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RENEWABLE SOURCES OF ENERGY-I

You have already known about non-renewable or exhaustible sources of energy. Most of us rely heavily on the use of non-renewable energy resources such as coal, oil and natural gas for our daily need but we know that these resources are finite in nature and eventually the day will come when they will vanish for ever. Before that they will become too expensive and also damaging for the environment. Sooner or later we have to think about using alternative energy resources which are renewable, may last forever.

The increasing population and change in our life style make great demand for energy resources. This ever increasing demand puts great pressure on non-renewable conventions energy sources and makes it necessary that we should look for other alternative energy resources. The sources like sun and wind can never be exhausted and are thus known as renewable sources of energy; they cause no emission of poisonous gases and are available locally. They are widely available and potential source of clean and limitless sources of energy. In this lesson you will study about such renewable sources of energy.

OBJECTIVES

After completing this lesson, you will be able to:

- *define renewable sources of energy;*
- *distinguish between renewable and non-renewable energy sources;*
- *list different renewable sources of energy;*
- *explain the importance of solar energy;*
- *describe the functioning of solar cooker, solar heater and solar cell;*
- *explain the methods of harnessing hydro energy and wind energy.*

Notes

29.1 ENERGY SOURCES

Humans have always been using some source of energy for a variety of purposes - cooking, warming, ploughing, transportation, lighting etc. To start they used fire wood and later kerosene or coal or rather lately the electricity. He used animal power (horse, bullock, camel, yak etc.) for transportation and for running minor mechanical devices like the persian wheel for irrigation or for running "kolhu" for extracting oil from oil seeds. During the last century or so, electricity has been produced from thermal plants (using coal) or from hydroelectric plants (using water current).

We can broadly categorise the source of energy according to periods of usage as follows-

(a) Conventional source of energy, which are easily available and have been in usage for long time.

(b) Non conventional source of energy, that are other than the usual or that are different from those in common practice.

Sources of energy

Conventional		Non conventional
Conventiona non-renewable energy	**Conventional renewable energy**	1. Solar energy 2. Hydro power 3. Wind energy 4. Nuclear energy 5. Hydrogen energy 6. Geothremal energy 7. Bio gas 8. Tidal energy 9. Bio-fuel
Mostly fossil fuels found under the ground. Coal, oil, natural gas etc. are the examples.	Mostly non-fossil fuels seen above the ground. Fire wood, cattle dung from vegetable wastes, wood charcoal etc. are the examples.	

Details of Non-renewable source of energy has been discussed in lesson-28.

Most of the renewable resources of energy are directly or indirectly related to sun or solar energy. Renewable sources of energy or non-conventional energy sources include sunlight, wind, water and biomass (firewood, animal dung, crop residue, agricultural wastes, biodegradable waste from cities and towns).Energy received from sun is known as **solar energy**, energy generated by water is **hydel energy** and energy obtained from underground hot dry rocks, magma, hot water springs or natural geysers etc is called **geothermal energy**. **Tidal energy** is derived from waves and tidal waves of oceans and seas.

INTEXT QUESTIONS 29.1

1. What do you consider sun the single most important natural energy resource? Why?

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2. Give three examples of conventional and non-conventional sources of energy.

_____

3. Give one point of difference between conventional and non-conventional sources of energy.

_____

4. Differentiate between non-renewable and renewable energy sources.

_____

29.2 RENEWABLE OR NON-CONVENTIONAL SOURCES OF ENERGY

The rapidly depleting fossible fuel sources of energy and escalating demand of energy have made it necessary to look for alternative sources of energy that are known as renewable or inexhaustible.

We can define inexhaustible energy resources as 'those resources which can be harnessed without depletion'. Most of these resources are free from pollution and some of them can be used at all places. These renewable energy resources are also known as non-conventional or inexhaustible or alternate energy sources.

These energy sources are solar, flowing water, wind, hydrogen and geothermal. We get renewable solar energy directly from the sun and indirectly from moving water, wind and biomass. Like fossil fuels and nuclear power, each of these alternatives renewable sources of energy has their own advantages and disadvantages. We are going to discuss some of them in detail.

