

CHAPTER 14

Sources Of Energy

Acknowledgment

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Energy crisis

Even though energy can neither be created nor destroyed, still we need to worry about energy crisis because energy in usable form is being dissipated to the surrounding in less usable forms.

(Activity 14.1) List four forms of energy that you use from morning, when you wake up, till you reach the school.

- a) Muscular energy to carry out physical work.
- b) Electrical energy for running various appliances.
- c) Chemical energy for cooking food or running vehicles.
- d) Light energy
- e) Heat energy

(Activity 14.2) Consider the various options we have when we choose a fuel for cooking our food. What are the criteria you would consider when trying to categorise something as a good fuel?

A good fuel should have
high caloric value,
have proper ignition temperature,
easy to handle and transport.

(Activity 14.2) Would your choice be different if you lived (a) in a forest? (b) in a remote mountain village or small island? (c) in New Delhi? (d) lived five centuries ago?

a) In a forest – Wood or leaves.

b) In a remote mountain village or small island
– cow dung or dry twigs

c) In New Delhi – L.P.G or C.N.G

d) 500 years ago – wood

(Activity 14.2) How are the factors different in each case?

Availability and quality of fuel are the factors that determine the choice of fuel.

While selecting a fuel what are the three relevant questions to ask about a fuel?

- (i) How much heat does it release on burning?
- (ii) Does it produce a lot of smoke?
- (iii) Is it easily available?

Characteristics of a good source of energy

A good source of energy:

- a) should give large amount of energy per unit volume or mass.
- b) must be easily accessible.
- c) must be easy to store and transport.
- d) must be economical.

Source of energy

The material that provides the required amount of energy is called **source of energy**.

Good fuel

A good fuel produces a huge amount of heat on burning, does not produce a lot of smoke, and is easily available.

What has led to the growing demand for energy?

Increasing industrialization has led to better quality of life all over the world. This has led to global demand for energy.

Need for conserving energy

Fossil fuels are non-renewable source of energy. If we continue to consume at such a rate, soon we will run out of energy. Hence we need to conserve fossil fuels.

Disadvantages of burning fuel

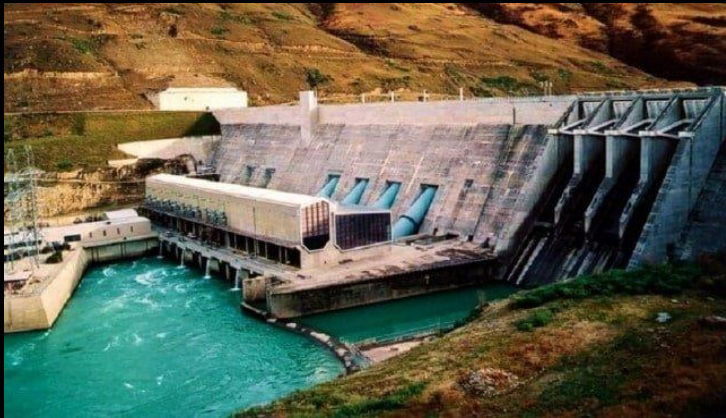
- a) Air pollution is caused by burning coal or petroleum products.
- b) The oxides of carbon, nitrogen and sulphur that are released on burning fossil fuels form acidic oxides cause acid rain. Acid rain affects water and soil resources.
- c) Greenhouse effect is caused due to gases like carbon dioxide.

Pollution by burning of fuel

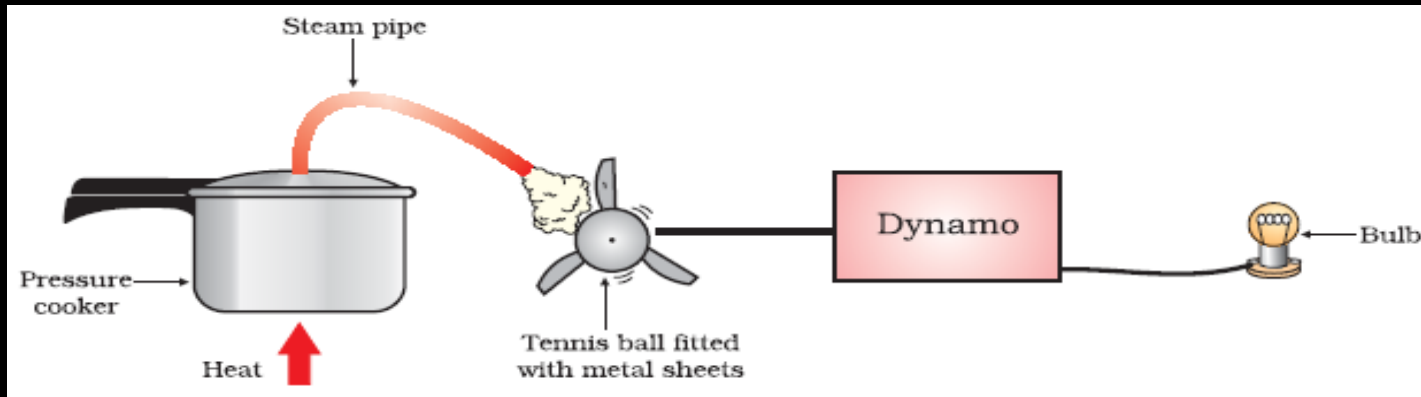
The pollution caused by burning fossil fuels can be somewhat reduced by increasing the efficiency of the combustion process and using various techniques to reduce the escape of harmful gases and ashes into the surroundings.

Ways of producing energy

- a) Thermal power plant
- b) Hydro power plants
- c) Wind mills



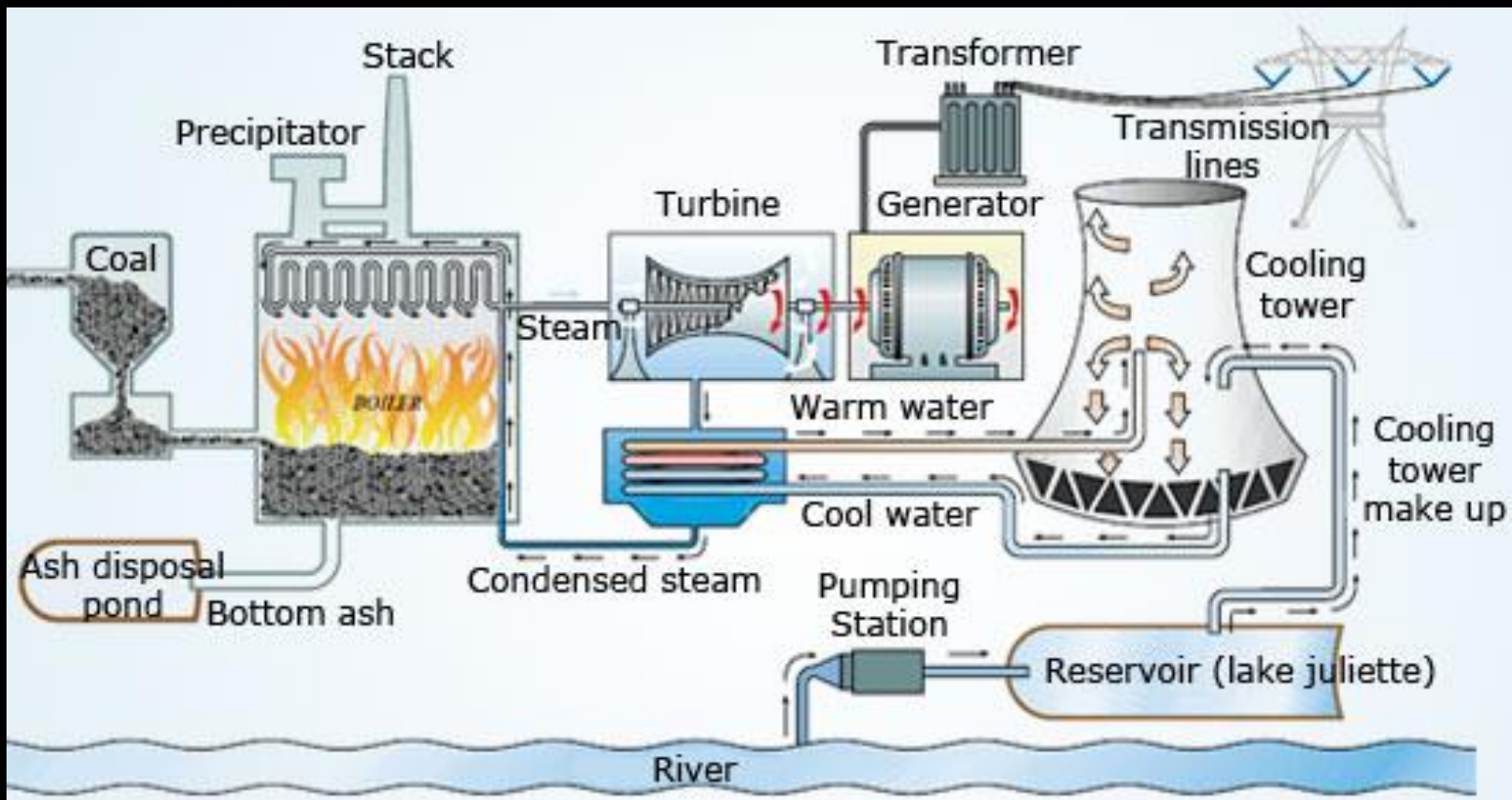
(Activity 14.3) Take a table-tennis ball and make three slits into it. Put semi-circular fins cut out of a metal sheet into these slits. Pivot the tennis ball on an axle through its centre with a straight metal wire fixed to a rigid support. Ensure that the tennis ball rotates freely about the axle. Now connect a cycle dynamo to this. Connect a bulb in series. Direct a jet of water or steam produced in a pressure cooker at the fins. What do you observe?



