ENERGY RESOURCES

Energy is a fundamental concept in physics, with applications throughout the natural sciences.

– Energy is the driving force for humans and machines

The total energy of a system can be subdivided and classified in various ways. For example, it is sometimes convenient to distinguish kinetic energy from potential energy. It may also be convenient to distinguish gravitational energy, electrical energy, thermal energy, and other forms. These classifications overlap; for instance thermal energy usually consists partly of kinetic and partly of potential energy. Energy is the primary and most universal measure of all kinds of work by human beings and nature. Most people use the word energy for input to their bodies or to the machines.

Energy: Energy is defined as the capacity for doing the work. The SI unit of energy is Joule (J).

Energy forms: Although every energy form is physically invisible, is presence is always felt. Energy can exist in various forms such as

1) Mechanical energy 2) Electrical energy
3) Chemical energy 4) Heat energy
5) Nuclear energy 6) Sound energy

Potential energy: The potential energy possessed by a body is due to its position or elevation relative to some datum plane.

Kinetic energy: The kinetic energy possessed by a body is due to the reason of its motion.

A body of mass m kg moving with a velocity V m/sec possesses an amount of kinetic energy = $mv^2/2g_c$ in Nm.

Energy sources: Energy either exists in earth or come from outer space.

Capital energy: The energy existing in the earth is known as capital energy.

Ex: fossil fuels (coal, Petroleum based fuel and natural gases), Nuclear fuels and heat traps.

Celestial energy or income energy: The energy comes from the outer space is called as celestial energy or income energy.

Ex: electromagnetic, gravitational and partical energy from stars.

- **NON RENEWABLE AND RENEWABLE ENERGY SOURCES**:

Non -Renewable energy Sources (conventional sources): The source which are formed in the earth crust over millions of year and which get depleted with their use are known as non-renewable or conventional energy sources.

Ex: fossil fuels (coal, Petroleum based fuel and natural gases), Nuclear fuels.

Renewable energy Sources (Non-Conventional): The sources which will not deplete with their use are known as renewable or non-conventional energy sources.

or

The energy resources which are produced continuously in nature and are essentially inexhaustible at least in the time frame of human societies.

Ex: solar energy, wind energy, tidal energy, hydal energy and ocean thermal energy.

Difference between Renewable and Non-Renewable source of energy

Renewable energy Sources	Non -Renewable energy Sources
1. The energy resources are non-exhaustible with their use.	The energy resources are exhaustible with their use
2. These are pollution free	Causes pollution
3. These are available at free of cost.	These are not directly available at free of cost
4. Initial cost to extract the energy source is more, but the maintenance cost is less	Initial cost is less but the maintenance cost is more.
5. The technology to extract the energy sources is not yet completely developed.	The technology to extract the energy sources is developed.
6. Ex: solar energy, wind energy, tidal energy, hydel energy etc.	Fossil fuels (coal, Petroleum based fuel and natural gases), Nuclear fuels.

RENEWABLE ENERGY SOURCES

1. LIQUID FLAT PLATE COLLECTOR (SOLAR ENERGY)

Liquid flat plate collector: solar energy can directly converted into heat energy by using flat plate collector. Figure shows a schematic representation of liquid flat plate collector.

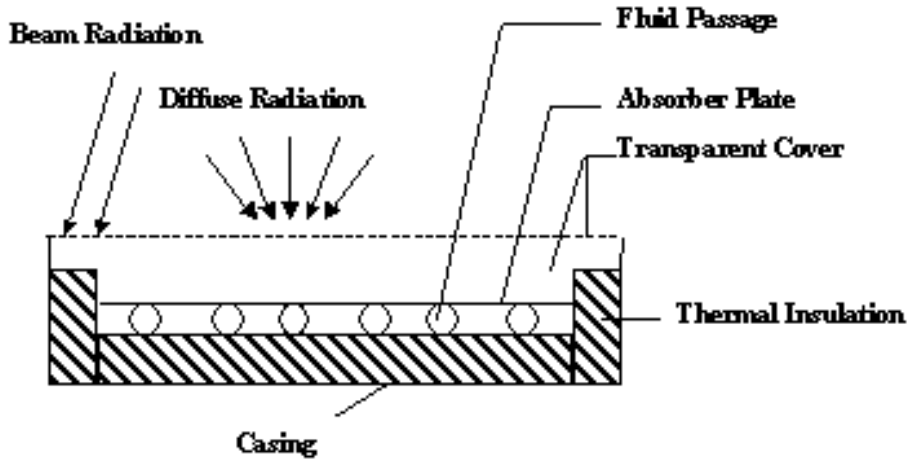


Fig. Liquid Flat Plate Collector

CONSTRUCTION: The majority of the flat plate collector has five main components as follows.

