AZURE

AZ Understanding Renewable Energy

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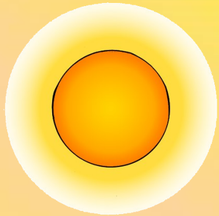
INTRODUCTION TO RENEWABLE ENERGY

SOLAR ENERGY
WIND ENERGY
HYDRO POWER
BIO-FUEL ENERGY
GEOTHERMAL ENERGY

SOLAR ENERGY

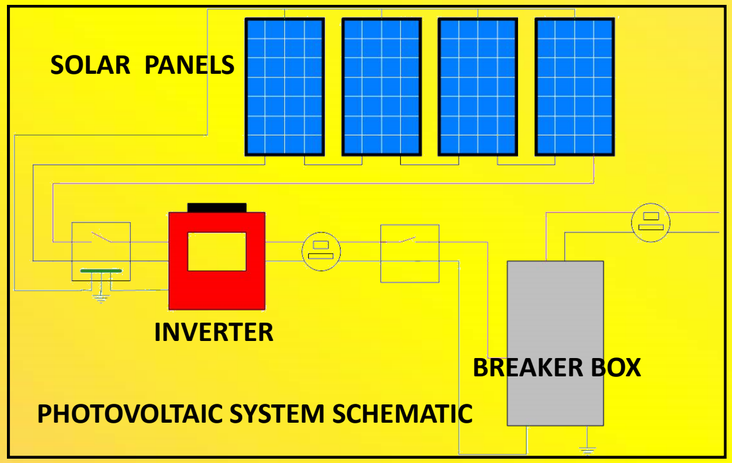


Solar energy is the energy we receive from the sun in the form of heat and light.
We can use solar energy to make electricity.

Solar panels are made from special materials which can convert sunlight into electricity. The electricity made by solar panels can be used to help power our homes and even cities.

PHOTOVOLTAIC POWER PLANT

How it works:
Solar panels convert sunlight into Direct Current (DC) electricity.

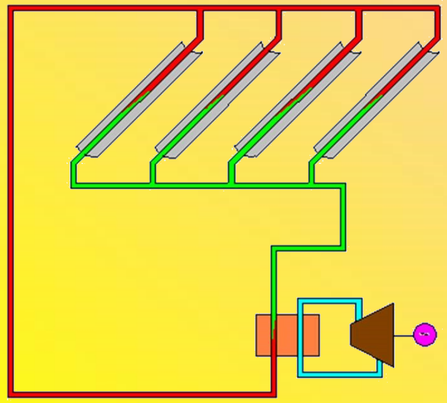


PHOTOVOLTAIC SYSTEM SCHEMATIC

An inverter contains electronic circuits that convert the DC electricity into AC electricity which can be used in our homes.

The heat energy we get from the sun can also be used to produce electricity. It can also be used to heat water for our homes.

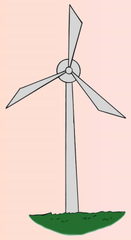
Solar (thermal) collectors harvest the sun's heat energy and use it to heat a liquid such as water, oil, or molten salt. The hot liquid can be stored for later use or used immediately to make steam to power an electric turbine/ generator or to provide heat.



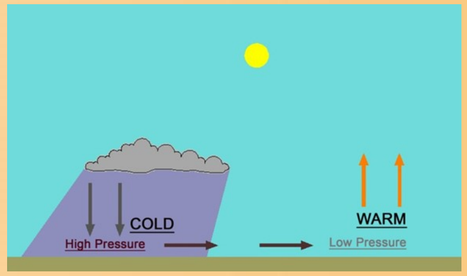
SOLAR THERMAL PARABOLIC TROUGH

SOLAR THERMAL POWER TOWER

WIND ENERGY



When the sun heats up the ground, the air close to the ground gets warm and rises. As the warm air rises, cooler air moves in to take its place. It is this moving air that makes the "wind" that we feel on our faces.



Wind has been used for hundreds of years for sail boats, windmills, and more recently to power large turbines to make electricity.

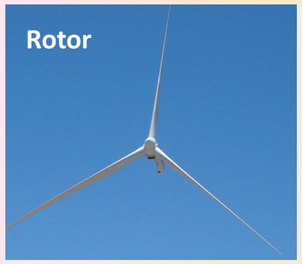
How it works:

In a wind turbine, the turbine blades are connected to a shaft that turns when the wind makes the blades move. The shaft is connected to a gearbox and an electric generator that makes electricity.

A modern wind turbine has three sections, the Tower, the Nacelle, and the Rotor.

The Tower supports the Nacelle and the Rotor and holds them high in the air where the wind blows more strongly.

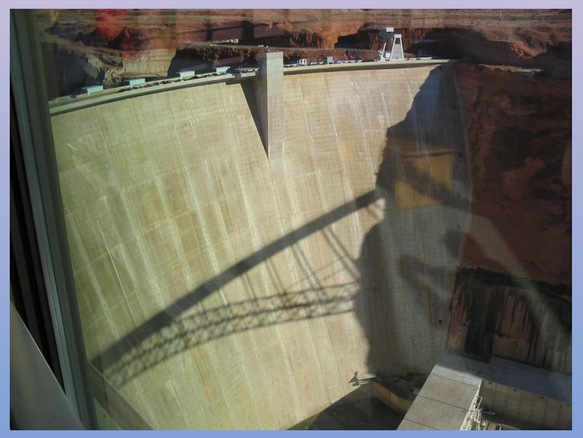
The wind turns the Rotor, which turns the mechanical gears and an electric generator inside the Nacelle.



