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Solar Energy: Applications as Non Conventional Energy Resource

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Summary:

Energy is the key input to drive and improve the life cycle. Primarily, it is the gift of the nature to the mankind in various forms. The consumption of the energy is directly proportional to the progress of the mankind. With ever growing population, improvement in the living standard of the humanity, industrialization of the developing countries, the global demand for energy is expected to increase rather significantly in the near future. The primary source of energy is fossil fuel, however the finiteness of fossil fuel reserves and large scale environmental degradation caused by their widespread use, particularly global warming, urban air pollution and acid rain, strongly suggests that harnessing of non-conventional, renewable and environment friendly energy resources is vital for steering the global energy supplies towards a sustainable path.

To meet the future energy demands and to give quality and pollution free supply to the growing and today's environment conscious population, the present world attention is to go in for natural, clean and renewable energy sources. Renewable energy is energy from a source that is replaced rapidly by a natural process and is not subject to depletion in a human timescale.

These energy sources capture their energy from on-going natural processes, such as geothermal heat flows, sunshine, wind, flowing water and biological processes. Most renewable forms of energy, other than geothermal and tidal power ultimately come from the Sun.

The sun is the Earth's primary source of energy, powering its most basic systems and cycles and shaping the world around us. It provides the planet with light and heat. The reaction between the sun's energy and the Earth's atmosphere determines weather patterns and rainfall, and our planet's tilt towards the sun creates the seasons. Its role in photosynthesis helps plants to grow and its role in biodegradation helps complete the natural cycle of ecosystems.

A lesser known role of solar energy is that it is the root of most the other forms of energy humans use for power. Wind power depends on the sun's impact on atmospheric movement to create wind patterns. Bioenergy (wood and other plant material) depends on photosynthesis. Even fossil fuels indirectly owe their creation millions of years ago to solar energy.

Introduction:

Renewable energy sources also called non-conventional energy are sources that are continuously replenished by natural processes. For example, solar energy, wind energy, Bio - energy, hydropower etc., are some of the examples of renewable energy sources.

A renewable energy system converts the energy found in sunlight, wind, falling-water, sea-waves, geothermal heat, or biomass into a form, we can use such as heat or electricity. Most of the renewable energy comes either directly or indirectly from sun and wind and can never be exhausted, and therefore they are called renewable.

The Sun's Energy:

The sun is composed of two layers of gas: an inner core of hydrogen and an outer layer of helium. For millions of years, the core of hydrogen gas has been burning and producing the outer layer of helium. An enormous amount of energy is created in this process. This **solar energy** radiates outward from the sun and into space, and some of this energy reaches the Earth's surface. This movement of energy is known as **solar radiation**.

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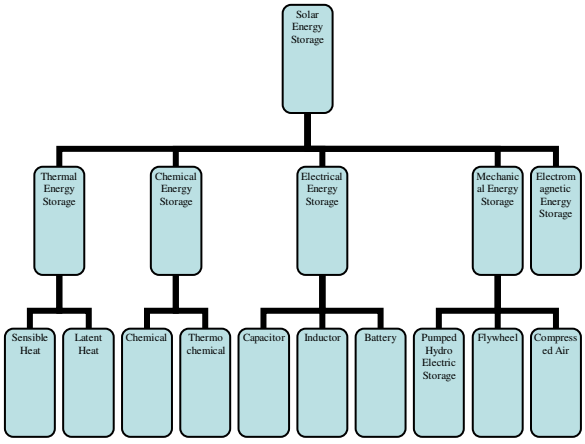
1. Solar Energy:

Solar energy is the most readily available and free source of energy since prehistoric times. It is estimated that solar energy equivalent to over 15,000 times the world's annual commercial energy consumption reaches the earth every year.

