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Electric cars obviously run on electricity, and the power sources for that electricity are not always 'clean'. Yes, there is no direct air pollution due to the absence of fossil fuel (coal) or petroleum products. But the source of that electric charge generation grid still has environmental consequences.

Topic Notes

- Good Sources of Energy
- Conventional Sources of Energy
- Alternative or Non- Conventional Sources of energy
- Environmental consequences

GOOD SOURCES OF ENERGY

Energy comes in different forms and one form can be converted to another. Energy, in the usable form, is dissipated to the surroundings in less usable forms. Hence, any source of energy we use, to do work, is consumed and cannot be used again.

Characteristics of Good Fuel

- (1) It should have a high calorific value, i.e., it should release a large amount of heat on burning.
- (2) It should not produce a lot of smoke.
- (3) It should be readily available.

Characteristics of a Source of Energy

- (1) It should do a large amount of work per unit volume or mass.
- (2) It must be convenient to use.
- (3) It should be easy to transport and store.
- (4) It should be capable of delivering desired quantity of energy at a steady rate over a long period of time.
- (5) Be economical

Example 1. Case Based:

List four forms of energy that you use from morning, when you wake up, till you reach the school. Identify the sources of these different forms of energy.

Let us find out the various options we have when we choose a fuel for cooking our food and the criteria one would consider when trying to categorise something as a good fuel. [NCERT Activity 14.1, 14.2]

- (A) The different forms of energy that we use in our daily life in urban homes are:

Select the row containing the incorrect option:

	Form of energy	Source
(a)	Electrical energy	Water or coal
(b)	Muscular energy	Food
(c)	Heat energy	Fossil fuels
(d)	Mechanical energy	Wood

- (B) Given below are statements regarding choosing a fuel for cooking our food. Select the incorrect statements.

- (I) Kerosene should be used as a cooking fuel as it is readily available.
- (II) LPG or Natural Gas should not be used for cooking as they emit a lot of smoke.

- (III) Biogas should be used as a cooking fuel in rural areas since it is a renewable source of energy.

- (IV) Coal should not be used as a cooking fuel since it produces a lot of smoke on burning.

- (a) Both (I) and (II)
- (b) Both (II) and (III)
- (c) Both (III) and (IV)
- (d) Both (I) and (IV)

- (C) Write two criteria one would consider when trying to categorise something as a good fuel.

- (D) How would the choice of fuel for cooking be different if you lived in a forest and in New Delhi?

- (E) Assertion (A) : Different fuels are used for cooking and heating room in winter.

Reason (R) : Calorific value of fuels is the only criteria for selecting a fuel.

- (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.
- (b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion.
- (c) (A) is true, but (R) is false.
- (d) (A) is false, but (R) is true.

Ans. (A) (d) Form of Energy: Mechanical energy; Source: Wood

Explanation: Mechanical energy is used in our daily life in cycling, mixer etc. The source may be electrical or chemical energy, but not wood, as wood is not considered a good source of energy.

- (B) (a) Both (I) and (II)

Explanation: Though kerosene is readily available, it should not be used as a cooking fuel as it emits harmful pollutants. Liquefied Petroleum Gas (LPG) or Natural Gas should be used for cooking as they do not emit any smoke when burnt.

- (C) (1) Amount of heat produced on burning fuel
(2) Ease of availability

(D) Some of the factors deciding the choice of fuel are the ease of availability, transportation, storage and cost. If a person lived in a forest, he

readily available. However for a person living in a city like New Delhi, he would use LPG or Natural gas (piped natural gas) as a fuel for cooking since it is readily available and produces no smoke.

(E) (c) (A) is true, but (R) is false.

Explanation: The choice of fuels depends on several factors such as calorific value of fuels,

emission of smoke etc.

Example 2. If you could use any source of energy for heating your food, which one would you use and why? [NCERT]

Ans. Fuel which heats the food faster without destroying the nutritional value of the food would be preferred for heating food. So, an electric oven or a heater would be better.

TOPIC 2

CONVENTIONAL SOURCES OF ENERGY

The global demand for energy has increased over the years due to rapid industrialization. It was met largely by the fossil fuels – coal and petroleum. But these are non-renewable and hence will get exhausted if consumed at the present rate. Alternate sources of energy, therefore, need to be explored.

Fossil Fuels

Coal, petroleum and natural gas are known as fossil fuels as they were formed by the fossilized remains of plants or animals. Coal is the fossilized remains of plants while petroleum is the fossilized remains of marine plants and animals. Fossil fuels are classified as non-renewable sources of energy.

Natural Gas

Natural gas is another fossil fuel found with petroleum in oil wells. It contains mainly methane and can be burnt easily to produce heat. When it is subjected

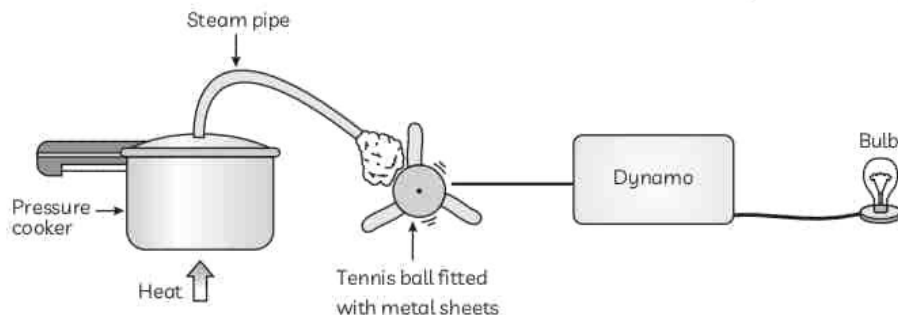
to high pressure, it is known as Compressed Natural Gas or CNG. It is an environment friendly gas as its combustion does not produce any polluting gases or particulate matter. It can also serve as an excellent feed stock for production of fertilizer and petrochemicals and also as a fuel.

Example 3. Case Based:

Take a table-tennis ball and make three slits into it. Put semicircular 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 as shown in figure below. Note your observations.

[NCERT Activity 14.4, 14.5]



(A) Select the incorrect observations from the first activity:

The figure in first activity denotes:

- (I) the figure denotes a turbine for generating electricity.
- (II) the simplest turbines have two moving parts, a rotor-blade assembly.
- (III) the moving fluid acts on the blades to spin them and impart energy to the rotor.

(IV) We need to move the fan, the rotor blade, with speed which would turn the shaft of the dynamo and convert the electrical energy into mechanical energy.

- (a) Both (I) and (II)
- (b) Both (II) and (III)
- (c) Both (III) and (IV)
- (d) Both (II) and (IV)

efficiently to run the turbine and generate electricity is:

- (a) Fossil fuels
 - (b) Solar energy
 - (c) Wind energy
 - (d) Water
- (C) What is observed when a jet of water or steam produced in a pressure cooker is directed at the fins in the first activity?
- (D) What is the difference in the way your grandparents or elders got water for their daily needs when they were young and the present times?
- (E) Assertion (A) : More energy from external sources was spent by our grandparents and elders in going to school when they were young as compared to present day students going to school.

Reason (R) : School vans and buses use fossil fuels such as petroleum and CNG.

- (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.
- (b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion.
- (c) (A) is true, but (R) is false.
- (d) (A) is false, but (R) is true.

Ans. (A) (d) Both (ii) and (iv)

Explanation: The figure denotes a turbine for generating electricity which consists of one moving part, a rotor-blade assembly. The fan, the rotor blade, is moved with speed which would turn the shaft of the dynamo and convert the mechanical energy into electrical energy.

(B) (b) Solar energy

Explanation: Fossil fuel coal is used in thermal power plant to generate electricity whereas water is used in hydro power plants to generate electricity. Wind energy farms are installed for generating electricity from wind mills. Solar energy can be used for generating electricity using solar cells but it cannot run turbine to generate electricity.

(C) When a jet of water or steam produced in a pressure cooker is directed at the fins, the moving fluid acts on the blades to spin them and impart energy to the rotor.

(D) Our grandparents and elders used to fetch water from wells or ponds in their village and later using handpumps. In the present time, water is supplied to homes from water treatment plants using pipelines.

Explanation: Our grandparents and elders used to either walk or used bicycle to go to their school and hence they used no external source of energy. Whereas, present day students go to school either by school buses or vans which consume fossil fuels and hence consume more energy from external sources.

Thermal Power Plant

Large amounts of fossil fuel are burnt in power stations to heat up water to produce steam which runs the turbine to generate electricity. Thermal power plants are set up near coal or oil fields as it is more efficient to transmit electricity as compared to transport coal or petroleum.

Energy from Water

Water flowing through rivers is an important source of energy which has been utilized for a variety of purposes. The energy of flowing water is a manifestation of solar energy. We are familiar with the energy transformations taking place during the water cycle. The energy of flowing water is used to generate electricity on a large scale at hydroelectric power plants.

Hydroelectric Power Plants

Principle: The kinetic energy of flowing water is transformed into potential energy by constructing high rise dams on rivers. The stored water is made to fall on turbine blades which rotate the armature of the electric generators to produce electricity.

