कैपिटल विश्वविद्यालय
Capital University
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Koderma, Jharkhand-825410, India

# CAPITAL UNIVERSITY

## NON CONVENTIONAL ENERGY SOURCE

## B TECH ELECTRICAL AND ELECTRONICS ENGINEERING

## PROFESSIONAL ENGINEERING CREDITS ASSESSMENT & CONTINUIOUS INTERNAL EVALUATION

ANSWER ANY 60 QUESTION

1. What are conventional and non-conventional energy source?

Conventional energy sources are:

(a) Fossil fuel energy

(b) Hydraulic energy

(c) Nuclear energy

The sources of energy which are being produced continuously in nature and are in

exhaustible are called renewable sources of energy (or) non-conventional energy.

Some of these sources are:

(a) Solar energy

(b) Wind energy

(c) Tidal energy

(d) Geothermal energy

(e) Energy from seas can be utilized as wave, tidal or ocean thermal energy.

2. what are meant by renewable energy sources?

Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us.

3. What are the advantages and disadvantages of conventional &non-conventional

energy source?

Some advantages of Non-conventional energy sources:

They are renewable in nature.

They produce little or no pollution as compared to traditional energy sources.

They require little maintenance.

They are a long-term cost-effective choice.

Some disadvantages of Non-conventional energy sources:

The initial setup cost is greater.

Energy cannot be taken 24/7, year-round, because certain days will be windier than others, and the sun will shine. stronger on other days.

Energy must be stored. Geographical locations might be difficult to navigate.

Advantages of Conventional Sources of Energy:

1. The efficiency of the energy sources is high. Because from 1gm of uranium we get 1 MW energy, from 1-tonne coal we get 2460 kWh energy.

2. The production expenses are low. According to government data of August 2021, the price of Uranium is $50/lb.

3. The raw materials of conventional Sources of Energy are easy to transport. Raw materials such as coal, petroleum, natural gas can be transported easily through trains or ships from one place to another.

4. Generally it doesn't need any specific place for installation. The government can easily set up a conventional plant according to their requirements. Such as if the government wants to install a thermal plant in Uttarakhand or in Jammu they can easily install it.

5. Though it can generate energy instance, so there is no need to wait and it produces much energy as the requirements.

Disadvantages of Conventional Sources of Energy

a. They are the main reason for the pollution. Because it is released carbon monoxide from polluters into the atmosphere. According to The International Energy Agency, only in 2018, India emitted 2,299 million tonnes of carbon monoxide. This report also said that India's per capita emissions were about 40% of the global average and contributed 7% to the global carbon dioxide burden.

b. Generating radioactive waste. We all know about the Fukushima Daiichi nuclear disaster which happened in 2011. Recently Japanese government has decided to release radioactively contaminated water into the ocean. But the environmentalists warn that it should be harmful to ocean life.

c. High startup cost. According to the government estimate, the cost may be about 50 to 70 crores INR for setting up a 10 MW thermal power unit. Whereas to set up a nuclear power plant, it is required ₹60,000 crores.

4. Explain the importance of non-conventional energy sources in the present context?

Non-conventional sources of energy are considered to be important as they are renewable, pollution-free, availability of them is in abundance, and they are environmentally friendly.

5. What is the status of non-conventional energy sources in India, and what are their

future prospect?

There is a capacity of about 1, 95,000 MW non-conventional energy in India. 31 % of it is the form of solar energy, 30% in ocean and geo-thermal, 26 % in biomass and 10 % in wind energy.India is a tropical country. It has enormous possibilities of tapping solar energy.

6. What is the present status of nuclear energy and what are their futureprospects?

Plans for expanding nuclear power. Electricity generation from nuclear power is projected to increase from about 2.7 trillion kilowatthours in 2006 to 3.8 trillion kilowatthours in 2030. The strongest growth in nuclear power is projected to occur in non-OECD Asia.

7. Comment on the future availability trend of fossil fuel in the world?

Fossil fuels will still provide 60% of energy in 2040, compared to 85% today, but the pattern of use will change, away from coal and towards gas, and increasingly concentrated in industry. Fossil fuel prices would be lower in a 2˚C scenario, with less need to mobilise high-cost reserves to meet demand.