29.3 SOLAR ENERGY

Sun is an abundent source of energy and it is inexhaustible. In the broadest sense, solar energy supports all life on earth and is the basis for almost every form of energy we use. The sun makes plants grow, which are burned as fuel or rot in swamps and are compressed underground for millions of years to become coal and oil. Heat from the sun causes temperature differences between areas, causing the wind to blow. Water evaporates because of the sun, water vapours are carried to high elevations, and when the water vapours condense and precipitate as rainfall. The water rushes down towards the sea through rivers, spin turbines is too made for generating electricity. It thus becomes clear that hydroelectricity is an indirect form of solar energy. However direct solar energy can be used as heat, light, and electricity through the use of solar cells.

The sun is often regarded as the ultimate answer to our energy problems. Sun provides a continuous supply of energy that far exceeds our current energy demand. It is free of cost,

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available in plenty, found everywhere and has no political barrier. Actually fossil fuels also represent sunlight stored millions of years ago. However, we are only able to trap and make use of a very small fraction of this abundant energy source. Solar energy use can be classified as: i) direct solar energy use; solar energy is captured directly as sunlight and used for heating, generating electricity and cooling ii) indirect use of solar energy derived from natural processes driven by the sun, for example wind, biomass, waves, hydroelectric power.

> 5,000 years ago, people "worshipped' the sun. Ra, the sun-god, who was considered the first king of Egypt. In Mesopotamia, the sun-god shamash was a major deity and was equated with justice. In Greece there were two sun deities, Apollo and Helios. The influence of the sun also appears in other religions-Zoroastrianism, Mithraism, Roman religion, Hinduism, Buddism, the Druids of England, and Aztecs of Mexico, the incase of Peru, and many Native American tribes.

29.3.1 Direct solar energy

Solar energy is abundant, everlasting and available free of cost. Direct use of solar energy can be used through various devices broadly directed into three types of systems a) passive, b) active c) photovoltaic.

(a) **Passive solar energy**

As you know some of the earliest uses of solar energy were passive in nature such as to evaporate sea water for producing salt and to dry food and clothes. In fact solar energy is still being used for these purposes. The more recent passive uses of solar energy is for cooking, heating, cooling and for the daylighting of homes and buildings. The effectiveness of passive solar energy depends on good building design; no mechanical means are employed in passive use of solar energy.

Passive use of solar energy for cooking

The energy from the sun can be harnessed, to cook food without any large, complex systems of lenses or mirrors. We all know that when sunshine falls on a dark surface, it is absorbed and transformed into heat energy. Glass is bad conductor of heat but if a shallow glass covered chamber painted black inside and insulated all around is exposed to sun for some time the inside temperature would soon exceeds upto 100^{o}C which is sufficient to cook food. On a hot summer day the temperature inside the solar box cooker will easily becomes140^{o}C. Solar cooker takes 5-6 hours to cook food. The solar box cooker is the poor man's device for direct use of renewable source of energy. In Indian conditions with plentiful sunshine we can use a solar box cooker for cooking of food. The great advantage of solar cooking is its convenience because the food will never get overcooked or burnt. Apart from its "load-and-forget" quality, the food cooked in the solar cooker is also more

tender and retains most of the nutritive values. But this comes at a cost is a slow process and take longer time i.e. solar cooking (Fig 29.1).

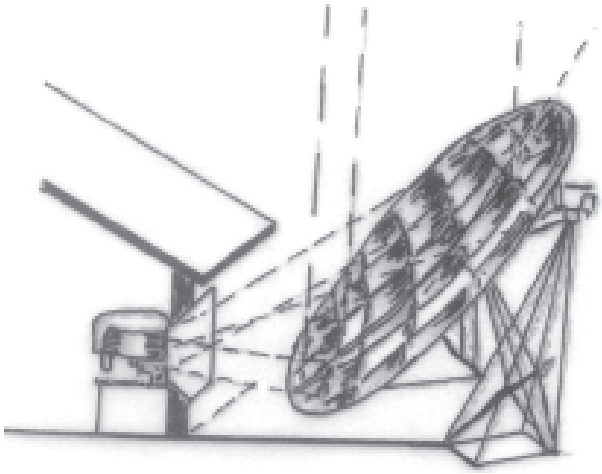

Fig. 29.1: *Solar Cooker*

India may be justifiably proud that the world's largest solar steam cooking system is operating in the Brahmakumaris' Ashram at Mount Abu in India. Here the solar energy is concentrated by a battery of concentrators /mirrors to convert water into superheated steam. The system can cook for 10,000 people. It was constructed at a costs one crore of rupees excluding the labour of the ashram inmates.

