UNIT-III

ENERGY RESOURCES, ELECTRICITY BILL & SAFETY MEASURES

ENERGY RESOURCES:

Conventional and Non-conventional energy resources.

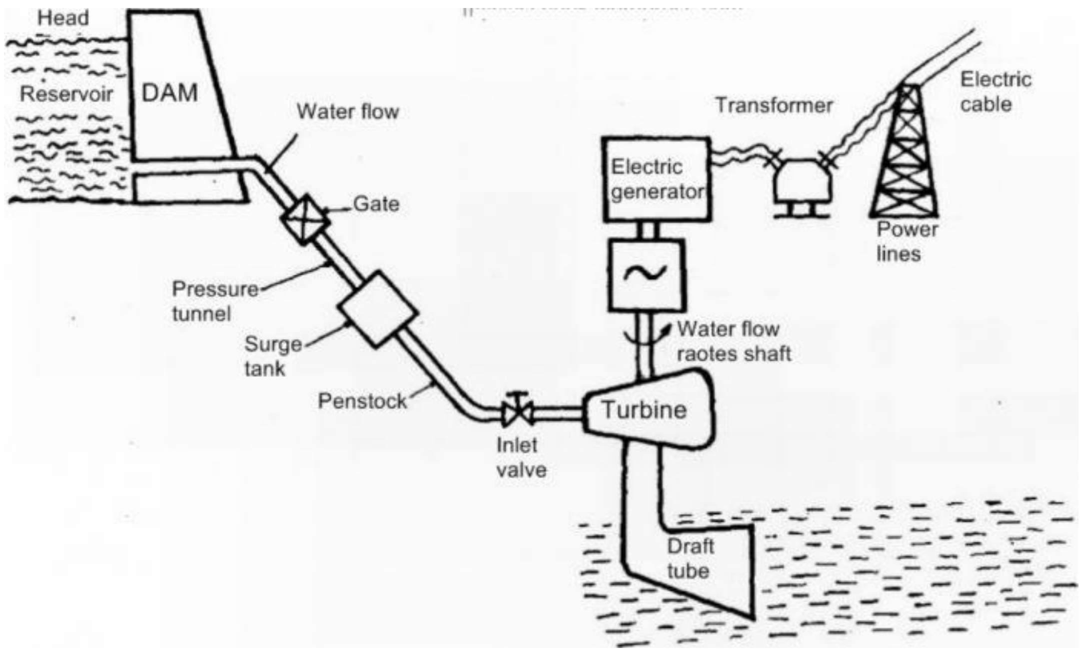
The conventional sources of energy are non renewable by any natural process. Non-conventional energy resources are renewable. These resources are available in a limited quantity. Non-conventional energy sources are eco-friendly in nature.

The differences between conventional and non-conventional energy sources are as follows-

Conventional sources of energy	Non-conventional sources of energy
Fossil fuel, CNG, coal, oil, natural gas are the examples of the conventional sources of energy.	Solar Energy, Wind Energy, Bio Energy, Hydro Energy, Tidal Energy, Ocean Energy are the examples of non-conventional energy resources.
The conventional sources of energy are non renewable by any natural process.	Non-conventional energy resources are renewable.
These resources are available in a limited quantity.	Non-conventional energy sources are eco-friendly in nature.
Conventional resources can also be classified as commercial and non commercial energy resources.	Non-conventional energy sources do not increase pollution.

Schematic Arrangement of Hydro-electric Power Station

Although a hydro-electric power station simply involves the conversion of hydraulic energy into electrical energy, yet it embraces many arrangements for proper working and efficiency. The schematic arrangement of a modern hydro-electric plant is shown in Fig. The dam is constructed across a river or lake and water from the catchment area collects at the back of the dam to form a reservoir. A pressure tunnel is taken off from the reservoir and water brought to the valve house at the start of the penstock. The valve house contains main sluice valves and automatic isolating valves. The former controls the water flow to the power house and the latter cuts off supply of water when the penstock bursts. From the valve house, water is taken to water turbine through a huge steel pipe known as *penstock*. The water turbine converts hydraulic energy into mechanical energy. The turbine drives the alternator which converts mechanical energy into electrical energy.



gates close, there is a sudden stopping of water at the lower end of the penstock and consequently the
penstock can burst like a paper log. The surge tank absorbs this pressure swing by increase in its level
of water.

Constituents of Hydro-electric Plant

The constituents of a hydro-electric plant are **(1)** hydraulic structures **(2)** water turbines and **(3)** electrical equipment. We shall discuss these items in turn.

1. Hydraulic structures. Hydraulic structures in a hydro-electric power station include dam, spillways, head works, surge tank, penstock and accessory works.

(i) Dam. A dam is a barrier which stores water and creates water head. Dams are built of concrete or stone masonary, earth or rock fill. The type and arrangement depends upon the topography of the site. A masonary dam may be built in a narrow canyon. An earth dam may be best suited for a wide valley. The type of dam also depends upon the foundation conditions, local materials and transportation available, occurrence of earthquakes and other hazards. At most of sites, more than one type of dam may be suitable and the one which is most economical is chosen.

(ii) Spillways. There are times when the river flow exceeds the storage capacity of the reservoir. Such a situation arises during heavy rainfall in the catchment area. In order to discharge the surplus water from the storage reservoir into the river on the down-stream side of the dam, spillways are used. Spillways are constructed of concrete piers on the top of the dam. Gates are provided between these piers and surplus water is discharged over the crest of the dam by opening these gates.

(iii) Headworks. The head works consists of the diversion structures at the head of an intake. They generally include booms and racks for diverting floating debris, sluices for by-passing debris and sediments and valves for controlling the flow of water to the turbine. The flow of water into and through head works should be as smooth as possible to avoid head loss and cavitations. For this purpose, it is necessary to avoid sharp corners and abrupt contractions or enlargements.

(iv) Surge tank. A surge tank is a small reservoir or tank (open at the top) in which water level rises or falls to reduce the pressure swings in the conduit. A surge tank is located near the beginning of the conduit. When the turbine is running at a steady load, there are no surges in the flow of water through the conduit *i.e.*, the quantity of water flowing in the conduit is just sufficient to meet the turbine requirements. However, when the load on the turbine decreases, the governor closes the gates of turbine, reducing water supply to the turbine. The excess water at the lower end of the conduit rushes back to the surge tank and increases its water level. Thus the conduit is prevented from bursting.