Advantages and Uses of Hydroelectricity

- (1) It does not cause any pollution.
- (2) It uses water which is a renewable source of energy.

Limitations of Hydroelectric Power Plants

- (1) These can be constructed only at a limited number of places.
- (2) When dams are built on rivers, large land areas get submerged which causes environmental and social problems.
- (3) It destroys the natural habitat of plants and animals and even human habitations.
- (4) It can adversely affect the ecosystem of adjoining as well as areas downstream.
- (5) It decreases fertility of soil in downstream areas.
- (6) It creates the problem of satisfactory rehabilitation of displaced people.

Improvements in the Technology for Using Conventional Sources of Energy

Biomass

Biomass is a form in which solar energy manifests itself. Plants and animals and excreta of living

It also includes wastes from tree, wood, cow dung, charcoal and baggage (residue of sugarcane after extracting its juice).

- (1) Biogas is an excellent fuel as it contains up to 75% methane.
- (2) Charcoal burns without flames and is relatively smokeless
- (3) It does not leave any residue like ash in wood, charcoal and coal burning.
- (4) It has a high heating capacity.

Biomass as fuel: Wood is used as a source of heat. Firewood is burnt in traditional chulhas for cooking and heating water.

Comparison between traditional chulhas and smokeless chulhas:

Traditional Chulhas	Smokeless Chulhas
Incomplete burning of firewood produces smoke. These are inefficient as only 8-10% energy of the fuel gets used. These need more fuel. These are not attached with chimneys.	Complete combustion of firewood takes place which produces no smoke. These are highly efficient. These need less fuel. These are attached with chimneys.

Charcoal

Charcoal is another commonly used fuel that is obtained from wood. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and the charcoal is left behind as a residue. This process of burning wood in a limited supply of oxygen is called destructive distillation of wood. Charcoal is an expensive fuel as destructive distillation of one kilogram of wood yields only 0.25 kg charcoal.

Advantages of Charcoal over Wood

- (1) Charcoal burns easily, producing no smoke.
- (2) It gives twice as much heat as is obtained by burning same mass of wood. These qualities make charcoal a better fuel than wood.

Biogas Plants

In a biogas plant, degradation of biomass is carried out by anaerobic micro-organisms called anaerobic bacteria in the presence of water but in the absence of oxygen. The components of a biogas plants are:

Mixing Tank: Equal amounts of animal dung and water are mixed in this tank. This mixture is called slurry which is then fed to the digester tank.

Digester tank: The anaerobic micro-organisms break down the complex compounds of the biomass in this underground tank. The digesters are designed like

days during which gases like methane, carbon dioxide, hydrogen and hydrogen sulphide are produced.

Outlet for gas: As more and more biogas is formed, it is taken out through the outlet pipe.

Overflow tank: When more and more biogas is formed inside the digester, it exerts pressure on the slurry in the digester tank which forces the spent slurry to the overflow tank.

Advantages of biogas plants

- (1) The main constituent of biogas is methane, which is an excellent fuel and burns without producing smoke.
- (2) Burning of biogas does not leave any residue.
- (3) Biogas can be used for heating, lighting and for producing electricity.
- (4) The slurry which is left behind is an excellent manure as it is rich in nitrogenous and phosphorus compounds.
- (5) It gives us a safe method to dispose off wastes.

Wind Energy

Moving air is called wind. Sun's energy is responsible for the movement of air from one region to another thus constituting wind. Wind possesses kinetic energy as it is moving air. Some of the common applications of wind energy are in winnowing and windmills.

Windmills

Principle: Windmills are devices which convert wind energy into mechanical or electrical energy and can therefore be used for working water lifting pumps, flour mills and electric generators.

Construction: It consists of a structure similar to a large electric fan that is erected at some height on a rigid support. The blades of a windmill are designed to create a pressure difference between its different regions when wind strikes them. This pressure difference creates a turning effect due to which the blades rotate with a speed which depends upon the wind velocity.

Wind energy farm: When a large number of windmills are erected over a large area and the energy output of each windmill is coupled together to generate electricity on a commercial scale, this is known as a wind energy farm. The wind power potential of our country is about 20,000 MW. The largest wind energy farm near Kanyakumari in Tamil Nadu can generate 380 MW of electricity.

Advantages of windmills:

- (1) It uses wind energy which is a renewable source of energy.

- (3) It requires no recurring expenses for the production of electricity.

Limitations of windmill:

- (1) Windmills can be established only at those places where wind blows for most part of the year.
- (2) The wind should be strong and steady to maintain desired levels of production. The minimum wind velocity required for a functional windmill is about 15 km/h.
- (3) Large areas of land are required to establish wind energy farms. An area of about 2 hectares is required for a 1 MW generator.
- (4) The setting up of wind energy farms is quite costly.

care of the energy needs during a period when there is no wind.

- (6) They need a high level of maintenance as the tower and blades are exposed to rain, sun storm and cyclone etc.

Example 4. How has the traditional use of wind and water energy been modified for our convenience? [NCERT]

Ans. Wind and water energy have been used traditionally for our energy requirements. But, the traditional use of wind and water energy have been modified to generate electricity on a large scale by installing wind energy farms and dams.

TOPIC 3

ALTERNATIVE OR NON-CONVENTIONAL SOURCES OF ENERGY

We need to exploit new sources of energy and also develop technology to use the known sources of energy more efficiently due to the increasing demand for energy.

Solar Energy

The energy obtained from the sun is called solar energy. Energy is produced in the interior of the sun by fusion reactions taking place between the hydrogen atoms which fuse to form helium and in the process release a tremendous amount of energy.

Solar energy devices: The devices which are used for harnessing solar energy are called solar energy devices. Some common solar energy devices are solar cooker, solar water heater and solar cell.

Principle of working of solar energy devices: The solar energy received on earth is very small and is approximately $1.4 \times (47/100)$ or 0.66 kJ/s. The solar energy devices should therefore be capable of collecting maximum amount of solar energy and also retain it for its utilization. There are two types of such devices:

- (1) Devices which collect solar energy as heat, for ex, solar heater, solar cooker etc.
- (2) Devices which convert solar energy into electricity, for ex, solar cell.

Solar Cookers

Principle: These devices collect solar energy in the form of heat over a period of few hours during a sunny day.

Construction: A solar cooker consists of the following:

Component	Purpose
An insulated wooden or metal box painted black from inside	The inner walls and bottom of the solar cooker is painted black to maximize absorption of solar radiations as black surfaces absorb much heat. It also helps in reducing heat losses due to reflection.
Thick glass sheet	Glass has a peculiar property that it allows infra-red radiations of shorter wavelengths but does not allow infra-red radiations of longer wavelengths to pass through it. This helps the heat to be retained inside the box as the glass cover does not allow the heat to radiate.
Plane mirror reflector	It increases the effective area for the collection of the solar energy.

Working: The food to be cooked is placed inside the solar cooker in a metal container. When the sun's rays fall on the reflector, it sends these rays to the top of the solar cooker. The rays get trapped inside the cooker due to which the temperature inside the box rises to about 100°C to 140°C in a few hours.

Advantages of solar cooker:

- (1) It saves fuel as it harnesses solar energy.
- (2) It does not produce any smoke and hence does not cause any pollution.
- (3) Since food gets cooked at relatively lower temperature, the nutrients in the food are preserved.
- (4) Their maintenance requires nominal expenditure.

Limitations of solar cooker:

- (1) It cannot be used for cooking food during night hours.

sunny day and not on a cloudy day.

- (3) The direction of the reflector has to be changed continuously so that it always faces the sun.
- (4) The box type solar cooker cannot be used for frying or baking.
- (5) There is a high initial expenditure on its installation.

Example 5. What kind of mirror; concave, convex or plain would be best suited for use in a solar cooker? Why? [NCERT]

Ans. Since the amount of solar energy available on earth's surface is not high, the sun's rays have to be reflected towards the solar cooker. Concave mirrors are therefore best suited for use in a solar cooker as they are converging mirrors and converge the sun's rays towards the focus of the mirror, where the food container is kept. Higher temperatures are achieved in a solar cooker by using concave mirrors as reflectors as compared to plane mirrors.

Solar Cell

Principle: These devices convert solar energy directly into electricity. They are made up of semiconductors like silicon and selenium.

Construction: Solar cells are made of a number of thin layers of silicon containing impurities and are arranged in such a way that when sunlight is incident on them, a potential difference is produced between the two regions of the wafers. A 2 cm² single solar cell can produce about 0.7 watt of electricity when exposed to sunlight. Solar cells are also known as photovoltaic cells.

Advantages and uses of solar cells:

- (1) These are used as the main source of energy in all artificial satellites and space probes.
- (2) Solar cells are used as a source of electricity for radio or wireless transmissions and at TV relay stations.
- (3) These are used for street lighting and for operating water pumps and radio and television sets in remote areas.
- (4) These are used for operating calculators, watches and toys.

Limitations of solar cells:

- (1) The initial cost of installation is quite high.

