8
Conservation of Energy

8.1 Introduction

If you were asked — where does your 'energy' to work come from? You would probably reply, 'from the food we eat'. Similarly, the energy used to cook your food comes from burning wood/coal/cowdung cakes/kerosene oil/gas/electricity. The energy to run your fan/T.V. comes from electricity. In this way, you are all aware of using energy in its different forms. But have you ever stopped to think what the world would be like if there was no light or heat from the sun or if there was no electricity to light up your home?

In this lesson, we will try and learn more about the sources of energy, the need to make wise use of whatever energy is available to us and also try and find new and innovative sources of energy to fulfill our daily energy requirements.

8.2 Objectives

After reading this lesson, you will be able to :

- explain the meaning of energy and list its various sources;
- classify as 'renewable' and 'non-renewable' sources of energy;
- generate awareness that energy is not infinitely available;
- suggest common methods of conserving energy in order to augment it;
- identify energy options for the future.

8.3 What is Energy?

Energy may be defined as

The capacity for doing work.

You must have seen that use of energy always brings about some change — a fan moves, a stove burns to give heat, a torch gives light, a calculator works when light falls on it, a pump brings up water, etc. You can perhaps quote many more examples. In all cases, some work is being done and the factor which provides the capacity for doing this work is known as 'energy'.

The question now is, *where* does energy *come from*?

Sun is the source of all natural energy in this world.

You may disagree and say that you get your energy from, say, fire, electricity, light, etc. You are right, of course. Let us examine this in a little detail.

The energy that you get from 'fire' comes from burning wood/coal/oil/natural gas. All these substances are known as '*fuels*'. Apart from wood, the other fuels are also known as '*fossil fuels*' because they are obtained from beneath the earth's surface. Over millions of years, the Sun's energy transformed dead plant material into coal/oil/natural gas. So we can see that all fuels derive their energy from the sun.

Fuels are storehouses of sun's energy.

'Electricity' is produced with the help of moving water/steam/coal/oil. You already know that coal and oil derive their energy from the sun. Moving water, too, derives its energy from the sun as it is a part of the water cycle caused by the sun.

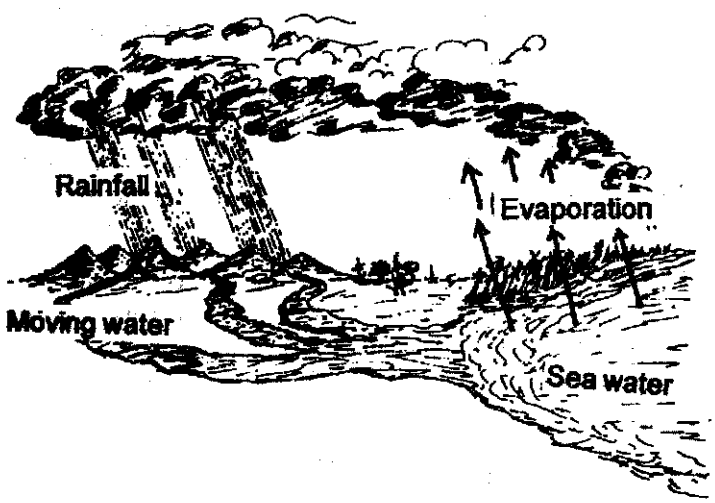


Fig. 8.1 The Water Cycle.

There are some other sources of energy like wind, nuclear fuel, geothermal energy, etc. Have you heard of windmills? When the sun causes a change in the air temperature, a *wind* is caused and we use the energy of this moving wind for various purposes. The energy released during nuclear reactions in nuclear fuels like plutonium and uranium is also used to produce electricity. Geothermal energy is the solar heat energy which is trapped by rocks deep within the earth. Scientists today have devised a way of utilising this energy for producing electricity etc.

Can you now list out the sources of energy?

Sources of Energy

1. Sun
2. Wind (wind mill)
3. Moving water (hydro electric projects)
4. Fuels (Wood/coal/oil/natural gas)
5. Nuclear fuels
6. Electricity
7. Geothermal energy.