8. What are limitations of solar energy?

Limitations of Solar Energy:

Can be harnessed only at those places which get plenty of sunlight.

Cannot be harnessed beyond certain latitudes.

Cannot be harnessed during night.

Current technologies are very costly

9. What are the indirect forms of solar energy?

Tidal energy is the indirect form of solar energy. Tides are the rise and fall of sea levels caused by the combine effects of the gravitational force exerted by the Moon and Sun and the rotation of the Earth. About 1% of the total solar radiation that reaches earth is converted into energy of wind.

10. How is the energy being continuously being produce in the sun?

Solar energy is created by nuclear fusion that takes place in the sun. Fusion occurs when protons of hydrogen atoms violently collide in the sun's core and fuse to create a helium atom. This process, known as a PP (proton-proton) chain reaction, emits an enormous amount of energy.

11. How does the collection of solar energy is affected by tilting a flat plate collector

with respect to ground?

Both the orientation and tilt angle change the solar radiation reaching the surface of the collector. Previous studies show that south is the optimum orientation direction. By utilizing maximum solar energy through the optimum tilt, we are able to harness the energy needed without polluting our environment.

12. How does sun tracking helps in energy collection by a flat plate solar collector?

The overall idea behind this technology is pretty simple. The Sun heats a dark flat surface, which collect as much energy as possible, and then the energy is transferred to water, air, or other fluid for further use

13. What is the average range of solar radiation received on the earth’s surface during

day?

About 40 per cent of the solar radiation received at the earth's surface on clear days is visible radiation within the spectral range 0.4 to 0.7 μm, while 51 per cent is infrared radiation in the spectral region 0.7 to 4 μm. The total radiation emitted by the sun in unit time remains practically constant..

14. What are the main advantages of flat plate solar collector?

Some advantages of the flat-plate collectors are that they are:

Easy to manufacture.

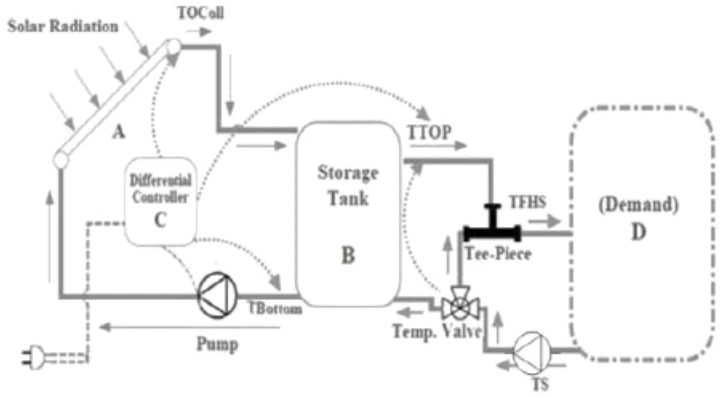
Low cost.

Collect both beam and diffuse radiation.

Permanently fixed (no sophisticated positioning or tracking equipment is required)

Little maintenance.

15. With the help of a schematic diagram , Explain the working of solar water heating?




A solar water heating system consists of a flat plate solar collector, a storage tank kept at a height behind the collector, and connecting pipes.

The collector usually comprises copper tubes welded to copper sheets (both coated with a highly absorbing black coating) with a toughened glass sheet on top and insulating material at the back. The entire assembly is placed in a flat box.

In certain models, evacuated glass tubes are used instead of copper; a separate cover sheet and insulating box are not required in this case.

Working of a solar water heater

The system is generally installed on the roof or open ground, with the collector facing the sun and connected to a continuous water supply.

Water flows through the tubes, absorbs solar heat and becomes hot.

The heated water is stored in a tank for further use.

The water stored in the tank remains hot overnight as the storage tank is insulated and heat losses are small.