	Biomass	Hydroelectricity
(1)	Biomass makes use of chemical energy	Hydro electricity makes use of kinetic energy of running or falling water from height
(2)	usage of biomass for energy requirement causes air pollution	Hydro electricity is pollution free source of energy

solar cells is limited.

- (3) The technology to obtain silicon in pure form is expensive.
- (4) Since silver is used for connecting the solar cells in a solar panel and silver is quite expensive, it adds to the cost of the solar cell.
- (5) The non-availability of efficient systems to store the electricity generated by solar cells and to make it available when required is another problem.

Solar Panel: When a large number of solar cells are connected together by means of connecting wires made of a good conductor like silver, we can obtain a large amount of electricity. This arrangement is known as a solar panel.

Example 6. Compare and contrast fossil fuels and the Sun as direct sources of energy. [NCERT]

Ans. Comparison between fossil fuels and sun as direct sources of energy is given below:

	Fossil Fuels	Sun
(1)	These are non-renewable sources of energy	It is a renewable source of energy
(2)	The fossil fuels have limited reserves and are depleting very fast due to over use	Sun is a very large and long lasting source of energy
(3)	Use of Fossil fuels results in air pollution.	Solar energy is totally clean does not cause any pollution.
(4)	These are expensive.	It is non-expensive though the initial cost is high.
(5)	These have to be extracted for use	It is readily available, though only during daytime
(6)	Can be used any time of the day and year	Can be used only during daytime when there is plenty of sunshine.

Example 7. Compare and contrast bio-mass and hydro electricity as sources of energy. [NCERT]

Ans. Comparison between bio-mass and hydro-electricity as sources of energy is given below:

(3)	imbalance.	ecological imbalances.
(4)	Biomass is relatively more economic source of energy than hydro electricity.	Hydro Electricity is relatively costly source of energy.
(5)	Residue is used as manure	No residue is left behind.

Energy from the Sea

Tidal Energy

The phenomenon of high and low tide give us tidal energy. The energy of the tides or the tidal energy can be harnessed by constructing a dam across a narrow opening to the sea. The water moves in and out of the openings in the dam during high and low tides which rotate the turbines and in this way electricity is generated. The main limitations of harnessing tidal energy are:

- (1) There are a very few sites that are suitable for building dams.
- (2) The rise and fall of water during tides is not high enough to generate electricity on a large scale.

Sea Wave Energy

Kinetic energy of huge waves near sea shore is trapped to generate electricity. When winds blow across the surface of the oceans, these get converted

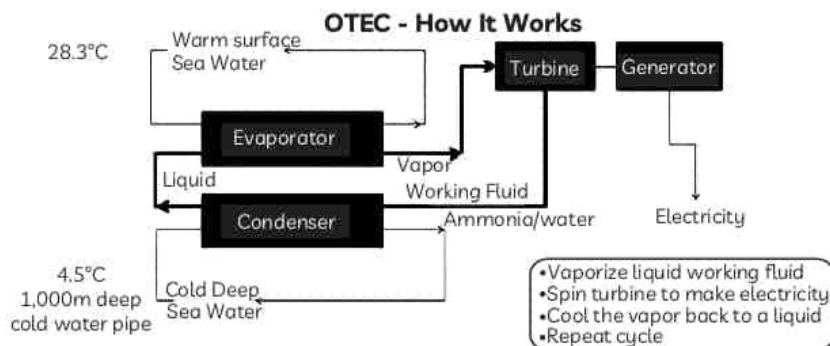
into waves which possess a lot of kinetic energy. Wave energy is used for rotation of turbine and production of electricity. Areas with an energy density of 40 MW per km of coastline are considered to be economically viable.

Ocean Thermal Energy (OTE)

The energy available from the ocean due to the difference in temperature between warm surface waters heated by the sun and colder waters found at ocean depths is known as Ocean Thermal energy.

Ocean Thermal Energy Conversion (OTEC) Power Plants:

These are devices used to harness the ocean thermal energy. There should be a temperature difference of at least 20°C between surface waters and water at depths up to 2000 m (2 km). The warm surface water is used to boil a liquid like ammonia or CFC which produces vapour which is used to drive turbine of generators. The cold water from the ocean depths is pumped up to convert the vapour again into liquid.



Example 8. What are the limitations of the energy that can be obtained from the oceans? [NCERT]

Ans. The limitations of energy that can be obtained from the ocean are:

- (1) There are very limited locations where dams can be built for harnessing tidal energy.
- (2) Wave energy can be trapped for generating electricity only where waves are very strong, which is quite limited.
- (3) It is very difficult to efficiently exploit the energy from oceans due to commercial reasons.

Geothermal Energy

The heat from inside the earth can be utilized as a source of energy under certain favorable conditions

that are created by natural processes. This energy is known as geothermal energy. The places below the surface of the earth where the hot magma collects are known as hot spots. The underground water in contact with these hot spots get converted into steam which is extracted by drilling holes through which pipes are driven in. The steam which comes up at high pressure is utilized to rotate the turbine of generators.

The advantages of geothermal energy are:

- (1) These can be harnessed for 24 hours throughout the year.
- (2) It is clean and environment friendly.
- (3) It is cost effective as the cost of producing electricity is half the cost of producing electricity by conventional means.

Nuclear reactions: The reactions in which the nucleus of an atom undergoes a change forming new atoms and releasing a tremendous amount of energy.

Nuclear fission: When the nucleus of a heavy atom (such as uranium, plutonium or thorium), is bombarded with low-energy neutrons it can be split apart into lighter nuclei.

During a fission reaction, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products.

Example: The fission of an atom of uranium produces 10 million times the energy produced by the combustion of an atom of carbon from coal.

Nuclear Fusion: The process in which nuclei of low atomic numbers combine to form a heavier atomic nucleus is known as nuclear fusion.

Nuclear Reactor: In a nuclear reactor designed for electric power generation, such nuclear 'fuel' can be

releases energy at a controlled rate. The released energy can be used to produce steam and further generate electricity.

Nuclear reactors are used for generation of electrical power, production of fissile materials and for nuclear research and are based on nuclear fission.

Nuclear hazards and safety measures:

- (1) Nuclear radiations seriously affect human bodies and materials including buildings.
- (2) A lot of radioactive materials are produced in nuclear reactors.
- (3) It should be ensured that there is no leakage in the moderator or cooling water of nuclear plants which can contaminate water bodies and soil.
- (4) The main hazard of nuclear power generation is the storage and disposal of spent or used fuels.
- (5) There is a risk of accidental leakage of nuclear radiations.

TOPIC 4

ENVIRONMENTAL CONSEQUENCES

The energy source we choose would depend upon on the following factors:

- (1) The ease of extracting energy from that source.
- (2) The economics of extracting energy from the source.
- (3) The efficiency of technology available.
- (4) The environmental damage that will be caused by using that energy source.

Example 9. Hydrogen has been used as a rocket fuel. Would you consider it a cleaner fuel than CNG? Why or why not? [NCERT]

Ans. Yes, hydrogen can be considered cleaner than CNG as burning of hydrogen produces water, whereas burning of CNG produces carbon dioxide which is a greenhouse gas and hence a pollutant.

Life of Energy Sources

Sources of energy can be classified as renewable and non-renewable sources. Sources that will get depleted some day are said to be exhaustible sources or non-renewable sources of energy.

Renewable and Non-renewable Sources of Energy

Renewable Source	Non-renewable Source
The sources of energy which are likely to be available for a long time and are inexhaustible. For ex, solar energy, wind energy, ocean waves and biogas.	The sources of energy which have taken a very very long time for their formation and cannot be replaced once they are exhausted. For ex, Fossil fuels like coal, petroleum and natural gas

Use of Wood as a Fuel

Although wood is a renewable source of energy since trees can be replenished, but a tree usually takes more than 15 years to mature and moreover large scale cutting of trees for obtaining firewood causes environmental problems.

Example 10. On what basis would you classify energy sources as

- (A) renewable and non-renewable?
- (B) exhaustible and inexhaustible?

Are the options given in (A) and (B) the same?

[NCERT]

Ans. (A) Renewable sources of energy are the sources which can be replenished over a reasonable

renewable sources are those sources of energy which take a very long time for replenishment. Examples of renewable sources are water and solar energy whereas coal and petroleum are non-renewable sources of energy.

(B) Exhaustible sources are the sources of energy which are limited and may get exhausted, whereas inexhaustible sources are

and hence may never get exhausted. Examples of exhaustible sources are coal and petroleum whereas water and biomass are examples of inexhaustible sources of energy.

Yes, the options given in (a) and (b) are the same, as they ultimately refer to the same sources of energy

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Which of the following is a non-renewable source of energy?

(a) Wood (b) Sun
(c) Fossil fuels (d) Wind

[CBSE 2017, 11, NCERT Exemplar]

Ans. (c) Fossil fuels

Explanation: Non-renewable sources are those sources that are present in a limited amount and once finished cannot be renewed again for millions of years.

Wood comes from trees, so it is a renewable source of energy. The Sun and wind are also renewable sources of energy but fossil fuels are non-renewable (conventional sources). Once they are used up, they can't be renewed again, so we need to conserve them.

