

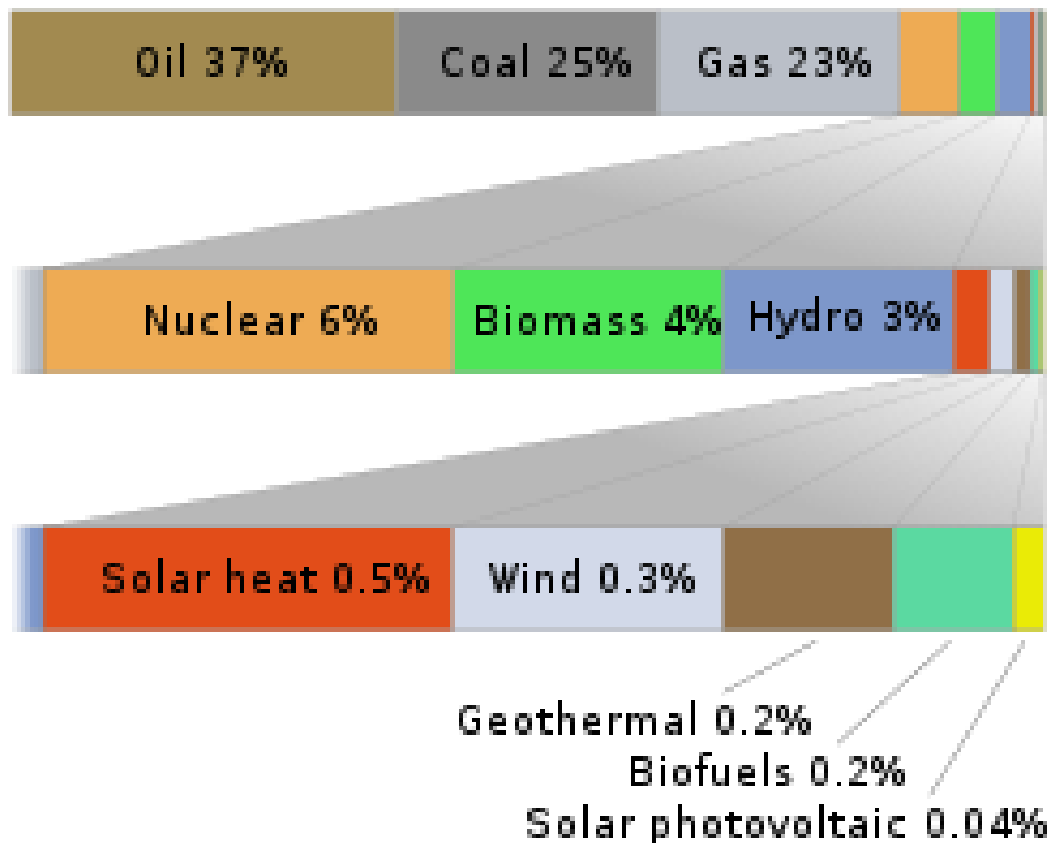
Sources of Energy

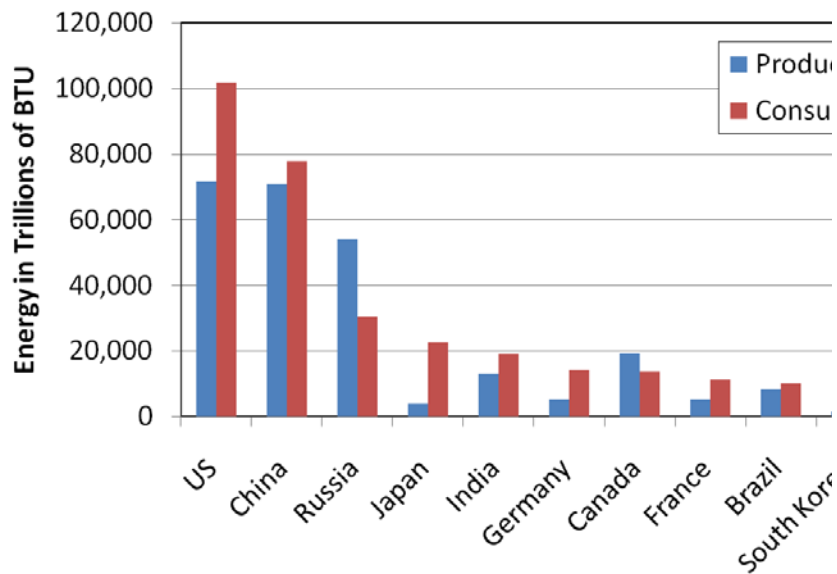
According to availability, energy sources can be classified as –

