

# SOURCES OF ENERGY

## ENERGY

- It is the ability or the capacity to do work. There are two types of energy:
  - Potential Energy: It is energy stored in any system.
  - Kinetic Energy: It is energy being used during any work.
- Energy comes in different forms. Some of the different form of energy are as follows:
  - Muscular energy : Energy for carrying out physical work.
  - Electrical energy : Energy for running various electrical appliances.
  - Chemical energy : Energy for cooking food or running a vehicle.
  - Geothermal energy : Energy from underground hot water springs.
  - Wind energy : Energy from moving wind.
  - Solar energy : Energy from sunlight.
  - Tidal energy : Energy from tides in sea water.
  - Nuclear energy : Energy due to nuclear reactions.
- “The total energy during a physical or chemical process is conserved. Energy can neither be created nor destroyed.” It does not mean that same energy will be available to perform endless activities.
- “Energy comes in different forms and one form can be converted to another.” This can be understood by following examples:
  - Dropping of a plate from height converts potential energy in to sound energy.
  - In burning of candle the chemical energy converts in to heat and light energy.
  - When a hot water is left at room temp. the heat energy is lost in environment.
- Thus a usable energy form is converted in to less usable form or dissipated to the environment in order to a work, and the same energy form cannot be used again or obtained back. That is why; we experience and deal with energy crisis.

## WHAT IS A GOOD SOURCE OF ENERGY?

- **Source of energy:** Anything which supplies useable energy to carry out various activities is known as source of energy. Such as, for cooking, for lighting, for running vehicles, for operating devices like TV, computer, etc.
- **Characteristics of a good source of energy:**
  - It should be able to do a large amount of work per unit volume or mass.
  - It should be easily accessible.
  - It should be easy to store and transport.
  - Most importantly, it should be economical.

- **Characteristics of a good fuel:**
  - It should have high calorific value, so that it can give more heat per unit weight.
  - It should burn without giving out any smoke and harmful gases to minimise the environmental pollution.
  - It should be cheap and easily accessible so that it can be used easily.
  - It should be easy to handle, safe to transport and convenient to store.
  
- Sources of energy can be classified in to two groups:
  - **Renewable source of energy:** An inexhaustible energy source that can be replenished in a short period of time. e.g. Solar energy, Hydro energy, Geothermal energy, Wind energy, Tidal energy, Biomass energy, etc.
  - **Non-renewable source of energy:** An exhaustible energy source that cannot be replenished in a short period of time. e.g. Fossil fuels - oil, natural gas and coal.
  
- Sources of energy can also be classified as:
  - **Conventional source of energy** are those which are being used extensively and meet a major portion of our energy requirements. e.g. Fossil fuel and Hydro energy.
  - **Non conventional source of energy** are those energy which are not being used extensively, but these sources of energy is being tapped with the help of advance technology to meet our growing energy requirements. Thses are also known as **Alternative sources of energy**. e.g. Solar energy, Geothermal energy, Wind energy, Tidal energy, Nuclear energy.

## CONVENTIONAL SOURCES OF ENERGY

### FOSSIL FUELS

- Fossil Fuels are the combustibile remains of plants and animals which got buried deep inside the earth millions of years ago due to some natural processes. There are three main types of fossil fuels: Coal, Petroleum and Natural gas.
- The exploitation of coal as a source of energy made the industrial revolution possible. Increasing industrialisation has led to a better quality of life all over the world. It has also caused the global demand for energy to grow at tremendous rate. The growing demand for energy was largely met by the fossil fuel- coal and petroleum. Our technologies are also development for using these energy sources.
- The fossil fuels are non-renewable sources of energy so there is a need to conserve them. If we use these sources of energy recklessly high, then we would run out of energy. For this alternate sources of energy were to be explored.
- At present, fossil fuels meet most of the energy requirement, it account for about 90% of world's production of commercial energy.