Passive use of solar energy for daylighting

Daylighting is using natural sunlight to light building interiors. Day lighting technologies are designed to maximize natural light for illuminating the interior of buildings. These may be in the form of core lighting when the building may have a central atrium to allow entry of maximum sunlight.

The most recent technology is hybrid solar lighting which collects sunlight and send it though optical fibres into buildings where it is combined with electric light in "hybrid" light fixtures. There are sensors in the room which keep a steady lighting level by adjusting the electric lights based on the sunlight available. This new generation of color lighting combines both electric and solar power.

Passive solar systems are maintenance free. There are no moving parts and so no energy is expended for heating or cooling a building and hence, there are no operating costs. The only major problem is that passive solar heating, cooling and lighting system can be used only in specially designed buildings. Daylighting of business and commercial buildings provides a higher quality of light and improves productivity and health and at the same time results in substantial saving on electric bills.

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(b) **Active use of solar energy**

Active solar heating and cooling systems rely on solar collectors which are usually mounted on roofs. Such systems also requires pumps and motors to move the fluids or blow air by fan in order to deliver the captured heat. (Fig.29.2 a and b). A number of different active solar heating systems are available. The main application of these systems is to provide hot water, primarily for domestic use. Active solar heating is extensively used in India, Japan, Israel, Australia and Southern United States having sunny climate.

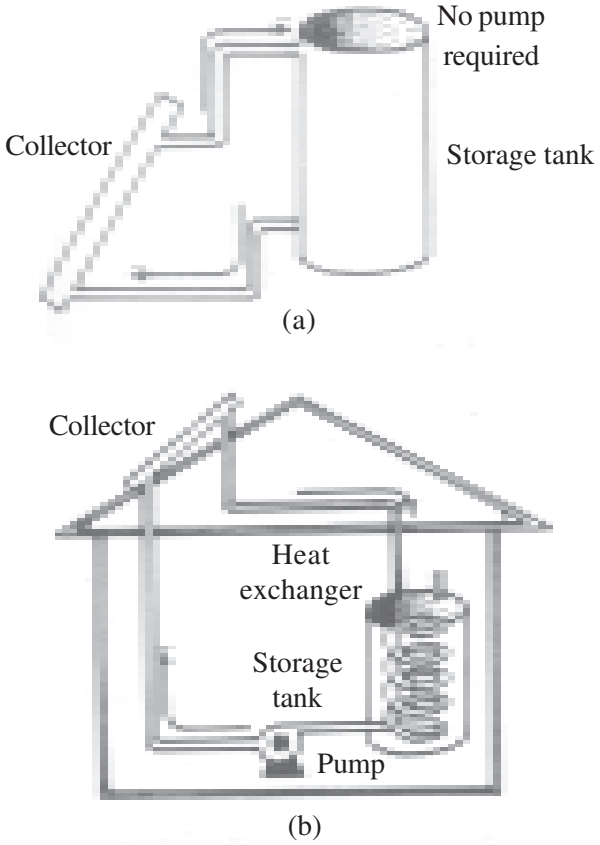

***Fig. 29.2**: Two active solar systems for heating water: (a) thermo siphon system. (b) direct pump system.*

Solar energy to produce electricity

Solar energy is used to generate high temperature heat or electricity. Solar collectors in sunny deserts can produce high temperature heat to spin turbines for producing electricity but cost of such devices are high. Several solar thermal systems can collect and transform radiant energy received from the sun into high temperature thermal (heat) energy, which can be used directly or converted into electricity. Huge arrays of computer-controlled mirrors called **heliostats** track the sun and focus sunlight on a central heat collection tower.

Solar energy for cooling

A solar collector can also be used for cooling. In this system, energy from the sunlight powers a small heat engine similar to an electric motor of a refrigerator. The heat engine drives a piston that compresses a special vapour into a liquid; the liquid then revapourizes and draws heat out of the surrounding air.