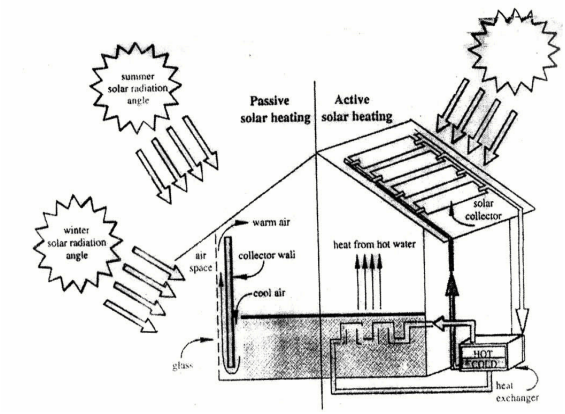
India receives solar energy in the region of 5 to 7 kWh/m for 300 to 330 days in a year. This energy is sufficient to set up 20 MW solar power plants per square kilometer land area.

Energy is released by the Sun as electromagnetic waves. This energy reaching the earth's atmosphere consists of about 8% UV radiation, 46% visible light and 46% infrared radiations. Solar energy storage is as per figure given below:



Solar energy can be used in two ways:

1. Solar Heating (Passive Solar Energy).
2. Solar Electricity (Active Solar Energy).



Solar Thermal Energy Application:

In solar thermal route, solar energy can be converted into thermal energy with the help of solar collectors and receivers known as solar thermal devices. The Solar-Thermal devices can be classified into three categories:

1). Low-Grade Heating Devices - up to the temperature of 100° C.
2). Medium-Grade Heating Devices -up to the temperature of 100° -300°C.
3). High-Grade Heating Devices -above temperature of 300° C.

Low-grade solar thermal devices are used in solar water heaters, air-heaters, solar cookers and solar dryers for domestic and industrial applications.

Solar Water Heaters:

Most solar water heating systems have two main parts: a solar collector and a storage tank. The most common collector is called a *flat-plate collector (see Figure 1).* It consists of a thin, flat, rectangular box with a transparent cover that faces the sun, mounted on the roof of building or home. Small tubes run through the box and carry the fluid – either water or other fluid, such as an antifreeze solution – to be heated. The tubes are attached to an absorber plate, which is painted with special coatings to absorb the heat. The heat builds up in the collector, which is passed to the fluid passing through the tubes.

An insulated storage tank holds the hot water. It is similar to

water heater, but larger is size. In case of systems that use fluids, heat is passed from hot fluid to the water stored in the tank through a coil of tubes.

Solar water heating systems can be either active or passive systems. The active systems, which are most common, rely on pumps to move the liquid between the collector and the storage tank. The passive systems rely on gravity and the tendency for water to naturally circulate as it is heated. A few industrial application of solar water heaters are listed below:

Hotels: Bathing, kitchen, washing, laundry applications
Dairies: Ghee (clarified butter) production, cleaning and sterilizing, pasteurization
Textiles: Bleaching, boiling, printing, dyeing, curing, ageing and finishing
Breweries & Distilleries: Bottle washing, wort preparation, boiler feed heating
Chemical /Bulk drugs units: Fermentation of mixes,
Electroplating/galvanizing units: Heating of plating baths, cleaning, degreasing applications
Pulp and paper industries: Soaking of Pulp.

Fig. 1 Solar Flat Plate Collector

Solar Cooker:

Solar cooker is a device, which uses solar energy for cooking, and thus saving fossil fuels, fuel wood and electrical energy to a large extent. However, it can only supplement the cooking fuel, and not replace it totally. It is a simple cooking unit, ideal for domestic cooking during most of the year except during the monsoon season, cloudy days and winter months.

Box type solar cookers:
The box type solar cookers with a single reflecting mirror are the most popular in India. These cookers have proved immensely popular in rural areas where women spend considerable time for collecting firewood. A family size solar cooker is sufficient for 4 to 5 members and saves about 3 to 4 cylinders of LPG every year. The life of this cooker is upto 15 years. This cooker costs around Rs.1000 after allowing for subsidy. Solar Cookers (Figure 2) are widely available in the market.

Figure 2. Box Type Solar Cooker

Solar Electricity Generation:

Solar Photovoltaic (PV): Photovoltaic is the technical term for *solar electric* Photo means "light" and voltaic means "electric". PV cells are usually made of silicon, an element that naturally releases electrons when exposed to light. Amount of electrons released from silicon cells depend upon intensity of light incident on it. The silicon cell is covered with a grid of metal that directs the electrons to flow in a path to create an electric current. This current is guided into a wire that is connected to a battery or DC appliance. Typically, one cell produces about 1.5 watts of power. Individual cells are connected together to form a solar *panel* or *module* capable of producing 3 to 110 Watts power Panels can be connected together in series and parallel to make a solar *array* (see Figure 3). This can produce any amount of Wattage as space will allow. Modules are usually designed to supply electricity at 12 Volts. PV modules are rated by their peak Watt output at solar noon on a clear day.