The bulb will start glowing. It will remain glowing till the ball is rotating with the help of steam.

Thermal power plants

In a thermal power plant fossil fuels are burnt to heat water to produce steam. Steam runs the turbine to generate electricity.

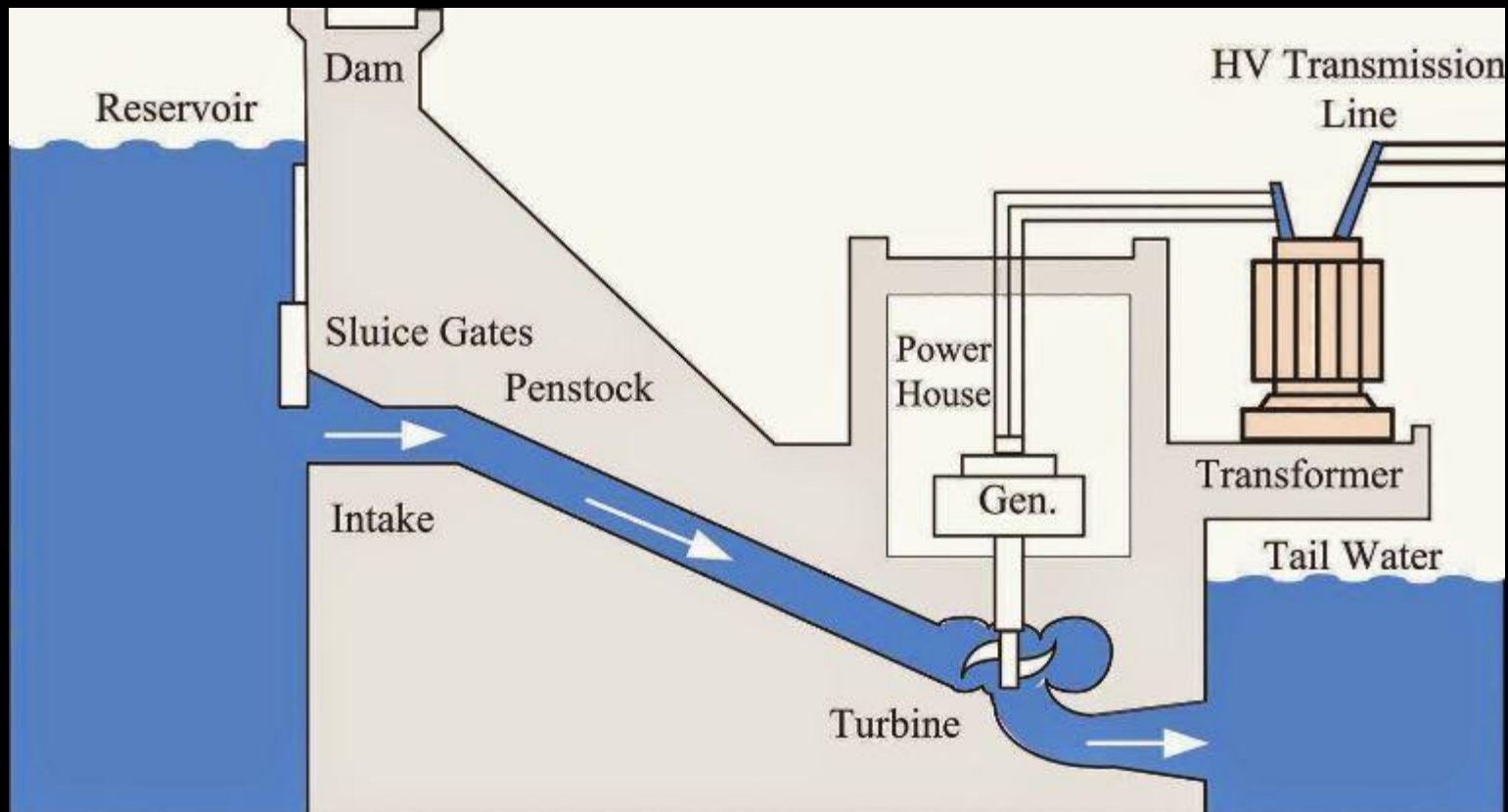


Why are thermal power plants set up near coal or oil fields?

Transmission of electricity is more efficient than transporting coal or petroleum over the same distance. Hence many thermal power plants are set up near coal or oil fields.

Hydro-electric power plants

Hydro power plants convert the potential energy of falling water into electricity by using the kinetic energy of the flowing water or the potential energy of water at a height.



Disadvantages of Hydro-electric power plants

- a) Dams can be constructed only in limited number of places.
- b) Large areas of agricultural land and human habitation are to be sacrificed as they get submerged.
- c) Large ecosystems are destroyed when submerged under the water in dams.
- d) The vegetation which is submerged rots under anaerobic conditions and gives rise to large amounts of methane which is also a green-house gas.
- e) It creates the problem of satisfactory rehabilitation of displaced people.

Why was there opposition to the construction of Tehri dam on the river Ganga and Sardar Sarovar project on the river Narmada?

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Why was there opposition to the construction of Tehri dam on the river Ganga and Sardar Sarovar project on the river Narmada?



182m Unity statue of Sardar Valla Bhai Patel

→ Tehri Dam



→ Sardar Sarovar Dam

Biomass

Biomass

The materials obtained from plants and animals used as fuel is called **bio-mass**.

Why is there a need for improvement of efficiency in biomass fuel?

Biomass does not produce much heat on burning and a lot of smoke is given out when they are burnt.

Therefore, there is a need to improve the efficiency of biomass.

Formation of charcoal

When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue.

Characteristics of charcoal

- a) Charcoal burns without flames.
- b) It is comparatively smokeless.
- c) It has higher heat generation efficiency.

Biomass Vs Charcoal

Biomass fuel	Charcoal
It produces a lot of smoke when burnt.	It burns without smoke.
It has low heat generation efficiency.	It has higher heat generation efficiency.



