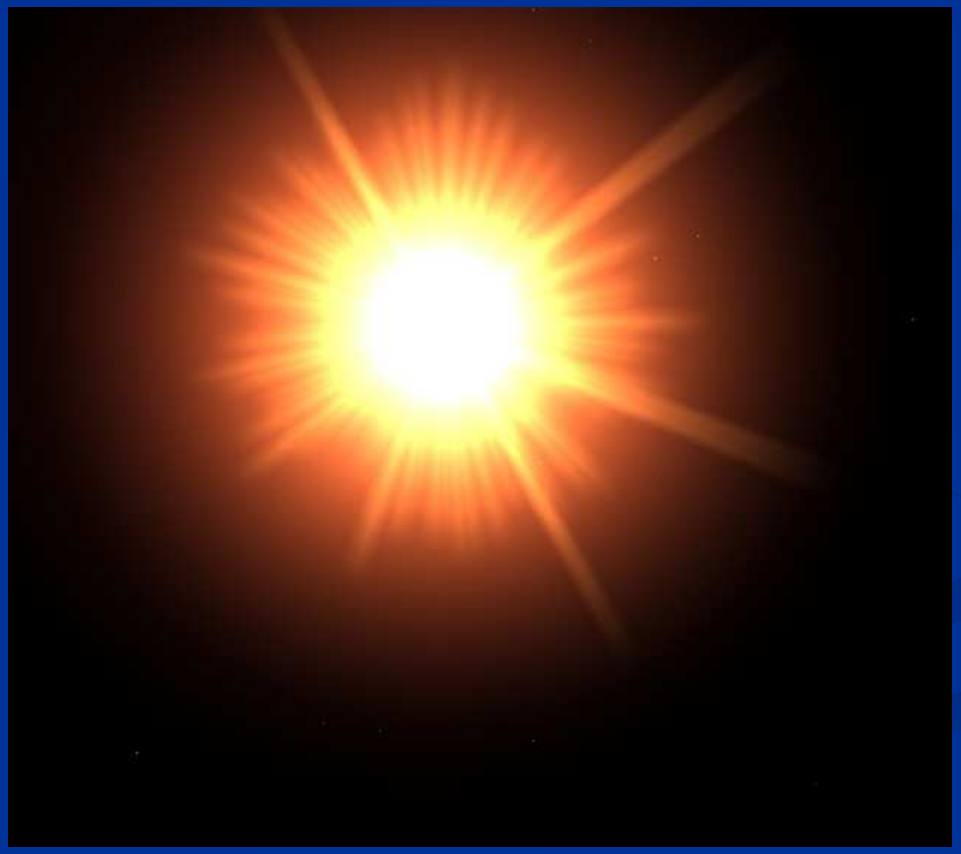
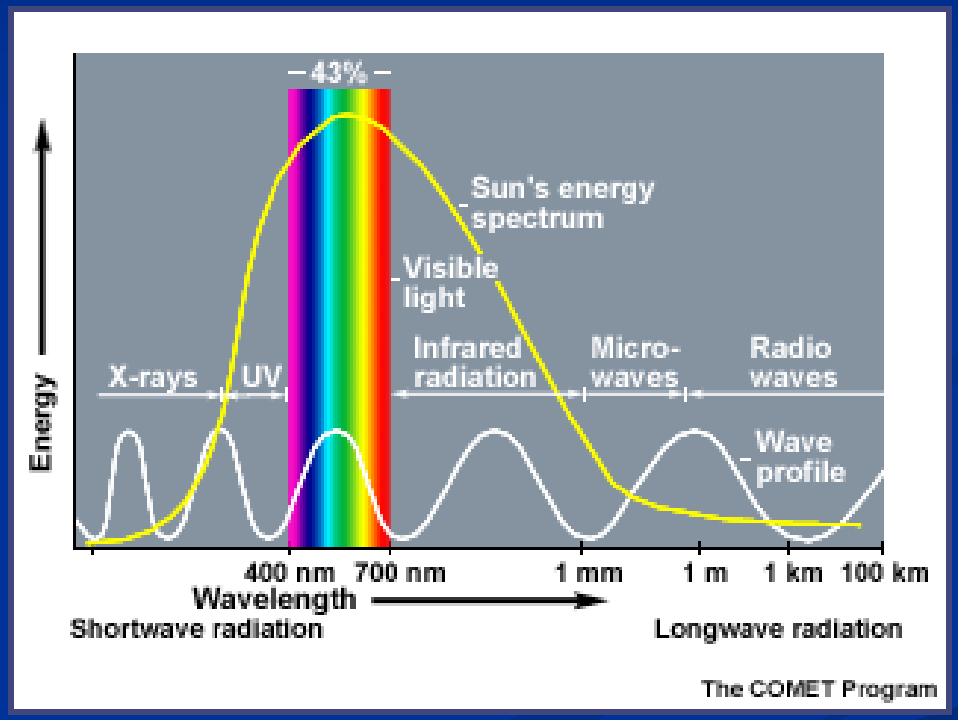
Solar Energy: An Ultimate Renewable Resource