(v) Penstocks. Penstocks are open or closed conduits which carry water to the turbines. They are generally made of reinforced concrete or steel. Concrete penstocks are suitable for low heads (< 30 m) as greater pressure causes rapid deterioration of concrete.

Nuclear Power Station

A generating station in which nuclear energy is converted into electrical energy is known as a **nuclear power station.**

In nuclear power station, heavy elements such as Uranium (U235) or Thorium (Th232) are subjected to nuclear fission in a special apparatus known as a *reactor*. The heat energy thus released is utilized in raising steam at high temperature and pressure. The steam runs the steam turbine which converts steam energy into mechanical energy. The turbine drives the alternator which converts mechanical energy into electrical energy. The most important feature of a nuclear power station is that huge amount of electrical energy can be produced from a relatively small amount of nuclear fuel as compared to other conventional types of power stations. It has been found that complete fission of 1 kg of Uranium (U235) can produce as much energy as can be produced by the burning of 4,500 tons of high grade coal.

Advantages

(i) The amount of fuel required is quite small. Therefore, there is a considerable saving in the cost of fuel transportation.

(ii) A nuclear power plant requires less space as compared to any other type of the same size.

(iii) It has low running charges as a small amount of fuel is used for producing bulk electrical energy.

(iv) This type of plant is very economical for producing bulk electric power.

(v) It can be located near the load centers because it does not require large quantities of water and need not be near coal mines. Therefore, the cost of primary distribution is reduced.

Disadvantages

(i) The fuel used is expensive and is difficult to recover.

(ii) The capital cost on a nuclear plant is very high as compared to other types of plants.

(iii) The erection and commissioning of the plant requires greater technical know-how.

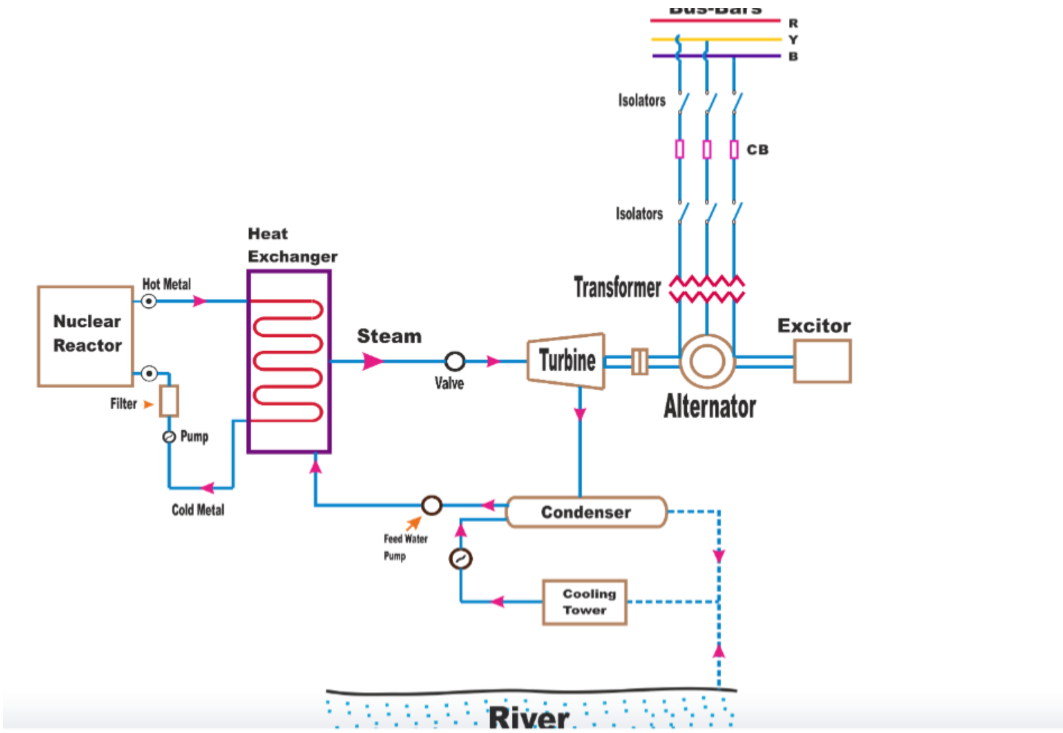
(iv) The fission by-products are generally radioactive and may cause a dangerous amount of radioactive pollution.

(v) e disposal of the by-products, which are radioactive, is a big problem. They have either to be disposed off in a deep trench or in a sea away from sea-shore.

Schematic Arrangement of Nuclear Power Station

The schematic arrangement of a nuclear power station is shown in Fig. The whole arrangement can be divided into the following main stages :

(i) Nuclear reactor ***(ii)*** Heat exchanger ***(iii)*** Steam turbine ***(iv)*** Alternator



(*i*) Nuclear reactor.

A nuclear reactor is a cylindrical stout pressure vessel and houses fuel rods of Uranium, moderator and control rods. The fuel rods constitute the fission material and release huge amount of energy when bombarded with slow moving neutrons. The moderator consists of graphite rods which enclose the fuel rods. The moderator slows down the neutrons before they bombard the fuel rods. The control rods are of cadmium and are inserted into the reactor. Cadmium is strong neutron absorber and thus regulates the supply of neutrons for fission. When the control rods are pushed in deep enough, they absorb most of fission neutrons and hence few are available for chain reaction which, therefore, stops. However, as they are being withdrawn, more and more of these fission neutrons cause fission and hence the *intensity* of chain reaction (or heat produced) is increased. Therefore, by pulling out the control rods, power of the nuclear reactor is increased, whereas by pushing them in, it is reduced.

(*ii*) Heat exchanger. The coolant gives up heat to the heat exchanger which is utilised in raising the steam. After giving up heat, the coolant is again fed to the reactor.

(*iii*) Steam turbine. The steam produced in the heat exchanger is led to the steam turbine through a valve. After doing a useful work in the turbine, the steam is exhausted to condenser. The condenser condenses the steam which is fed to the heat exchanger through feed water pump.

