

Chapter

3**SOURCES OF ENERGY****Introduction**

A source of energy is one which can provide adequate amount of energy in a convenient form over a long period of time.

All the sources of energy can be divided into two main categories :

- (i) Non-Renewable sources of energy
- (ii) Renewable sources of energy

➤ **Non-Renewable Sources of Energy :**

Those sources of energy which have accumulated in nature over a very long time and cannot be quickly replaced when exhausted are called non-renewable sources of energy.

*For Example : Fossil fuels (coal, Petroleum and Natural Gas)
Nuclear fuels (such as uranium).*

Non-renewable sources of energy are dug out from the earth.

Note :

Though nuclear fuels are non-renewable source of energy dug out from the earth, they are not conventional sources of energy.

➤ **Renewable Sources of Energy :**

Those sources of energy which are being produced continuously in nature and are in exhaustible are called renewable sources of energy.

For Example : Hydro energy, Wind energy, Solar energy, Biomass energy etc.

Another name for renewable sources of energy is the alternative sources of energy.

➤ **Characteristics of a Good Source of Energy :**

A good source of energy should have the following characteristics

- It should have high calorific value.
- It should be capable of delivering desired quantity of energy at a steady rate over a long period of time.
- It should be easily available.
- It should be easy to store and transport.
- It should not cause any environmental pollution.
- Moreover, it should be economical.

➤ **Conventional Source of Energy :**

Sources of energy that have been in use for centuries are called conventional sources of energy.

For Example : Coal, Petroleum, Flowing water, etc.

➤ **Fossil Fuels :**

The combustible substances formed from the dead remains of the plants and animals which were buried under the earth over millions of year ago are called fossil fuels.

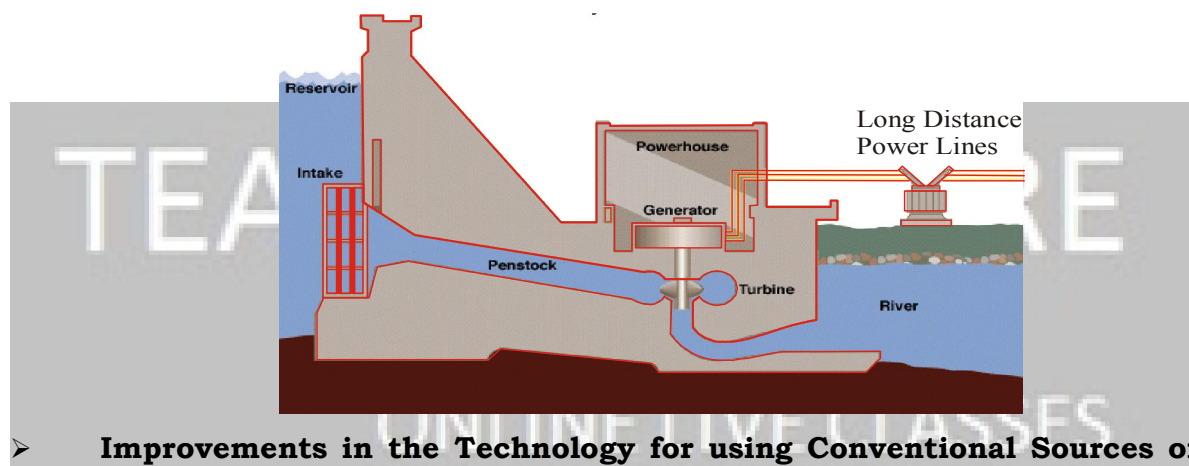
For Example : Coal, Petroleum and Natural Gas.

➤ **Thermal power plants :**

A thermal power plant produces electricity by burning fossil fuels.

➤ **Hydro Power Plants :**

Flowing water is one of the major sources of energy. A hydro power plant converts the potential energy of falling water into electricity.



➤ **Improvements in the Technology for using Conventional Sources of Energy :**

- **Bio-mass:** The waste material of living things (like cattle dung) and the dead parts of living things (like plants, trees and animals) is called bio-mass. The most common examples of bio-mass being used as a fuel are: Wood, cow-dung cakes and agricultural wastes.
- **Charcoal :** Charcoal is commonly used fuel which is obtained from wood. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it gets removed and a black residue called charcoal is left behind.