1. **Conventional / Consumable Sources of Energy:** These are the energy sources used conventionally to produce mechanical work. Energy obtained from mineral or fossil fuels are examples of this category.
2. **Renewable Sources of Energy:** These are the energy sources often used as an alternative of the conventional sources and are naturally replenishing in character. Energy generated from natural resources – such as sunlight, wind, rain, tides, geothermal heat are termed as Renewable energy and these sources are called renewable sources of energy.

World Energy Resource and Consumption

- Total worldwide energy consumption in 2008: 474×10^{18} J
- 80 to 90 percent energy derived from fossil fuels





Primary Energy Sources

Fossil Fuel	Nuclear Energy	Renewable Energy	Emerging Fuels
<ul style="list-style-type: none">•Oil•Natural Gas•Coal•Oil Sand	<ul style="list-style-type: none">•Fission•Fusion	<ul style="list-style-type: none">•Solar thermal•Wind•Hydro•Geo-thermal•Tidal	<ul style="list-style-type: none">•Biofuels•Fuel cells•Hydrogen

Fossil Fuels

- Fossil fuels are formed from the fossilized remains of dead plants and animals by exposure to heat and pressure in the Earth's crust over millions of years
- The fossil fuels include coal, petroleum, and natural gas, and contain high percentages of carbon
- Fossil fuels range from volatile materials with low carbon to hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like anthracite coal
- Fossil fuels are non-renewable resources because they take millions of years to form, and reserves are being depleted much faster than new ones are being formed
- The burning of fossil fuels produces around **21.3 billion** tons of carbon dioxide per year, but the natural processes can only absorb about half of that amount .

Petroleum Oil

- The world has produced about 1 trillion barrels of oil to date
- Over the next century or so, approximately 2 trillion barrels more are expected to be produced from conventional proved reserves and undiscovered conventional oil
- Oil and petroleum products have powered the world in the form of motor fuels for more than a century, and demand is expected to grow over the long term
- Between now and 2030, global energy consumption is projected to increase about 33 percent, with oil and gas, along with coal, continuing to meet the largest part of that demand.

The fuels include:

1. Ethane and other short-chain alkanes
2. Diesel fuel (petrodiesel)
3. Gasoline
4. Jet fuel
5. Kerosene
6. Liquefied petroleum gas (LPG)
7. Natural gas (Methane)

Oil reserve scenario

Country	Reserve	Reserve life
	10 ⁹ bbl	years
Saudi Arabia	267	72
Canada	179	149
Iran	138	95
Iraq	115	150
Kuwait	104	110

Natural Gas

- Natural gas provides 23 percent of all energy consumed in the world
 - An economical, environmentally friendly and efficient energy source, natural gas is the cleanest-burning conventional fuel, producing lower levels of greenhouse gas emissions than do heavier hydrocarbon fuels, such as coal and oil
 - Natural gas fuels electric power generators, heats buildings and is used as a raw material in many consumer products, such as those made of traditional plastics
 - The International Energy Agency predicts that the demand for natural gas will grow by more than 67 percent through 2030
-

Natural Gas reserve

Country/ Region	Natural gas proven reserves (tr m ³)
<i>World</i>	180,650
Russia	43,300
Iran	29,610
Algeria	28,080
Qatar	25,260

Coal

- Coal makes up about 28 percent of the world's total energy use
- In addition to generating electricity, coal is used in steel production, cement manufacturing and other industrial processes
- From 2005 to 2030, world coal consumption is expected to increase 65 percent

Country	Bituminous & anthracite	Sub-Bituminous & lignite	TOTAL	Share
United States	111,338	135,305	246,643	27.1
Russia	49,088	107,922	157,010	17.3
China	62,200	52,300	114,500	12.6
India	90,085	2,360	92,445	10.2
Australia	38,600	39,900	78,500	8.6

Renewable Sources of Energy

Renewable energy is energy generated from natural resources—such as sunlight, wind, rain, tides and geothermal heat—which are renewable (naturally replenished). Renewable energy technologies include –