2. In a hydro power plant:
- (a) the potential energy possessed by stored water is converted into electricity
(b) the kinetic energy possessed by stored water is converted into potential energy
(c) electricity is extracted from water
(d) water is converted into steam to produce electricity

[CBSE 2016, 15, NCERT Exemplar]

3. Ocean thermal energy is due to:
- (a) energy stored by waves in the ocean
(b) temperature difference at different levels in the ocean
(c) pressure difference at different levels in the ocean
(d) tides arising in the ocean

[CBSE 2016, 15, 14, NCERT Exemplar]

4. The major problem in harnessing nuclear energy is how to:
- (a) split nuclei?
(b) sustain the reaction?
(c) dispose off spent fuel safely?
(d) convert nuclear energy into electrical energy?

[CBSE 2016, 15, NCERT Exemplar]

5. Which part of the solar cooker is responsible for the greenhouse effect?
- (a) Coating with black colour inside the box
(b) Mirror
(c) Glass sheet
(d) Outer cover of the solar cooker

[NCERT Exemplar]

Ans. (c) Glass sheet

Explanation: Solar cookers are covered with a glass plate which traps infrared radiations

to escape. In other words we can say that it provides greenhouse effect. Solar cookers achieve a higher temperature by using mirrors to focus the rays of the Sun.



Related Theory

The trapping of heat in the environment due to the presence of greenhouse gases like CO_2 , methane, water vapour etc. causes the greenhouse effect. This raises the temperature of Earth.

6. The main constituent of biogas is:

- (a) methane (b) carbon dioxide
(c) hydrogen (d) hydrogen sulphide

[CBSE 2019, 14, 13, NCERT Exemplar]

Ans. (a) methane

Explanation: Bio gas is an excellent fuel as it contains up to 75% methane. It burns without smoke, leaves no residue like ash in wood, charcoal and coal burning. Its heating capacity is high. It is also used for lighting.

7. The power generated in a windmill:

- (a) is more in the rainy season, since damp air would mean more air mass hitting the blades
(b) depends on the height of the tower
(c) depends on wind velocity
(d) can be increased by planting tall trees close to the tower

[CBSE 2016, Exemplar]

8. Choose the correct statement:

- (a) The Sun can be taken as an inexhaustible source of energy
(b) There is infinite storage of fossil fuel inside Earth
(c) Hydro and wind energy plants are non-polluting sources of energy
(d) Waste from a nuclear power plant can be easily disposed off

[CBSE 2017, 16, 10, NCERT Exemplar]

9. In a hydroelectric power plant, more electrical power can be generated if water falls from a greater height because:

- (a) its temperature increases
(b) larger amount of potential energy is converted into kinetic energy
(c) the electricity content of water increases with height
(d) more water molecules dissociate into ions [CBSE 2018, NCERT Exemplar]

surface is:

- (A) Biomass (B) Solar radiations
(C) Tides (D) Winds [CBSE 2020]

11. Which is the type of system where the energy is harnessed by the heat accumulated on the surface of water?

- (a) Wind energy
(b) Wave energy
(c) Ocean thermal energy conversion
(d) Solar energy

Ans. (c) Ocean thermal energy conversion

Explanation: Absorption of heat from the sun by the seas and oceans, solar radiation causes ocean currents and moderate temperature gradients from the water surface downward especially in tropical waters.

12. The correct energy conversion taking place in a hydroelectric power plant is:

- (a) Potential energy of water → Kinetic Energy of turbine → Electrical energy
(b) Potential energy of turbine → Kinetic Energy of water → Electrical energy
(c) Heat energy of water → Kinetic Energy of turbine → Electrical energy
(d) Potential energy of water → Heat Energy → Electrical energy

13. Which of the following are non-conventional sources of energy:

- (I) Wind energy
(II) Water
(III) Solar energy
(IV) Geothermal energy
(a) Both (I) and (II)
(b) Both (II) and (III)
(c) Both (III) and (IV)
(d) Both (II) and (IV)

14. Approximately what percentage of energy requirement in India is met by hydro power plants?

- (a) 10 % (b) 25 %
(c) 50 % (d) 75 %

Ans. (b) 25 %

Explanation: A quarter or 25 % of the energy requirement in India is met by hydro power

coal and petroleum for meeting our energy requirements.

15. The table below lists the sources of energy and whether they are exhaustible or non-exhaustible. Select the row containing incorrect information:

	Source of energy	Whether exhaustible or non-exhaustible
(a)	Fossil fuel	Exhaustible
(b)	Wind	Non-exhaustible
(c)	Water	Exhaustible
(d)	Solar	Non-exhaustible

16. Two fuels obtained from biomass are:

- (a) Coal and biogas
- (b) Petroleum and natural gas
- (c) Charcoal and biogas
- (d) Charcoal and natural gas

Ans. (c) Charcoal and biogas

Explanation: 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. Charcoal burns without flames, is comparatively smokeless and has a higher heat generation efficiency. Similarly, 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 biogas.

Assertion-Reason Questions

For the following questions two statements are given one labeled Assertion (A) and the Other labeled Reason (R). Select the correct answer to these questions from the codes

- (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.
- (b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion.
- (c) (A) is true, but (R) is false.
- (d) (A) is false, but (R) is true.

17. Assertion (A) : In a wind energy farm, a number of windmills are erected over a large area.

Reason (R) : The output of a single windmill is quite small and cannot be used for commercial purposes.

Ans. (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.

18. Assertion (A) : All exhaustible sources of energy are non-renewable.

Reason (R) : Energy sources that cannot be regenerated are called renewable sources of energy.

Very Short Answer Type Questions

19. Name two constituents of biogas.

[CBSE 2018]

Ans. The two constituents of biogas are:

- (1) Methane
- (2) Carbon dioxide
- (3) Hydrogen
- (4) Hydrogen sulphide

(Must write Methane and any 1 of remaining to get full marks)

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

20. Geothermal energy is the energy produced by the heat of molten rocks formed in the deeper hot regions of the earth's crust. This energy is harnessed to generate electricity. When water is made to flow deep underground in the rocks it returns as steam (or hot water, which is later converted to steam) to drive a turbine on an electric power generator.

In India, exploration and study of geothermal fields started in 1970. The Geological Survey in India has identified 350 geothermal energy locations in the country. The most promising of these is in Puga Valley of Ladakh. The estimated potential for geothermal energy in India is about 10000 MW. There are seven

geothermal provinces in India namely the Himalayas, Sohna, West coast, Cambay, Son-Narmada-Tapi; Godavari and Mahanadi. Most power stations in India produce Alternating Current (A.C).

- (A) What are geothermal energy hot-spots?

(B) Name two countries, other than India, where power plants based on geothermal energy are operational.

(C) Name the phenomenon that explains the working of an electric generator.

(D) State an important advantage of using AC over DC.

[CBSE 2020]

is very vast, but geothermal energy can be harnessed only in particular areas. The particular areas where geothermal energy can be harnessed are called geothermal hot spots.

- (C) Electromagnetic induction is the phenomenon that explains the working of an electric generator.

Explanation: An electric generator is a machine which converts mechanical energy into electrical energy. The phenomenon of electromagnetic induction can be seen as:

Mechanical energy $\xrightarrow[\text{Field}]{\text{Magnetic}}$ Electrical energy

The phenomenon of generation of an electric current in a circuit from magnetic effects is called electromagnetic induction.

- (D) An important advantage of using AC over DC is that electric power can be transmitted over long distances without much loss of energy.



Related Theory

The frequency of AC in India is 50 Hz. DC always flows in one direction, whereas AC reverses its direction periodically. AC can also be changed to DC whenever required.

21. Acid rain as the name suggests can be said to be the precipitation of acid in the form of rain in the simplest manner. Taj Mahal, one of the 7 wonders of the world, is largely affected by acid rain.



Acid rain happens because:

- the Sun causes the heating of the upper layer of atmosphere
- the burning of fossil fuels releases oxides of carbon, nitrogen and sulphur in the atmosphere
- electrical charges are produced due to friction amongst clouds
- Earth atmosphere contains acids

[NCERT Exemplar]

of carbon, nitrogen and sulphur in the atmosphere

Explanation: The oxides of carbon, nitrogen and sulphur that are released on burning fossil fuels are acidic oxides. These lead to acid rain, which affects our water and soil resources.



Related Theory

The activities (polluting the atmosphere by industrial exhausts) as well as natural phenomena (emission of volcanoes) cause acid rain due to the above mentioned oxides that are released.

22. Solar power in India is a fast developing industry. The country's solar installed capacity reached 30,071 GW as of 31 July, 2019. India has the lowest capital cost per MW to install solar power plants. Solar electricity generation recorded nearly 3.4% of total utility electricity generation in January 2019. The following table shows Annual Solar Power Generation of the last six years.

Year	Solar Power Generation (TWh)
2013-14	3.35
2014-15	4.60
2015-16	7.45
2017-18	25.87
2018-19	39.27

Our country is lucky to receive solar energy for the greater part of the year. It is estimated that during a year India receives the energy equivalent to more than 5000 trillion kWh from the Sun.