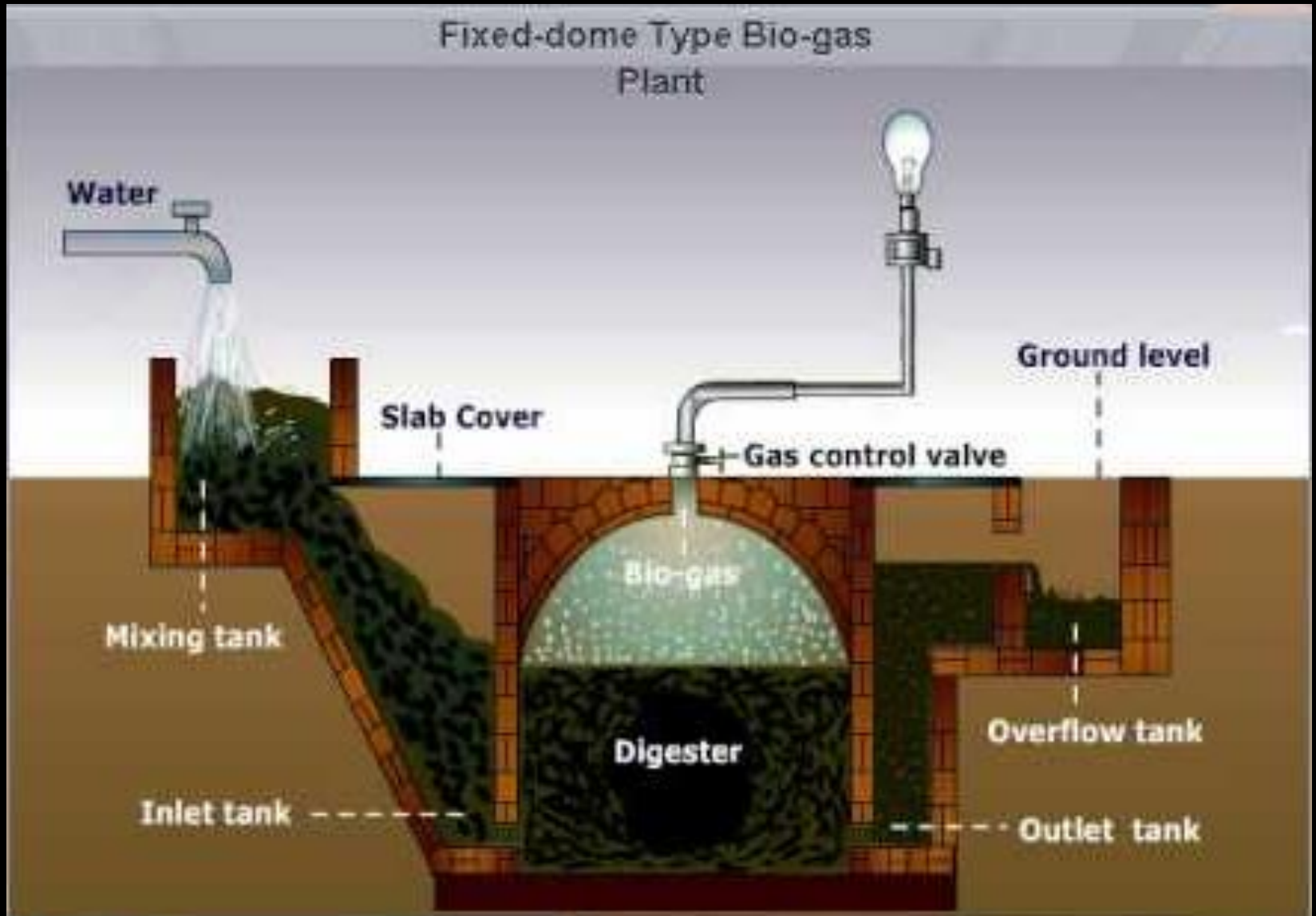
Biogas

Biogas is a mixture of methane, hydrogen, carbon dioxide and hydrogen sulphide.

Production of biogas

Cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give bio-gas.

Biogas



Characteristics of Biogas

- a) Bio-gas is an excellent fuel.
- b) It burns without smoke.
- c) It leaves no residue on burning.
- d) Its heating capacity is high.

Spent slurry

The slurry left behind is removed periodically and used as excellent manure, rich in nitrogen and phosphorous.



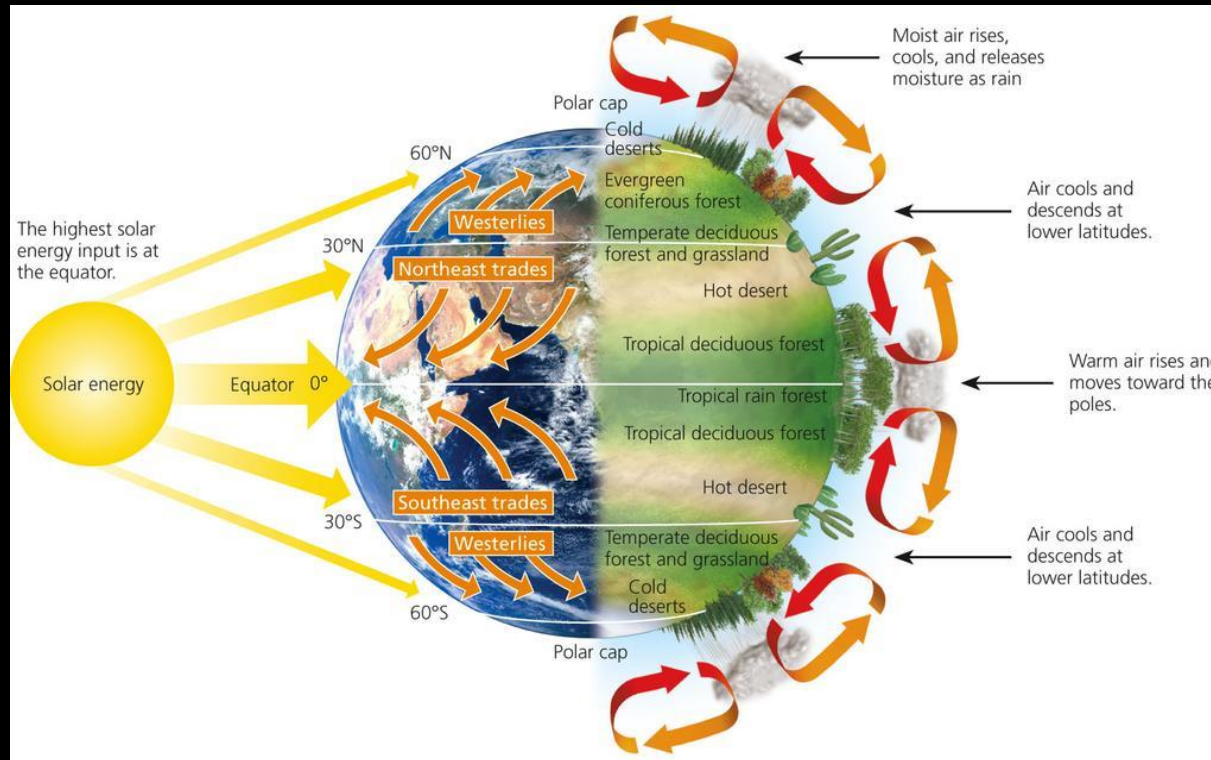
Advantages of biogas

- a) The large-scale utilisation of bio-waste and sewage material provides a safe and efficient method of waste-disposal.
- b) It supplies energy.
- c) Spent slurry can be used as manure.

Wind energy

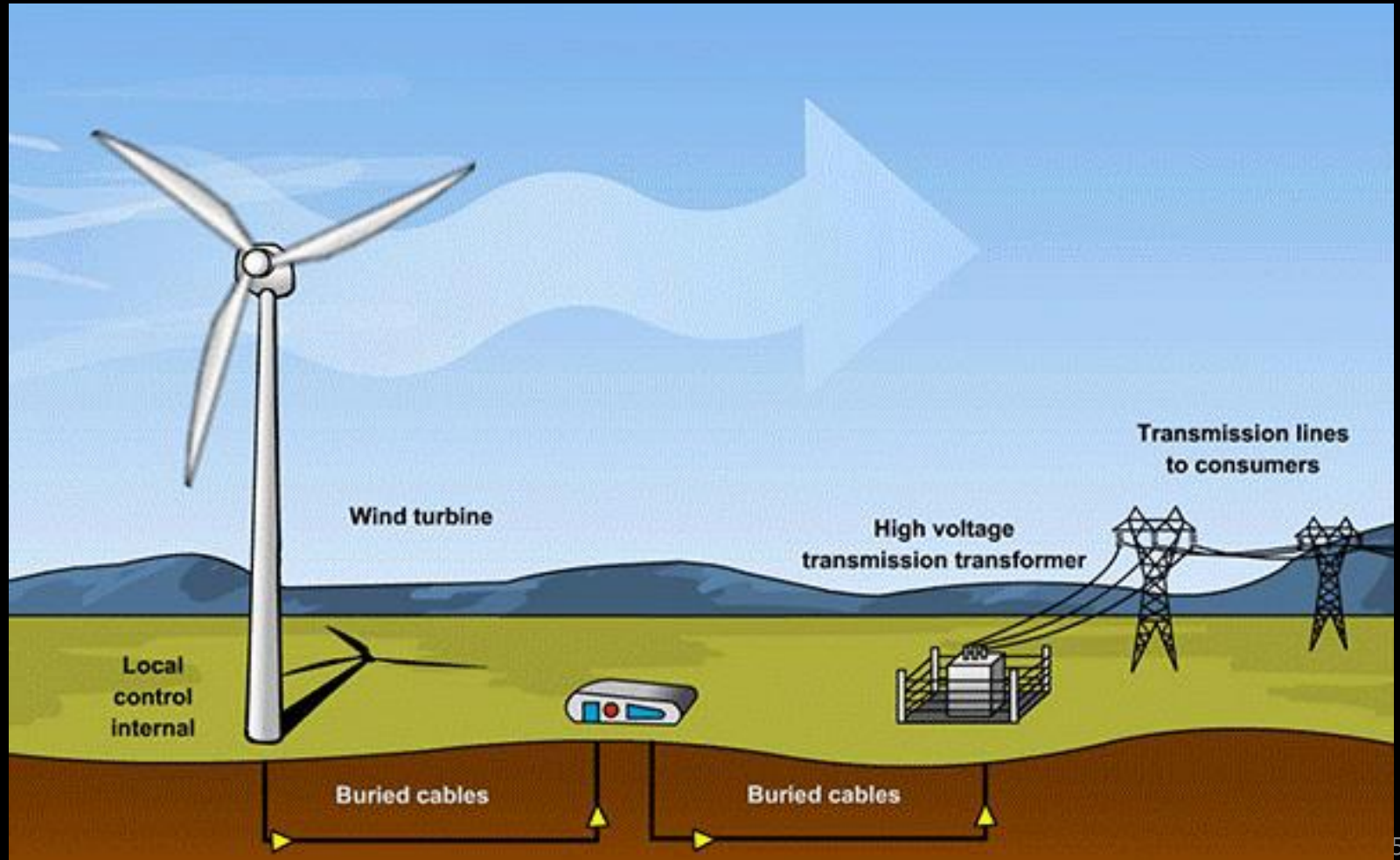
How is wind energy derived from solar energy?