(c) **Solar cells or photovoltaic technology**

Solar energy can be converted directly into electrical energy (direct current, DC) by photovoltaic (PV) cells commonly called solar cells. Photovoltaic cells are made of silicon and other materials. When sunlight strikes the silicon atoms it causes electrons to eject. A typical solar cell is a transparent wafer that contains a very thin semi conductor. (Fig. 29.3). Sunlight energizes and causes electrons in the semiconductor to flow, creating an electrical current. Solar cells can provide electricity to remote villages. India is the world's largest market for solar cells.

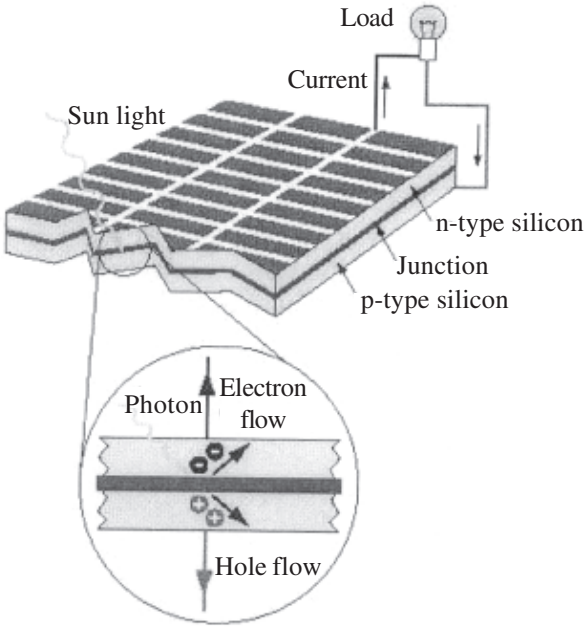

Fig. 29.3: *Photovoltaic cell*

PV cells can be used for -

(i) domestic lighting.

(ii) street lighting.

(iii) village lighting.

(iv) water pumping.

(v) electrification.

Notes

(vi) desalination of salty water.

(vii) powering of remote telecommunication repeater stations and

(viii) railway signals.

INTEXT QUESTIONS 29.2

1. Why solar energy is most important renewable type of energy.

   _____

2. Describe the various uses of solar energy.

   _____

3. What are photovoltaic cell and how they work?

   _____

29.4 INDIRECT SOLAR ENERGY

A large number of energy sources such as wind, tide and hydroelectric ultimately depend on solar energy. In this lesson out of the various type of indirect solar energy sources. We will discuss (a) wind energy, (b) tidal energy and (c) hydroelectric energy and (d) biomass energy.

29.4.1 Wind energy

About 2% of the sunlight striking the earth is converted into the kinetic energy of moving air called wind. The uneven absorption of the solar radiation by the earth's surface causes differences of temperature, density and pressure which produce air movements at local, regional and global levels powered by wind energy. The kinetic energy of the wind can be harnessed by converting it into mechanical energy or electrical energy using suitable devices.

As early as 4000 - 3500 BC, the first sailing ship and wind mills were developed by harnessing wind energy. The wind has been used to power ships, grind grains, pump water for irrigation and do other types of work (Fig. 29.4a).

In present times the greatest potential for using wind is for the production of electricity. Wind turbines, like wind mills are mounted on a tower to capture the most of the wind energy. Wind mills can be used to drive generators to producing electricity.

To produce electricity wind is used to turn the shaft of a turbine which is attached to a generator that produces electricity. Thus wind turbines transform wind energy into mechanical power which can be used to generate electricity. (Fig. 29.4b).

(a)