- What are solar cells?
- How much voltage can be developed and how much electricity can be produced by one typical solar cell when exposed to the Sun?
- The future of power generation by solar energy is bright in India. Give reason.
- List two advantages of solar cells.

[CBSE 2020]

Ans. (A) Solar cells are devices which convert Solar energy (Sun's energy) directly into electricity. A solar cell is also known as a solar photovoltaic (SPV) cell.

Related Theory

A solar cell is made of element silicon. It consists of square piece of silicon. The electric power generated by a single solar cell is very small. So a number of cells are joined together to form a solar panel.

- (B) One typical cell produces a voltage of 0.5 V–1V and can produce about 0.7 W of electricity when exposed to the sun.

Related Theory

Solar devices like solar cooker, solar geyser etc. also use solar energy but can be used only at certain times during the days. This limitation was overcome by combining solar cells in an arrangement called solar cell panel.

(D) Advantages of solar cells: The solar cells

- (1) have no moving parts, require little maintenance and work satisfactorily without the use of any focusing device.
- (2) can be set up in remote and inaccessible area or very sparsely inhabited areas.

23. Thermal power plants have been in operation since quite some time. Bharat Heavy Electricals (BHEL) has commenced civil works at 660 MW Sagardighi supercritical thermal power project in the state of West Bengal. BHEL is a manufacturer of power generation equipment with an installed base of over 1,90,000 MW power plant equipment globally.



The fuel used in thermal power plants is:

- (a) water (b) uranium
(c) biomass (d) fossil fuels

[CBSE 2020, 16, NCERT Exemplar]

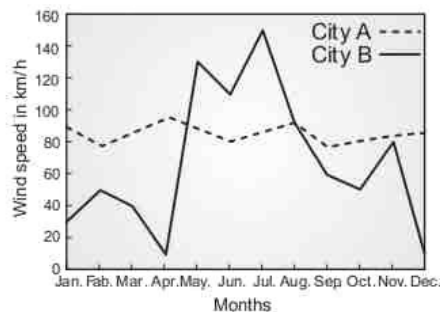
24. Renewable energy sources such as wind energy are vital for the Indian economy, not only from the point of view of supply, but also from the perspective of environmental and social benefits. India is the world's fifth largest wind-power producer and the largest windmill facilities in India are installed in Tamil Nadu. Muppandal is a small village of Tamil Nadu and

in the state. It uses wind from the Arabian Sea to produce renewable energy. The suitability of Muppandal as a site for wind farms stems from its geographical location as it has access to the seasonal monsoon winds.



The electrical generators used on wind turbines in sites like Muppandal, produce an output AC of 240 V and a frequency of 50 Hz even when the wind speed is fluctuating. A transformer may be required to increase or decrease the voltage so it is compatible with the end usage, distribution or transmission voltage, depending on the type of interconnection.

- (A) State the principle behind electric generator.
(B) The output frequency of wind turbine is 50 Hz. What is meant by this statement?
(C) Why do you think Muppandal is at an advantageous position for this project?
(D) Based on the data represented in the graph below, which of the two cities A or B would be an ideal location for establishing a wind-farm and why?



Ans.

- (A) The principle behind electric generator is Electromagnetic Induction- the phenomenon of producing current in a coil by changing the magnetic field associated with it.
(B) The polarity of the output alternating current changes every $\frac{1}{100}$ seconds.

In 1 second the output (AC) completes 50 cycles.

(D) City A

It is more suitable for a wind-farm as there is consistently high wind-speed in that city throughout the year.

[CBSE Marking Scheme 2019]

25. A nuclear power plant is a thermal power station in which the heat source is a nuclear reactor. As is typical of thermal power stations, heat is used to generate steam that drives a steam turbine connected to a generator that produces electricity. As of 2018, the International Atomic Energy Agency reported there were 450 nuclear power reactors in operation in 30 countries around the world.

Nuclear power is the fifth-largest source of electricity in India after coal, gas, hydroelectricity and wind power. As of November 2020, India has 22 nuclear reactors in operation in 7 nuclear power plants, with a total installed capacity of 6,780 MW.



Which one of the following statements is not true about nuclear energy generation in a nuclear reactor?

- Energy is obtained by a process called nuclear fission.
- The nucleus of Uranium is bombarded with high energy neutrons.
- A chain reaction is set in the process
- In this process a tremendous amount of energy is released at a controlled rate.

[CBSE 2020]

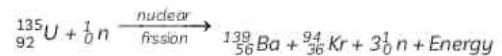
Ans. (b) The nucleus of uranium is bombarded in the high energy neutrons.

Explanation: In a nuclear reactor, nuclear fission of nuclear fuel takes place to generate nuclear energy. Nuclear energy is released when nucleus of uranium is bombarded with low energy neutrons. Hence, this statement (b) is incorrect. All other three statements are correct.

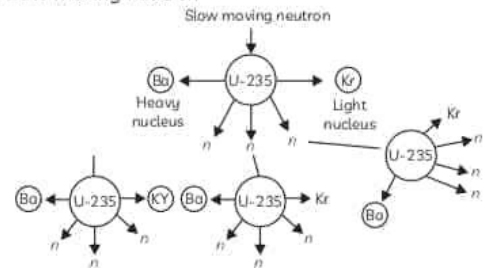
Related Theory

Nuclear fission is the phenomenon of splitting of Uranium (heavy atom) into two medium weight nuclei. When it is bombarded with a slow neutron. A large amount of energy is released. In a nuclear reactor, nuclear fuel is a part of a self sustaining fission chain reaction that releases energy at a controlled rate.

Chain reaction



Slow moving neutron



The fission of an atom of uranium produces 10 million times the energy produced by the combustion of an atom of carbon from coal.

26. The Tehri dam is the highest dam in India and one of the highest in the World. The Tehri dam withholds a reservoir of capacity 4.0 km³ and surface area 52 km². It is used for irrigation, municipal water supply and the generation of 1000 MW of hydro electricity.

The Tehri Dam has been the object of protests. Environment activist Shri Sunder Lal Bahuguna led the "Anti Tehri Dam Movement" from 1980s to 2014. The protest was against the displacement of town inhabitants and environmental consequences of the weak ecosystem. The relocation of more than 1,00,000 people from the area has led to protracted legal bat over resettlement rights and ultimately resulted in the delayed completion of the project.

(A) How is hydropower harnessed?

(B) Define 1 MW.

(C) Mention two disadvantages of constructing Tehri Dam.

(D) What happens when water from great heights is made to fall on blades of turbine? [CBSE 2020]

Ans. (B) 1 mW is a unit for measuring power (megawatt)

$$1 \text{ mW} = 1000 \text{ kW} \quad 1 \text{ kW} = 1000 \text{ W}$$

$$1 \text{ mW} = 10^6 \text{ W}$$

(C) Disadvantages of constructing Tehri Dam:

- Large ecosystems are destroyed when submerged under the water in dams.

under anaerobic conditions and release a large amount of methane gas which is a green-house gas.

- (3) Large areas of agricultural land is used.
- (4) It creates a problem of satisfactory rehabilitation of displaced people.

(Any two)

(D) When water from great heights is made to fall on blades of turbine, the potential energy of the water changes into kinetic energy which is transferred to the turbine. Moving turbine rotates the armature of a generator and kinetic energy of water changes to electricity.

27. 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. You could also measure the temperature of the water in the two conical flasks with a thermometer.

Next, study the structure and working of a solar cooker and/or a solar water-heater, particularly with regard to how it is insulated and maximum heat absorption is ensured. Design and build a solar cooker or water-heater using low-cost material available and check what temperatures are achieved in your system.

[NCERT Activity]

- (A) In the first activity, two conical flasks, one painted white and the other black, are filled with water and then placed in direct sunlight for half an hour. Select the correct observation regarding their temperature:
- (a) Both the conical flasks will be equally hot.
 - (b) The conical flask painted black will be hotter.
 - (c) The conical flask painted white will be hotter.
 - (d) The conical flask painted white will absorb more heat
- (B) The parts of a box - type solar cooker is given below. Select the row containing incorrect information.

	Part	Description
(a)	Black box	An insulated metal or wooden box which is painted white from the inside to radiate more heat.

(c)	Plane Mirror	Plane mirror is fixed to the box with the help of hinges and it acts as a reflector
(d)	Cooking Containers	A set of aluminium containers blackened from the outside are kept in the box

- (C) The property used by solar cookers and solar water heaters is:
- (a) A reflector absorbs more heat as compared to a white surface under identical conditions.
 - (b) Black surface reduces loss of heat by radiation.
 - (c) White surface absorbs more heat as compared to a reflecting surface under identical conditions.
 - (d) Black surface absorbs more heat as compared to a white or a reflecting surface under identical conditions.
- (D) The purpose of a glass sheet fixed on the box of the solar cooker is:
- (a) To focus sun's radiations at one point.
 - (b) To absorb maximum heat of the sun's rays.
 - (c) To prevent heat from escaping escape from the cooker box.
 - (d) To reflect sun's rays towards the cooker box.
- (E) Which of the following is not a limitation of solar cooker?
- (a) Some solar cookers take longer to cook food than a conventional stove or an oven.
 - (b) Reduces carbon footprint by cooking without carbon dioxide-based fuels.
 - (c) It can be used only at certain time of the day.
 - (d) It cannot be used during nights and rainy days.