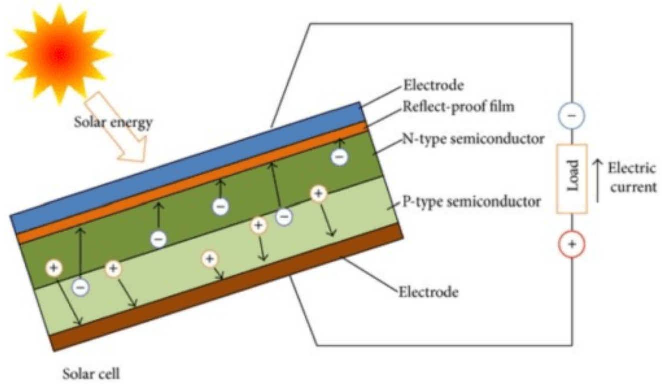
(*iv*) Alternator. The steam turbine drives the alternator which converts mechanical energy into electrical energy. The output from the alternator is delivered to the bus-bars through transformer, circuit breakers and isolators.

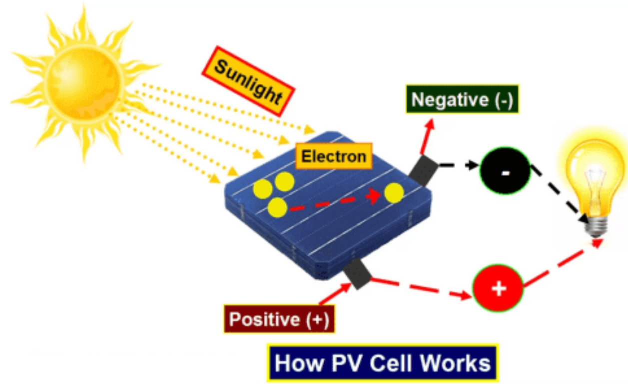
What is Solar Power Plant?

The solar power plant is also known as the Photovoltaic (PV) power plant. It is a large-scale PV plant designed to produce bulk electrical power from solar radiation. The solar power plant uses solar energy to produce electrical power. Therefore, it is conventional power plant. Solar energy can be used directly to produce electrical energy using solar PV panels. Or there is another way to produce electrical energy that is concentrated solar energy. In this type of plant, the radiation energy of solar first converted into heat (thermal energy) and this heat is used to drive a conventional generator. This method is difficult and not efficient to produce electrical power on a large scale. Hence, to produce electrical power on a large scale, solar PV panels are used.

Photo Voltaic (PV) Principle

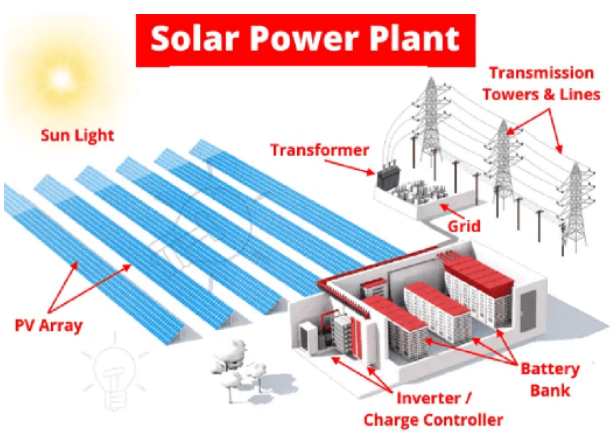
Silicon is the most commonly used material in solar cells. Silicon is a semiconductor material. Several materials show photoelectric properties like; cadmium, gallium arsenide, etc. Electron-holes pairs are created in solar cells. The PV materials have the property to absorb photons of sunlight. The valance band electrons of semiconductor material are at lower energy and the electrons of conduction band are at a higher energy level. The difference between this energy level is known as band gap energy E_g. When sunlight falls on solar cells, the difference between photon energy E and band gap energy E_g is absorbed by the cell. And it excites some electrons to jump across the band gap. These electrons move from the valance band to the conduction band and create holes in the valance band. Therefore, if the potential difference exists within the cell, the electrons of the conduction band and holes of the valance band made the flow of current in the circuit.

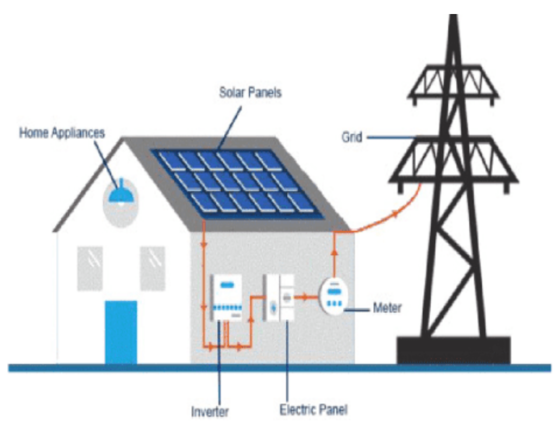




How does a solar power plant work?

1. **Solar Panels:** The solar power plant comprises thousands of solar panels, which are made up of semiconductor materials like silicon. When sunlight hits the solar panels, it excites electrons in the semiconductor, creating a flow of direct current (DC) electricity.
2. **Inverters:** The DC electricity generated by the solar panels is then sent to inverters, which convert it into alternating current (AC) electricity. AC electricity is the standard form of electricity used in homes and businesses.
3. **Transformer and Grid Connection:** The AC electricity is then passed through a transformer to increase its voltage to the appropriate level for grid transmission. Afterward, the electricity is fed into the electrical grid through power lines, supplying renewable energy to homes and businesses.





Wind Power Plant Definition

Wind power plants, also known as wind farms, are facilities that use wind turbines to convert the kinetic energy of the wind into electrical energy. These plants are a source of renewable energy and help reduce greenhouse gas emissions. Wind Power plants are a collection of wind turbines either horizontal or vertical type. These turbines collect the energy individually and are connected to a common plant. The wind turbine is also similar to the normal turbine, as it converts kinetic energy into mechanical energy.