Charcoal is Better Fuel than Wood :

- Charcoal has a higher calorific value than wood. That is, charcoal produces more heat on burning than an equal mass of wood.
- Charcoal does not produce smoke while burning.

- Charcoal is a compact fuel which is easy to transport and convenient to use.

➤ **Bio-Gas :**

Bio-gas is a mixture of various gases such as methane (CH_4), Carbon dioxide (CO_2), Hydrogen (H_2) and Hydrogen sulphide (H_2S). Bio-gas is produced by the anaerobic degradation of animal wastes like cow-dung, plant wastes, vegetable wastes and sewage in absence of oxygen. Bio-gas is popularly known as “***gobar gas***” as it is mostly obtained from cow-dung.

➤ **Wind Energy and Windmill :**

Energy obtained from moving air i.e. wind is called wind energy.

➤ **Non-Conventional or Alternative Source of Energy :**

Sources of energy that we have started using in new ways or only in recent times are called non-conventional or alternate sources of energy.

For Example : Tidal energy, Geothermal energy etc.

➤ **Solar Energy :**

The energy obtained from the sun is called solar energy.

Solar Cooker: A solar cooker is a device which is used to cook food by using solar radiation.

➤ **Solar Cell :**

A solar cell is a device which converts solar energy into electricity.

➤ **Energy from the Sea or Ocean :**

Oceans are huge reservoirs of energy. The energy from sea/ocean water is available in the following forms:

➤ **Wave Energy :**

Energy from the oceans is available in the form of oceanic or sea waves. Due to the blowing of wind on the surface of water in the sea or ocean, a very fast sea waves (or water waves) move on its surface. The kinetic energy of this moving water rotates the turbine of a generator and produces electricity.

➤ **Tidal Energy:**

The alternate rise and fall of ocean or sea waters twice in a day is known as tides. The tides are caused due to the gravitational pull of mainly the moon on the spinning earth. The kinetic energy of moving water during high and low tides provides a source of energy in the coastal areas. Tidal energy is harnessed by constructing a tidal barrage or dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity.

➤ **Ocean Thermal Energy :**

The heat energy available due to the temperature difference between the different layers of ocean water is known as ocean thermal energy.

➤ **Geothermal Energy :**

Geothermal energy is the heat energy from hot rocks present inside the earth. At some places in the world, the rocks at some depth below the surface of the earth are very hot called hot spots and are sources of geothermal energy.

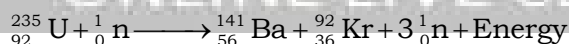
The extremely hot rocks present below the surface of earth heat the underground water and turn it into steam. As more and more steam is formed between the rocks, it gets compressed to high pressures. A hole is drilled into the earth upto the hot rock and a pipe is put into it. The steam present around the hot rocks comes up through the pipe at high pressure. This high pressure steam turns the turbine of a generator to produce electricity.

➤ **Nuclear Energy :**

The energy stored in the nuclei of atoms can be obtained by carrying out two types of nuclear energy reactions called **Nuclear Fission** and **Nuclear Fusion**. The energy released during these reactions is called nuclear energy.

➤ **Nuclear Fission :**

The process in which an unstable nucleus of heavy atom such as uranium, plutonium, or thorium is splitted up into two lighter nuclei when bombarded with low energy neutrons is called nuclear fission.

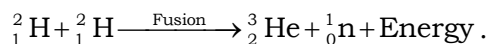


➤ **Nuclear Fusion :**

The process in which two or more light nuclei combine together to form a heavy nucleus along with the release of large amount of energy is called nuclear fusion.

For Example:

Two deuterium nuclei (${}_1^2\text{H}$) fuse together to form helium nucleus.



SOLVED EXAMPLES

Example 1:

What is a good source of energy?