1. Solar Energy
 2. Wind Energy
 3. Hydro Energy
 4. Wave Energy
 5. Tidal Energy
 6. Geothermal Energy
- Most renewable energies are derived from solar radiation, either direct or indirect:
 - Direct: direct use of solar energy for heating and electricity generation.
 - Indirect: energy from wind, waves, running water, plant and animals

Solar Energy

Solar energy refers to the utilization of the radiant energy from the Sun. Direct sunlight can be utilized two major ways

- Solar thermal energy
- Solar Photovoltaic

Solar Thermal Energy

Concentrated Solar Power

- Parabolic trough collector tracks the sunlight during the day and concentrates the solar radiation on a receiver tube placed on its focus.
- A receiver tube is located at the focus of the parabolic shaped mirror.
- Heat transferred to the synthetic fluid passes through the receiver and heated to the temperature enough to generate steam. The typical temperature of the working fluid becomes around 700 °C
- That heated fluid then passes through a heat exchanger to turn water into steam.

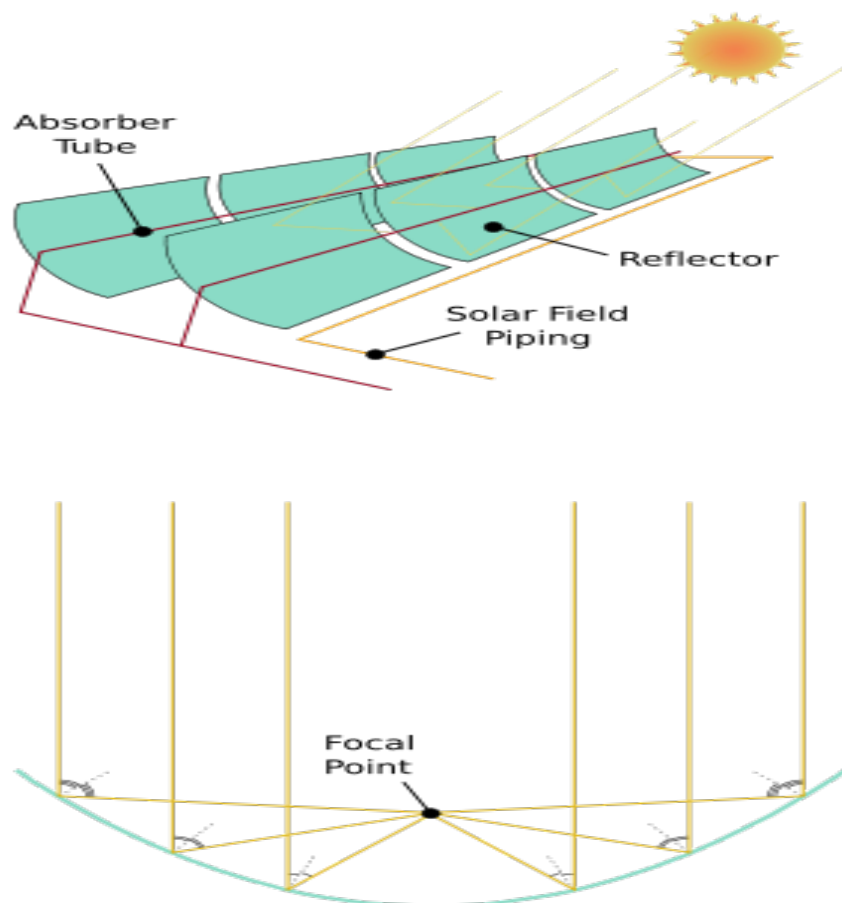
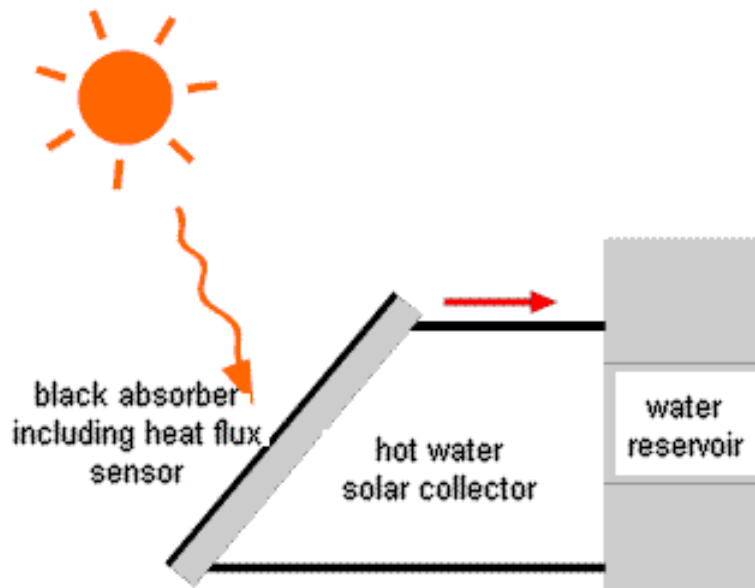