Unequal heating of the landmass and water bodies by solar radiation generates air movement and causes winds to blow. So wind energy is derived from solar energy.



Wind Energy

To generate electricity, the rotatory motion of the windmill is used to turn the turbine of the electric generator.



Why the output of a single windmill cannot be used for commercial purposes?

The output of a single windmill is quite small and cannot be used for commercial purposes.

The energy output of each windmill in a farm is combined together to get electricity on a commercial scale.

Wind Energy Farms

A number of windmills erected over a large area is known as **wind energy farm**.



Advantages of Wind Energy

- a) Wind energy is environment-friendly.
- b) It is an efficient source of renewable energy.
- c) It requires no recurring expenses for the production of electricity.

Limitations of Wind Energy

- a) Wind energy farms can be established only at those places where wind blows for the greater part of a year.
- b) The wind speed should also be higher than 15 km/h to maintain the required speed of the turbine.
- c) There should be some back-up facilities (like storage cells) to take care of the energy needs during a period when there is no wind.
- d) Establishment of wind energy farms requires large area of land.
- e) The initial cost of establishment of the farm is quite high.
- f) Since the tower and blades are exposed to rain, Sun, storm and cyclone, they need a high level of maintenance.

(Activity 14.4) Find out from your grand-parents or other elders –

(a) How did they go to school?

They used to walk or animal driven vehicle or cycle.

(b) How did they get water for their daily needs when they were young?

They used to draw water from wells or rivers.

(c) What means of entertainment did they use?

Fairs, group games or dance etc. were the source of entertainment.

Compare the above answers with how you do these tasks now.

Nowadays we use fuel or electricity for all our needs

Is there a difference? If yes, in which case more energy from external sources is consumed?

There is a lot of difference. Now much more energy is consumed from external sources.

Solar energy

(Activity 14.5) Take two conical flasks and paint one white and the other black. Fill both with water. Place the conical flasks in direct sunlight for half an hour to one hour. Touch the conical flasks. Which one is hotter?

The one with a black paint will be hotter and will give a higher temperature.

You could also measure the temperature of the water in the two conical flasks with a thermometer. Can you think of ways in which this finding could be used in your daily life?

In daily life, we can wear light coloured clothes in summer and dark coloured clothes in winter. We can use this property to use heat from the sun for cooking and heating water.

Solar energy

The energy produced by the sun in the form of heat and light energy is called as **solar energy**.

Solar Cooker

Solar cooker is a device which uses solar energy to cook food.



Function of Mirror in solar energy

It is kept facing the sun so that a strong beam of light falls in the cooker top after reflecting from the mirror.



Function of glass plate in solar energy

The glass plate does not allow heat rays to pass through it and go outside the box. As a result, the infrared rays get absorbed in the box, which increases its internal temperature up to about 100°C.



Glass Plate

Function of black surface in solar energy

Black surface absorbs more heat than other surfaces.



Black Paint

Advantages of solar energy

- a) Solar energy is renewable source of energy.
- b) It is eco-friendly.
- c) It is abundantly available.
- d) It does not pollute the environment.

Limitations of solar energy

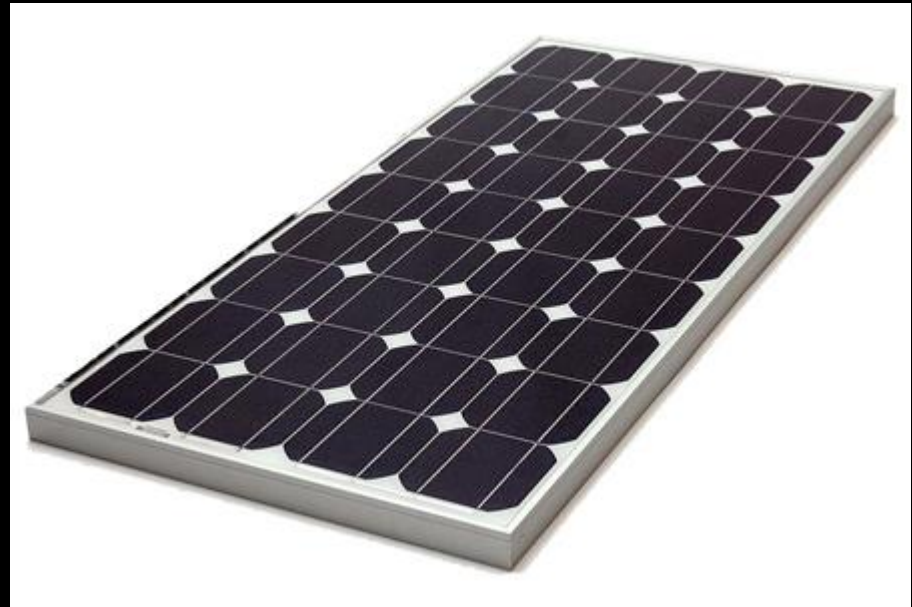
- a) Solar cooker can be used only at certain times of the day.
- b) It cannot be used on cloudy day and during night.
- c) It cannot be used for frying.
- d) It takes long time for cooking.

Solar cell

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

Solar Panel

A large number of solar cells combined in an arrangement is called **solar panel**.



Advantages of Solar cell

- a) Solar cells have no moving parts, so they require little maintenance.
- b) They work satisfactorily without the use of any focusing device.
- c) They can be set up in remote and inaccessible areas where laying of power transmission lines may be expensive or not possible.

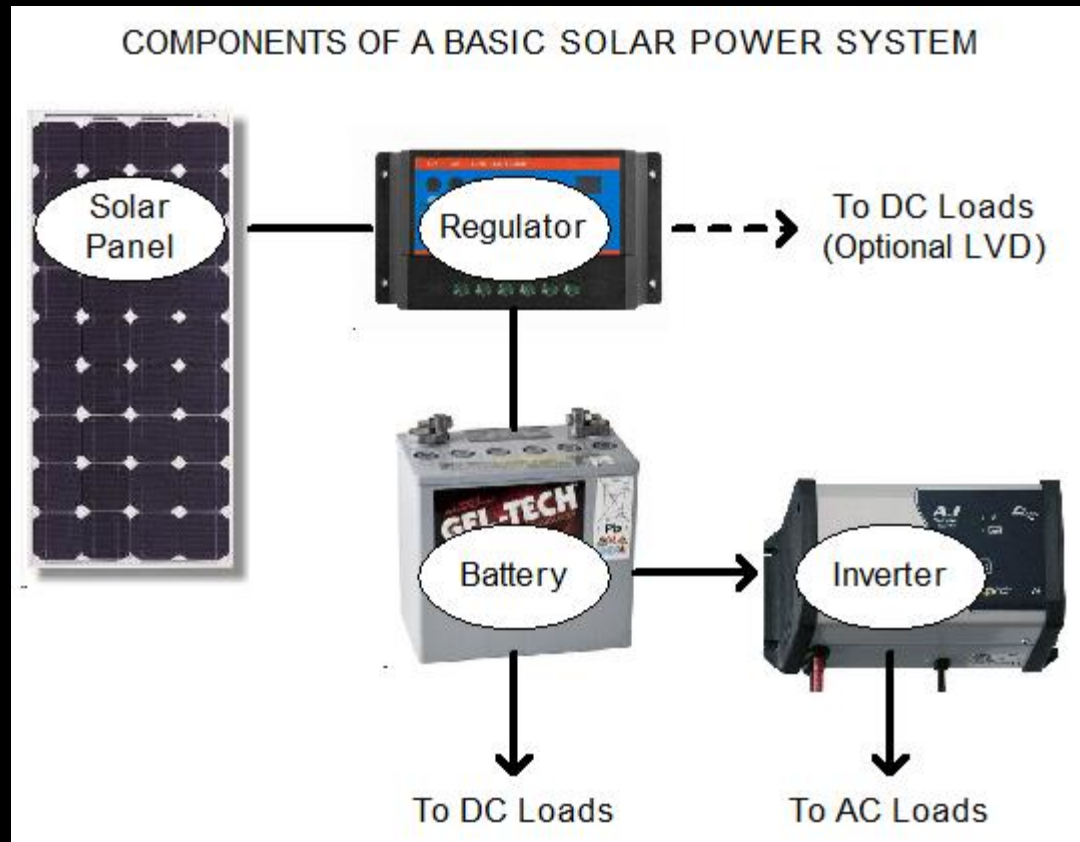


Why are solar energy devices costly?