INTEXT QUESTIONS 8.1

1. Tick mark the sources of energy from the list given below:

(i)	Petrol	(vi)	Pond water
(ii)	LPG	(vii)	Tap water
(iii)	Turpentine oil	(viii)	River water
(iv)	Kerosene oil	(ix)	Sunlight
(v)	Engine oil	(x)	Charcoal

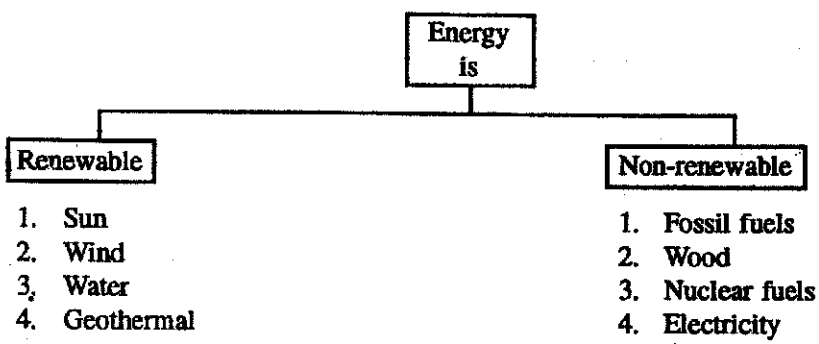
2. State whether the following statements are true or false and correct the false statements :

   (i) Electricity can be produced with the help of pond water.
   (ii) Wind is caused due to change in air pressure.
   (iii) Geothermal energy was initially solar energy.
   (iv) Wood, coal and oil are natural fuels.
   (v) Electricity can only be produced from water/steam/coal/oil.

8.4 Energy — Renewable or Non-Renewable?

Let us first see what is meant by the terms 'renewable' and 'non-renewable'.

Renewable means anything which that can be replaced endlessly, i.e. there is an endless supply. **Non-renewable** means something which can be repelaced up to a limited period after which its supply runs out. On the basis of the above explanation, can you now separate the sources of energy as renewable and non-renewable? We can say:



Renewable Sources

You know that there will be an endless supply of solar energy. We will always be able to use the energy of moving wind and water so long as the sun is there is cause them to move. Rocks deep inside the earth have trapped the sun's energy but if we use this geothermal energy at a faster rate than it is being trapped, it may also prove to be limited. But there is no immediate danger of this happening as estimates predict that the sun's energy will last for a long, long time to come.

Non-renewable Sources

Fuels like coal, oil and natural gas have taken millions of years to be formed. But the rate at which coal is being mined and oil drilled for meeting our energy requirements, is much faster than the rate at which they are being formed. Hence, existing supplies are fast running out.

Electricity is produced by burning fuels like coal or oil, by using the energy of flowing water or of steam or by using nuclear fuels. You may argue that since fuels are limited in supply, we can always switch to producing electricity by using flowing water. In that case, electricity would then be a renewable source of energy. But this is not actually so because hydroelectric projects have already been set up at most of the possible sites on major rivers in the country. These power projects are already producing electricity to their maximum capacity and there are no prospects of increasing the supply of electricity to meet increased demand. Hence, electricity, too, becomes a non-renewable source of energy.

Today, *nuclear fuels* are also being used to produce electricity but we have to remember that supplies of all nuclear fuels are limited and if they are used unwisely they will soon run out.

Intext Questions 8.2

1. From the list given below, separate the renewable sources of energy from the non-renewable sources by marking R and NR respectively.

(i) Sunlight	(vii) Wood
(ii) Petroleum	(viii) Kerosene
(iii) Steam	(ix) Nuclear fuel
(iv) Charcoal	(x) Electricity
(v) Water	(xi) LPG
(vi) Diesel	(xii) Wind

8.5 Energy Conservation : Why?

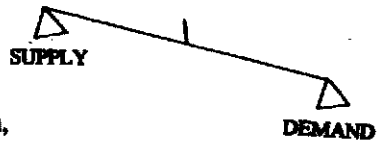
> Energy conservation involves use of leller energy for the same level of activity.

Let us try to understand this with the help of an example. Supposing you want to make *'dal'* for lunch. There are two ways of doing this : you could cook the dal in an ordinary pan with a lid on it or you could use a pressure cooker. Needless to say, there resultant 'dal' would be the same in both cases. By using a pressure cooker, you would save both time and energy used for cooking. Supposing we go a step further and say that you wish to cook not only 'dal' but also rice and potatoes. Again, one way would be to cook the three separately, resulting in the use of stove at least three times, and another way could be to use separators of a pressure cooker and cook all the three together.