1. **Transparent cover**: A transparent cover which may be one or more sheets of glass or radiation transmitting plastic film.
2. **Absorber plate**: It basically consists of a flat surface with high absorptivity for solar radiation, called the absorbing surface. It is normally made of metallic or black surface. Usually metal plates are made of copper, steel or aluminium material with 1 to 2 mm thickness.
3. **Tubes, fins, fluid passages or channels:** These are integral with the collector absorber plate or connected by soldered, brazed or clamped to the bottom of the absorber plate. And tubes are made with copper having diameter ranges from 1 to 1.5 cm. Pitch ranging from 5 to 15 cm.
4. **Insulation:** Insulation should be provided at the back and sides to minimise the heat losses. Standard insulating materials such as fibre glass, glass wool are used for this purpose. Thermal insulation of 5 to 10 cm thickness is usually placed behind the absorber plate.
5. **Casing or Container:** casing or container which encloses the other components and protects them from the weather.

WORKING: In the liquid flat plate collector as shown in above fig. a blackened sheet of metal is used to absorb all the sunlight, direct and diffuse recitation. A sheet of metal coated in black has the property of absorbing the sunlight falling on it and convert it into heat. The heat generated in the sheet of metal is subsequently transferred to fluids like air and water etc through tubes wall. When

the conduction, convection and radiation losses during absorption, generation and transfer are prevented, this method of solar energy conversion will have very high conversion efficiencies.

2. HYDRO POWER PLANT

Hydro power: principle of electric power generation from hydropower plants. Figure shows the schematic arrangement of commonly used hydro-plant.

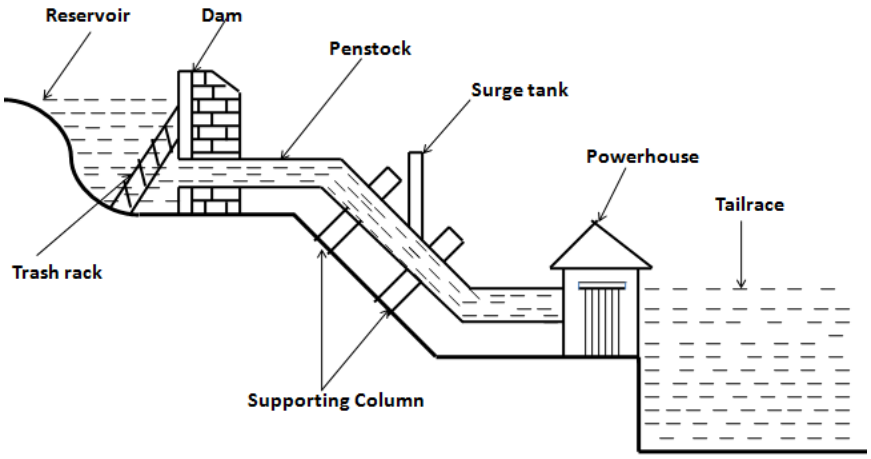


Fig. shows the schematic arrangement of commonly used hydro power-plant

CONSTRUCTION: The function of the different component used in hydro-power plants are

1. **Reservoir**: The purpose of the reservoir to store the water during rainy season and supply the same during summer when the runoff is low.
2. **Dam**: The purpose of the dam is creating the artificial reservoir and many times artificial head also.
3. **Trash rack**: The function of the trash rack is to prevent the flow of debris, sand and fishes to the prime mover. It is always located before the intake of the water from the reservoir.
4. **Penstock**: The penstock is a special pipe carrying the water from surge tank to the turbine. This is made of steel or reinforced concrete.
5. **Surge tank**: This keeps in reducing the pressure surges developed due to sudden backflow of water as load on the turbine is reduced.
6. **Prime mover**: The function of the prime mover is to convert the potential energy of water into mechanical energy. Which consist of turbine generator etc.
7. **Draft tube**: It is connected to the outlet of the reaction turbine which helps to increase the efficiency of the turbine by converting the part of kinetic energy into useful head.

8. **Generator**: The function of the generator is to generate electrical power using mechanical power of turbine.
9. **Step up transformer**: The function of step up transformer is to raise the voltage generated at the generator terminal.

WORKING: The water flow during peak rainy season is stored in the reservoir and it is carried to the prime mover through a penstock. The potential energy of the water is converted into mechanical energy as it passes through the water turbine. The mechanical energy of the water turbine in turn is used to generate electrical power. The electric power is transmitted through transformer to consumers.