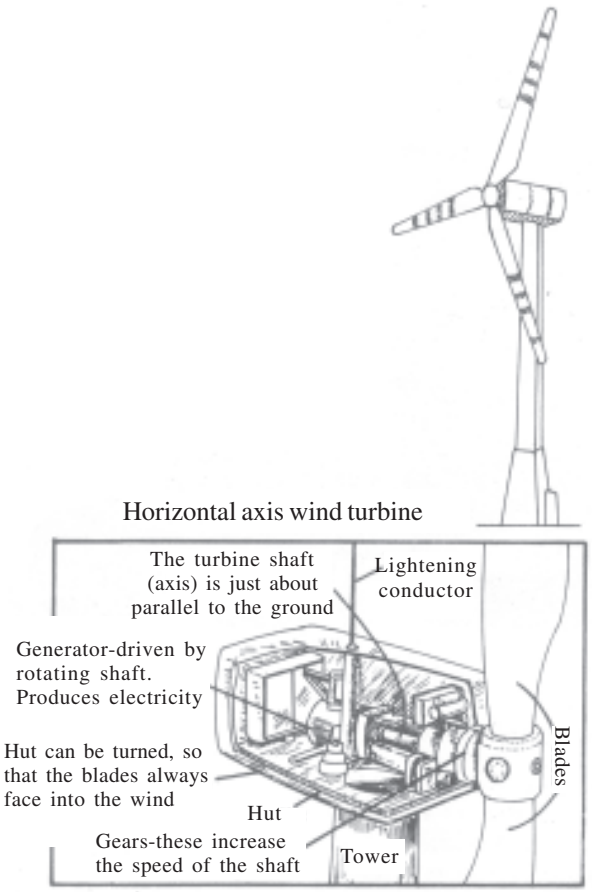

Fig. 29.4: *(a) Wind mill used for pumping water (b) Wind mill used for generating electricity showing detail of shaft*

Wind turbines can be used single or in clusters. When wind turbines occur in clusters they are called 'wind farms' (Fig. 29.5). Small wind turbines called aero generators and can be used to charge large batteries.

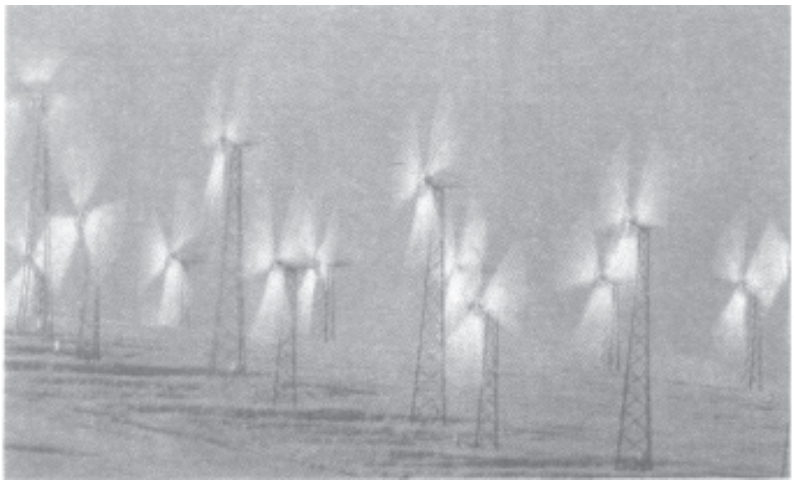

Fig.29.5: *Wind farms*

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Five nations - USA, Germany, Denmark, Spain and India - account for 80% of the world's installed wind energy capacity.

> India rank 5th in the world with a total wind power capacity if 1080 MW out of which 1025 MW have been established in commercial projects.

In India the states of Tamil Nadu and Gujarat lead in the field of wind energy. At the end of March 2000 India had 1080 MWs capacity wind farms, of which Tamil Nadu contributed 770 MW capacity, Gujarat has 167 MW followed by Andhra Pradesh, which has 88 MW installed wind farms. There are about a dozen wind pumps of various designs, which provide water for afforestation, irrigation, domestic purpose, used in various tasks of the country.

Recently, there has been a renewed interest in wind as a source of energy. India is the fifth largest producer of wind power in the world. Countries engaged in development of wind energy include Great Britain, Netherlands, Greece, Spain, Denmark, USA (California) and India. Andhra Pradesh generates maximum energy through wind power. Other states generating energy through wind are Tamil Nadu, Gujarat, Karnataka, Kerala, Madhya Pradesh and Maharashtra. A total of 26 project sites have been developed in these states resulting in a capacity of 57MW.

29.4.2 Tidal energy

Tidal power projects attempt to harness the energy of tides as they flow in and out. The main criteria for a tidal power generation site are that the mean tidal range must be greater than 5 metres.

The tidal power is harnessed by building a dam across the entrance to a bay or estuary creating a reservoir. As the tide rises, water is initially prevented from entering the bay. Then when tides are high and water is sufficient to run the turbines, the dam is opened and water flows through it into the reservoir (the bay), turning the blades of turbines and generating electricity.