What is the benefit of using a pressure cooker or of cooking things together? You are 'conserving energy', i.e. you are using less energy to achieve the same results.

The question that now arises is, WHY do we need to conserve energy ? After all, all forms of energy are easily available to us the moment.

We Must Conserve Energy Because:



1. Demand exceeds supply

There is an increasing demand for energy due to increasing population, industrialisation, traffic on roads and automation in home/office/farm, etc.

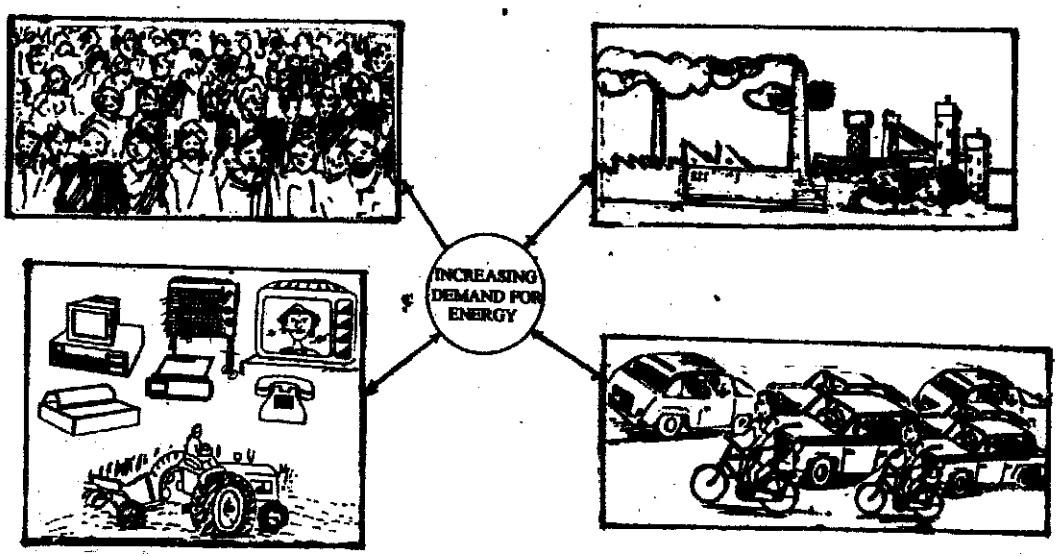


Fig. 8.4 Demands on Energy

You yourself must have observed that the ever increasing population is creating an increasing demand for energy. Increasing number of people need more houses to live in and this leads to increased felling of trees to provide timber and furnishing. At the same time, more coal/kerosene oil/gas is needed to cook the food for more people. More people today need more electricity to light their home, to run their coolers/geysers, to use washing machines, computers, etc., which results in increased power cuts. What steps do you think should be taken to reduce or close this gap between demand and supply of energy? We have two options before us:

(i) increase the supply
(ii) reduce the demand

Since supply of energy is limited, we are left with the second option, i.e. to reduce demand of energy. How can we do this?

By conservation and wise use of energy available.

2. Energy saved is energy generated

You must all be familiar with a bank. Whatever money you manage to save, you put in a bank and after some time you can see your savings grow, if you are careful to take out less money than you put in. If at any point of time, you start using the money faster than you put it in, you will soon run out of money and will have to face a shortage.

Now, imagine that there is an energy bank. Whatever energy you save in your daily activities gets accumulated in this energy bank so that you can use it in future. As your

'energy savings' grow, there will be less pressure to produce more energy. Similarly, the energy that you save could be used elsewhere, e.g. if you decide to have a daytime wedding in the family, with no decorative lights, the electricity you save could perhaps prevent a couple of power cuts in the city.

Every person's motto today should be:

Save on Something (S.O.S.)

3. Fuels are limited

Fuels are the most common sources of energy and you have already learnt that the deposits of coal, gas and oil are limited. A look at the chart given below will tell you where we stand today in terms of their availability to us in the years to come.