Working of Wind Power Plant

Turbine works on the principle of conversion of kinetic energy of wind to mechanical energy used to rotate the blades of a fan connected to an electric generator. When the wind or air touches the blades (or) vanes of the windmill it the air pressure can be uneven, higher on one side of the blade and lower on the other. Hence, uneven pressure causes the blades to spin around the center of the turbine. The turbine does not operate at wind speeds above 55 mph with the use of the controller.

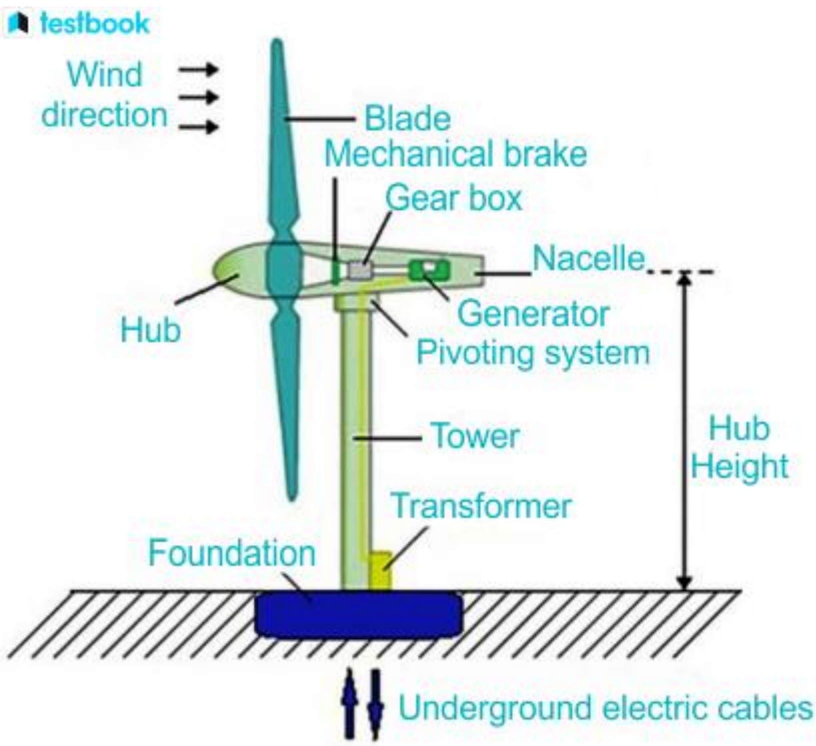


Fig : Working of wind power plant

The rotor shaft of the turbine (ie., low speed and high speed) is interlinked with the gearbox which converts the speed from 30 to 60 rpm into 1000 to 1800 rpm.As the gearbox consists of gears, to transmit mechanical energy. These speeds are most suitable to the generator for the generation of electricity. When the rotor of the turbine rotates it drives a generator through a setup gearbox causing the generator to produce electrical energy. Windmills are available in size from 100 KW to 36 MW mainly used off-shore Now the engineers are designing 10 MW of the wind turbine.

Types of Wind Power Plant (Wind Turbines)

There are two types of wind turbines

Horizontal Axis Wind Turbines (HAWT)

Vertical Axis Wind Turbine (VAWT)

Horizontal Axis Wind Turbines (HAWT): These turbines resemble windmills, with the tip of the shaft pointing in the direction of the wind. Smaller turbines are steered by wind vanes mounted on the building since they must face the wind. Wind sensors and servos are used with larger turbines to turn them.

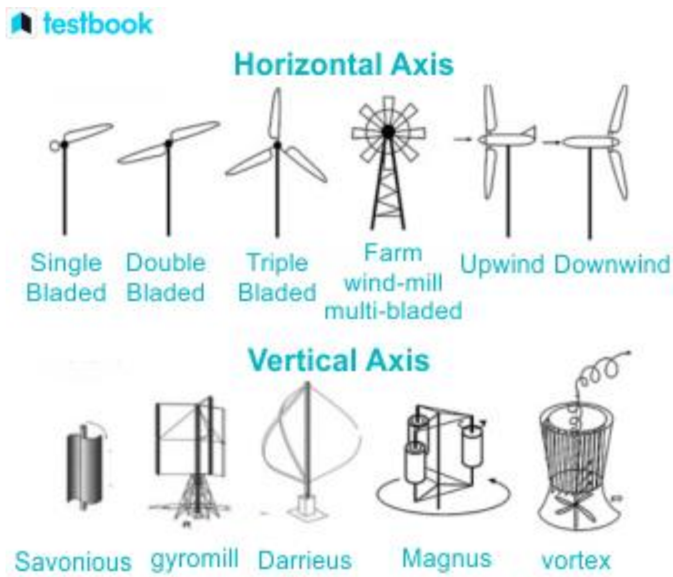


Fig 3: Types of wind turbines

Vertical Axis Wind Turbine (VAWT)

Mounted on the vertical shaft is the main root. This gets rid of the problems with horizontal wind turbines. As they require more space and are difficult to install. The sub types consist of Darius Type turbine, Savonious Type Turbine. The above figure shows different types of Wind turbines

Components of Wind Power Plant

Blades are usually made of fiber glass or balsa wood. Most turbines have either two or three blades.

Rotor: It includes the blades and the hub together. The blades spin the rotor, which is attached to a shaft that transfers the torque it creates into the gearbox. The rotor provides pitch regulation for power output optimization and control.

Low-Speed Shaft: The rotor turns the low-speed shaft at about 15 to 30 rotations per minute.

Fig 4: Construction and Working of Windmill

Gear box connect the low-speed shaft to the high-speed shaft and increases the rotational speeds from about 15 to 30 rotations per minute (rpm) to about 1000 to 1800 rpm, the rotational speed required by most generators (alternators) to produce electricity. This is an expensive and heavy part of wind turbines.Generator is usually an induction generator that produces 50-cycle AC electricity.

Anemometer: It measures the wind speed and transmits the data to the controller. The controller then corrects the turbine's direction, pitch, and yaw to best harvest the available wind energy. Wind vane measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.