Fig. Parabolic Trough Collector

Solar Water Heater



Schematic of solar water heater (natural circulation system)

Solar Photovoltaic (PV)

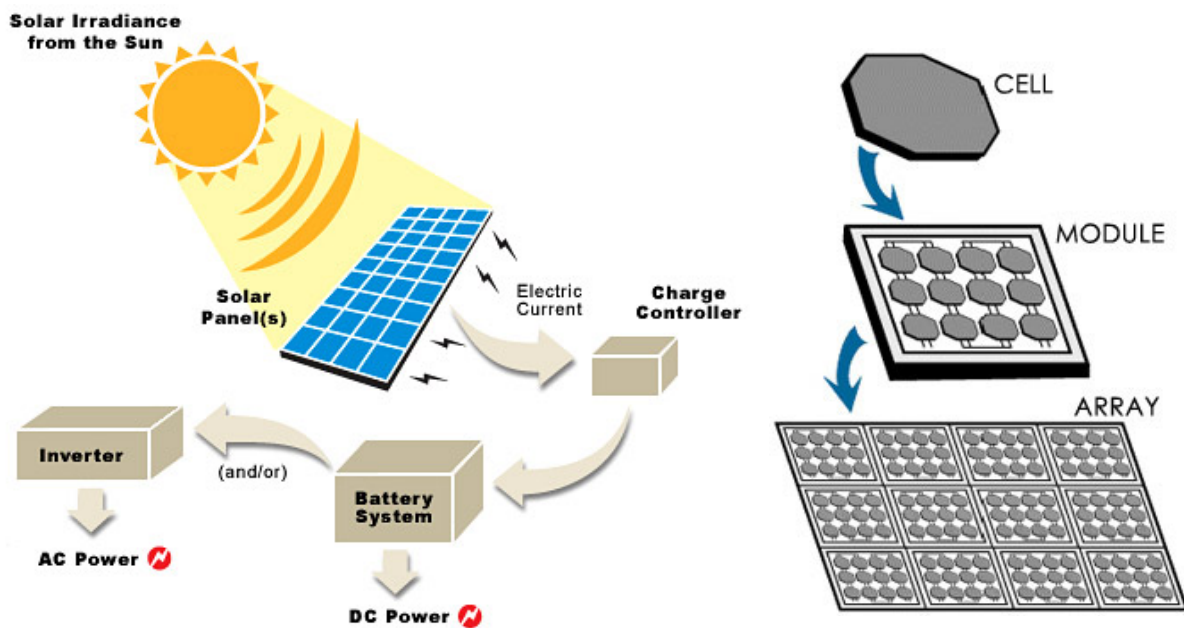


Fig.: solar energy conversion using PV cell

Fig.: components of a solar array

Wind Energy

Wind power is the conversion of wind energy into useful form, such as electricity, using wind turbines. Most wind power is generated in the form of electricity. Large scale wind farms are connected to electrical grids. Individual turbines can provide electricity to isolated locations. In windmills, wind energy is used directly as mechanical energy for pumping water or grinding grain. Wind energy is plentiful, renewable, widely distributed, clean, and reduces greenhouse gas emissions when it displaces fossil-fuel-derived electricity. Therefore, it is considered by experts to be more environmentally friendly than many other energy sources. Modern wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5–3 MW have become the most common for commercial use.