Solution:

A good source of energy should have the following qualities:

- (i) It should be easily available.
- (ii) It should do a large amount of work per unit volume/mass.
- (iii) It should be easy to store and transport.
- (iv) It should be economical.
- (v) It should not cause environmental pollution.

Example 2:

On what basis would you classify energy sources as

- (i) renewable and nonrenewable?
- (ii) exhaustible and inexhaustible?

Are the options given in (i) and (ii) the same.

Solution:

- (i) Renewable sources of energy are those sources which can be regenerated again. Non-renewable sources of energy are those sources which would get depleted some day and cannot be regenerated.
- (ii) Exhaustible sources of energy are those which will get depleted some day and cannot be regenerated. Inexhaustible sources of energy are those which can be regenerated again due to some continuing or repetitive currents of energy.

Options given in (i) and (ii) are exactly the same. A non-renewable source is an exhaustible source. A renewable energy source is an inexhaustible source.

Example 3:

What are the advantages and disadvantages of using a solar cooker? Are there places where solar cookers would have limited utility?

Solution:

Advantages of a solar cooker:

- (i) There is no cost of fuel.
- (ii) It is environment friendly and there is no residue like ash etc.
- (iii) Cooking is hygienic and nutritious.

Disadvantages of solar cooker:

- (i) The cooking is slow.
- (ii) It cannot be used at all times.
- (iii) A solar cooker can perform only limited functions.

Solar cookers have limited utility at the places where sunlight is less as in Polar Regions or where there are too much rains.

Example 4:

What are advantages of bio-gas over other traditional fuels?

Solution:

- i) It burns without smoke leaving no ash.
- ii) It can be used directly for heating, lighting and generating electricity.
- iii) The slurry that is left behind in a bio-gas plant is used as manure rich in nitrogenous and phosphorous compounds.

Example 5:

What are the two most commonly used forms of energy? What are their sources?

Solution:

Two most commonly used forms of energy are :

- i) Thermal (heat) energy and it is obtained by burning of fuels like firewood, cow-dung cakes, charcoal, coal, petroleum products, natural gases, etc.
- ii) Electrical energy, which is generated by harnessing different types of sources of energy.

Some examples are hydroelectric power plants using energy of flowing water, thermal power plants in which heat is produced by burning fuels and then the heat energy is converted into electrical energy, nuclear power plants harnessing nuclear energy, solar panels, windmills, OTEC power plants, etc.



EXERCISE**LEVEL-I**

1. List two nutrients that the slurry left behind in the biogas plant contain.
2. Some of the gases are responsible for global warming. Name these gases.
3. What is the full form of CNG?
7. Why is CNG considered as environmental friendly fuel?
8. The main constituent of petroleum gas is :
 - (a) Methane
 - (b) Ethane
 - (c) Butane
 - (d) propane
9. The natural gas consists mainly of :
 - (a) Methane
 - (b) Ethane
 - (c) Propane
 - (d) Butane
7. LPG consists mainly of :
 - (a) Butane
 - (b) Ethane
 - (c) Butanone
 - (d) Methane
8. Which of the following is used as a moderator in the reactor of a nuclear power station?
 - (a) Liquid sodium
 - (b) Boron
 - (c) Graphite
 - (d) Carbon dioxide
9. The control rods used in the reactor of a nuclear power plant are made of :
 - (a) Steel
 - (b) Graphite
 - (c) Uranium
 - (d) Boron
10. The 'coolants' which can be used in the reactor of a nuclear power station are :
 - (a) Liquid mercury and nitrogen dioxide
 - (b) Liquid sodium and carbon dioxide
 - (c) Liquid ammonia and carbon monoxide
 - (d) Liquid boron and uranium oxide.

LEVEL-II

1. What happens when wood is burnt in a limited supply of oxygen? Name the residue left behind after the reaction and state two advantages of using this residue as a fuel over wood.
2. How is energy generated in a nuclear fission reaction? Why is the large scale use of nuclear energy prohibitive?