16. What is solar house?

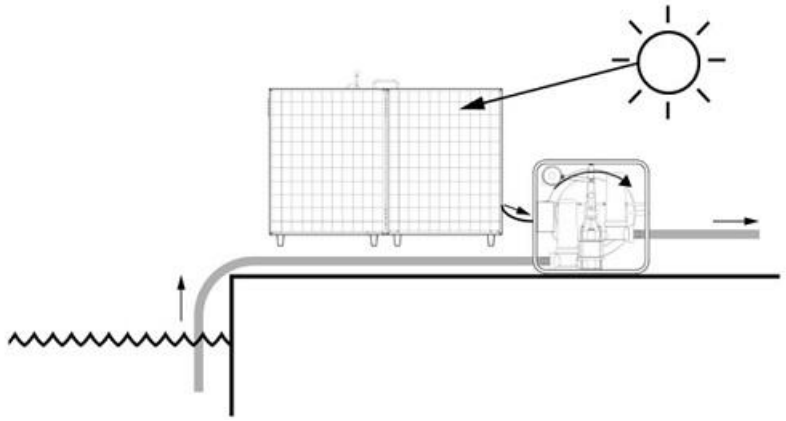
A house equipped with glass areas and so planned as to utilize the sun's rays extensively in heating

17. With the help of schematic diagram, explain the working of solar thermal water

pump?

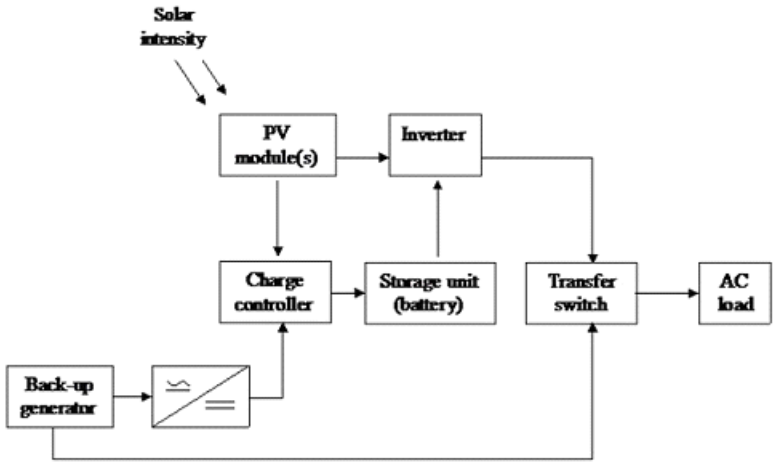
When solar energy (Light energy) falls on the photovoltaic panels it gets converted into electrical energy in the form of DC. Now this DC can either drive a DC motor coupled with a pump or can be inverted through an inverter so that it can drive an AC motor.

working of solar pump



The coupled pump will lift water from low to high. It may be noted that solar power is available only during the day time with clear sky therefore if we need irrigation or power at night time we have to have a storage device that could be either a battery or a pumped storage arrangement. In the pumped storage arrangement, we lift the water and store it at a high elevation during the day and in the night when solar power is not available, we get a gravity flow for irrigation.