❖ WIND POWER PLANT

Wind power: Wind energy is the energy contained in the force of the winds blowing across the earth's surface. When harnessed, wind energy can be converted into mechanical energy for performing work such as pumping water, grinding grain by wind mills and producing electrical energy by wind turbines. Figure shows the schematic arrangement of typical windmill.

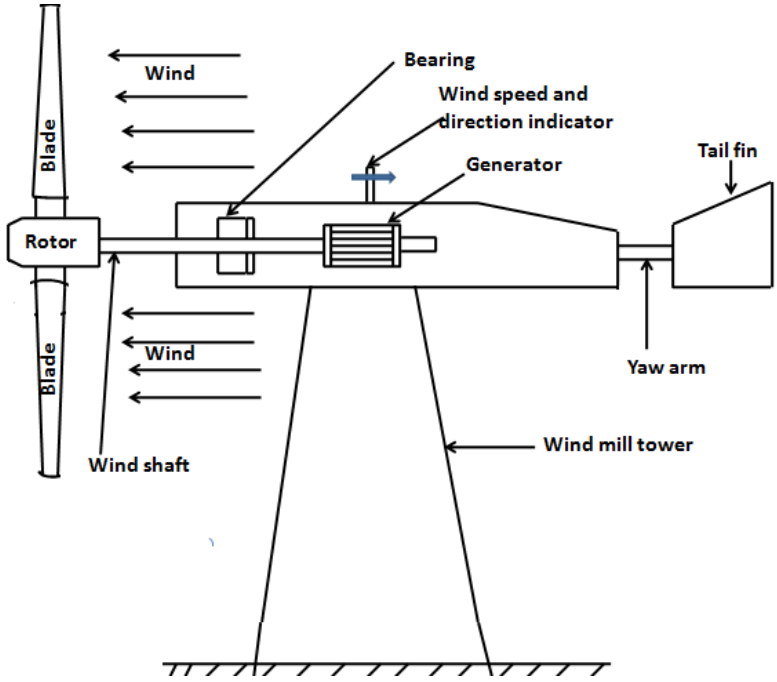


Fig. Wind mill

CONSTRUCTION: The function of the different component used in windmill is

1. **Blades**: Blades are usually made in aerofoil shape with light weight composite material.

2. **Rotor**: The rotor is usually one of the important components for effective utilization. Rotors are mainly of two types horizontal axis rotor and vertical axis rotor. The advantage of vertical axis machines is that they operate in all wind direction and thus need no yaw adjustment.
3. **Wind speed and direction indicator**: the purpose of indicator is to sense the wind speed, wind direction.
4. **Yaw Control**: Most of wind turbines are yaw active, that is to say, as the wind direction changes, a motor rotates the turbine slowly about the vertical axis so as to face the blades into the wind.
5. **Wind Mill Tower:** This supports the rotor, housing the rotor bearing. It also house many control mechanism incorporated like changing the pitch of the blades for safety devices and tail vane to orient the rotor to face the wind.

WORKING: wind energy is defined as the kinetic energy associated with the movement of large masses of air over the earth's surface. The circulation of air in the atmosphere is caused by the non-uniform heating of the earth's surface by the sun. The air immediately above a warm area expands and become less dense. It is then forced upwards by a cool denser air which flows in from the surrounding areas causing a wind. Then kinetic energy of wind can be converted into mechanical energy by rotating wind turbine blades.

❖ GEOTHERMAL POWER PLANT

Geothermal power plants can be divided into two main groups, steam cycles and binary cycles. Typically the steam cycles are used at higher well enthalpies, and binary cycles for lower enthalpies. The steam cycles allow the fluid to boil, and then the steam is separated from the brine and expanded in a turbine. Usually the brine is rejected to the environment (re-injected), or it is flashed again at a lower pressure. Here the Single Flash (SF) and Double Flash (DF) cycles will be presented.

A binary cycle uses a secondary working fluid in a closed power generation cycle. A heat exchanger is used to transfer heat from the geothermal fluid to the working fluid, and the cooled brine is then rejected to the environment or re-injected. The Organic Rankine Cycle (ORC) and Kalina cycle will be presented.