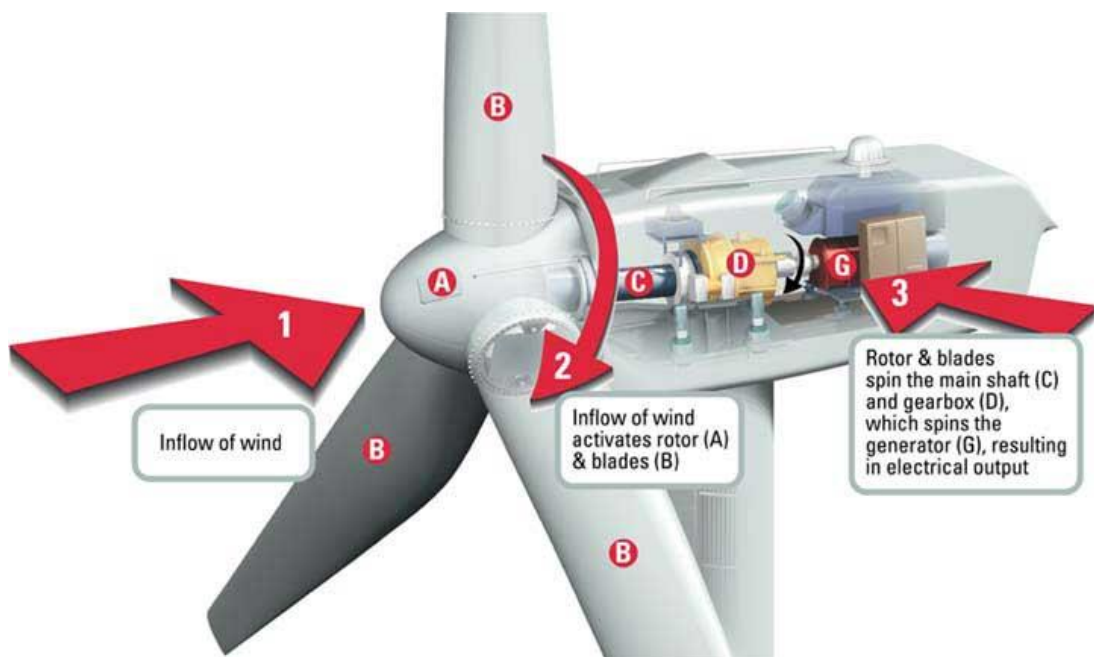
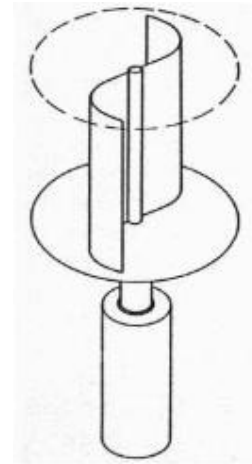


Fig.: working principle of a wind turbine

A wind turbine is a rotating machine which converts the kinetic energy in wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is then converted to electricity, the machine is called a wind generator, wind turbine, wind power unit (WPU) or wind energy converter (WEC). Wind turbines can be separated into two types based by the axis in which the turbine rotates.



Horizontal Axis Wind Turbine (HAWT)



Vertical Axis Wind Turbine (VAWT)

Hydro Energy

Hydropower, hydraulic power or water power is power that is derived from the force or energy of moving water, which may be harnessed for useful purposes. Hydroelectricity is a form of hydropower, and is the most widely used form of renewable energy. It produces no waste, and does not produce carbon dioxide (CO₂), a greenhouse gas. Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. In this case the energy extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. This height difference is called the head. The amount of potential energy in water is proportional to the head. To obtain very high head, water for a hydraulic turbine may be run through a large pipe called a penstock.