	Fuel	Known supplies (in years)	When likely to run out
1.	Natural Gas	about 40	A.D. 2035
2.	Oil	about 60	A.D. 2055
3.	Coal	about 290	A.D. 2285

After this what?

You can see that oil and natural gas are likely to run out during your own lifetime. The choice is before us : either we carry on as we are or we must plan the use of fuels and conserve them for future use.

INTEXT QUESTIONS 8.3

Q1. Match column A with column B.

Column A	Column B
(i) Cooking two dishes together	1. Renewable
(ii) Increased industrialization results in	2. Energy generated
(iii) Energy saved is	3. Limited
(iv) Natural fuels are	4. Increased demand for energy
	5. Conserves energy
	6. Population explosion

2. List four factors which contribute in creating a gap between the demand and supply of energy today.
   (i)
   (ii)
   (iii)
   (iv)

8.6 Conservation of Energy : How ?

By now you all have realised the fact that we are facing a very real possibility of the energy resources drying up during our lifetime.

Conservation of energy has to be the order of the day. Each and everyone of us has to unite and collectively take action to preserve and conserve energy. Each one of us has to think, "As an individual, is there something which I can do?"

Yes, there are many smalls ways in which we can contribute our share of efforts in energy conservation. Let us see how we can do so.

Energy can primarily be conserved:

1. At home
2. In the field/work place
3. On the road

1. Energy Conservation at Home

(a) Power

> Switch off a little ..... save a lot!

Take a look at your last power bill. It need not have been as much as it is. Just a little care, a little alertness on your part could have brought it down. How?

- Switch off lights and fan while leaving a room.
- Change over to *energy efficient tubelights* from power consuming bulbs.
  - Remember! A 40 watt tubelight gives twice as much light as a 100 watt incandescent bulb.
  - This means a savings of 60% power in addition to more light!
- Replace *traditional chokes* of tube lights with *electronic chokes*. They consume 1/3 energy.
- Keep lights and fixtures clean and dirt free.

> Dust and dirt reduce lighting levels by as much as 30%.

- Use dimmer switches to adjust the amount of lighting you need at any time.
- Use light colours for walls. This helps reduce lighting requirements by up to 40%.
- Replace old fan regulators with electronic regulators.
- Use a refrigerator of the size your family needs.

> Oversized refrigerators mean more power consumed.

- Avoid opening the fridge door frequently.
- Defrost your fridge regularly.
- Use your washing machine at proper loads.
- Mix hot water in a bucket for a bath rather than having a geyser shower.
- Switch on the AC an hour later and switch it off an hour earlier.

> An AC switched off for an hour can keep a 40 watt tubelight on for 50 hours

- When ironing, ensure that you have collected all the clothes first.
- Use your oven, hair dryer and vacuum cleaner sparingly to save on power.
- Avoid non-ISI appliances — they may be good bargains but being sub-standard and their components inefficient, they consume more electricity.

> ISI is your guarantee to energy savings.

(b) Fuel

As for power, you can adopt many simple ways in which to cut down on your bills.

Those of you who use LPG or gas cylinders for cooking at home are already aware of the way in which gas prices have been shooting up recently. Kerosene prices are not far behind. So what can we do to reduce our fuel bills? Here are some tips.

- Use ISI marked cooking stoves only.
- Replace traditional wood stoves with the 'unnat chullah' developed by the Government. These are 20-25% more heat efficient.
- Use solar cookers as far as possible.

Solar energy is free and abundantly available.

Fig. 8.3 Unnat Chullah

- Avoid cooking in open pans. Use a pressure cooker and save your fuel.
- Use separators of a pressure cooker to cook more than one dish at a time.
- Use copper bottom or sandwich bottom pans which are more heat sensitive.
- Switch on the gas after putting the pan on and switch off before removing the pan.
- Keep the burner holes clean and free of dirt and grease.
- Use small burner for small-sized vessels.
- Switch off the regulator switch of the gas cylinder at night.
- Avoid reheating food.

The above are just some tips to avoid excessive power/fuel usage at home. These tips will lead to substantial savings on your energy bills without compromising on comfort and convenience in any way.

2. In the field / workplace

(a) In the field

Farmers are increasingly using farm machinery like tractors, threshers, water pumps, etc. An effort must be made by farmers too, to conserve energy, which means they must try to get maximum work done with the use of least possible energy. Let us see how.