Solar Pump Block Dia

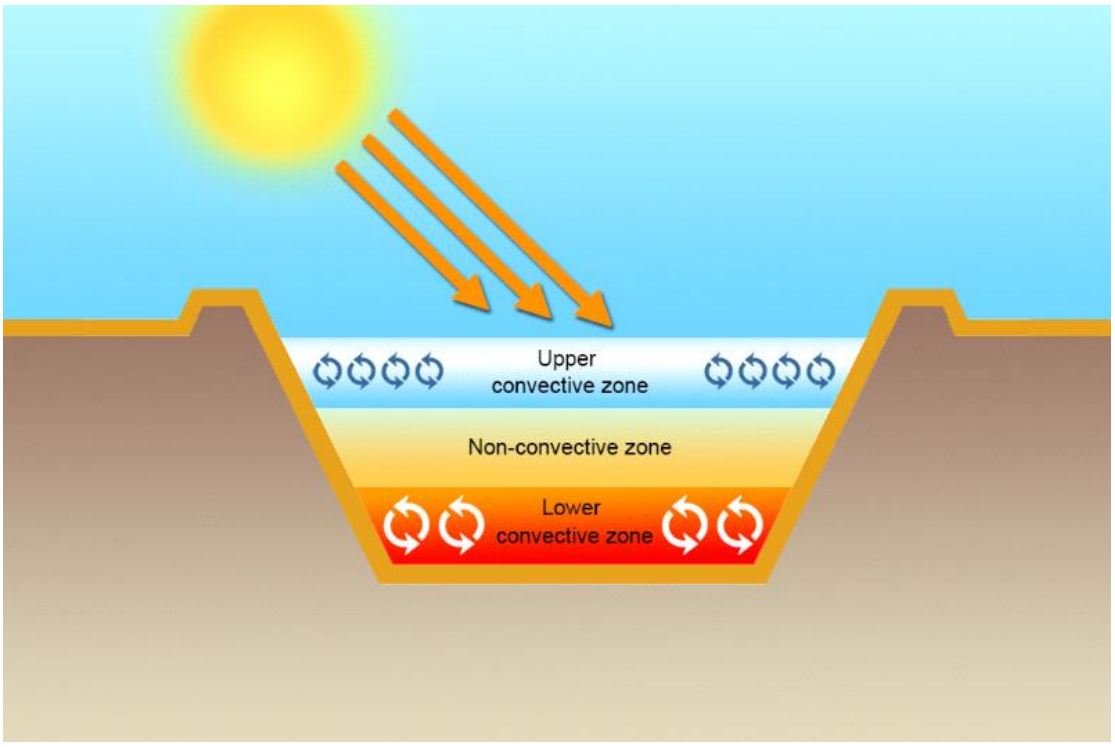



The above block diagram above shows how ac load which may be a solar pump either from an ac generator or from a battery in the event solar power is not available. Please note how the inverter and converter both have been used to get the maximum flexibility.

18. With the help of schematic diagram, explain the working of solar pond electric

power plant?

The concept of a solar pond is derived from the observation that in some naturally occurring lakes, a significant temperature rise of about 40 degree Celsius to 50 degree Celsius. This is because of the fact that there is a natural salt concentration gradient in these lakes, whereby the water at the bottom remains denser even when it is hotter than the water at the top. Thus convection does not occur and heat is lost from the hot water only by conduction. The salt concentration gradient in such lakes is maintained naturally because of the presence of salt deposits at the bottom of the lakes, which approximates to saturation concentrations because of fresh water streams which flow across the top.




The schematic diagram of solar pond is shown in above figure. The top layer remains at ambient temperature while the bottom layer attains a maximum steady state temperature of about 60 degree celsius to 85 degree celsius. As stated earlier it combines the functions of heat collection with long term storage and can provide sufficient heat for the entire year. Typically it is about two or three meters deep with a thick liner that is durable and made of plastic placed at the bottom. Materials used for the liner include low density polyethylene (LDPE), high density polyethylene (HDPE), woven polyster yarn (XB-5). Salts are dissolved in the water, the concentration varying from 20 to 30 percent at the bottom to almost zero at the top. Left to itself the concentration gradient will disappear over a period of time because of upward diffusion of the salt. Fresh water is added at the top of the pond in order to maintain the concentration gradient, while slightly saline water is run off. Simultaneously, concentrated brine is added at the bottom of the pond. The amount of salt required for this purpose is about 50 g/m2 – day, which is large quantity when considered on an annual basis. Hence the normal practice is to recycle the salt by evaporating the saline water runoff from the surface in an adjacent evaporation pond.