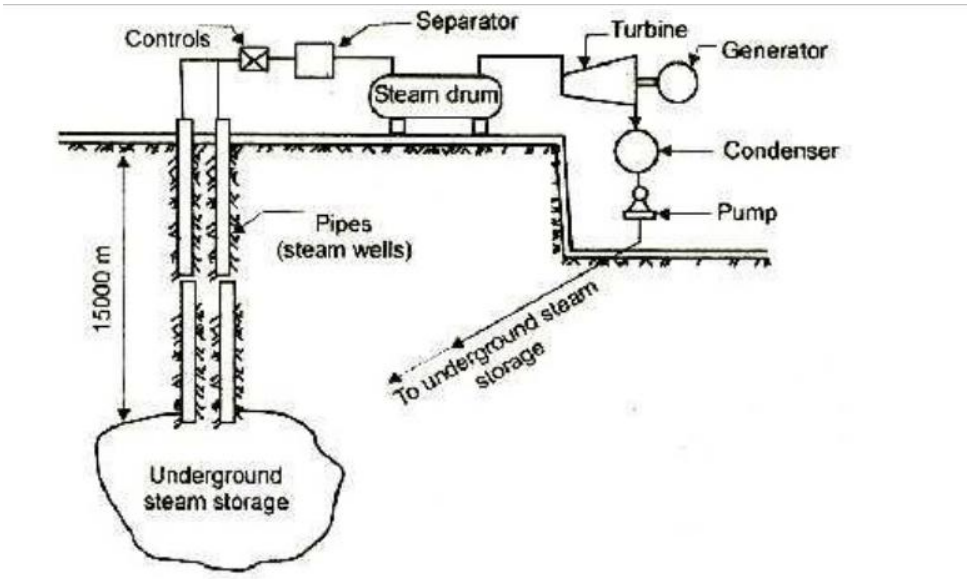


Figure: Geo-thermal power plant

Steam well

Pipes are embedded at places of fresh volcanic action called steam wells, where the molten internal mass of earth vents to the atmospheric with very high temperatures. By sending water through embedded pipes, steam is raised from the underground steam storage wells to the ground level.

Separator

The steam is then passed through the separator where most of the dirt and sand carried by the steam are removed.

Turbine

The steam from the separator is passed through steam drum and is used to run the turbine which in turn drives the generator. The exhaust steam from the turbine is condensed. The condensate is pumped into the earth to absorb the ground heat again and to get converted into steam.

Location of the plant, installation of equipment like control unit etc., within the source of heat and the cost of drilling deep wells as deep as 15,000 metres are some of the difficulties commonly encountered.

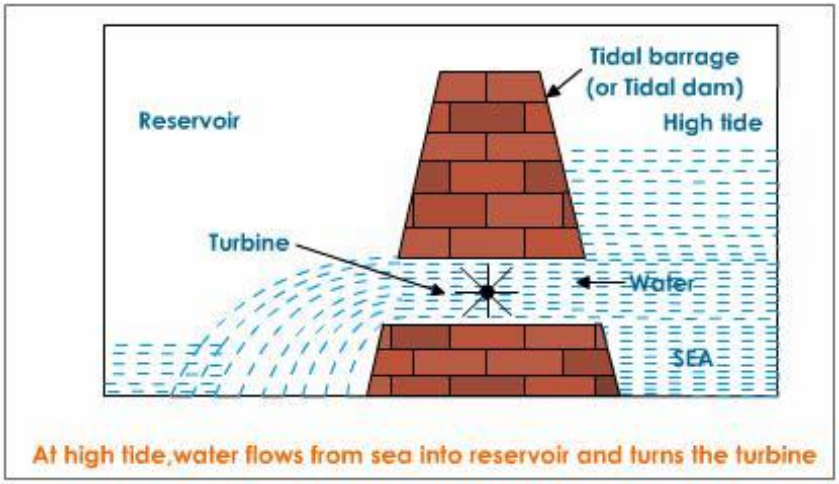
- **TIDAL ENERGY**

Tidal energy comes into existence due to rise and fall of tides when ocean surges. It is also a form of renewable energy and currently used to generate electricity.