- Maintain tractors well. Poor maintenance leads to 25% loss of diesel.
- Prevent leaks.

Loss of one drop per second results in a loss of 2000 litre of diesel per year!

- Switch off the engine when the tractor is not in use.
- Drive in appropriate gear.

Use of wrong gear increases diesel consumption by 30% and decreases work efficiency by 50%.

- Keep the air filter clean to reduce wear and tear of the engine.
- Replace old tyres.
- Plan the use of tractor on the field. Digging in lengthwise direction rather than in the widthwise lines saves diesel.

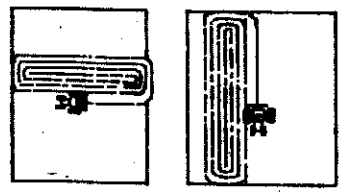


Fig. 8.4 Planned digging

(b) At the work place

The feeling people generally have is — "Who cares about energy conservation at the office — after all, I'm not paying for it !" But this is where we go wrong — ultimately it is we who pay for all the energy that is wasted in the office — in the form of energy shortages, higher price to be paid for energy, more taxes and so on. So, it becomes imperative that we not only adopt some energy-saving measures at our work place but also encourage our fellow workers to do the same. Here are some suggestions for you:

- Ask the cleaning staff not to switch on all lights and fans before people come to the office.
- Switch off fans and lights when you leave the room.
- Minimise the use of air-conditioners.
- Switch off computers when not in use.
- Avoid unnecessary photocopying of documents.
- Encourage people to use the stairs instead of the lift, specially in places like hospitals.
- Try and ensure that the office vehicles are used only for official purpose and not for personal use.

3. On the road

Many more people own vehicles today than they did ten years ago. Vehicles are used to go to the office as well as for family outings. This has resulted in a tremendous increase in the use of petrol. What do you suggest should be done to control the use of petrol ? We could consider the following :

- Use a car pool instead of individual cars to travel to work

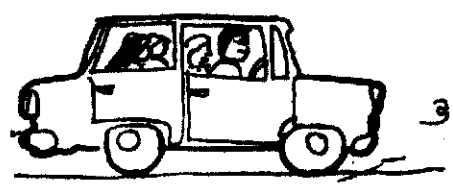


Fig. 8.5 Car pool : An economical way of travelling

- Adopt petrol-saving measures such as
  - * Drive at a slow and constant speed
  - * Minimise the use of brake and clutch
  - * Maintain proper air pressure in the tyres

* Switch off the engine if you have to stop for more than 2 minutes
* Prevent leakage of fuel at all costs
* Keep the engine well tuned.

- Encourage installation of light sensitive switches for street lights.
- Discourage the use of neon lights for advertising — these can easily be replaced by using solar panels which convert solar energy to electrical energy which lights up neon signs at night.

INTEXT QUESTIONS 8.4

1. Fill in the blanks:
   (i) _____are more energy-efficient than bulbs.
   (ii) _____chokes consume 1/3 energy as compared to traditional chokes.
   (iii) _____coloured walls help in reducing the lighting requirement of a room.
   (iv) More power is consumed by_____refrigerators.
   (v) Energy saving is guaranteed by using products bearing the _____mark.
2. State whether the following statements are true of false and correct the false statements:
   (i) Wood stoves are very heat efficient.
   (i) Cookers which work on solar energy save a lot of fuel.
   (ii) Sandwich bottom pans take a long time to heat.
   (iii) Small burners are suitable for small vessels.
   (iv) Food should be eaten as soon as it is cooked.
   (vi) Driving in the correct gear increases work efficiency by 50%.
   (vii) Wear and tear of engines depends upon the state of the air filter.
   (viii) Computers should not be switched off during the day.
   (ix) Wastage of energy in the office does not affect you personally.
   (x) Street lights need light sensitive switches.

8.7 What is the Alternative ?

We all agree that our prime concern today should be to utilise energy in such a manner that it can be made to last for as long as possible. You can see from the chart given earlier that natural gas and oil will run out in the next 40 and 60 years respectively. We may be able to stretch their use to 80 and 120 years respectively, by adopting stringent conservation methods. But what happens after that? We would be back at square one, unless we can think of some alternatives.