In order to extract the energy stored, hot water is removed continuously from the bottom passed through a heat exchanger and returned to the bottom. Alternatively heat is extracted by water flowing through a heat exchanger coil submerged at the bottom. Because of movement and mixing of the fluid both at the top and the bottom, the solar pond is characterized by 3 zones such as a surface convective zone, a non convective concentration gradient zone and a lower convective zone. The upper convective zone or surface convective zone (SCZ) usually has a small thickness around 10 to 20 cm. It has a low

uniform concentration, which is close to zero, as well as a fairly uniform temperature which is close to the ambient air temperature.Both temperature and concentration increases with the depth in this zone. It serves principally as an insulating layer and reduces heat losses in the upward direction. Some of the heat collection also takes place in this zone and it serves also as part of the thermal storage. The lower convective zone (LCZ) is comparable in thickness to the non convective zone. It serves as the main heat collection as well as thermal storage medium. The lower convective zone is often referred to as storage zone or as the bottom layer.

Typically the temperature in the lower convective zone of a well designed large pond operating in India might fluctuate cyclically between a maximum value of 85 degree celsius to 95 degree celsius in summer and a minimum of 50 degree celsius to 60 degree celsius in winter. The annual collection efficiency generally ranges between 15 and 25 per cent. These values are lower than those obtained for a flat plate collector. Nevertheless solar ponds are more cost effective since their cost per square meter is much less than that of a liquid flat plate collector system. This is particularly true when the area is of the order of 1000 m2 or more.

19. What are major advantages and disadvantages of solar PV system?

Advantages of solar PV – in a nutshell

PV panels provide clean – green energy. During electricity generation with PV panels there is no harmful greenhouse gas emissions thus solar PV is environmentally friendly.

Solar energy is energy supplied by nature – it is thus free and abundant!

Solar energy can be made available almost anywhere there is sunlight

Solar energy is especially appropriate for smart energy networks with distributed power generation – DPG is indeed the next generation power network structure!

Solar panels cost is currently on a fast reducing track and is expected to continue reducing for the next years – consequently solar PV panels has indeed a highly promising future both for economical viability and environmental sustainability.

Photovoltaic panels, through photoelectric phenomenon, produce electricity in a direct electricity generation way

Operating and maintenance costs for PV panels are considered to be low, almost negligible, compared to costs of other renewable energy systems

PV panels have no mechanically moving parts, except in cases of sun-tracking mechanical bases; consequently they have far less breakages or require less maintenance than other renewable energy systems (e.g. wind turbines)

PV panels are totally silent, producing no noise at all; consequently, they are a perfect solution for urban areas and for residential applications (see solar panels for home)

Because solar energy coincides with energy needs for cooling, PV panels can provide an effective solution to energy demand peaks – especially in hot summer months where energy demand is high.

Though solar energy panels' prices have seen a drastic reduction in the past years, and are still falling, nonetheless, solar photovoltaic panels are one of major renewable energy systems that are promoted through government subsidy funding (FITs, tax credits etc.); thus financial incentive for PV panels make solar energy panels an attractive investment alternative.

Residential solar panels are easy to install on rooftops or on the ground without any interference to residential lifestyle.

Disadvantages of Solar PV – in a nutshell

As in all renewable energy sources, solar energy has intermittency issues; not shining at night but also during daytime there may be cloudy or rainy weather.

Consequently, intermittency and unpredictability of solar energy makes solar energy panels less reliable a solution.

Solar energy panels require additional equipment (inverters) to convert direct electricity (DC) to alternating electricity (AC) in order to be used on the power network.

For a continuous supply of electric power, especially for on-grid connections, Photovoltaic panels require not only Inverters but also storage batteries; thus increasing the investment cost for PV panels considerably

In case of land-mounted PV panel installations, they require relatively large areas for deployment; usually the land space is committed for this purpose for a period of 15-20 years – or even longer.

Solar panels efficiency levels are relatively low (between 14%-25%) compared to the efficiency levels of other renewable energy systems.

Though PV panels have no considerable maintenance or operating costs, they are fragile and can be damaged relatively easily; additional insurance costs are therefore of ultimate importance to safeguard a PV investment.

20. Explain mechanism of photoconduction in a PV cell?

Conversion of light energy in electrical energy is based on a phenomenon called photovoltaic effect. When semiconductor materials are exposed to light, the some of the photons of light ray are absorbed by the semiconductor crystal which causes a significant number of free electrons in the crystal.