3. Distinguish between renewable and non-renewable sources of energy. Also give an example of each of these sources.
4. (a) What is geothermal energy?
(b) What are the advantages of wind energy?
5. Explain ocean – thermal energy and how can it be harnessed. Mention any two limitations in obtaining the energy from the ocean?
6. (i) Why is hydrogen considered a better and cleaner fuel than CNG?
(ii) Mention any two areas where solar cells are used as source of energy.
(iii) State the biggest hindrance in trapping geothermal energy.

LEVEL-III

1. Explain why :
 - (i) It is difficult to burn a piece of wood fresh from a tree.
 - (ii) Pouring dry sand over the fire extinguishers it.
 - (iii) It is difficult to use hydrogen as a source of energy.
 - (iv) Charcoal is considered a better fuel than wood.
2. (i) What is nuclear energy?
(ii) For peaceful purposes, how this energy can be utilized? Explain it.
(iii) Name the recent project in India related to nuclear energy which faced opposition from the local public over its implementation. Why?
3. The surface area of a concentrator type solar heater is 5 m^2 . It can reflect 80% of solar radiation incident on it while it absorbs the rest. Calculate the energy concentrated by the heater at its focus in 2 hours if solar energy was delivered to it at the rate of $4.4 \text{ kJ/ m}^2\text{s}$.
4. Why is there so much emphasis on changing over from petrol/diesel driven automobiles to CNG-driven vehicles.
5. The world energy consumption pattern indicates that the energy consumption will be tripled in a period of 50 year. So, people should be engaged in promoting energy efficiency and conservation of precious sources of energy. Their effort needs to be replicated.
 - (a) As a responsible citizen of India, what steps would you take to conserve energy?
 - (b) What message is conveyed to you by the information given above?



WORKSHEET-1

1. Define calorific value of a fuel.
2. What is a source of energy? What are the two main categories of the sources of energy?
3. State any four characteristics of a good source of energy.
4. What is the difference between a renewable and a non-renewable source of energy.
5. Which of the following is not a fossil fuel?
 - (a) Coal
 - (b) Petroleum gas
 - (c) Biogas
 - (d) Natural gas
6. What is the main constituent of :
 - (a) Petroleum gas?
 - (b) Natural gas?
7. Explain the principle of working of a thermal power plant. Diagram to illustrate your answer.
8.
 - (a) Name the part of a box-type solar cooker which allows the sun's heat rays to enter the box but does not allow inside heat to go out.
 - (b) Explain why, a plane mirror reflector is used in a box-type solar cooker.
9.
 - (a) What is a solar cell? Draw the labeled diagram of a solar cell.
 - (b) Name the semi-conductor material which is usually used for making solar cells.
 - (c) Write the uses of solar cells.
10.
 - (a) What is wind? What type of energy is possessed by wind?
 - (b) State two advantages of using wind energy for generating electricity.
 - (c) Mention two limitations of wind energy for generating electricity.



WORKSHEET-2

1. Name any three forms of energy which could be harnessed from the sea.
2. What is the function of anaerobic micro-organisms such as anaerobic bacteria in a biogas plant?
3. What is biomass? Give three examples of biomass.
4. How is charcoal prepared? Explain why, charcoal is a better fuel than wood.
5.
 - (a) What is biogas? Name the major component of biogas.
 - (b) What are the raw materials used for making biogas.
 - (c) Describe the construction and working of a biogas plant with the help of a labeled diagram.
 - (d) Write any two uses of biogas.
 - (e) Write any two advantages of using biogas.
6.
 - (a) What is geothermal energy?
 - (b) What is the source of heat contained in geothermal energy?
 - (c) Explain how, geothermal energy is used to generate electricity.
 - (d) State two advantages of geothermal energy.
 - (e) State two disadvantages of geothermal energy.
7. The constituent of biogas which makes it an excellent fuel is :
 - (a) Butane (b) methane (c) propane (d) Ethane
8. Of what material are the control rods of a nuclear reactor made?
9. What is nuclear fission? Explain with an example. Write the equation of the nuclear reaction involved.
10.
 - (a) What is nuclear fusion? Explain with an example. Write the equation of the reaction involved.
 - (b) Why are very high temperatures required for fusion to occur?

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