our total electricity supply*, meaning that the potential for exploring solar electricity is huge.



* Source: Basic Research Needs For Solar Energy Utilization, USDOE Office of Science, April 2005

Nature of Solar Energy

Solar energy is available as long as the sun shines, but its intensity depends on weather conditions and geographic location. Solar energy travels in straight lines and can be blocked by objects such as clouds.



Solar Energy can be reflected or concentrated by diffraction. For example, we can focus light rays from the sun using magnifying glass to generate heat and raise the temperature of an object.

Applications of Solar Energy

From pocket calculators to multi-storey buildings with photovoltaic panels, solar power has been widely used in our daily lives for decades. This unique and abundant resource can be utilized even in the most remote territories to generate electricity, as long as there is plenty of sunshine.

Popular solar energy conversion systems:

Solar Photovoltaic (PV) Systems

Sunlight can generate electricity directly using photovoltaic (PV) cells. PV panels, assembled from PV cells, can be grouped into arrays to generate electrical power for practical applications.



In 2010, HK Electric commissioned the largest thin-film photovoltaic system at Lamma Power Station in Hong Kong with installed capacity of 550kW.



Solar PV panels mounted on the rooftop of HK Electric's Marsh Road Station Building.



PV panels mounted on Chow Yei Ching Building, HKU.

Solar Thermal Collectors

- Solar Hot Water Systems

This is a very common application for solar energy. A collector is placed on the roof or wall of a building facing the sun to absorb solar radiation, which then heats the water, storing it for later use.

- Solar Thermal Electricity

Solar thermal collectors concentrate solar radiation into heat energy to produce steam, which then turns a turbine to produce electricity.



Solar hot water system installed at Lamma Power Station in Hong Kong.



Concentrating solar power plant in the Mojave Desert, California, USA.
Courtesy: DOE/NREL
Credit: Gretz, Warren

Pilot Application of Solar Collectors for Power Generation

Solar Dish Stirling System

25 kW solar dish in Sandia National Laboratories test site, Albuquerque, New Mexico, USA.



Courtesy: Stirling Energy Systems, Inc



Courtesy: Stirling Energy Systems, Inc

Concentrating solar power plants (PS20)

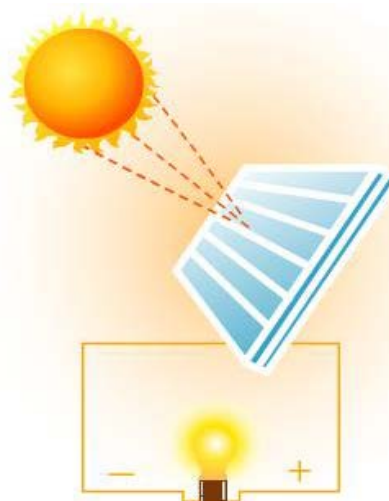


PS20 is a 20MW solar power plant in Seville, Spain. The plant uses a field of 1,255 flat mirrors to concentrate sunlight on a receiver mounted on the central tower to produce steam which drives a turbine to generate electricity.

Solar Photovoltaic (PV) Systems

PV cells directly convert sunlight into electricity using crystalline or amorphous silicon semiconductors. Compared with conventional crystalline silicon type PV panels, amorphous silicon thin film photovoltaic (TFPV) modules use very little semiconductor material and require less energy in the manufacturing process. Hence TFPV has shorter energy pay back time, leading to lower capital cost.