Ans. (A) (b) The conical flask painted black will be hotter.

Explanation: The conical flask painted black will be hotter as compared to the flask painted white as a black surface absorbs more heat as compared to a white or a reflecting surface under identical conditions.

compared to a white or a reflecting surface under identical conditions.

- (E) (b) Reduces carbon footprint by cooking without carbon dioxide-based fuels.

Explanation: As solar cooker uses only solar energy, there is no pollution caused as it does not use carbon dioxide based fuels and hence carbon footprint is reduced.

28. When Poorva visited Bengaluru along with her parents, she noticed that most houses had solar panels installed on their roof top. However, despite their ability to generate clean, green electricity, solar panels aren't as commonplace as they could be. The main sticking point, of course, is price. Due to their need for relatively expensive semiconductor materials, conventional solar cells don't yet have a price-efficiency combination that can compete with other sources of electricity. A conventional solar cell is made of a thin wafer of a semiconductor with a metallic electrode deposited on its rear side.



The values of voltage developed in a solar cell and power of a solar cell when exposed to electricity are given in the following table. Select the row containing the correct values:

	Voltage Developed in a Solar Cell	Power Produced in a Solar Cell
(a)	0.7 V	0.5 – 1.0 kW
(b)	0.5 – 1.0 V	0.7 W
(c)	5 – 10 V	0.7 kW
(d)	1.5 – 2.0 V	7 W

Ans. (b) Voltage Developed in a Solar Cell: 0.5 – 1.0 V;
Power Produced in a Solar Cell: 0.7 W

Explanation: A typical solar cell develops a voltage of 0.5–1 V and can produce about 0.7 W of electricity when exposed to the Sun.

ultimate source of energy for bio-mass, wind and ocean thermal energy.

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. [NCERT Activity 14.7, 14.8]

- (A) The ultimate source of energy for bio-mass is:

- (a) Living organisms
(b) Sun
(c) Water
(d) Earth

- (B) Following statements are given below regarding wind energy and nuclear energy.

Select the incorrect statements:

- (I) Wind energy does not contaminate the environment but nuclear energy may contaminate the environment.
(II) Efficiency of wind energy farms is less than that of nuclear plants.
(III) Wind energy farms can be set up anywhere whereas nuclear power plants can be set up only at specific locations.
(IV) Both are non-conventional sources of energy
(a) Both (I) and (II)
(b) Both (II) and (III)
(c) Both (II) and (IV)
(d) (II), (III) and (IV)

- (C) Select the correct statement regarding different sources of energy:

- (a) Geothermal energy makes use of steam trapped in rocks due to geological changes.
(b) Nuclear energy makes use of chemical reactions between different atoms to produce energy.
(c) Hydroelectricity makes use of gravitational pull of the moon on the spinning earth.
(d) Wave energy makes use of potential energy possessed by the waves.

- (D) Out of coal, petroleum, solar energy and wind, minimum pollution is caused by:

- (a) Coal
(b) Petroleum
(c) Solar energy
(d) Wind energy

affect the?:

- (a) Ease of extracting energy from that source.
- (b) Economics of extracting energy from the source and efficiency of the technology available.
- (c) Environmental damage that will be caused by using that source.
- (d) Has less energy efficiency and more calorific value

Ans. (A) (b) sun

Explanation: The ultimate source of energy for bio-mass is the sun as these fuels are plant and animal products and plants and animals ultimately depend on sun for their energy needs.

(B) (c) Both (III) and (IV)

Explanation: The wind energy farms can be set up only at specific locations where wind blows for the greater part of a year and the wind speed should also be higher than 15 km/h

(E) (d) Has less energy efficiency and more calorific value

Explanation: All the above factors affect the choice of a particular source of energy.

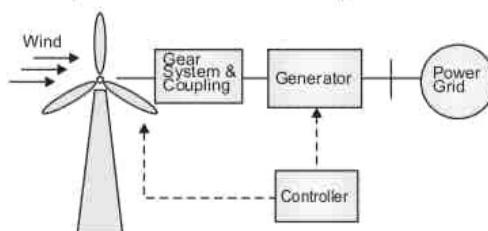
30. Shaurya visited her paternal village after quite some time. She was pleasantly surprised to see that most of the houses had biogas chulhas at their place as a biogas plant was built by an NGO at the village.



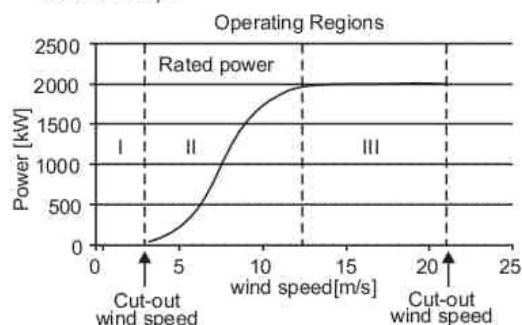
Why is biogas considered an excellent fuel?
[CBSE 2019]

31. Wind power is one of the fastest-growing renewable energy technologies. Usage is on the rise worldwide, because costs are falling. Global installed wind-generation capacity onshore and offshore has increased by a factor of almost 75 in the past two decades, jumping from 7.5 gigawatts (GW) in 1997 to some 564 GW by 2018. Production of wind electricity doubled between 2009 and 2013, and in 2016 wind energy accounted for 16% of the electricity generated by renewables. Many

but the best locations for generating wind power are sometimes remote ones. Offshore wind power offers tremendous potential.



The power curve of a wind turbine is a graph that indicates how large the electrical power output will be for the turbine at different wind speeds. At very low wind speeds, the torque exerted by the wind on the blades is insufficient to bring the turbine to rotate. The wind speed at which the turbine starts to generate electricity is called cut-in or start up wind speed and is typically between 3 and 4 m/s. Above the cut-in wind speed, there is sufficient torque for rotation, and power production increases before reaching a threshold. The lowest wind speed at which the nominal power is reached is called the rated (or nominal) wind speed and is typically between 12 and 17 m/s. The cut-off wind speed corresponds to the maximum wind speed a wind turbine can safely support while generating power and is usually about 25 m/s.



(A) Study the above power graph and select the row containing the correct information:

	Lowest Wind Speed at which the Nominal Power is Reached	Wind Speed at which the Turbine Starts to Generate Electricity	Maximum Wind speed a Wind Turbine can Safely Support while Generating Power
(a)	12 m/s	3 m/s	22 m/s
(b)	3 m/s	12 m/s	22 m/s

(d)	22 m/s	3 m/s	12 m/s
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- (B) In a water-lifting pump:
- The up and down motion of windmill is converted to rotatory motion.
 - The horizontal motion of windmill is converted to rotatory motion.
 - The rotatory motion of windmill is converted to horizontal motion.
 - The rotatory motion of windmill is converted to up and down motion.
- (C) ② Select the correct statements regarding wind mills:
- The rotatory motion of the windmill is used to turn the turbine of the electric generator.
 - The output of a single windmill is quite large and can be used for commercial purposes.
 - A wind energy farm is a large area where a number of windmills are erected.
 - The energy output of each windmill in a farm is coupled together to get electricity on a commercial scale.
- Both (I) and (II)
 - Both (II) and (III)
 - (I), (III) and (IV)
 - (II), (III) and (IV)
- (D) ② Which of these processes explains the extraction of energy from wind to do work?
- conversion of mechanical energy of wind into kinetic energy
 - conversion of kinetic energy of wind into mechanical energy
 - conversion of mechanical energy of wind into potential energy
 - conversion of potential energy of wind into mechanical energy
- (E) ② The minimum wind speed to maintain the required speed of the turbine is:
- 15 km/h
 - 18 km/h
 - 20 km/h
 - 25 km/h

Ans. (A) (a) Lowest Wind Speed at which the Nominal Power is Reached : 12 m/s ; Wind Speed at which the Turbine Starts to Generate Electricity : 3 m/s ; Maximum Wind speed a Wind Turbine can Safely Support while Generating Power : 22 m/s

Explanation: The lowest wind speed at which the nominal power is reached is called the rated (or nominal) wind speed and is about 12 m/s.

to generate electricity is called cut-in or start up wind speed and is about 3 m/s.

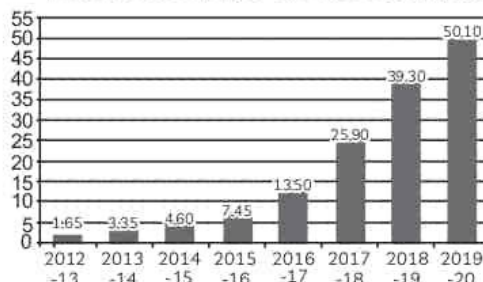
The maximum wind speed a wind turbine can safely support while generating power is the cut-off speed and is about 22 m/s.