- **Advantages of using fossil fuels:**
  - The burning of fossil fuels can generate large amount of heat energy with a small amount of fuel.
  - Fossil fuels are readily available, easy to use, currently plentiful and less expensive.
- **Disadvantages of using fossil fuels:**
  - Burning of fossil fuel lead to air pollution.
  - On burning fuel, the oxides of carbon, nitrogen and sulphur are released which are acidic oxides. This lead to acid rain which affects on water and soil resources.
  - CO<sub>2</sub> is produced during combustion of fossil fuel, which is a green house gas and causes global warming.
- However the pollution caused by burning fossil fuels can be reduced by two ways:
  - By increasing the efficiency of the combustion process, and
  - By using various techniques to reduce the escape of harmful gases and ashes into the surroundings.
- Besides direct use of fossil fuel (in gas stoves and vehicle), it can be used to produce more convenient secondary energy forms such as electrical energy.

## THEMAL POWER PLANT

- A thermal power plant generates electrical power from heat produced by burning fossil fuels like coal and petroleum.
- **Working of a thermal power plant:**
  - Coal or oil is burn in a furnace to produce heat energy. This heat energy is used to boil water in a reservoir.
  - The steam produced in the reservoir is allowed to fall on a turbine at high pressure, which rotates the turbine with high speed.
  - A generator or dynamo connected to turbine through an axle rotates with high speed and produce electricity.
  - The electricity so produced is transmitted to distant places through transmission wires.
- Thermal power plants are usually set up near coal field or oil filed. This is because the transmission of electricity is more efficient than transporting coal or petroleum over the same distance.

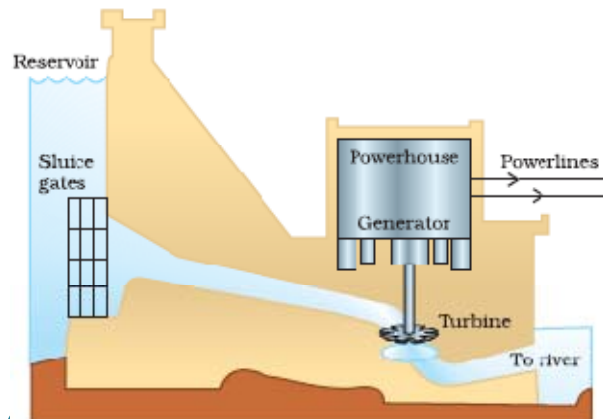
## HYDRO POWER PLANTS

- Water energy is most convenient renewable source of energy and it is obtained from water flow and water falling from height.

- A plant which generates electricity on a large scale from flowing water is called **hydroelectric power plant**.
- The electricity produced from the kinetic energy of flowing water is called **hydroelectricity**.

- **Working of a hydro power plant:**

- For the production of hydroelectricity, high rise dams are constructed on the river to obstruct the flow of water and thereby collect water in large reservoir.
- The water level rises in the reservoir and in this process the kinetic energy of flowing water gets transformed into potential energy.
- The water from high level in the dam is carried through pipes to the turbine at the bottom of the dam.
- When fast moving water coming from dam falls on the blades of water turbine the kinetic energy of water rotates the water turbine rapidly.
- When the turbine rotates, the armature coil of generator also rotates rapidly and generates electricity.



- **Principle of generation of hydroelectricity:** Potential energy of water stored in a dam is converted into kinetic energy of the falling water. The water falls on the turbine, so the kinetic energy of falling water is converted into kinetic energy of the armature of the generator connected to turbine. Then kinetic energy is converted into electrical energy in the generator.

- **Disadvantages of hydroelectricity & problems associated with construction of dam.**

- Dams can be constructed only at a limited number of places, preferably in hilly terrains.
- Large land area gets submerged in water thereby destroying natural habitat of large number of plants and animals. It adversely affects the ecosystem of that area.
- Large area of agricultural land and human habitation are to be sacrificed as they are submerged. And further create problems of satisfactory rehabilitation.
- The vegetation which is submerged under the water rots under anaerobic conditions and gives rise to large amounts of methane, which causes the greenhouse effect.