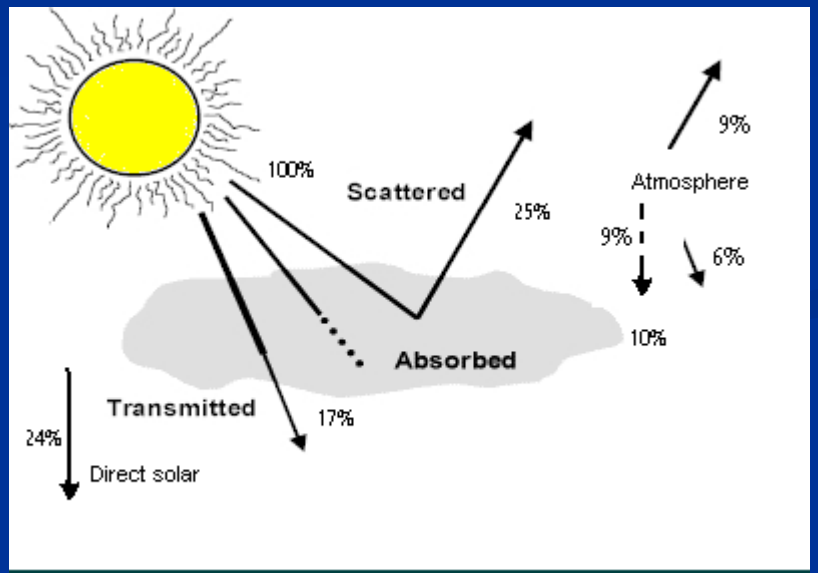
What is Solar Energy?

- Originates with the thermonuclear fusion reactions occurring in the sun.
- Represents the entire electromagnetic radiation (visible light, infrared, ultraviolet, x-rays, and radio waves).



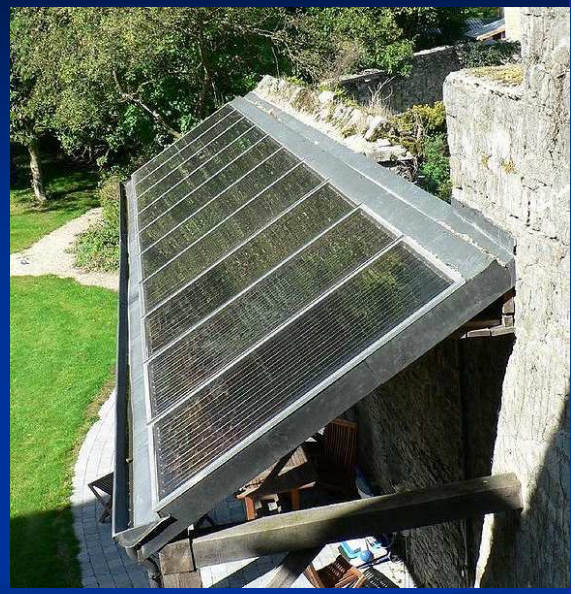
How much solar energy?

- The Earth receives 174 petawatts (PW) of incoming solar radiation (also called as insolation) at the upper atmosphere. Approximately 30% 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.



Applications of Solar Energy

Putting Solar Energy to Use: Heating Water



- This method is a passive method
- The water in these tubes can heat up to more than 160 ° F in less than an hour under direct sunlight.
- Tanks of hot water are used as storage.
- The homeowner can shower, bathe, wash clothes, or do dishes using the heated water directly from the flat plate collector.
- As of 2007, the total installed capacity of solar hot water systems is approximately 154 GW.

Solar Furnace

Solar Furnace in Barstow, California.

Solar-Thermal Electricity: Solar Furnace

- The solar furnace is much larger than a solar trough, mainly because it uses hundreds of flat mirrors, called heliostats, to collect sunlight over a much larger area.
- This sunlight is bounced onto a single curved mirror the size of a ten-story building. Since the mirror is curved, the sunlight can be focused onto one central tower opposite it.
- Like the solar trough collector, this central tower uses the sunlight to create electricity by heating fluids to create steam to run through a turbogenerator.
- The solar furnace effectively generates about one thousand kW of energy, enough to power more than six hundred homes. However, it is still used as a research site, as duplicates of the furnace are still too expensive to build and operate competitively.