Is there an alternative? Yes, there certainly is! You have already studied that energy is renewable and non-renewable. If we want to stretch our non-renewable sources of energy we have to supplement them with the renewable sources.

Do you remember which are the renewable sources of energy? Since the use of these sources is not widely prevalent today, we also refer to them as **non-conventional** sources of energy. The non-renewable sources of energy are also known as the **conventional** sources of energy.

8.8 Energy Options for the Future

1. Biogas

Biogas is a product of fermentation of animal manure in the absence of air. It chiefly consists of methane gas which can safely be used as a fuel for cooking as well as lighting.

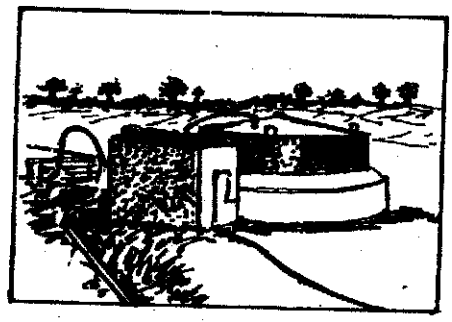


Fig. 7.6 Biogas : The cheap and healthy fuel.

Ordinarily, a small biogas plant fed by the manure of 2-3 animals can produce enough gas for the daily cooking and lighting needs of a family of four persons. In addition, biogas can be used to pump water or run small motors of less horsepower.

Some other advantages are:

- The sludge or digested waste is an excellent fertilizer and increases the yield of crops and vegetables.
- It keeps the environment around the house clean since all animal manure is fed into the biogas plant.
- It prevents eye and lung diseases caused due to smoke from firewood.
- It conserves forests because wood is no longer used as fuel.
- It generates employment to masons and labourers needed to set up more biogas plants.

2. Solar Energy

Solar energy is available free of cost and is absolutely non-polluting. It has been available to mankind for centuries but it is only recently that technological advancements have been made to trap and effectively utilise this energy. Some of the ways in which solar energy is being used today are:

(a) Solar Cooker — This is a shallow, square box with a black bottom and a glass top. When the black bottom is hit by sunlight passing through the glass top, it gets heated up. When a meal is kept inside the box, it gets cooked by this heat.

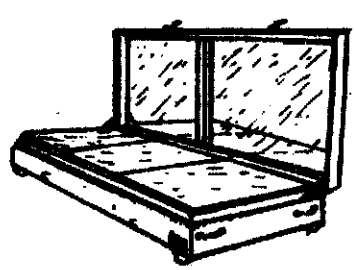


Fig. 8.7 Solar Cooker

Some advantages of using a solar cooker are:

- Fuel cost is reduced. Regular use preserves an average of 2 kg of combustible wood per day!
- It is totally safe to use — there is no fire, no burst gas cylinder, no leaking gas, no electric shocks!
- It does not require constant attention.
- It can cook up to four dishes at a time.
- It is very easy to use.

Use a solar cooker to cook your family's lunch!

(b) **Solar lighting** — Ordinary daylight is transformed to electrical energy with the help of solar cells. These solar cells produce electricity according to the amount of sunlight falling on them. When chemical storage batteries are used along with these cells, the excess energy produced on sunny days is stored for use on cloudy days with little direct sunlight.

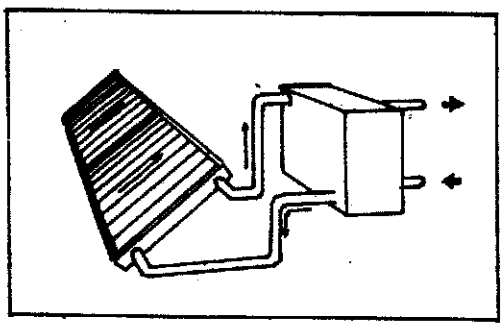


Fig. 8.8 Solar panels

Solar cells are used to produce lighting in

(i) Streets

(ii) Homes

(iii) Neon sign for advertising

(c) **Solar Heating** — Heat energy from the sun is being used in various ways today. It is used to:

- Heat water for bathing purposes in hotels/hostels
- Provide central heating in homes/hotels/hostels
- Make salted water fit for drinking purpose
- Dry timber and crops in solar furnaces
- Provide refrigeration in small, specially designed refrigerators. These are specially useful in keeping life-saving drugs at a low temperature and in preserving perishable agricultural produce like fruits and vegetables and milk and its products.