- The fish in the downstream region do not get sufficient nutrients and hence the production of fish is decreases.
- It reduces the fertility of soil in downstream area due to lack of annual floods in the river.
- Opposition to the construction of Tehri Dam on river Ganga and Sardar Sarovar project on the Narmada are due to such problems.
- **Advantages of hydroelectricity:**
  - It produces no primary waste or pollution.
  - Electricity can be generated constantly, as long as sufficient water is available.
  - It provides cheap electricity and have a very low generation and maintenance cost.
  - Hydropower is renewable resource. Since the water in the reservoir would be refilled each time it rains.

## IMPROVEMENTS IN THE TECHNOLOGY FOR USING CONVENTIONAL SOURCES OF ENERGY

### BIO-MASS

- Various plant and animals products, their residues and dead materials where chemical energy is contained are collectively called **Biomass**.
- Biomass is oldest source of heat energy which has been used as fuel for a long time. Wood, animal dung, agricultural residue, vegetable waste and sewage are chief sources of biomass.
- The energy obtained from biomass is known as **Bio-energy**.
- **Advantages of biomass:**
  - It is abundant on earth and is **generally renewable**.
  - Organic waste as fuel will be always available because we are continuously producing them.
  - Biomass can be utilised to produce electricity.
- **Disadvantages of biomass:**
  - During direct burning of biomass fuel complete combustion does not take place so it does not produce much heat.
  - A lot of smoke is produced, which posses various environmental hazard and health hazard.

### WOOD

- Wood is burnt to generate heat for cooking food and warm rooms. During direct burning complete combustion does not take place so it does not produce much heat. A lot of smoke is produced, which posses various environmental hazard and health hazard. So

the direct method or traditional method is not suitable for generating good amount of heat energy.

- To overcome this problems and for effective use, we convert wood into **charcoal** by a process called destructive distillation.
- Here, when the wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as residue. Charcoal burns without flames and it is comparatively smokeless and has a higher heat generating efficiency.

## BIOGAS

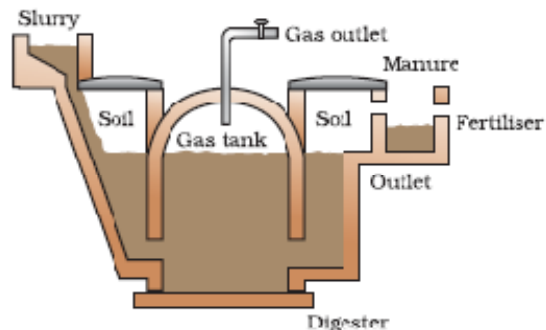
- Biogas is a mixture of various gases formed when the animal dung, sewage and various plant materials mixed with water is allowed to decompose in the absence of oxygen. Biogas is also called gobar-gas as it is mostly obtained from the animal wastes.
- **Constituents of Biogas:** It is mixture of gases such as methane, carbon-dioxide, hydrogen and hydrogen sulphide. Methane is the chief constituent which is about 75%. Methane is a good source of heat energy.

- **Biogas Plant: Working and Construction.**

- The plant has a dome like structure built with bricks.
- Slurry of cow dung and water is made in the mixture tank from where it is fed into the digester.
- The digester is a sealed chamber in which there is no oxygen.
- At the top of dome, there is a gas outlet pipe and a gas valve.
- In the mixing tank anaerobic micro-organisms that do not require oxygen decompose break down complex compound of the cow dung slurry.
- It takes a few days for the decomposition process to be complete.

After decomposition, gases like methane, carbon dioxide, hydrogen and hydrogen sulphide are generated. These are biogases.

- The biogas is stored in the gas tank above the digester from where they are drawn through pipes for use.