- a) Availability of special grade silicon for making solar cells is limited.
- b) Silver used for interconnection of cells in the panel adds to the cost.

Limitations of solar energy

- a) The cost of installation of solar cells is very high.
- b) It produces direct current which needs to be converted into alternating current for use.



Applications of solar energy

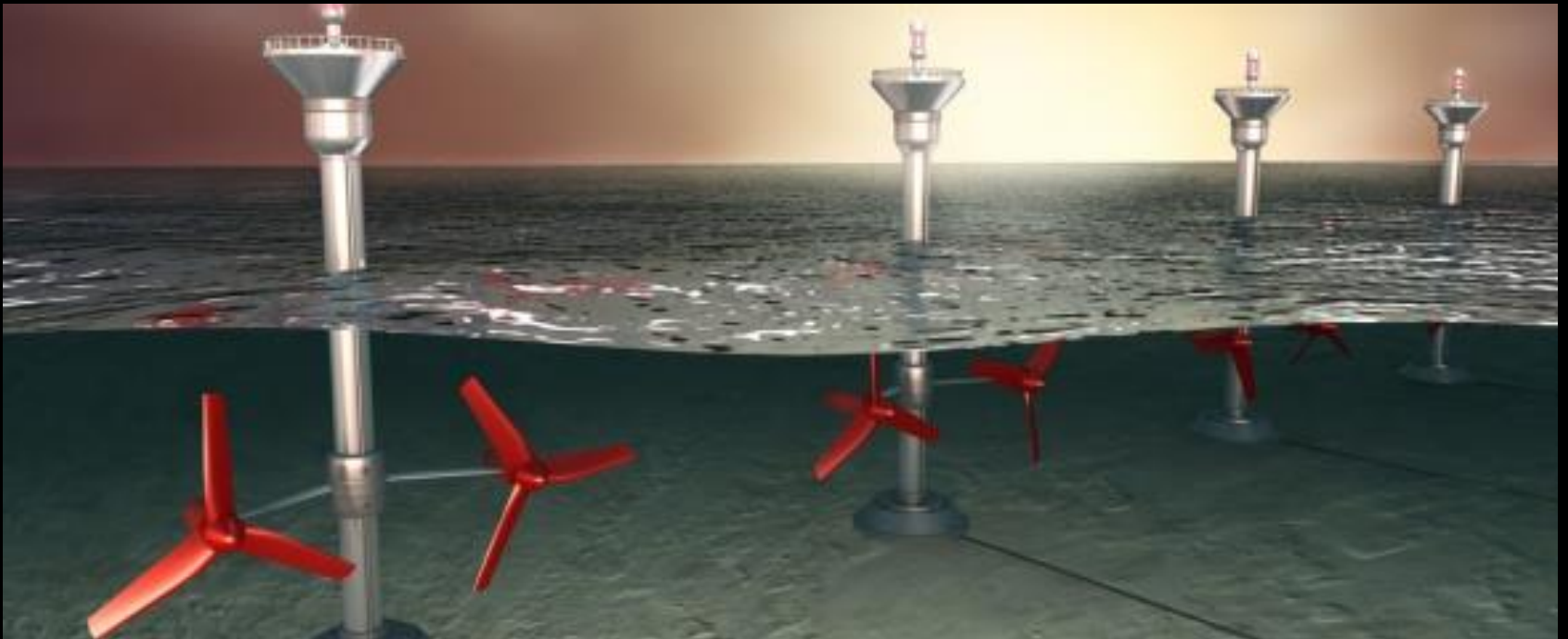
- a) Solar cells are used in artificial satellites and space probes.
- b) Radio & wireless transmission systems.
- c) Traffic signals, calculators and many toys are fitted with solar cells.



Tidal Energy

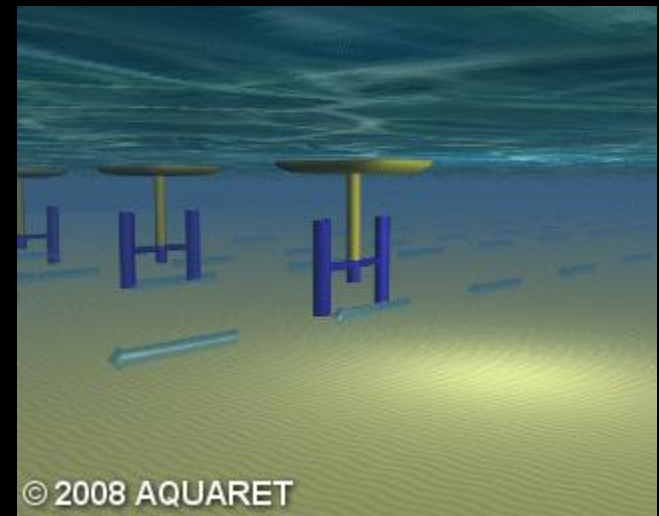
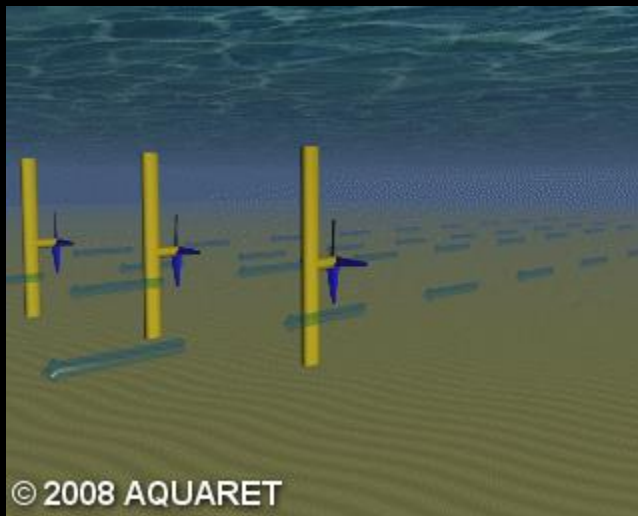
Tidal Energy

The energy harnessed by constructing dam across a narrow opening to the sea is called **tidal energy**.



Limitations of harnessing tidal Energy

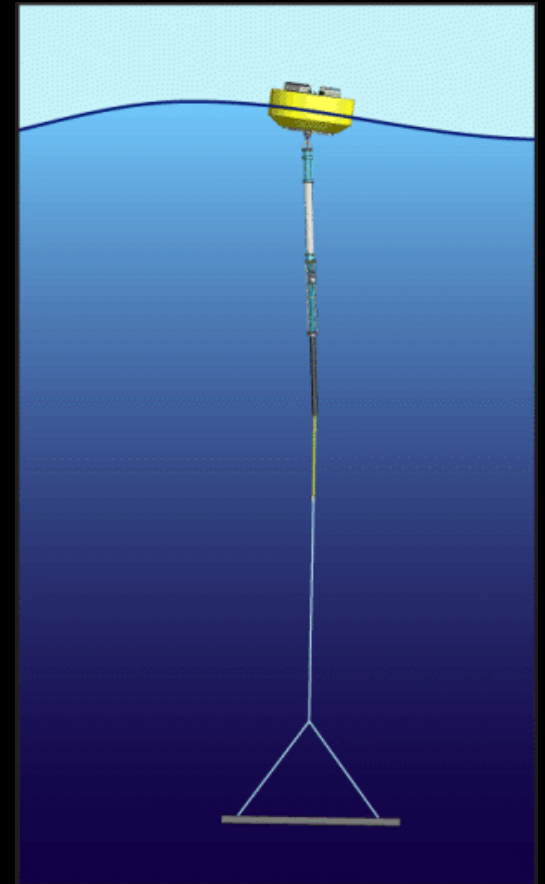
The electricity generated is not high enough to generate electricity on large scale. The sites where dams can be constructed across narrow openings to the sea is limited.



Wave energy

The kinetic energy possessed by huge waves near sea shore is trapped to generate electricity called **wave energy**.

Wave energy can be produced only where waves are very strong.



Ocean Thermal Energy

Ocean Thermal Energy

The energy obtained because of the difference in temperature of sea surface heated by the sun and colder water found at the deeper layers of ocean is called **ocean thermal energy**.



Ocean Thermal Energy

The water at the surface of the sea or ocean is heated by the Sun while the water in deeper sections is relatively cold. The warm surface-water is used to boil a volatile liquid like ammonia. The vapours of the liquid are then used to run the turbine of generator. The cold water from the depth of the ocean is pumped up is used to condense vapour again to liquid.