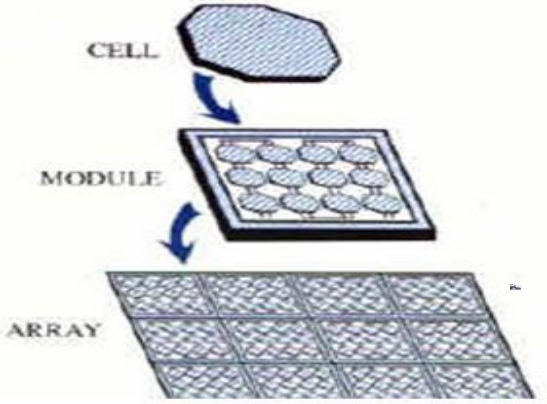


Fig. 3 Solar Photovoltaic Array.

Some applications for PV systems are lighting for commercial buildings, outdoor (street) lighting (See Figure 4.) rural and village lighting etc. Solar electric power systems can offer independence from the utility grid and offer protection during extended power failures. Solar PV systems are found to be economical especially in the hilly and far flung areas where conventional grid power supply will be expensive to reach.

Figure 4. Photovoltaic Domestic and Streetlights.

Performance:

The performance of a solar cell is measured in terms of its efficiency at converting sunlight into electricity. Only sunlight of certain energy will work efficiently to create electricity, and much of it is reflected or absorbed by the material that makes up the cell. Because of this, a typical commercial solar cell has an efficiency of 15%—only about one-sixth of the sunlight striking the cell generates electricity. Low efficiencies mean that larger arrays are needed and higher investment costs. It should be noted that the first solar cells, built in the 1950s, had efficiencies of less than 4%.

Solar Water Pumps:

In solar water pumping system, the pump is driven by motor run by solar electricity instead of conventional electricity drawn from utility grid. ASPV water pumping system consists of a photovoltaic array mounted on a stand and a motor-pump set compatible with the photovoltaic array. It converts the solar energy into electricity, which is used for running the motor pump set. The pumping system draws water from the open well, bore well, stream, pond, canal etc

Photovoltaic Water Pumping

Cumulative Achievements Of Solar Energy In India

Source/Technologies	Units	Cumulative Physical Achievements up to 31/3/05	India's Position in the World
Power Generation			
Solar Photovoltaics Power	MW	264	Fifth
Water Pumping			
Solar PV Pumps	Number	6,818	
Solar Lighting Systems			
Solar Street Lighting Lamps	Number	54,795	
Home Lighting Systems	Number in Million	0.342	

Conclusion:

Keeping in view the reserves of the fossil fuels and the economy concerns, our conventional fuels are likely to dominate the world primary energy supply for another decade but environmental scientists have warned that if the present trend is not checked then by 2100, the average temperature around the globe will rise by 1.4 to 5.8 degrees Celsius, which will cause a upsurge in the sea water levels drowning all lands at low elevation along the coastal lines. So the world has already made a beginning to bring about the infrastructural changes in the energy sector so as to be able to choose the renewable energy development trajectory. In developing countries, where a lot of new energy production capacity is to be added, the rapid increase of renewable source is, in principle, easier than in the industrial countries where existing capacity would need to be converted if a rapid change were to take place. That is, developing countries could have the competitive advantage for driving the world market. However, strong participation of developed countries is needed since majority of energy technologies in use in developing countries have been developed and commercialized in developed countries first. Nevertheless, India must give more thrust to the research and development in the field of non-conventional energy sources not only to mitigate greenhouse effect but also to lessen dependence on oil/gas import, which consumes major chunk of foreign exchange reserve. It is also clear that an integrated energy system consisting two or more renewable energy sources has the advantage of stability, reliability and are economically viable. Last but not the least, it is for the citizens also to believe in power of renewable energy sources, and understand its necessity and importance.

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