- **Advantages of Biogas:**

- It is an excellent fuel due to presence of 75% of methane.
- It burns without smoke and leaves no residue like ash.
- Its heating capacity is high.
- It can be used for lightening also.
- It is a cheaper source of energy.

- The slurry left behind in the digester, is removed periodically and used as excellent manure rich in nitrogen and phosphorus.
- Large scale utilization of biogas and sewage materials provides a safe and efficient method of waste disposal besides supplying energy and manure.

## WIND ENERGY

Page | 7

- Moving air is called **wind**. As the moving object possesses kinetic energy, so the wind has also kinetic energy. The kinetic energy of wind is known as **wind energy**.
- Unequal heating of landmass and water bodies by solar radiation generates air movements and cause wind to blow. So, wind energy comes from solar energy in an indirect way.
- **Uses of wind energy:**
  - Traditionally, wind energy was used through windmills to pump water from a well and to grind wheat into flour.
  - Due to technological improvement in windmills, now wind energy is used to generate electricity.
- **Windmill:** A windmill is a machine which resembles a large electric fan, erected at some height on a rigid support. It converts kinetic energy of wind into mechanical or electrical energy.
- **Generation of electricity through windmill:**
  - When the blowing wind strikes across the blades of a windmill it exerts a force which rotates its blade.
  - The rotatory motion is used to turn the turbine of the electric generator, which then generates electricity.
  - The output of a single windmill is quite small and cannot be used for commercial purposes. Therefore, a large number of windmills are erected over a large area. This set up is called a **wind energy farm**.
  - The energy output of each windmill in a farm is coupled together to get electricity on a commercial scale.
- **Limitations of wind energy:**
  - Wind energy farms can be established only at those places where wind blows for the greater part of a year.
  - To meet the required speed of the turbine the wind speed should also be higher than 15km/hr.
  - There should be some back-up facilities, like storage cells, to take care of energy needs during a period when there is no wind.

- **Advantages of wind energy:**
  - It is environment friendly and produces no water and air pollution.
  - No waste by-products such as carbon dioxide. It helps prevent global warming.
  - An efficient source of renewable energy, which means, we will never run out of it.
  - It requires no remaining expenses for the production of electricity.
- **Disadvantages of wind energy:**
  - Establishment of wind energy farm requires large area of land. For 1MW generator, the farm needs about 2 hectares of land.
  - The initial cost of establishment of the farm is quite high.
  - Since windmills are exposed to the varieties of nature like rain, sun, storm and cyclone, they need high level of maintenance.

## NON CONVENTIONAL SOURCES OF ENERGY

- With the progress of technology, demand of energy increases day by day. Due to change in life style, machines are employed to do more and more tasks. Our basic requirements of energy also increase as industrialization improved our living standards.
- As demand for energy increase, there is a need to look for more and more sources of energy. A technology could be developed to use the available or known sources of energy more efficiently and also look for new sources of energy. Any new source of energy which needs to be exploited would need specific devices developed with that source in mind.
- The non conventional sources of energy include urban waste, agricultural waste, energy plantations, animal and human waste, solar energy, wind energy, tidal energy, geo thermal energy, etc. These are pollution free, environmentally clean and socially relevant.

## SOLAR ENERGY

- It refers to energy that is collected from sunlight. An enormous amount of energy has been radiating by the sun for nearly 5 billion years and will continue radiating for about 5 billion year more.
- The small part of solar energy reaches the outer layer of the earth's atmosphere and nearly half of it is absorbed while passing through the atmosphere and rest reaches the earth surface.
- **Advantages of solar energy:**
  - Solar energy imparts no fuel cost as it requires no fuel.
  - Solar energy is a renewable resource. As long as the sun exists, its energy will reach earth.
  - Solar energy generation causes no air and water pollution.



- In sunny countries, solar energy can be used in remote location like a wind turbine.
- Solar energy can be used very efficiently for heating (solar ovens, solar water and home heater) and day lighting.