Wind turbines can be grouped together to make wind farms especially in areas where the wind blows strongly and continuously.

HYDRO POWER

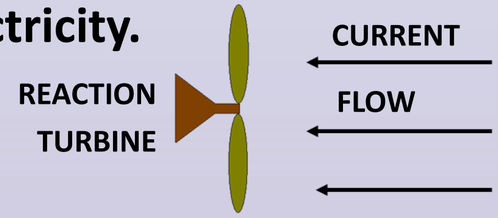
Hydroelectric energy comes from the energy in moving water.
The water can be a flowing river, the up and down motion of ocean waves, the water released from a dam, or the water currents caused by ocean tides.
This energy can be used to operate machinery, such as in a flour mill or make electricity using an electrical generator.



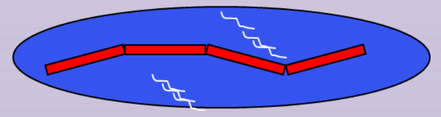
GLEN CANYON DAM, AZ

How it works:

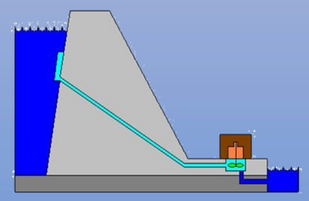
The flow of current in a river can be used to power a reaction turbine and a generator submerged in the river to make electricity.



The up-down motion of the ocean surface can be used to power wave machines.



In a dam, the potential energy of the water behind the dam is converted into kinetic energy by letting the water fall down towards a turbine.
The flowing water spins the turbine which is connected to an electric generator



One of the earliest turbines was the water wheel that used water flowing in a river as the source of energy. The "undershot" water wheel uses the water flowing in the river under a wheel that is connected to mechanical equipment to grind grain. The "overshot" water wheel is where the river is diverted and made to flow over an water wheel.

UNDERSHOT WATER WHEEL

BIO-FUEL ENERGY

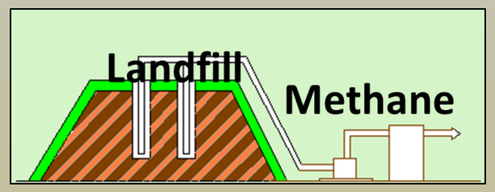
Biomass is material that comes from living or recently dead plants and animals. Some examples are grass, wood from trees, and waste from humans and other animals.

Biomass can be used as a fuel directly or can be converted into bio-gas or liquid fuels which can be burned to provide heat for cooking, warm our homes, generate electricity, power our cars, create food additives, manufacture plastics and other materials.

The five methods of using Bio-Fuel are: Digestion, Gasification and Pyrolysis, Lipid Oil Extraction, Direct Burning, and Fermentation.

How it works:

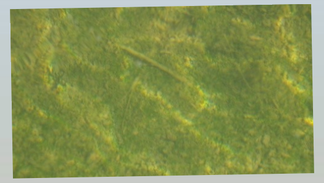
<u>Digestion</u> - Biomaterial such as manure from a Concentrated Animal Feeding Operation (CAFO) is put into a tank and microbes digest the solid material which produces a gas called methane.



Household waste is also digested in a landfill. The methane can be collected and used as a fuel.

<u>Gasification and Pyrolysis</u> - Dry material is heated and turned into gas mixture of carbon monoxide (CO) and and hydrogen (H_2) called Syn-Gas.

<u>Lipid Oil Extraction</u> - Oil can be can squeezed from plants such as soy beans and algae. The oil can be processed to make fuels and other chemicals.



ALGAE

<u>Direct Burning</u> - Biomass can be burned in a boiler, where water is boiled to make steam, which can be used to power a turbine/ generator to make electricity.

<u>Fermentation</u> - A process in which the sugars in biomass material are reacted with yeasts to produce ethanol. Ethanol can be used as a fuel for automobiles.

GEOTHERMAL ENERGY

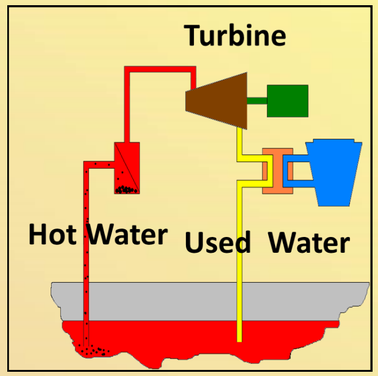
Geothermal Energy is the heat contained in the earth. Indications that geothermal energy is close to the earth's surface are volcanoes, mud pots, fumaroles, geysers, and hot springs.

The most active geothermal areas on earth are in the "Pacific Ring of Fire".

Geothermal energy can heat or cool a building, be used in greenhouses for agriculture, or be used to generate electricity.

How it works:

A hole is drilled deep into the earth and geothermal hot water "flashes" into steam when it reaches the earth's surface. The steam powers a turbine/ generator to make electricity. The used water is put back into the earth to get hot again..



Different technologies are used in geothermal power plants depending on the temperature of the geothermal resource.

<u>Hot Dry Steam</u>: Steam comes directly out of the drilled hole.

<u>Flash Steam</u>: High pressure hot water comes out of the drilled hole and flashes to steam at the earth's surface.

<u>Binary Cycle</u>: The hot water coming out of the drilled hole is used to vaporize an organic liquid with a low boiling point.

<u>Hot Dry rock</u>: Cold water is injected into the drilled hole and is heated by the hot rock in the earth.

Not all Geothermal resources are hot enough to make electricity. Greenhouse farming uses warm geothermal water to heat the greenhouse, so vegetables can be grown in the winter.