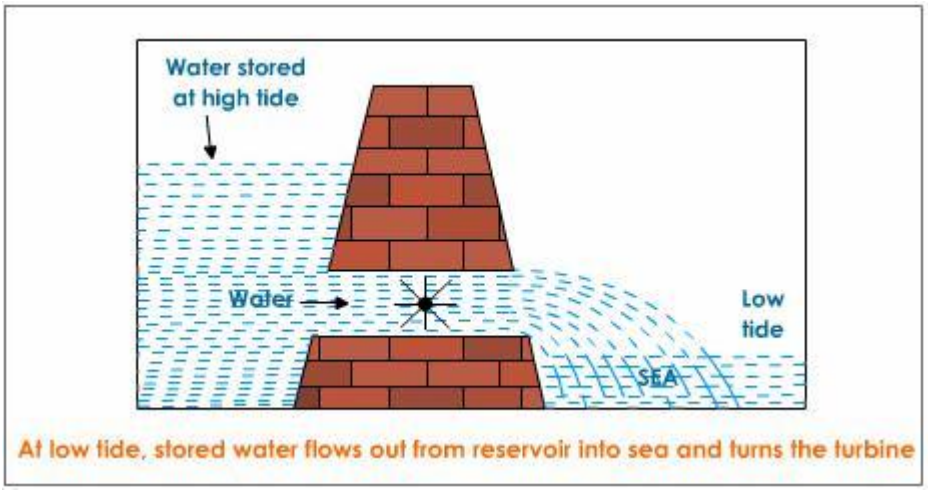
Tidal energy or tidal power can be defined as the energy that is the result of the moon and the sun's gravitaional influence on the ocean. Height differences between high and low tides create tidal currents in coastal areas, and these currents can be strong enough to drive turbines.

Working:

During high tide, when the level of water in the sea is high, sea-water flows into the reservoir of the barrage and turns the turbines. The turbines then turn the generator shaft to produce electricity.



During low tide, the sea-water stored in the barrage reservoir is allowed to flow out into the sea. This flowing water also turns the turbines and generates electricity. Thus, as the sea-water flows in and out of the tidal barrage during high and low tides, the turbines rotate continuously to generate electricity.



❖ NUCLEAR POWER PLANT

Nuclear energy: Nuclear energy is the chemical energy released during the **fission (splitting) or fusion (combining)** of atomic nuclei.

1. **Fusion process**: In nuclear fusion process, small-atomic number nuclei are joined together to form larger nuclei. In the process an extremely small fraction of mass is converted into energy.
2. **Fission process**: In a fission process a nucleus explodes into two roughly equal size nuclei with generation of energy.

Principles of nuclear power plants: The figure shows the schematic diagram of nuclear power plant.

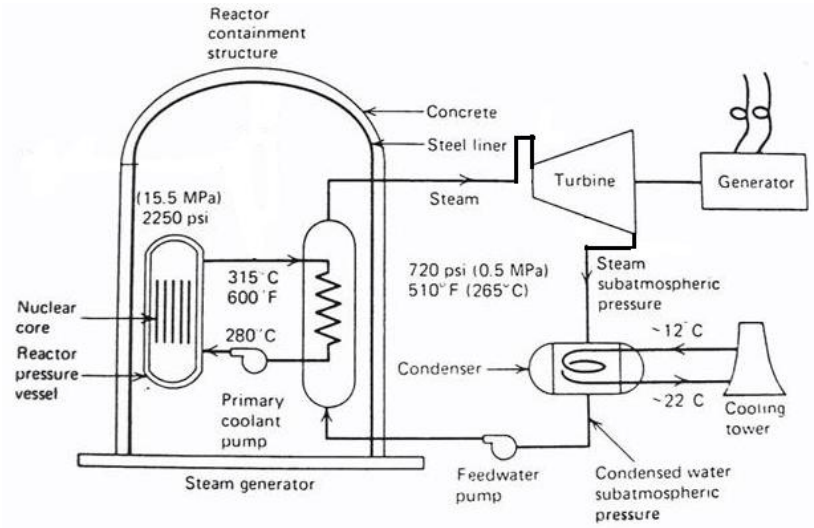


Fig. Nuclear Power Plants

CONSTRUCTION: The function of the different component used in nuclear power plants is

1. **Nuclear Reactor**: Is a device where nuclear chain reactions are initiated, controlled and also sustained at a steady rate
2. **Fuels**: The fuels which are commonly used are natural uranium containing 0.7% U^{235}.
3. **Coolant**: The purpose of the coolant is to transfer the heat generated in the reactor core and use it for steam generation.
4. **Control rods**: The purpose of the control rod is maintain the value of multifilication factor as one, that is to allow only neutron evolved in each fission to take part in further fission reaction.
5. **Moderator**: The function of the moderator is to reduce the energy of neutrons evolved during fission.

WORKING: high pressure cold water is pumped into the reactor core. It absorbs the heat energy generated due to nuclear fission. A pressuriser is used to increase the boiling point of water, which enables the water to absorb large amount of heat. High pressure, high temperature water from

pressurizer enters into steam generator. Here hot water gives the heat to feed water, which turn gets converted into steam. The generated high pressure and high temperature steam is expanded by passing through steam turbine. Rotational energy of the turbine is converted into electrical energy by coupling a generator to the shaft of steam turbine.