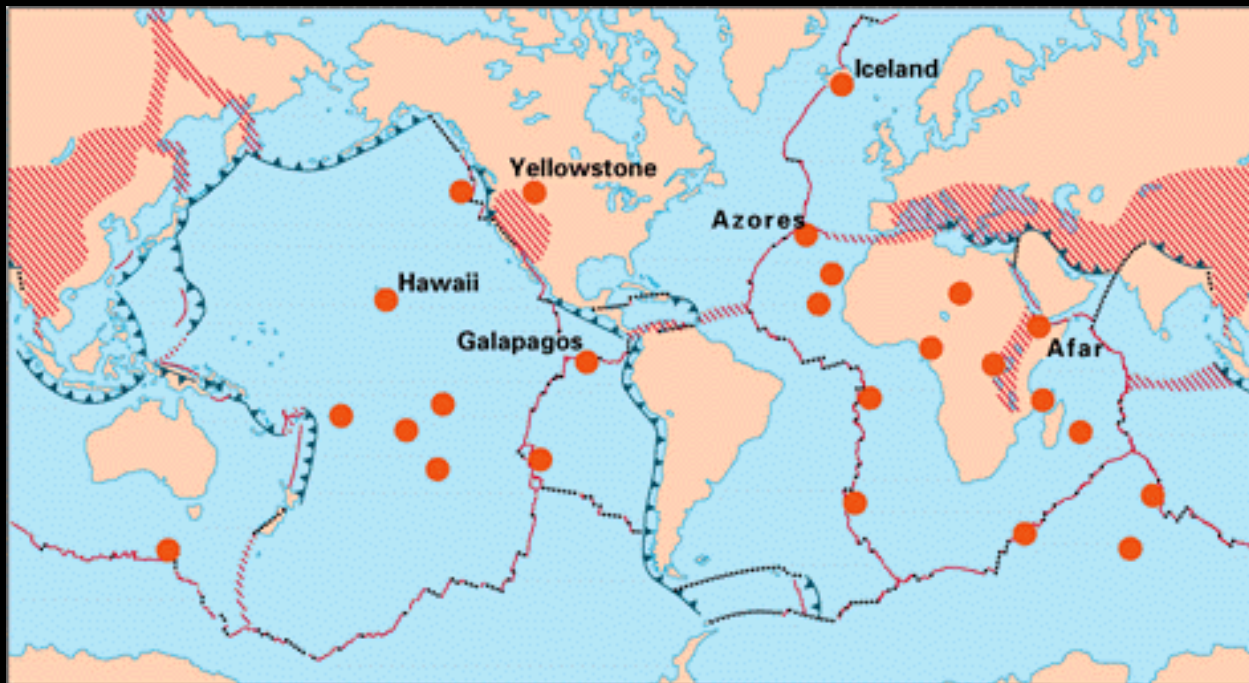
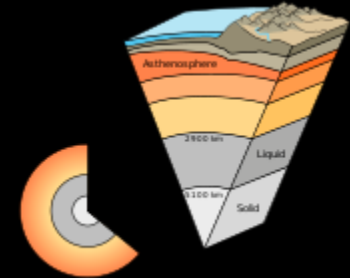
Limitations of Ocean Thermal Energy

The forms of energy that can be obtained from the ocean are tidal energy, wave energy, and ocean thermal energy. There are several limitations in order to harness these energies.

- a) Tidal energy depends on the relative positioning of the Earth, moon, and the Sun.
- b) High dams are required to be built to convert tidal energy into electricity.
- c) Very strong waves are required to obtain electricity from wave energy.
- d) To harness ocean thermal energy efficiently, the difference in the temperature of surface water (hot) and the water at depth (cold) must be 20°C or more.

Hotspots

The molten rocks formed in the deeper hot regions of earth's crust are pushed upward and trapped in certain regions called 'hot spots'.



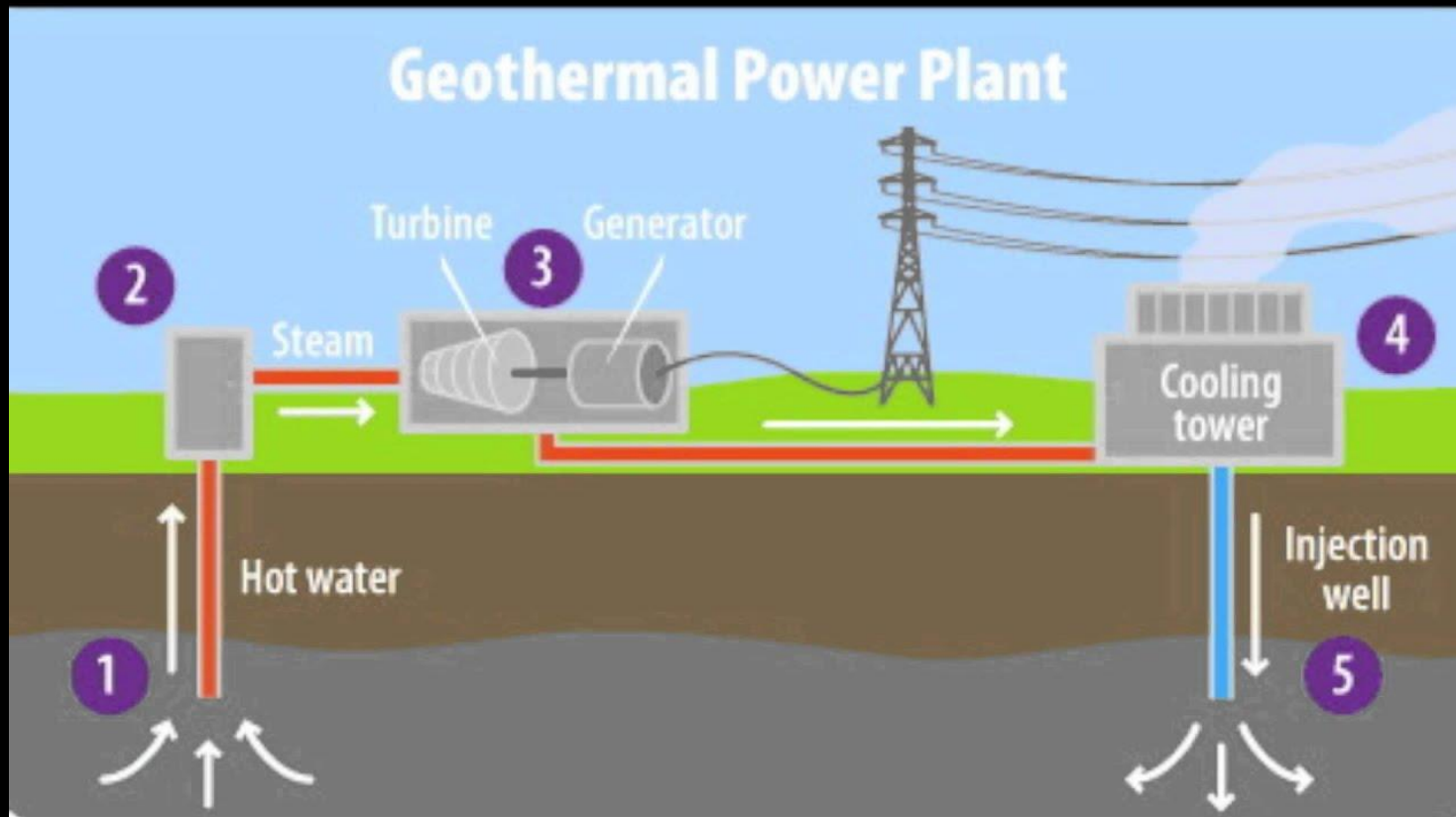
Hot springs

When underground water comes in contact with the hot spot, steam is generated which finds outlets at the surface known as **hot springs**.