INTEXT QUESTIONS 8.5

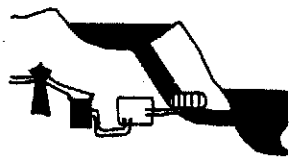
1. List at least four advantages of using non-conventional sources of energy.
2. Name the chief constituent of biogas.

3. Complete the sentence

   Biogas can be used for _____ _____ to

4. Name the device used to transform daylight to electrical energy.

3. Hydel Energy

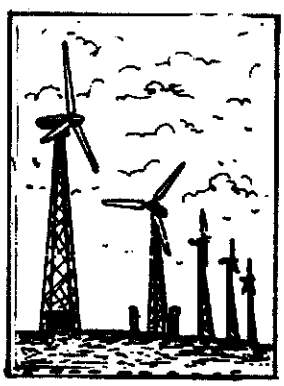


'Hydel' refers to water. Surely, all of you must have heard of big hydroelectric projects in our country like Bhakra-Nangal Project or the Damodar Valley Corporation (DVC), etc. These are enormous projects set up at the cost of crores of rupees and they generate lots of electricity. With the growing demand for electricity, the need to set up more such projects is being felt. But since most of the major sites on the big rivers have already been used for the purpose, there is very little scope of setting up more big projects. Then, what is the alternative? We have to now devise and set up microhydel projects.

It is realised that a small quantity of water falling from a great height can produce as much power as a large quantity of water falling a much shorter distance. Thus, the smaller rivers can be used to set up microhydel projects. The advantages of installing such micro projects are:

- They do not require heavy investment on installation.
- They are comparatively easy to maintain.
- They can be set up to locally supply electricity to geographically far flung areas which are not covered by the national grid system.
- Local supply of electricity reduces cost of distribution.
- Decentralization of power production and supply eases pressure on the larger power projects.

4. Wind Energy



Man has been using wind energy since a long time now - to sail boats on water, to grind grain by setting up wind mills, etc. And now, growing technological advancement has made it possible to generate electricity by using wind power. Let us see how this is done. A very simple structure consisting of blades or propellers and a direction controller is mounted on a high tower. The wind machine is fixed in an open area. When the wind blows, the propellers rotate and generate electricity in the generator to which they are connected.

The amount of energy generated depends upon the wind speed. A two fold increase in wind speed results in an eight fold increase in energy produced. It is estimated that an average annual wind speed of 20km/hr is essential for economical electricity production whereas a windspeed of 10km/hr is sufficient to work windpumps.

Some of the advantages of using wind energy are:

- it is absolutely free and non-polluting
- it can be used to generate and supply electricity in geographically isolated or hilly areas
- wind machines are cheap to set up and maintian

Be Non-conventional!

What are the advantages of using the non-conventional sources of energy ?