Again when the reservoir (the bay) is filled, the dam is closed, stopping the flow and holding the water in reservoir when the tide falls (ebb tide), the water level in the reservoir is higher than that in the ocean. The dam is then opened to run the turbines (which are reversible), electricity is produced as the water is let out of the reservoir.

The dams built to harness the tidal power adversely effect the vegetation and wildlife.

A dam is built across an estuary or bay, allowing the incoming and outgoing waters to flow through small openings fitted with propellers that run electric turbines (Fig. 29.6). To date the numbers of tidal electric plants are limited to forty. La Rance in France is the only commercial power station operating in the world. In India a major power project costing Rs. 5000 crores is proposed to be set up in the Hanthal Creek in the Gulf of Kutch in Gujarat.

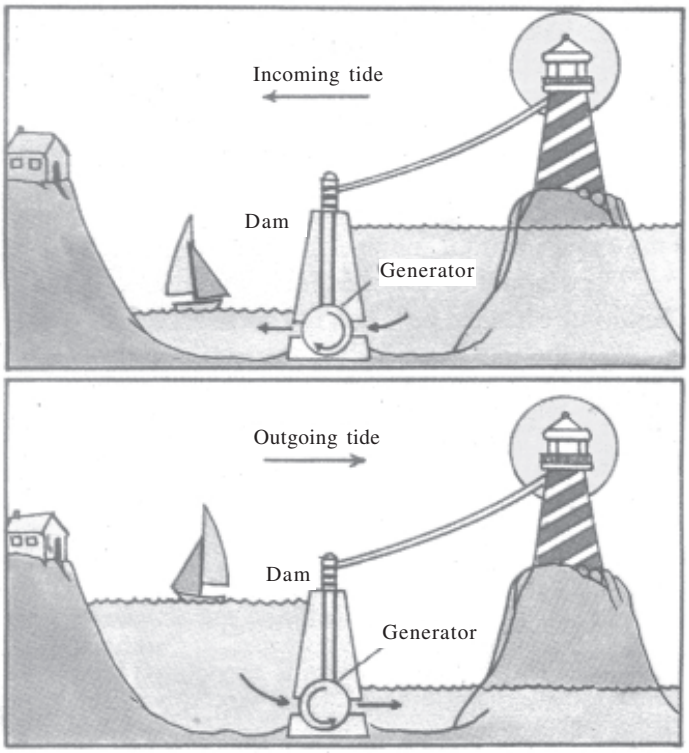

Fig. 29.6: *Tidal power station*

29.4.3 Hydropower Energy

The energy in moving waters is one of the most widely used renewable energy source. Humans have harnessed waterpower since the times of the Roman Empire. In earlier times the kinetic energy of flowing rivers and streams was trapped by means of water wheels that were used to grind grain, saw wood and manufacture textiles. It was only in 1800s that the energy of water was converted into electricity. Hydroelectric power uses the kinetic energy of moving water to make electricity.

Generation of electricity by using the force of falling water is called **hydro electricity or hydel power**. It is cheaper than thermal or nuclear power. Dams are built to store water at a higher level; which is made to fall to rotate turbines that generate electricity.

Hydroelectricity or hydropower is the fourth largest source of commercial energy production and consumption globally.

The basic principle behind hydropower energy is the damming of rivers to create artificial in waterfalls, sometimes natural waterfalls are also used. The falling water is used to turn the turbines that drive electrical generators. One of the greatest advantages of hydropower is that once the dam is built and turbines become operative, it is relatively cheap and clean source of energy.

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Hydropower also has some disadvantages, building of dam seriously disturbs and damages the natural habitats and some of them are lost forever. Human habitations also get disturbed making people homeless.