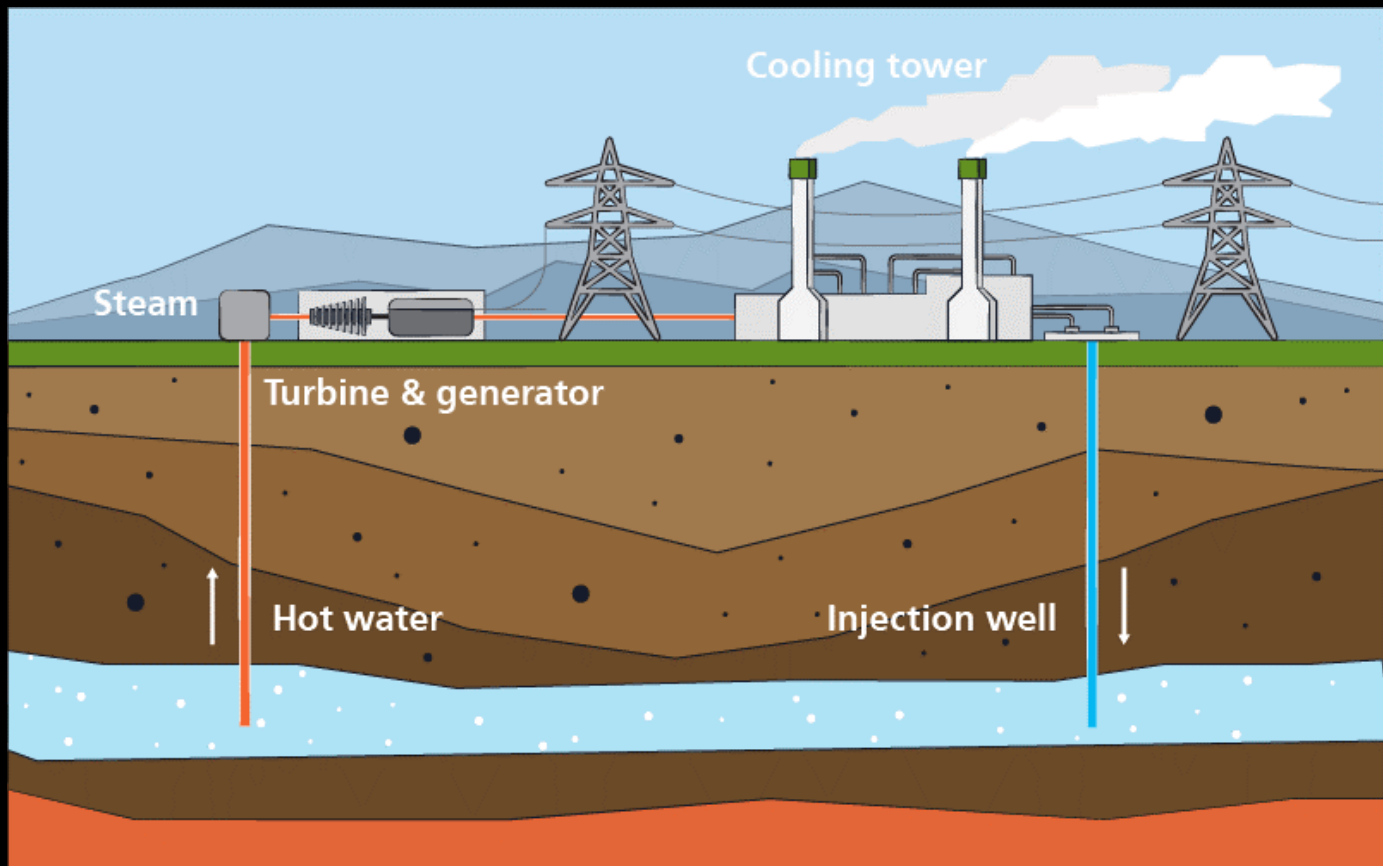
Geothermal energy

The energy obtained from hot molten rocks and trapped hot fluids inside the earth is called **geothermal energy**.



How is Geothermal energy produced?

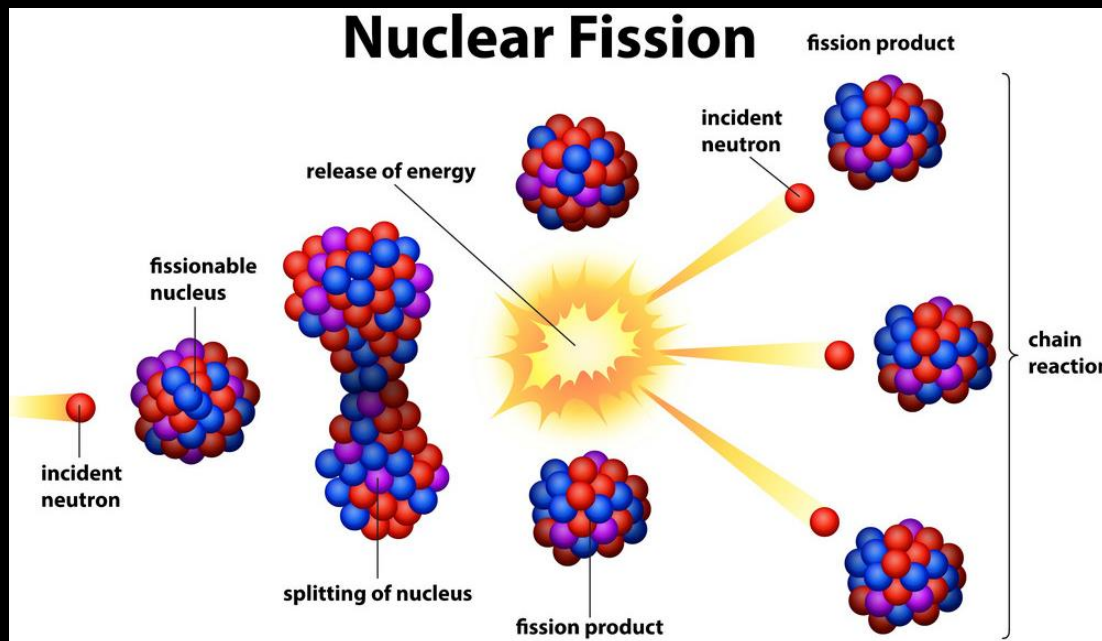
When underground water comes in contact with the hot spot, steam is generated. The steam trapped in rocks is routed through a pipe to a turbine and used to generate electricity.



Nuclear energy

Nuclear fission

The process in which nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons splits apart into lighter nuclei with release of a tremendous amount of energy is called **nuclear fission**.



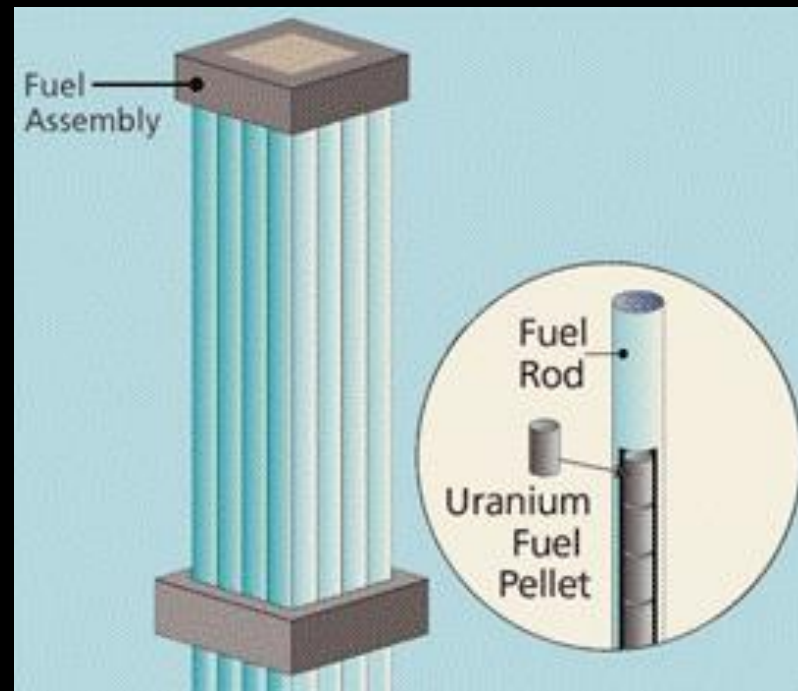
Nuclear Reactor

Nuclear reactor is a device in which converts nuclear energy into electrical energy.