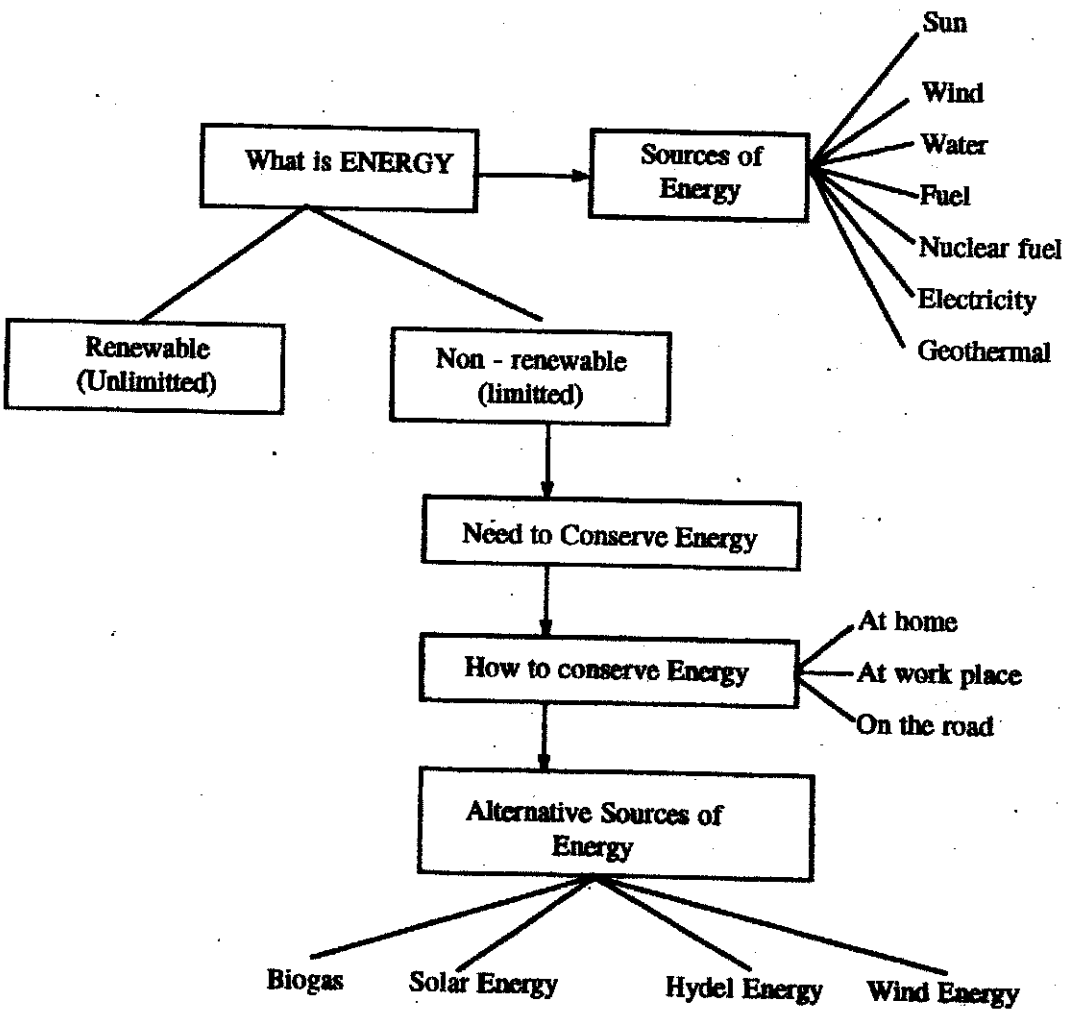
1. There is a never-ending supply.

2. These are easily available.
3. Production and use of non-conventional energy is always pollution free and leaves the environment clean.
4. These are locally produced, hence there is low cost of distribution.
5. Energy production units can be started on a small scale, hence heavy investment is not required.
6. Job opportunities for the local people are opened up.

INTEX QUESTIONS 8.6

1. What is the difference between a big hydro-electric project and micro hydel project?
2. List five advantages of setting up micro hydel projects.

8.9 What You Have Learnt



8.10 Terminal Excercises

1. Explain with examples what you understand by the term 'energy'.
2. Give two examples each of renewable and non-renewable sources of energy in your locality.
3. List five suggestions you would give a housewife to conserve energy in her kitchen.

8.11 Answers to Intext Questions

8.1 1. (i), (ii), (iv), (viii), (ix), (x)

2. (i) False. River water is needed.
   (ii) False. Winds are caused due to change in air temperature.
   (iii) True
   (iv) True
   (v) False. Nuclear fuels and hydrothermal energy can also be used.

8.2 R - (i), (xii), (v)

NR - (ii), (iii), (iv), (vi), (vii), (ix), (x), (xi)

8.3 1. (i)-5, (ii)-4, (iii)-2, (iv)-3

2. Refer to text.

8.4 1. (i) Tube lights (ii) Electronic
   (iii) Light (iv) Oversized
   (v) ISI

2. (i) False. Wood stoves are not heat efficient. (ii) True
   (iii) False. They heat up very fast. (iv) True
   (v) True (vi) True
   (vii) True should be switched off when not in use (viii) False. They
   (ix) False. It does affect you personally. (x) True.

8.5 1. Refer to the text.
2. Methane
3. Cooking, lighting, pump, motors
4. Solar cells

8.6 1. Refer to the text.
2. Refer to the text.