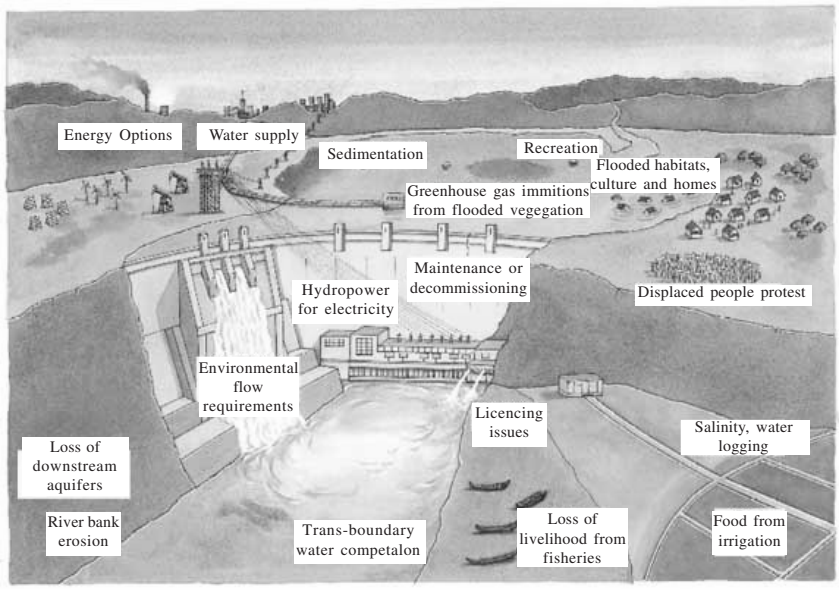

Fig. 29.7: *Environmental effects of hydropower*

INTEXT QUESTIONS 29.3

1. What is the difference between air and wind?

   _____

2. Why wind energy is called indirect solar energy?

   _____

3. What is significance of dams in the production of hydroelectricity?

   _____

WHAT YOU HAVE LEARNT

- Presently there is focus on alternative source of energy that are renewable or inexhaustible in nature such as solar, wind, water and tidal energy. They are inexhaustible sources of energy and do not cause air pollution, health problem, or climatic changes.
- Solar energy is one of the most important sources of energy, which is used for heating, and cooling of buildings, for cooking food and generating electricity. The limitation

Notes

with solar energy is that on a cloudy day or in winters it is not available and the current technologies are fairly limited.

- Passive solar energy system often involves architectural designs that enhance absorption of solar energy without requiring mechanical power.
- Active solar energy system uses solar collectors are used to heat waters for houses and keep the buildings warms.
- Photovoltaic is a technology that is used to convert sunlight directly into electricity. And is used for various purposes.
- Hydroelectric power is used for generating energy, It is also indirect form of solar energy and has several advantages but the high construction cost and silting of reservoirs which lesson the life of power station are the main drawbacks.
- Tidal power is another renewable energy resource, but suitable sites for harnessing this energy are limited and technologies are few.

TERMINAL EXERCISE

1. List the various uses of solar energy and describe the advantages and disadvantages of solar energy.
2. Why photovoltaic cells are considered to be an ideal solar energy collection device? What are some of their limitations?
3. What are the limitations of tidal power as a source of electricity?
4. Discuss the advantages and disadvantages of hydropower energy.
5. Which has greater future potential for energy production wind or water power also discuss which one of these you think has more environmental problem?
6. Discuss why our country is not utilizing the renewable resources at their fullest potential.

ANSWER TO INTEXT QUESTIONS

29.1

1. Sun is one of the most important natural energy source. All other energy sources are directly derived from the sun.
2. Coal, oil and natural gas are the examples of conventional energy while solar, hydro power, wind, nuclear, biogas, geothermal energy are the examples of non-conventional source of energy (any three examples)
3. -have been in usage for a long time

   -are other than the usual or that are different from those in common practices.

Notes

4. -Mostly fossil fuels found under the ground

   -Mostly non-fossil fuels seen above the ground.

29.2

1. Solar energy is the most important renewable energy because it is most abundantly present, it is present all the time and is everlasting and available free of cost.
2. Solar energy is used in a passive manner that is directly in drying food and clothes, to evaporate sea water to get salt. Solar cookers use solar energy for cooking, solar energy used directly for heating and lighting buildings. Solar energy used in active way for producing hot water for domestic use.
3. Photovoltaic cell is a solar cell to produce electricity from solar energy. It is a thin wafer like semi conductor. Sunlight energizes and causes electrons to flow in the semi conductor producing an electrical current.

29.3

1. Moving air is called wind. Uneven absorption of solar radiation by earths surface causes difference of temperatures, density and pressure which produces air movements or wind.
2. It is the solar energy of sun which causes the kinetic energy of wind.
3. Dams are built on rivers to store water at a higher level, which is made to fall to rotate turbines that generate electricity. Generation of electricity by using the force of falling water is called hydro electricity.