High-Speed Shaft: Drives the generator Yaw drive in upward turbines face into the wind. The yaw drive keeps the rotor facing into the wind as the wind direction changes. Down wind turbines don’t require a yaw drive, the wind blows the rotor downwind Yaw Motor powers the yaw drive.

ELECTRICITY BILL:

Power rating of household appliances:

HOUSEHOLD APPLIANCES

Kitchen Appliances	Running Watts	Surge Watts
Coffee Maker	1,000 W	0 W
Deep Freezer	500 W	1,500 W
Dishwasher	1,500 W	1,500 W
Electric Can Opener	170 W	0 W
Electric Kettle	1,200 W	3,000 W
Electric Stove (8" Element)	2,100 W	0 W
Food Dehydrator	800 W	0 W
Food Processor	400 W	0 W
Fryer	1,000 W	0 W
Microwave	1,000 W	0 W
Pressure Cooker	700 W	0 W
Refrigerator / Freezer	700 W	2,200 W
Rice Cooker	200 W	500 W
Toaster	850 W	0 W

Other Appliances	Running Watts	Surge Watts
Cell Phone Battery Charger	25 W	0 W
Clock Radio	50 - 200 W	0 W
Copy Machine	1,600 W	0 W
Electric Mower	1,500 W	0 W
Electric Strimmer	300 W	500 W
Fax	60 - 80 W	0 W
Garage Door Opener (1/2 HP)	875 W	2,350 W
Outdoor Light String	250 W	0 W
Paper Shredder	200 W	220 W
Printer	400 - 600 W	0 W
Projector	220 W	270 W
Scanner	10 W	18 W
Security System	500 W	0 W
Treadmill	280 W	900 W

Essential Appliances	Running Watts	Surge Watts
Ceiling Fan	60 W	70 W
Central AC (10,000 BTU)	1,500 W	4,500 W
Central AC (24,000 BTU)	3,800 W	11,400 W
Common Light Bulb	75 W	0 W
Electric Water Heater	4,000 W	0 W
Furnace Fan Blower (1/2 HP)	800 W	2,350 W
Furnace Fan Blower (1/3 HP)	700 W	1,400 W
Garage Door Opener (1/2 HP)	875 W	2,350 W
Heat Pump	4,700 W	4,500 W
Humidifier (13 Gal.)	175 W	0 W
Space Heater	1,800 W	0 W
Sump Pump (1/2 HP)	1,050 W	2,150 W
Sump Pump (1/3 HP)	800 W	1,300 W
Well Water Pump (1/2 HP)	1,000 W	2,100 W
Window AC (10,000 BTU)	1,200 W	3,600 W
Window AC (12,000 BTU)	3,250 W	9,750 W

Entertainment Appliances	Running Watts	Surge Watts
Home Internet Router	5 W	15 W
Home Phone	3 W	5 W
Laptop	300 W	0 W
Monitor	200 - 250 W	0 W
Stereo	450 W	0 W
Television	500 W	0 W
VCR / DVD Player	100 W	0 W
Video Game System	40 W	0 W

Entertainment Appliances	Running Watts	Surge Watts
Clothes Dryer (Electric)	5,400 W	6,750 W
Clothes Dryer (Gas)	700 W	1,800 W
Curling Iron	1,500 W	0 W
Electric Shaver	15 W	20 W
Hair Dryer	1,250 W	0 W
Iron	1,200 W	0 W
Vacuum Cleaner	200 W	700 W
Washing Machine	1,150 W	2,250 W

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Definition of unit used for the consumption of electrical energy

The unit of electrical energy is *watt-sec* or *joule* and is defined as follows: One watt-second (or joule) energy is transferred between two points if a p.d. of 1 volt exists between them and 1 ampere current passes between them for 1 second *i.e.*,

Electrical energy in watt-sec (or joules)= voltage in volts × current in amperes × time in seconds

Joule or watt-sec is a very small unit of electrical energy for practical purposes. In practice, for the measurement of electrical energy, bigger units *viz.*, watt-hour and kilowatt hour are used.

1 watt-hour = 1 watt × 1 hr

= 1 watt × 3600 sec = 3600 watt-sec

1 kilowatt hour (kWh) = 1 kW × 1 hr = 1000 watt × 3600 sec = 36 x 105 watt-sec.

Two-part tariff.

When the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed, it is called a **two-part tariff**.

In two-part tariff, the total charge to be made from the consumer is split into two components *viz*.,fixed charges and running charges. The fixed charges depend upon the maximum demand of the consumer while the running charges depend upon the number of units consumed by the consumer. Thus, the consumer is charged at a certain amount per kW of maximum demand plus a certain amount per kWh of energy consumed

Total charges = Rs (b × kW + c × kWh)

where, b = charge per kW of maximum demand

c = charge per kWh of energy consumed

This type of tariff is mostly applicable to industrial consumers who have appreciable maximum demand.

Advantages

(*i*) It is easily understood by the consumers.

(*ii*) It recovers the fixed charges which depend upon the maximum demand of the consumer but are independent of the units consumed.

Disadvantages

(*i*) The consumer has to pay the fixed charges irrespective of the fact whether he has consumed or not consumed the electrical energy.

(*ii*) There is always error in assessing the maximum demand of the consumer

Calculation of electricity bill for domestic consumers

Electricity consumption is the volume of energy you use over a given period of time. It is usually measured in kWh

- **Television:** 100-400 W, which is equivalent to 0.1-0.4 kW.
- **Air conditioning:** 900-2,000 W, which is equivalent to 0.9-2 kW.
- **Microwave:** 900-1,500 W, which is equivalent to 0.9-1.5 kW.
- **Fridge:** 200-400 W, which is equivalent to 0.2-0.4 kW.
- **Oven:** 1,200-3,000 W, which is equivalent to 1.2-3 kW.

- **Incandescent lamp:** 30-80 W, which is equivalent to 0.03-0.08 kW.
- **LED light bulb:** 3-12 W, which is equivalent to 0.003-0.012 kW.