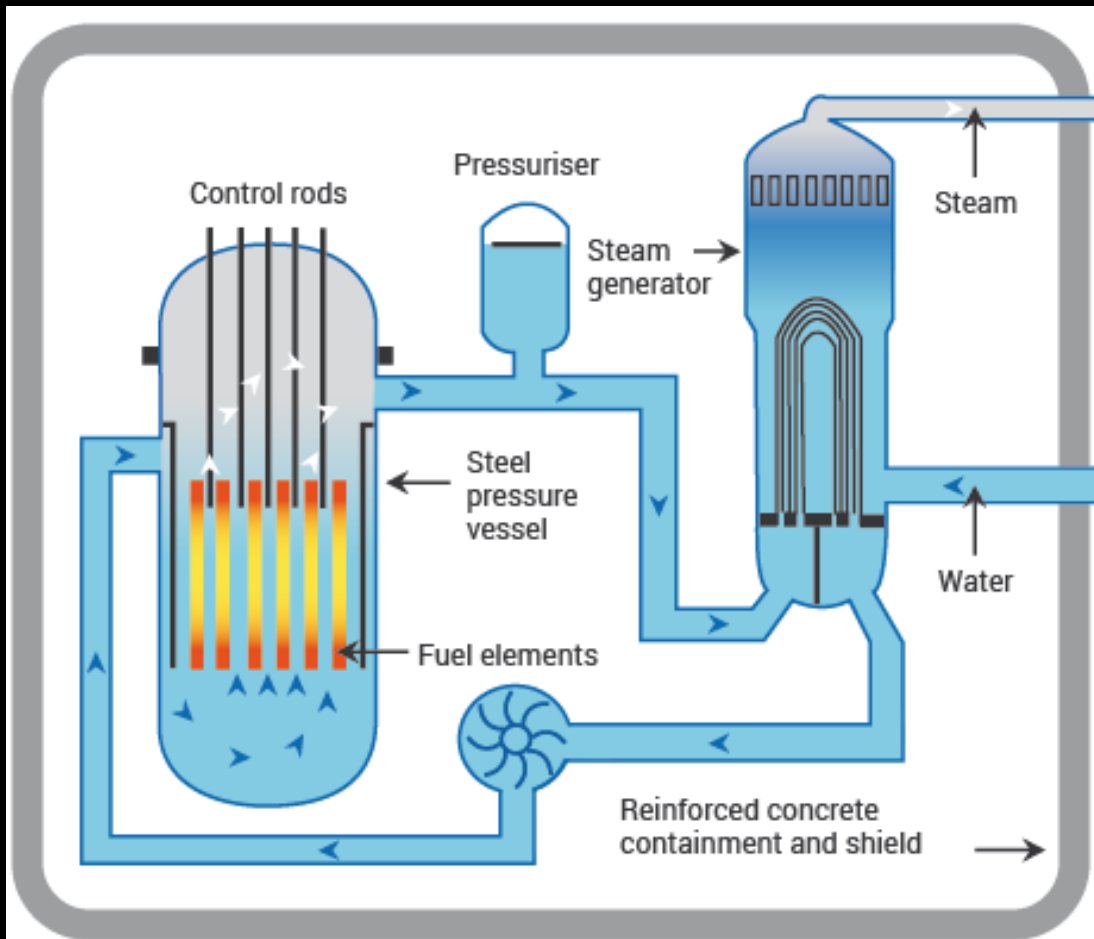
Principle of Nuclear Reactor

In a nuclear reactor, nuclear 'fuel' undergoes self-sustaining fission chain reaction that releases energy at a controlled rate.



Nuclear energy to electricity

In a nuclear reactor, nuclear 'fuel' undergoes self-sustaining fission chain reaction that releases energy at a controlled rate. The released energy is used to produce steam which rotates the turbine to generate electricity.



Advantages of nuclear energy

The advantages of nuclear energy are as follows:

- a) Large amount of energy is produced per unit mass.
- b) It does not produce smoke. It is a clean energy.
- c) Fission of one atom of uranium produces 10 million times the energy released by burning of one atom of carbon.

Limitations of nuclear energy

- a) Improper nuclear-waste storage and disposal result in environmental contamination.
- b) There is a risk of accidental leakage of nuclear radiation.
- c) The cost of installation of a nuclear power plant is high.
- d) There is limited availability of uranium.

Hazards of nuclear energy

The major hazard of nuclear power generation is the storage and disposal of spent or used fuels.



(Activity 14.7) Discuss in class the question of what is the ultimate source of energy for bio-mass, wind and ocean thermal energy.

Sun is the ultimate source of energy because the energy we get from plants, wind, ocean thermal energy are because of sun's energy.

Is geothermal energy and nuclear energy different in this respect? Why?

Geothermal energy and nuclear energy are not influenced by the sun. Geothermal energy arises because deeper regions of earth's crust are very hot. Nuclear energy arises due to radioactive substance.

Where would you place hydroelectricity and wave energy?

Hydroelectricity and wave energy are influenced by the sun.

(Activity 14.8) Gather information about various energy sources and how each one affects the environment. Debate the merits and demerits of each source and select the best source of energy on this basis.

Various sources of energy	Effect on environment
1. Hydroelectricity	Dams can cause imbalance in environment
2. Thermal electricity	Pollution, fossil fuels get exhausted
3. Petroleum	Pollution, fossil fuels get exhausted
4. Bio-mass	Pollution
5. Tidal/wave energy	No effect
6. Solar energy	No effect
7. Geothermal energy	No effect
8. Nuclear energy	Pollution

Can any source of energy be pollution-free? Why or why not?

No source of energy can be pollution-free.

It is considered that solar cells are pollution-free.

However, even their making causes environmental damage indirectly.

In the case of nuclear energy, there is no waste produced after the fusion reactions. However, it is not totally pollution-free.

To start the fusion reactions, approximately 10^7 K temperature is required, which is provided by fission reactions. The wastes released from fission reactions are very hazardous.

Hence, no source of energy is pollution-free.

**Renewable
&
Non-renewable
source of energy**

Renewable source of energy

- a) Renewable sources will last as long as the Earth receives light from the sun.
- b) These sources are freely available in nature.
- c) These sources do not cause any pollution.

Advantages of Renewable source of energy

Renewable sources of energy are those which can be regenerated. They are inexhaustible.

Examples: Solar energy, Wind Energy, water energy (hydro-energy), geothermal energy, ocean energy, biomass energy (firewood, animal dung and biodegradable waste from cities and crop residues constitute biomass).

Non-Renewable source of energy

Non-renewable sources of energy are those which are exhaustible and cannot be replaced once they have been used.

Examples: Coal, Oil and Natural gas.

(Activity 14.8) Debate the following two issues in class.

(a) The estimated coal reserves are said to be enough to last us for another two hundred years. Do you think we need to worry about coal getting depleted in this case? Why or why not?

We should worry coal reserves are likely to be exhausted within 200 years because it got millions of years for buried plants to be converted into coal.

(Activity 14.8) Debate the following two issues in class.

(b) It is estimated that the Sun will last for another five billion years. Do we have to worry about solar energy getting exhausted? Why or why not?

We should not worry about solar energy getting exhausted in another five billion years because it is a very long time for any civilization to exist.

On the basis of the debate, decide which energy sources can be considered (i) exhaustible, (ii) inexhaustible, (iii) renewable and (iv) non-renewable. Give your reasons for each choice.

Coal is exhaustible and is non-renewable. Solar energy is inexhaustible and is renewable.

Name two energy sources that you would consider to be renewable. Give reasons for your choices.

- a) Sun: The energy derived from the Sun is known as solar energy. Solar energy is produced by the fusion of hydrogen into helium, fusion of helium into other heavy elements, and so on. A large amount of hydrogen and helium is present in the Sun. Therefore, solar energy can replenish on its own. The Sun has 5 billion years more to burn. Hence, solar energy is a renewable source of energy.
- b) Wind: Wind energy is derived from air blowing with high speed. Wind energy is harnessed by windmills in order to generate electricity. Air blows because of uneven heating of the Earth. Since the heating of the Earth will continue forever, wind energy will also be available forever.

Give the names of two energy sources that you would consider to be exhaustible. Give reasons for your choices.

- a) Coal: It is produced from dead remains of plants and animals that remain buried under the earth's crust for millions of years. It takes millions of years to produce coal. Industrialization has increased the demand of coal. Coal cannot replenish within a short period of time. Hence, it is a non-renewable or exhaustible source of energy.
- b) Wood: It is obtained from forests. Deforestation at a faster rate has caused a reduction in the number of forests on the Earth. It takes hundreds of years to grow a forest. If deforestation is continued at this rate, then there would be no wood left on the Earth. Hence, wood is an exhaustible source of energy.

Fossil fuels Vs Sun's energy

Fossil fuel	Solar energy
<p>Obtained from underneath earth's crust.</p> <p>It is directly available.</p> <p>They are limited in amount.</p> <p>It is non-renewable.</p> <p>They are very costly.</p>	<p>Solar energy is direct source of energy.</p> <p>It is unlimited.</p> <p>It is renewable.</p> <p>It is free of cost.</p>

Biomass Vs Hydroelectricity

Biomass

It is renewable source.
It is derived from dead plants and animal wastes.

Hydroelectricity

It is renewable source.
It is obtained from the potential energy stored in water.

What are the environmental consequences of the increasing demand for energy? What steps would you suggest to reduce energy consumption?

Industrialization increases the demand for energy. Fossil fuels are easily accessible sources of energy that fulfil this demand. The increased use of fossil fuels has a harsh effect on the environment. Too much exploitation of fossil fuels increases the level of greenhouse gas content in the atmosphere, resulting in global warming and a rise in the sea level.

It is not possible to completely reduce the consumption of fossil fuels. Some measures can be taken such as using electrical appliances wisely and not wasting electricity. Unnecessary usage of water should be avoided. Public transport system with mass transit must be adopted on a large scale. These small steps may help in reducing the consumption of natural resources and conserving them.

Exercise (MCQ)

1. A solar water heater cannot be used to get hot water on:

- (a) a sunny day.
- (b) a cloudy day.
- (c) a hot day.
- (d) a windy day.

2. Which of the following is not an example of a bio-mass energy source?

- (a) wood
- (b) gobar-gas
- (c) nuclear energy
- (d) coal

3. Most of the sources of energy we use represent stored solar energy. Which of the following is not ultimately derived from the Sun's energy?

(a) geothermal energy

(b) wind energy

(c) nuclear energy

(d) bio-mass.

END