▪ **Disadvantages of solar energy:**

- Solar heat and electricity are not available at night and may be unavailable due to weather condition.
- Solar electricity is expensive compare to grid electricity.

## SOLAR COOKER

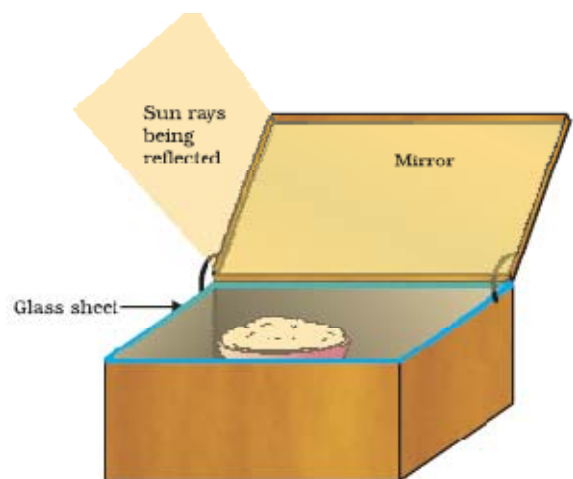
- A solar cooker is a device which is used to cook food using solar energy.
- A black surface absorbs more heat as compare to white under identical condition. Solar cooker use this property in its working.
- It consists of an insulated metal and wooden box which is painted black from inside.
- Solar cooker are covered with a glass top and an adjustable plane mirror which acts as reflector attached to the box.
- The food to be cooked is placed in a metal container and the black painted cooker is kept in a box and covered with a glass sheet.
- Solar cooker is kept in sun light in such a way that strip beam of sunlight falls over the cooker top.
- The sun rays pass through the glass sheet cover and get absorbed by black surface and temperature of the box slowly rises up. The heat cooks the food.

▪ **Advantages of solar cooker:**

- It saves fuel.
- It does not cause any kind of pollution.
- The nutrients of food do not get destroyed.

▪ **Limitation of using solar cooker:**

- It cannot be used during night time.
- It cannot be used on cloudy day.
- The direction of the reflection of the cooker needs to be adjusted frequently.



## SOLAR CELLS

- It is a device which converts solar energy or light energy directly into electrical energy. Silicon is used for making solar cells, but the availability of the special grade silicon for

making solar cells is limited. Silver is used for interconnection of the cells in the solar cell panel.

- The limitation of using solar energy is overcome by using solar cells that convert solar energy into electricity. A typical cell develops a voltage of 0.5-1V and can produce about 0.7W of electricity when exposed to the sun.
- A large number of solar cells are combined in an arrangement called solar cell panel that can deliver enough energy for practical use.
  
- **Advantages of solar cells:**
  - The principal advantages associated with solar cells are that they have no moving parts, require little maintenance and work quite satisfactorily without the use of any focusing device.
  - They can be set up in remote and inaccessible areas or very sparsely inhabited areas in which laying of a power transmission line may be expensive and not commercially viable.
  
- **Uses of solar cells:**
  - In spite of the high cost and low efficiency solar cells are used for many scientific and technological applications.
  - Artificial satellites and space probes like Mars orbiters use solar cells as the main source of energy.
  - Radio and wireless transmission systems and TV relay stations in remote locations use solar cell panels.
  - Traffic signals, calculators and many toys are fitted with solar cells.

## ENERGY FROM THE SEA

### TIDAL ENERGY

- Due to the gravitational pull of mainly the moon on the spinning earth, the level of water in the sea rises and falls. The phenomenon is called high and low tides and the difference in sea levels creates tidal energy.
- Because the tidal forces are caused by interaction between the gravity of earth, moon and sun, tidal power is essentially inexhaustible and classified as a renewable energy source.
- Tidal energy is harnessed by constructing a dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity.
- **Advantages of tidal energy:**
  - It is a renewable source of energy.
  - It does not cause any pollution.
  - Once constructed, there is no further cost involved.
  - It is a long term source of electricity.