21. What range of wind speed is considered favorable for wind power generation?

A minimum wind speed (generally 12-14 km/h) to begin turning and generate electricity. strong winds (50-60 km/h) to generate at full capacity. winds of less than 90 km/h; beyond that speed, the turbines must be stopped to avoid damage.

22. What factors led to the accelerated development of wind power?

The three main factors that influence power output are: wind speed, air density, and blade radius. Wind turbines need to be in areas with a lot of wind on a regular basis, which is more important than having occasional high winds ...

23. Explain the mechanism of production of local winds.

Since water has a very high specific heat, it maintains its temperature well. So water heats and cools more slowly than land. If there is a large temperature difference between the surface of the sea (or a large lake) and the land next to it, high and low pressure regions form. This creates local winds

24. What are the most favourable sites for installing wind turbines?

Favorable sites include the tops of smooth, rounded hills; open plains and water; and mountain gaps that funnel and intensify wind. Wind resources are generally more favorable for electricity generation at higher elevations above the earth's surface

25. Explain the major application of wind power.

Wind energy is harnessed from moving air, and it has been used for thousands of years, whether it was to propel the first sailboats or to spin the blades on a windmill. This is a type of kinetic energy that is generated from air currents and that can be transformed into electricity through an electric generator.

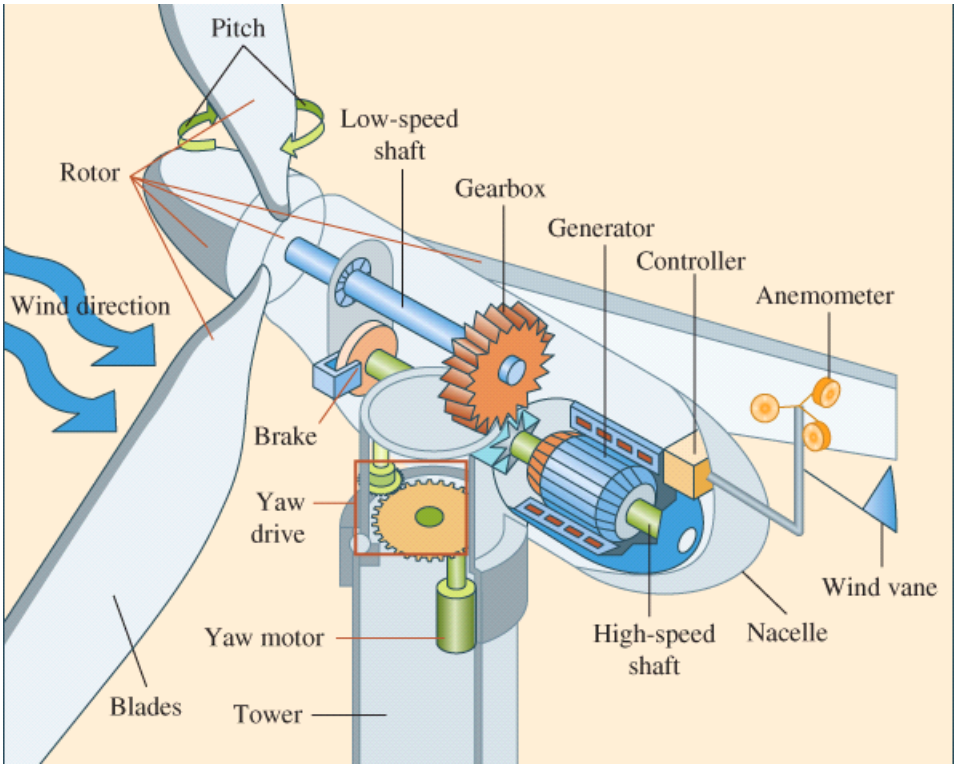
26. Sketch the diagram of a HAWT, and explain the function of its main components.

Horizontal-Axis Wind Turbine Working Principle

The horizontal-axis wind turbine (HAWT) is a wind turbine in which the main rotor shaft is pointed in the direction of the wind to extract power. The principal components of a basic HAWT are shown in Figure 1.