- (B) (d) The rotatory motion of windmill is converted to up and down motion.

Explanation: A water pumping windmill is simple, and efficient. The blades of the windmill wheel catch the wind, which turns the rotor. The wheel assembly is attached to a hub assembly, which drives a geared mechanism that converts the rotary motion to an up-and-down motion. This motion drives a pump rod, up and down inside of a pipe in the well. A cylinder with a sealed plunger going up and down inside forces the water up the pipe.

32. Solar power in India is a fast developing industry. India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Solar photovoltaics power can effectively be harnessed providing huge scalability in India. Solar also provides the ability to generate power on a distributed basis and enables rapid capacity addition with short lead times. Off-grid decentralized and low-temperature applications will be advantageous from a rural electrification perspective and meeting other energy needs for power and heating and cooling in both rural and urban areas. Solar energy has taken a central place in India's National Action Plan on Climate Change with National Solar Mission as one of the key Missions. Recently, India achieved 5th global position in solar power deployment by surpassing Italy. Solar power capacity has increased by more than 11 times in the last five years from 2.6 GW in March, 2014 to 30 GW in July, 2019.

The following graph shows annual solar power generation of the last seven years.



solar energy incident on earth's outer atmosphere reaches the earth's surface?

- (a) 20 % (c) 30 %
 (b) 50 % (d) 80 %
- (B) The average solar energy incident over India's land area is given in table below. Select the row containing the correct information:

	Solar Energy Incident over India's Land Area per Year	Average Solar Energy Incident per sq. m per Day
(a)	2500 billion kWh	40-70 Wh
(b)	5000 trillion kWh	4-7 kWh
(c)	500 trillion kWh	4-7 Wh
(d)	5000 billion kWh	0.4-0.7 kWh

- (C) (2) Energy conversion taking place in solar cell is:
- (a) Solar energy is converted to Chemical energy
 (b) Chemical energy is converted to electrical energy
 (c) Heat energy is converted to Light energy
 (d) Solar energy is converted to electrical energy
- (D) The advantages of using solar cells are given below. Select the incorrect statements:
- (I) They have no moving parts.
 (II) They make use of focusing devices for satisfactory performance.
 (III) They can be set up in remote areas where laying of a power transmission line may be expensive.
 (IV) Special grade silicon used in making solar cells are abundantly available
- (a) Both (I) and (II)
 (b) Both (I) and (IV)
 (c) Both (II) and (III)
 (d) Both (II) and (IV)
- (E) (2) The substance used for interconnection of cells in solar panel is:
- (a) Silver (b) Gold
 (c) Platinum (d) Copper

Ans. (A) (c) 50 %

Explanation: Only a small part of solar energy reaches the outer layer of the earth's atmosphere. Nearly half of it is absorbed while passing through the atmosphere and the rest reaches the earth's surface.

Area per year : 5000 trillion kWh: Average solar Energy incident Sq.m per Days 4-7 kWh

Explanation: About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day.

(D) (d) Both (II) and (IV)

Explanation: Solar cells work quite satisfactorily without the use of any focusing devices. Silicon, which is used for making solar cells, is abundant in nature but availability of the special grade silicon for making solar cells is limited.

33. Sardar Sarovar Dam (SSD), on the Narmada river, is located in the village of Kevadia in the state of Gujarat. It is one of the largest and most controversial interstate, multipurpose river valley infrastructure development projects in the country. The Sardar Sarovar Project (SSP) also consists of auxiliary works and a 1,450 MW power complex.

SSP was estimated to have cost INR 400bn (\$8bn) in 2010-2011, revised from the initial estimate of INR 64bn (\$1.25bn) in 1988. It is part of the Narmada Valley Development Project, a major plan to generate power and supply water for drinking and irrigation to states of Gujarat, Madhya Pradesh and Maharashtra. The scheme was conceived by the late Sardar Vallabhbhai Patel in 1946-1947. It envisages the construction of 30 major dams, 135 medium and 3,000 smaller dams along the river, with SSD being the largest of them all. They are expected to generate about 4,000 MW of power in total.



(A) (2) In hydroelectric power plants:

- (a) Kinetic energy is converted to potential energy
 (b) Wind energy is converted to solar energy
 (c) Solar energy is converted to wind energy

kinetic energy

- (B) Hydroelectric power plant uses :
- Non-renewable source of energy
 - Non-conventional source of energy
 - Conventional source of energy
 - Exhaustible source of energy
- (C) ④ Given below are statements regarding problems associated with constructions of big dams.
- Select the correct statements.
- The dams can be constructed only along the river course in plain areas.
 - Large areas of agricultural land and human habitation are to be sacrificed as they get submerged.
 - Large eco-systems are destroyed when submerged under the water in dams.
 - The submerged vegetation rots and produces large amounts of carbon dioxide, a green house gas.
- Both (I) and (II)
 - Both (II) and (III)
 - Both (I) and (IV)
 - Both (III) and (IV)
- (D) The present installed capacity of the Sardar Sarovar Project is:
- 1.450 MW
 - 1450 kW
 - 1450 MW
 - 4000 MW
- (E) The table below lists the comparison between thermal power plant and hydro power plant. Select the row containing incorrect information:

	Thermal Power Plant	Hydropower Plant
(a)	Fossil fuels are burned to produce steam which runs turbine	The kinetic energy of water is used to run turbine
(b)	Set up near coal or oil fields	Set up near oceans
(c)	Causes pollution	Is pollution free
(d)	Does not affect ecosystem	Affects ecosystem

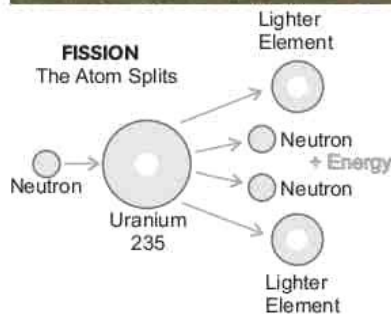
Ans. (B) (c) Conventional source of energy

Explanation: Hydroelectric power plant uses water, which is a conventional source of energy and Hydro power plants convert the potential energy of falling water into electricity. It is a non-exhaustible source of energy as water in the reservoir would be refilled each time it rains.

- (E) (b) Thermal Power Plant Set up near coal or oil fields ; Hydropower Plant: Set up near oceans

Explanation: Thermal power plants are usually set up near coal or oil fields to reduce the cost of transportation of coal or petroleum. In order to produce hydel electricity, high-rise dams are constructed on the river to obstruct the flow of water and thereby collect water in larger reservoirs.

34. Nuclear energy can be used to create electricity, but it must first be released from the atom. In the process of nuclear fission, atoms are split to release that energy. A nuclear reactor, or power plant, is a series of machines that can control nuclear fission to produce electricity. The fuel that nuclear reactors use to produce nuclear fission is pellets of the element uranium. Nuclear energy produces electricity that can be used to power homes, schools, businesses, and hospitals. The first nuclear reactor to produce electricity was located near Arco, Idaho. The Experimental Breeder Reactor began powering itself in 1951. The first nuclear power plant designed to provide energy to a community was established in Obninsk, Russia, in 1954.



- (A) ④ The table below lists the fuel, process involved and principle used for generating nuclear energy. Select the row containing the correct information:

(a)	Helium	Nuclear fusion	Mass of the original nucleus is a little more than the sum of the masses of the individual products.
(b)	Carbon	Nuclear fusion	Mass of the original nucleus is a little less than the sum of the masses of the individual products.
(c)	Uranium or Plutonium	Nuclear fission	Mass of the original nucleus is a little more than the sum of the masses of the individual products.
(d)	Uranium or Plutonium	Nuclear fission	Mass of the original nucleus is a little less than the sum of the masses of the individual products.

(B) ④ Which of the following statements regarding nuclear reactors designed for electric power generation are incorrect?

- (I) In a nuclear reactor designed for electric power generation the nuclear fuel undergoes fusion.
- (II) A self sustaining chain reaction takes place.
- (III) Energy is released at an uncontrolled rate.
- (IV) The released energy is used to produce steam and further generate electricity.

- (a) Both (I) and (II)
- (b) Both (II) and (III)
- (c) Both (III) and (IV)
- (d) Both (I) and (III)

(C) In nuclear fission, a heavy nucleus such as Uranium is bombarded with:

- (a) A slow moving neutron
- (b) A fast moving neutron
- (c) A slow moving proton
- (d) A fast moving electron

(D) ④ The major hazard of nuclear power generation is:

- (a) It produces lot of smoke
- (b) Storage and disposal of spent fuels
- (c) Limited availability of uranium
- (d) Uncontrolled chain reaction

(E) Which of the following is not a reason for large scale use of nuclear energy being prohibitive?

- (a) Risk of accidental leakage of nuclear radiation.
- (b) High cost of installation of a nuclear power plant.
- (c) Low risk of environmental contamination
- (d) Limited availability of uranium.

Ans. (C) (a) A slow moving neutron

Explanation: In nuclear fission, when a heavy nucleus such as Uranium is

bombarded with a slow moving neutron, the nucleus splits into two or more lighter nuclei.