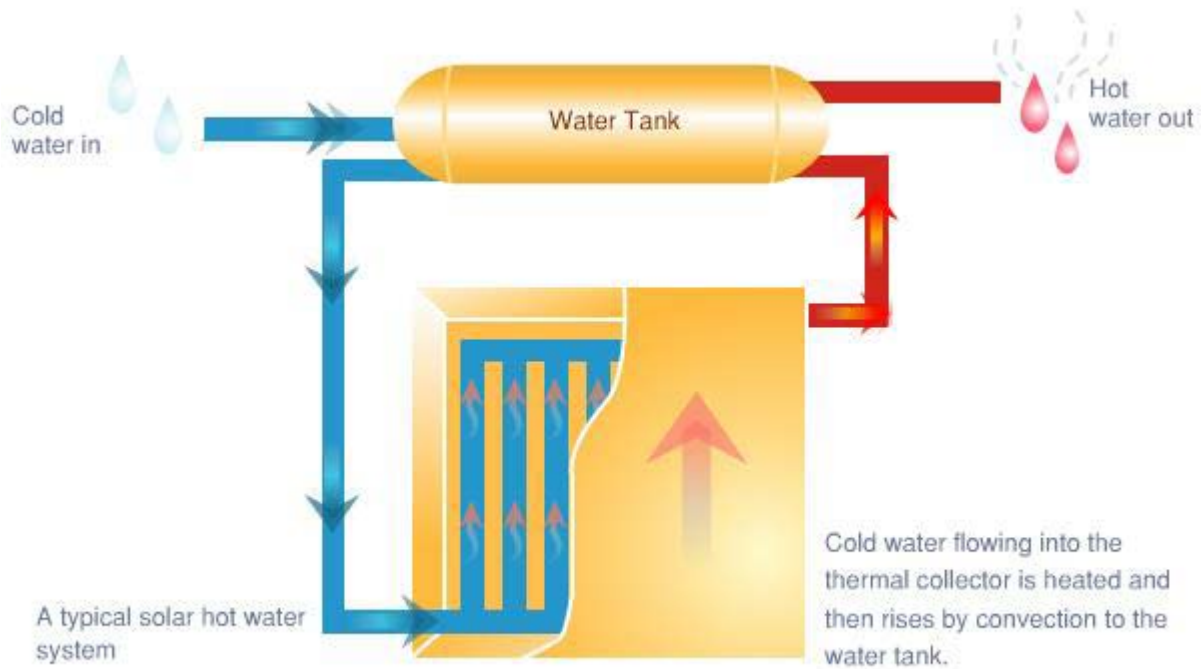
PV systems can be connected directly to grid or operated in standalone systems with backup batteries. The operations are quiet and easy to maintain.



When sunlight strikes the PV cells, excited electron moves to the top, creating a negative charge on the front surface and a positive charge on the back surface. An electric current will flow through a device, such as a light bulb, that is connected to the PV cell.

Solar Hot Water Systems

Solar hot water systems are usually made up of collectors, storage tanks, piping and controls. Collectors capture incoming solar radiation and heat the water, which is then stored in tanks for domestic and other uses. Solar energy is stored as heat for later use. Solar hot water systems are usually mounted on the roof or wall of houses or low-rise buildings.



Application Worldwide

PV systems offer a number of unique benefits that have led to their rapid growth in popularity in recent years. This growth was particularly impressive in countries such as Germany, Spain and Japan which led the world in terms of total PV installed capacity as of the end of 2008*.

Rank	Country	Installed Capacity
1	Germany	5,340 MW
2	Spain	3,354 MW
3	Japan	2,144 MW

* Source: International Energy Agency Photovoltaic Power Systems Programme (PVPS) Annual Report 2008



Japan

Small-scale rooftop PV systems are commonly used for domestic purposes.

Courtesy: IEA PVPS website:
<http://www.iea-pvps.org>



Germany

This picture shows one of the world's largest grid-connected PV systems (10 MW), Bavaria Solarpark. Photo courtesy PowerLight Corp.



Spain

This picture shows one of the world's largest photovoltaic plant (60MW), Omedilia Photovoltaic Park.

Benefits of Solar Energy

It is abundant

Solar energy is generally available everywhere, every day, though the intensity varies with weather conditions and geographical locations.



It is environmentally friendly



Solar power does not emit noise, heat or greenhouse gases. It will not deplete natural resources. Every 1,200 units of solar electricity generated reduces around 1 tonne of carbon dioxide (CO₂) that would normally be produced through fossil fuels.

It is convenient to install

Solar panels can be retrofitted into existing building structures and fixtures.



Courtesy: IEA PVPS website:
<http://www.iea-pvps.org>

Challenges of Solar Energy

It is unpredictable



The availability of solar energy is controlled by nature. It is only available during daylight hours and with clear skies.

It usually works better in rural areas than urban areas

The close proximity of buildings in urban areas and the resulting shadows sometimes pose limitations on the absorption of solar energy.



It can be costly to build solar energy facilities



Photo courtesy PowerLight Corp.



Courtesy: IEA PVPS website:
[http:// www.iea-pvps.org](http://www.iea-pvps.org)
Copyright: PowerLight Corp.

Solar PV energy facilities require high start-up costs compared to their output, making them less cost-effective.