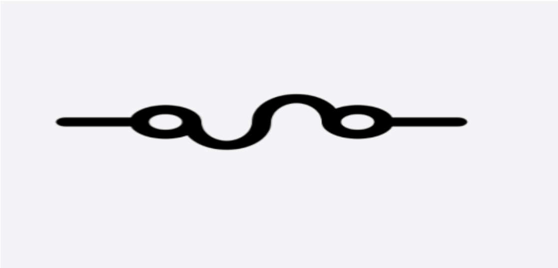
To calculate consumption, you multiply the power in kW by the hours you use the devices per day, per week or per month. For example, let's examine the consumption at the home of Agnes and Roman:

The TV has a power of 200 W, that is, 0.2 kW. They have it on for 2 hours a day, so their daily consumption is 0.4kWh. If you want to know your monthly consumption, you just multiply the daily consumption by the number of days in the month, for example, 30. So you would have a monthly consumption of 12 kWh.

EQUIPMENT SAFETY MEASURES:

Working of Fuse :

A **fuse** *is a short piece of metal, inserted in the circuit, which melts when excessive current flows through it and thus breaks the circuit.* The fuse element is generally made of materials having low melting point, high conductivity and least deterioration due to oxidation *e.g.*, silver, copper etc. It is inserted in series with the circuit to be protected. Under normal operating conditions, the fuse element is at a temperature below its melting point. Therefore, it carries the normal current without overheating. However, when a short-circuit or overload occurs, the current through the fuse increases beyond its rated value. This raises the temperature and fuse element melts (or blows out), disconnecting the circuit protected by it. In this way, a fuse protects the machines and equipment from damage due to excessive currents.



The time required to blow out the fuse depends upon the magnitude of excessive current. The greater the current, the smaller is the time taken by the fuse to blow out. In other words, a fuse has inverse time-current characteristics as shown in Fig. Such a characteristic permits its use for overcurrent protection.

Advantages

(*i*) It is the cheapest form of protection available.

(*ii*) It requires no maintenance.

(*iii*) Its operation is inherently completely automatic unlike a circuit breaker which requires an elaborate equipment for automatic action.

(*iv*) It can break heavy short-circuit currents without noise or smoke.

(*v*) The smaller sizes of fuse element impose a current limiting effect under short-circuit conditions.

(*vi*) The inverse time-current characteristic of a fuse makes it suitable for overcurrent protection.

(*vii*) The minimum time of operation can be made much shorter than with the circuit breakers.

Disadvantages

(*i*) Considerable time is lost in rewiring or replacing a fuse after operation.

(*ii*) On heavy short-circuits, discrimination between fuses in series cannot be obtained unless There is sufficient difference in the sizes of the fuses concerned.

Desirable Characteristics of Fuse Element

The function of a fuse is to carry the normal current without overheating but when the current exceeds its normal value; it rapidly heats up to melting point and disconnects the circuit protected by it. In order that it may perform this function satisfactorily, the fuse element should have the following desirable characteristics:

(*i*) low melting point *e.g.*, tin, lead.

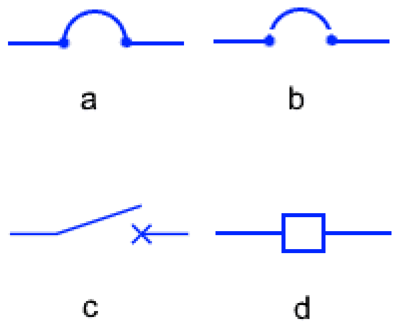
(*ii*) high conductivity *e.g.*, silver, copper.

(*iii*) free from deterioration due to oxidation *e.g.*, silver.

(*iv*) low cost *e.g.*, lead, tin, copper.

What is Miniature Circuit Breaker (MCB)?

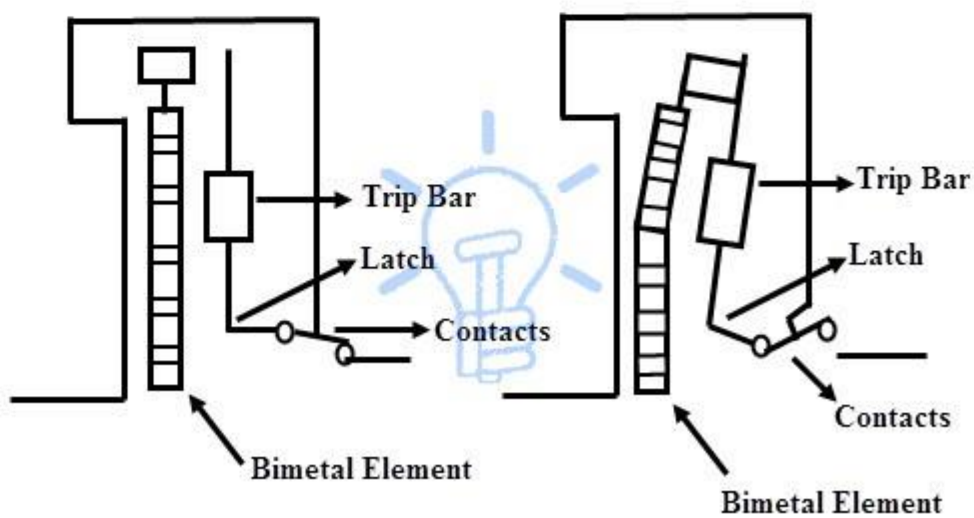
An **MCB or miniature circuit breaker** is an electromagnetic device that embodies a complete enclosure in a molded insulating material. The main function of an MCB is to switch the circuit, i.e., to open the circuit (which has been connected to it) automatically when the current passing through it (MCB) exceeds the value for which it is set. It can be manually switched ON and OFF as similar to normal switch if necessary.



Circuit Breaker Symbols

Working & Operation of MCB

Under normal working conditions, MCB operates as a switch (manual one) to make the circuit ON or OFF. Under overload or short circuit condition, it automatically operates or trips so that current interruption takes place in the load circuit. The visual indication of this trip can be observed by automatic movement of the operating knob to OFF position. This automatic operation MCB can be obtained in two ways as we have seen in MCB construction; those are magnetic tripping and thermal tripping.



Under overload conditions, the current through the bimetal causes it to raise the temperature of it. The heat generated within the bimetal itself is enough to cause deflection due to thermal expansion of metals. This deflection further releases the trip latch and hence contacts get separated. In some MCBs, the magnetic field generated by the coil causes it to develop pull on bimetals such that deflection activates the tripping mechanism.