(E) (c) Low risk of environmental contamination

Explanation: Improper nuclear-waste storage and disposal result in environmental contamination which is one of the reasons for large scale use of nuclear energy being prohibitive.

35. Koyal was reading about harnessing the energy from the ocean. She read about the OTEC technology which generates electricity from turbines turned by steam produced from heating the warmer surface waters of the sea into steam. The steam is then condensed by the deeper colder waters which are pumped up from depths of around 1000 metres.



What is the operating principal in OTEC systems?

Ans. The OTEC or Ocean Thermal Energy Conversion systems work on the principle that there is a temperature difference between the water at the surface of the ocean is about 20 k warmer than the water at depths up to 2 km which is used to boil a volatile liquid whose vapours are then used to run the turbine of a generator.

human technologies. Today, wind power is symbolized in most people's minds by a big, white, monolithic wind turbine. As we try to move into the post-carbon era, it's worth remembering that only wind, nuclear, and solar have the same technical potential to provide energy as fossil fuels do today. Perhaps the face of future power generation won't be huge smokestacks, but fields of wind turbines.



What are the factors which limit the use of wind energy?

Ans. The factors which limit the use of wind energy are that the wind energy farms can be established only at places where wind blows for the greater part of the year and wind speed should also be greater than 15 km/h.

37. Geothermal energy, form of energy conversion in which heat energy from within the earth is captured and harnessed for cooking, bathing,

and other uses. Heat from Earth's interior generates surface phenomena such as lava flows, geysers, fumaroles, hot springs, and mud pots. The heat is produced mainly by the radioactive decay of potassium, thorium, and uranium in Earth's crust and mantle and also by friction generated along the margins of continental plates.



What are hot spots? How are they different from hot springs?

Ans. Hot spots are the regions in the earth's crust where molten rocks formed in the deeper hot regions of the earth's crust are pushed and trapped. Hot springs are the outlets on the surface of the earth from where hot water comes out.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

38. What is the role of a plane mirror and a glass sheet in a solar cooker? [NCERT Exemplar]

Ans. The plane mirror reflects most of the light that falls on it. Solar cookers achieve a higher temperature by using mirrors to focus the rays of the Sun.

A glass sheet is used in a solar cooker because the sun rays pass through the glass sheet cover and get absorbed inside the cooker box. It traps more and more heat rays of the Sun, thus heating the food item.

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

39. What are the limitations in obtaining energy from wind? [CBSE 2016, 10, NCERT Exemplar]

Ans. Limitations in obtaining energy from wind:

- (1) Firstly, wind energy farms can be established only at those places where wind blows for the greater part of a year.
- (2) The speed of wind should also be higher than 15 km/h to maintain the required speed of the turbine.
- (3) There should be some back up facilities (like storage cells) to take care of energy needs during a period when there is no wind.

(4) Establishment of wind energy farms requires a large area of land. For a 1 MW generator, the farm needs about 2 hectares of land.

(5) The initial cost of establishment of the farm is quite high. Since the tower and blades are exposed to the vagaries of nature like rain, sunlight, storm and cyclone, they need a high level of maintenance.

(Mention any 3 for a 3 marks question)

[5 marks]

40. How can solar energy be harnessed? Mention any two limitations in using solar energy. How are these limitations overcome?

[CBSE 2017, 13, NCERT Exemplar]

Ans. Solar energy can be harnessed directly by using solar cookers, solar heaters or solar cells. In a solar cooker, the heat energy by the Sun is used for cooking purposes. In a solar heater, heat energy is used to heat the water. In solar cells, it is converted into electricity.

Solar cookers: A black surface absorbs more heat as compared to a white or a reflecting surface under identical conditions. Solar cookers and solar water heaters use this property in their working. Some solar cookers achieve a higher temperature by using mirrors to focus the rays of the Sun. They are covered with a glass plate to trap solar radiations by the greenhouse effect.

Solar cell: A photovoltaic cell absorbs light and converts it directly into electrical energy. These cells are made from semi-conductor elements, like silicon, gallium and germanium, through silicon solar cells. A group of photovoltaic cells is known as a solar panel.

Solar water heaters: Solar water heaters are essentially boxes that are topped by a sheet of transparent glass. Sunlight is let in and a portion of the heat is prevented from escaping. The bottom of the box houses a reflector that focuses sunlight on a metal tube that is positioned in the tank's centre. Black in colour, the metal tube is able to absorb heat more easily.

Limitations in using solar energy are:

- (1) Solar energy is not available at night or when the Sun is hidden under clouds.
- (2) The domestic use of solar cells for the production of electricity is not possible due to high cost.

These limitations can be overcome by the following ways:

- (1) The first limitation can be overcome by converting solar energy into electrical energy using solar cells and storing them for future use.
- (2) The second limitation can be overcome if the government takes some steps to reduce the price of solar cells.

41. (a) Why is there a need for harnessing non-conventional sources of energy? How can energy be harnessed from the sea in different ways? [CBSE 2017, 16, NCERT Exemplar]

42. (a) What are the environmental consequences of using fossil fuels? Suggest the steps to minimize the pollution caused by various sources of energy, including non-conventional sources of energy, that cause global warming.

[CBSE 2017, 14, 11, NCERT Exemplar]

43. Energy from various sources is considered to have been derived from the Sun. Do you agree? Justify your answer.

[CBSE 2020, 17, 13, 12, NCERT Exemplar]

Ans. Yes. The statement that energy from various sources is considered to have been derived from the Sun, reasons for which are:

Wind energy: Due to uneven heating of Earth's surface by sunrays at two different adjoining places, a pressure difference is created and wind is produced.

Wave energy: Strong winds are generated due to the Sun and waves are generated by strong winds blowing across the sea.

Ocean thermal energy: The difference between the temperatures of water on the surface and water at depth in seas and oceans is due to the Sun.

Energy from fossil fuels: Fossil fuels (coal, petroleum, etc) are formed when large plants and ancient creatures are buried deep inside Earth's crust under the effect of a lot of pressure and heat.

Solar energy: The phenomenon of generation of electricity by light (photoelectric effect) is possible only in the presence of the Sun.

Bio mass: Plants convert solar energy into chemical energy with the help of inorganic substances (i.e., air, water, etc). These are consumed by plants and animals, and produce wastes from which energy is obtained.

Energy from flowing water: Water from sea and rivers evaporate, precipitate and condense and fall at different places of Earth as snow and rainfall. This water is collected in a dam and when allowed to flow rotates the turbine of the generator and electricity is produced.

is considered to be derived from the Sun.

44. Explain the principle and working of a biogas plant using a labelled schematic diagram. [NCERT Exemplar]

45. Name the process used to generate nuclear energy. List two elements commonly used for the generation of nuclear energy. Give two reasons which make the large scale use of nuclear energy prohibitive.

Ans. (1) Controlled Nuclear Fission reaction
(2) Uranium, Plutonium, Thorium (any two)

(1) Difficulty in storage and disposal of spent or used fuels.

(2) Risk of accidental leakage of nuclear radiations.

(3) High risk of environmental contamination.

(any two)

[CBSE Marking Scheme 2019]

46. Name two energy sources that you would consider to be renewable. Give justification for your choices. Can these energy sources be pollution free?

List two reasons in support of your answer.

[CBSE 2019]

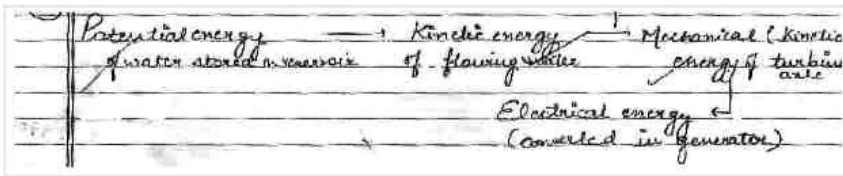


VERY SHORT ANSWER Type Questions

[1 mark]

1. Write the energy conversion that takes place in a hydropower plant.

Ans.



[CBSE Topper 2018]

2. List two characteristics of a good fuel.

Ans.

A good fuel is the one that -

1. does a large amount of work per unit volume or mass i.e. it has high calorific value.
2. has a moderate ignition temperature.
3. is easy to store and transport.

[CBSE Topper 2019]

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

3. What is a dam? Why do we seek to build large dams? While building large dams, which three main problems should particularly be addressed to maintain peace among local people? Mention them.

Ans.

Dam is a structure made to obstruct the flow of water for creating an impoundment or diverting the flow of water for one's own use. Dams are built for storage of water, for electric generation, recreation, protection from drought or flood etc.

Problems to be addressed to maintain peace among people :-

- (i) They must be provided with full rehabilitation facilities. The owners of Tawa Dam are still fighting for facilities promised to them in 1970.
- (ii) They must be given required amount of money for resettlement, again creating conditions for them. They should also be provided with equal land area that has been taken from them to construct a dam with a developmental approach.
- (iii) Benefits of dam must be guaranteed to them and not only to rich urban areas & industries.
- (iv) Appraisal to reduce the damages due to large floods being met by a shelter for wildlife which has been displaced.

[CBSE Topper 2018]