Parabolic Dishes and Troughs

Because they work best under direct sunlight, parabolic dishes and troughs must be steered throughout the day in the direction of the sun.

This site in California is currently generating about a third of the energy production of a large nuclear plant, or enough energy to power 350,000 homes.

Solar-Thermal Electricity: Parabolic Dishes and Troughs

- Scientists in the Mojave Desert of California have been examining as a way to serve large numbers of people at once.
- At this site, nine sets of sixty-four curved mirrors (which are about 2 ½ feet by just over 4 feet) are used to focus sunlight onto tubes that run along the center of the curved mirrors.
- Synthetic oils in the tubes, which are about 150 feet long, absorb the solar energy and heat up, reaching temperatures around 735 °F. Merely running the tube through a large vat of water causes the water to boil. The steam from the boiling water is then used to drive a turbogenerator, which creates electricity.

Direct Conversion into Electricity

- The photovoltaic panels of this solar energy plant in California's Mojave Desert produce enough electricity to power thousands of homes.
- Many of these PV cells must be linked together to create enough electricity to power most electrical motors. For instance, a solar-powered car would need about 375 PV cells to run efficiently.
- When PV cells are linked together by running a wire from one PV cell to the next, they are called modules.
- The more the cells collecting energy and funneling it to one destination, such as an electric motor, the more the power that motor receives

Solar Panels in Use

- More commonly seen, perhaps, is the use of solar modules to power traffic signals, road signs, and streetlights.
- For people who live far away from any source of electricity to power their homes or businesses, solar modules are sometimes a solution.
- These solar modules may be attached to the roof of a home or may be on freestanding bases.
- The modules are angled toward the sun to capture the most energy. As the sun's angle to the earth varies throughout the year, the owners often reset the angle of the modules to capture the most energy from the sun.

Solar Cookers

- Solar cookers use sunlight for cooking, drying and pasteurization.
- They can be grouped into three broad categories: box cookers, panel cookers and reflector cookers.
- A basic box cooker consists of an insulated container with a transparent lid. It can be used effectively with partially overcast skies and will reach temperatures of 90–150 °C.
- Panel cookers use a reflective panel to direct sunlight onto an insulated container and reach temperatures comparable to box cookers.

Greenhouses

- Greenhouses convert solar light to heat, enabling year-round production and the growth of specialty crops and other plants not naturally suited to the local climate.
- Primitive greenhouses were first used during Roman times to produce cucumbers year-round.
- Greenhouses remain an important part of horticulture today, and plastic transparent materials have also been used to similar effect in polytunnels and row covers.

Solar Chemical

- Solar chemical processes use solar energy to drive chemical reactions. These processes offset energy that would otherwise come from an alternate source and can convert solar energy into storable and transportable fuels. Solar induced chemical reactions can be divided into thermochemical or photochemical.
- Hydrogen production technologies have been a significant area of solar chemical research since the 1970s. Aside from electrolysis driven by photovoltaic or photochemical cells, several thermochemical processes have also been explored.
- One such route uses concentrators to split water into oxygen and hydrogen at high temperatures (2300-2600 °C). Another approach uses the heat from solar concentrators to drive the steam reformation of natural gas thereby increasing the overall hydrogen yield compared to conventional reforming methods.

Natural Zeolites

- Zeolite is a mineral made of alkali or alkaline earth metal with crystal water. Experiments conducted have shown positive results for solar energy storage.
- Further studies showed that natural zeolites could be used as replacements for the synthetic zeolites for solar energy storage. The amount of radiation that the solar energy emits differs with the weather changes, the season and day and night conditions in the same place.
- Zeolites have the unique characteristics to absorb and deabsorb water which makes it the preferred material for solar energy storage. When the zeolites are heated the water molecules escape and the heat energy is stored. When the process of reabsorbing the water molecules starts the heat energy is released.

Limitations

- The most obvious drawback of solar energy is its sole dependence on the sun. Once the weather becomes cloudy or night strikes, energy collection comes to a halt. However, recent advancements of technology now allow the generated power to be stored in special batteries which provide roughly enough electricity to last a night
- Very expensive to build solar power stations.
  Solar cells cost a great deal compared to the amount of electricity they'll produce in their lifetime.
- Can be unreliable unless you're in a very sunny climate.
- The weather can affect the efficiency of solar cells.
- Solar power can't compete with current utilities as a cost effective solution
- Sun does not shine consistently.
- Solar energy is a diffuse source. To harness it, we must concentrate it into an amount and form that we can use, such as heat and electricity.
- Argument that sun provides power only during the day is countered by the fact that 70% of energy demand is during daytime hours. At night, traditional methods can be used to generate the electricity.

The End