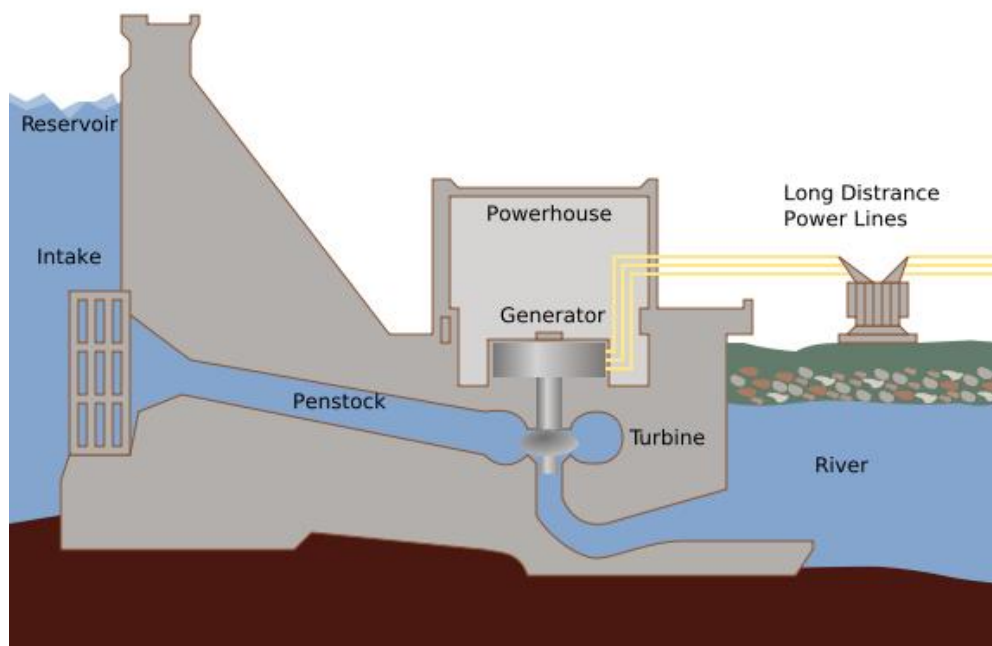


Fig.: schematic diagram of a hydroelectric power plant

Small capacity hydroelectric power plants can be divided into two categories. The plant that has a capacity of less than a megawatt (> 1 MW) is known as mini hydro power plant. Micro hydro plants has a capacity around 100 kW.

Tidal Energy

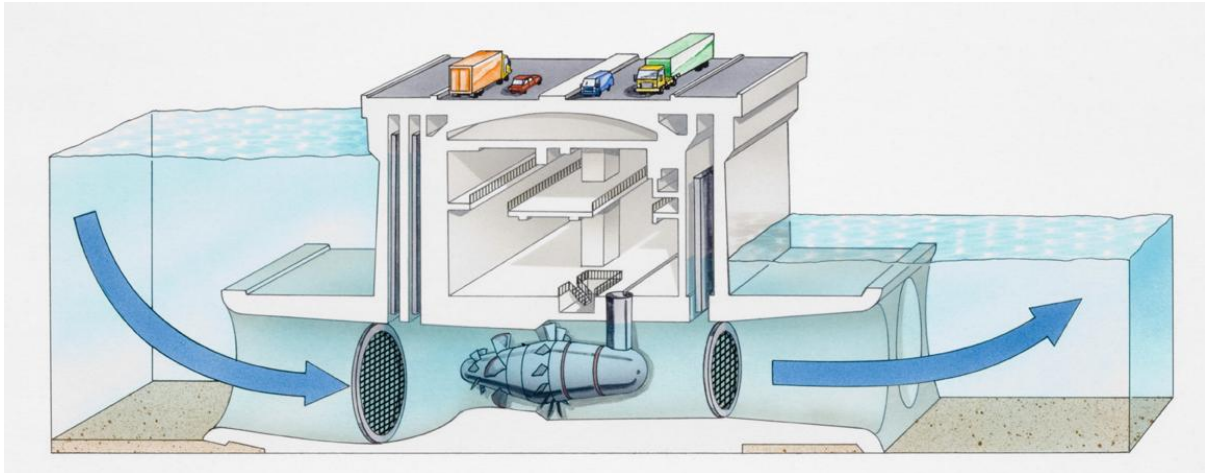


Fig.: schematic diagram of a tidal power plant

Tidal energy is a form of hydropower that converts the energy of tides into electricity or other useful forms of power. Tidal power can be harnessed either from tidal streams, using barrages to obtain the potential energy or by using tidal lagoons.