Under short circuit or heavy overload conditions, magnetic tripping arrangement comes into the picture. Under normal working conditions, the slug is held in a position by a light spring because the magnetic field generated by the coil is not sufficient to attract the latch. When a fault current flows, the magnetic field generated by the coil is sufficient to overcome the spring force holding the slug in position. And hence slug moves and then actuate the tripping mechanism.

A combination of both magnetic and thermal tripping mechanisms are implemented in most miniature circuit breakers. In both magnetic and thermal tripping operations, an arc is formed when the contacts start separating. This arc is then forced into arc splitter plates via arc runner. These arc splitter plates are also called arc chutes where arc is formed into a series of arcs and at the same time energy extracted and cools it. Hence this arrangement achieves the arc extinction.

Advantages	**Disadvantages**
Reliability	Limited overcurrent rating
Easy to install and use	Nuisance tripping
Cost-effective	Replacement and maintenance
Space-saving	Limited protection for high power appliances

PERSONAL SAFETY MEASURES:

Electric Shock

What is electric shock?

Our bodies conduct electricity. If any part of your body meets live electricity an electric current flows through the tissues, which causes an electric shock. People sometimes call it electrocution. Depending on the length and severity the electric shock, injuries can include:

1. Burns to the skin
2. Burns to internal tissues
3. Electrical interference or damage (or both) to the heart, which could cause the heart to stop or beat erratically .

What causes electric shock?

Some causes of electric shock include:

1. Faulty appliances
2. Damaged or frayed cords or extension leads
3. Electrical appliances in contact with water

4. incorrect, damaged or deteriorated household wiring

5. Downed power lines

6. Lightning strike.

If it is safe to do so, disconnect the power supply before trying to help someone with electric shock.

Symptoms of electric shock

Typical symptoms of an electric shock include:

1. unconsciousness
2. difficulties in breathing or no breathing at all
3. a weak, erratic pulse or no pulse at all
4. burns, particularly at the place where the electricity entered and left the body (entrance and exit burns)
5. cardiac arrest.

Earthing:

Earthing is defined as **“the process in which the instantaneous discharge of the electrical energy takes place by transferring charges directly to the earth through low resistance wire.”**

Low resistance earthing wire is chosen to provide the least resistance path for leakage of fault current.When the overload current is passed through the equipment or when the fault occurs in the system due to the current, the fault current from the equipment flows through the earthing system. The various types of electric earthing systems are:

1. Pipe Earthing

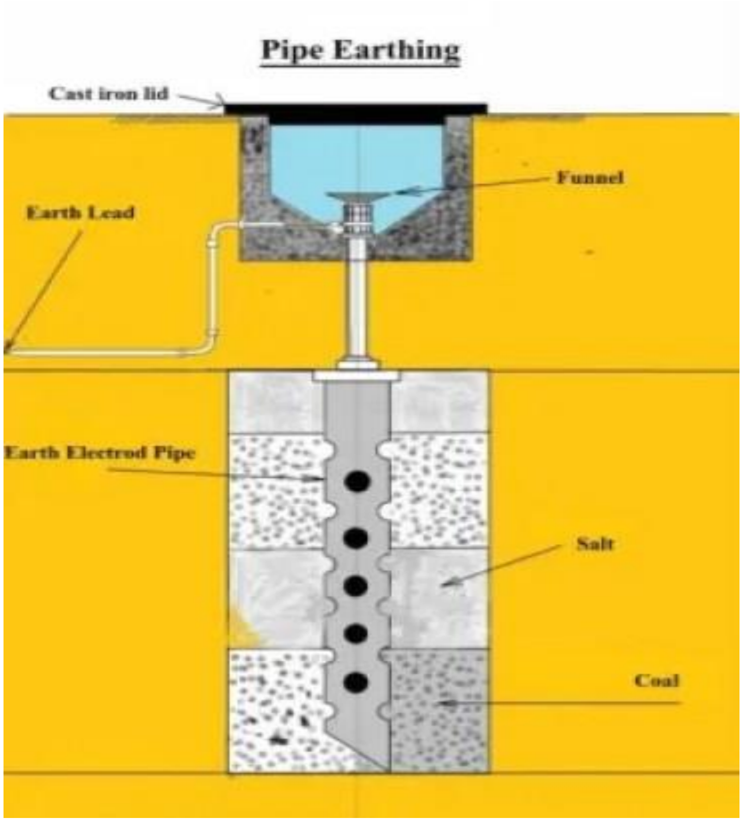


Fig 2: Pipe Earthing

Pipe earthing is a common method of connecting to the earth's electrical conductors by using a steel pipe. Galvanized steel pipe with a diameter of 38 mm and a length of 2 meters is used as an earth electrode in pipe earthing by being laid vertically in the ground.The amount of moisture in the soil and the strength of the current influence the size of the iron pipe that needs to be used. The soil's moisture will determine the maximum depth at which the steel pipe may be installed. The finest and most effective method of earthing is pipe earthing, which is also easily affordable.

2. Plate Earthing

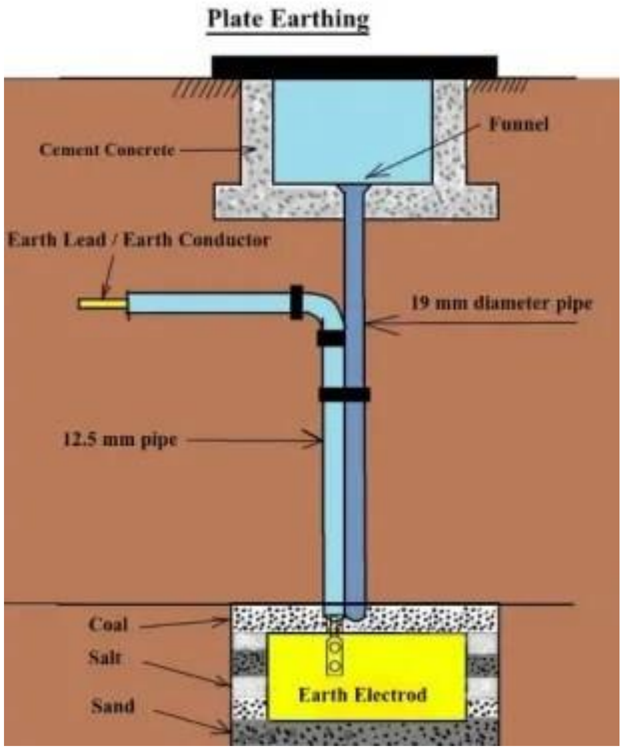


Fig 3: Plate Earthing

For this form of earthing, a plate composed of copper or galvanized iron is placed vertically in the ground pit less than three meters above the ground. For a more effective electrical grounding system, one must maintain the earth's moisture condition surrounding the plate earthing system. This plate is attached to electrical wires to redirect the electric charge within the earth.