Geothermal Energy

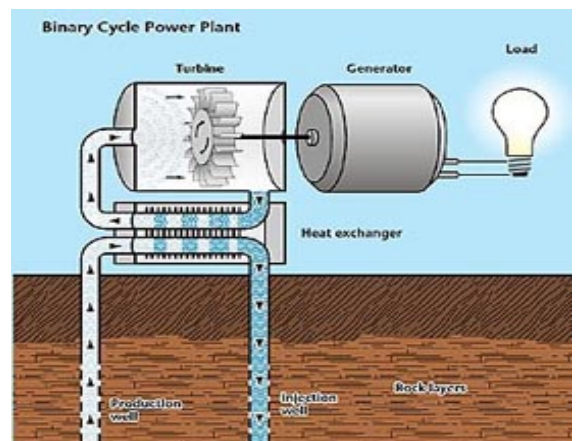
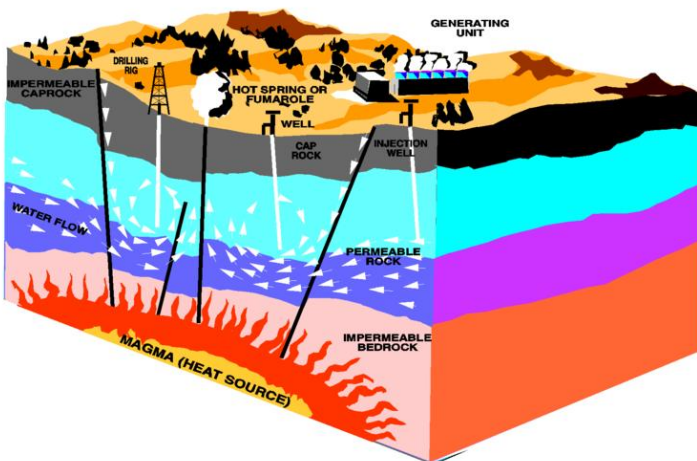


Fig.: schematic diagram of a geothermal power plant

Geothermal power is energy generated by heat stored beneath the Earth's surface, or the collection of absorbed heat derived from underground in the atmosphere and oceans.

Fuels

Fuel is any material that is burned or altered to obtain energy (usually thermal). Fuel releases its energy either through a chemical reaction means, such as combustion or nuclear means, such as nuclear fission or fusion. An important property of useful fuel is that its energy can be stored to be released only when needed, and that the release is controlled in such a way that the energy can be harnessed to produce work.

Properties of Fuels

Heating Value: The heating value or calorific value of a substance, usually a fuel or food, is the amount of heat released during the combustion of a specified amount of it. The calorific value is a characteristic for each substance. It is measured in units of energy per unit of the substance, usually mass, such as: kcal/kg, kJ/kg, J/mol, Btu/m³. Heating value is commonly determined by using a bomb calorimeter. The heat of combustion for fuels is expressed as the HHV and LHV.

1. **HHV** – The quantity known as higher heating value (HHV) (or gross calorific value or gross energy or upper heating value) is determined by bringing all the products of combustion back to the original pre-combustion temperature, and in particular condensing any vapor produced. This is the same as the thermodynamic heat of combustion since the enthalpy change for the reaction assumes a common temperature of the compounds before and after combustion, in which case the water produced by combustion is liquid.
2. **LHV** – The quantity known as lower heating value (LHV) (or net calorific value) is determined by subtracting the heat of vaporization of the water vapor from the higher heating value. This treats any H₂O formed as a vapor. The energy required to vaporize the water therefore is not realized as heat.

Higher (HHV) and Lower (LHV) Heating values of some common fuels are given below.

Fuel	HHV (MJ/kg)	LHV (MJ/kg)
Methane	55.5	50.0
Gasoline	47.3	44.4
Kerosene	46.2	43.0
Diesel	44.8	--

Stoichiometric Air – Fuel Ratio: It can be defined as the exact ratio of air and a particular fuel to completely combust it to water and carbon di-oxide. The stoichiometric air – fuel ratio of gasoline is 14.7

Power Generation Scenario of Bangladesh

Installed capacity of BPDB power plants(As on June'2010)

Hydro	230	MW	(3.95 %)
Steam	2638	MW	(45.31 %)
Gas Turbine	1466	MW	(25.18 %)
Combined Cycle	1263	MW	(21.69%)
Diesel	226	MW	(3.87 %)
Total	5823	MW	(100.00%)

TOTAL INSTALLED CAPACITY	5823 MW
BPDB	3719 MW
IPP	1330 MW
SIPP & Rental	548 MW
REB	226 MW
PRESENT GENERATION CAPABILITY	5271 MW