3. Strip or Wire Earthing

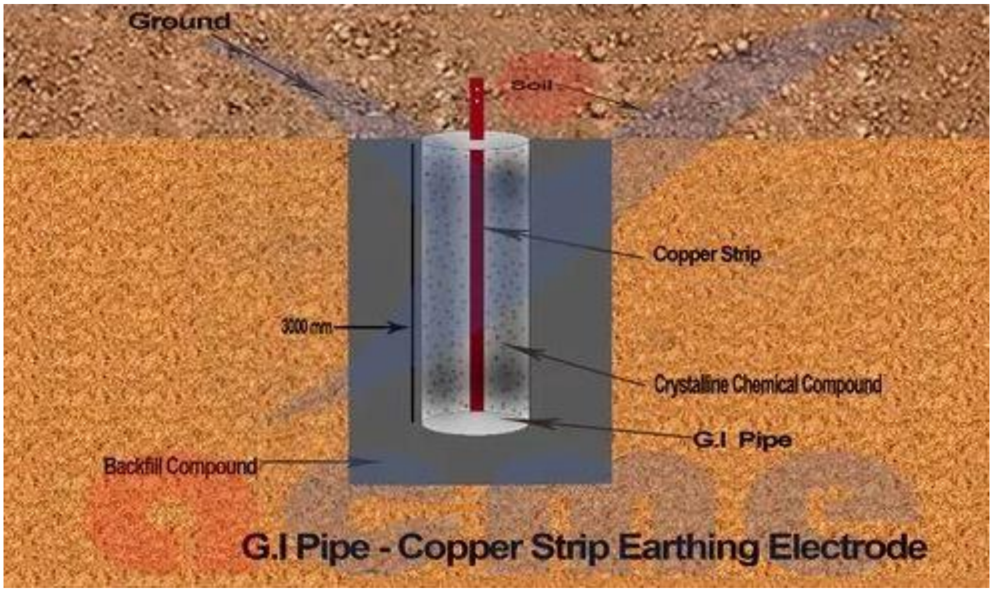


Fig 4: Strip or Wire Earthing

In this form of earthing, strip electrodes with a minimum cross-sectional area of 6.0 mm2 and a minimum depth of 0.5 m are buried in horizontal trenches. If the electrodes are made of galvanized iron or steel, their cross-sectional area shall not be less than 25 mm x 1.6 mm. When buried in the ground, a conductor with a minimum length of 15 m would provide enough earth resistance.

4. Rod Earthing

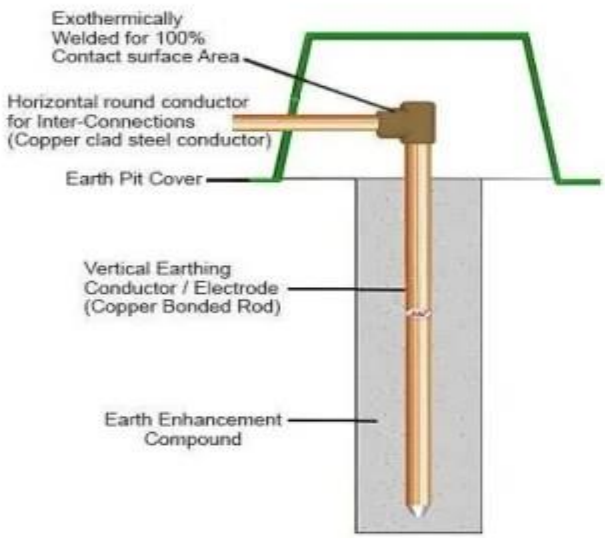


Fig 5: Rod Earthing

In this method of earthing, a copper rod with a galvanized steel pipe is placed vertically into the ground manually or with a hammer to the desired value; the lengths of the implanted electrodes reduce the earth's resistance. The rod used for this purpose is buried in the dirt at a certain depth, securely diverting the short-circuit electricity to the ground. This earthing technique is suitable for sandy areas and is also very budget-friendly.

Advantages of Earthing

1. The safest and most effective way to provide safety for a building from electrocution is through earthing.
2. The earth has no potential and is considered neutral. Balancing is accomplished because low resistance cable links low equipment to the ground.
3. Metal may be utilized in electrical systems without considering its conductivity since it won't transmit current if properly earthed.
4. If sufficient earthing precautions are taken, a rapid increase in voltage or overload has no negative effects on the object or the user.
5. It reduces the possibility of fire hazards that the current leakage may otherwise bring about.

Safety precautions to avoid electric shocks

It's vitally important to take safety precautions when working with electricity. Safety must not be compromised and some ground rules need to be followed first. The basic guidelines regarding electrical safety documented below will help you while working with electricity.

1. The first step of electrical safety, avoid water at all times when working with electricity. Never touch or try repairing any electrical equipment or circuits with wet hands. It increases the conductivity of the electric current.

2. Never use equipment with frayed cords, damaged insulation, or broken plugs.

3. If you are working on any receptacle at your home then always turn off the mains. 4. Always use insulated tools while working.

5. Electrical hazards include exposed energized parts and unguarded electrical equipment which may become energized unexpectedly.

6. Always use appropriate insulated rubber gloves and goggles while working on any branch circuit or any other electrical circuit.
7. Never try repairing energized equipment. Always check that it is de-energized first by using a tester.
8. Never use an aluminum or steel ladder if you are working on any receptacle at height in your home.