The rotor receives energy from the wind and produces a torque on a low-speed shaft. The low-speed shaft transfers the energy to a gearbox, high-speed shaft, and generator, which are enclosed in the nacelle for protection.

Notice how the blades are connected to the rotor and to the shaft. This shaft is called the low-speed shaft because the wind turns the rotating assembly at a leisurely 10 to 20 revolutions per minute (rpm) typically.




The low-speed shaft connects to the gearbox, which has a set of gears that increase the output speed of the shaft to approximately 1,800 rpm for an output frequency of 60 Hz (or a speed of 1,500 rpm if the frequency is 50 Hz). For this reason, the shaft from the gearbox is called the high-speed shaft.

The high-speed shaft is then connected to the generator, which converts the rotational motion to AC voltage. This speed is critical if it is used to turn the generator directly because the frequency of the ac from the generator is related directly to the rate at which it is turned.

Almost all horizontal-axis wind turbines have similar components to those discussed in this article, but there are some exceptions. For example, direct-drive wind turbines do not have a gearbox, and they usually have a DC generator rather than an AC generator. These may or may not include a converter to AC (which can be located at the tower base).

In commercial turbines, a computer or programmable logic controller (PLC) is the controller. The controller takes data from an anemometer to determine the direction the wind turbine should be

pointed, how to optimize the energy harvested, or how to prevent over-speeding in the event of high winds.

27. Explain various design of blades of HAWTs and their relative features.

The vast majority of horizontal-axis wind turbines used in the commercial production of power for utility companies are three-blade turbines.

Single-Blade Turbines

Single-blade wind turbines are used in a few limited applications, but they are the least used of all the Horizontal-Axis Wind Turbines.

To rotate smoothly, single-blade turbines must have one or two counterbalances. Figure 6 shows a single-blade wind turbine with two counterbalances.

The advantage of this type of wind turbine is the lower cost because of the use of only one turbine blade (and the small weight savings), but single-blade turbines must run at much higher speeds to convert the same amount of energy from the wind as two-blade or three-blade turbines with the same size blades.

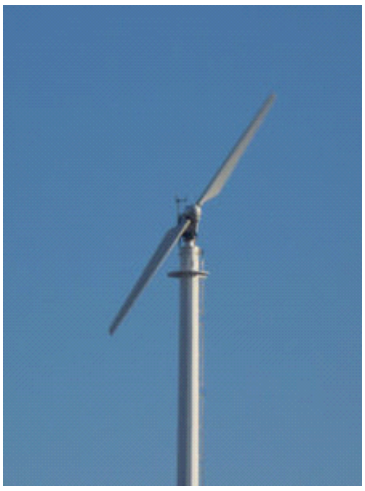
Because the single-blade turbine must run at higher speeds, more wear and fatigue are generated on the blade and bearings in the mounting mechanism, which in turn means higher maintenance costs over the life of the turbine.

Single-blade turbines also require extensive setup procedures to ensure that the blade is mounted perfectly and is balanced to limit oscillation and vibration. Because of these problems, very few single-blade turbines are in use today

Two-Blade Wind Turbines

Compared to three-blade turbines, two-blade wind turbines have the advantage of saving on the cost and the weight of the third rotor blade, but they have the disadvantage of requiring higher rotational speed to yield the same energy output. This is a disadvantage in terms of both noise and wear of critical bearings, shafts, and gearboxes.

Two-blade turbines have experienced high-fatigue failures of the blade and other mechanical parts, so they have limited application. Figure 7 shows a two-blade wind turbine.



Another way to improve the efficiency of the two-blade turbine is to make the two blades thicker and wider than traditional turbine blades so that the two blades can convert more wind energy.

The thicker blades also mean that the blades are stronger and better able to resist fatigue problems. New composite materials allow the increased size without adding substantial weight to each blade.

These materials also allow the blade to be produced at a lower cost. Even with these more efficient blades, however, the two-blade turbine is still slightly less efficient than the three-blade turbine.

One advantage to a two-blade turbine is that it is faster and safer to install than the three-blade version.

A three-blade turbine always has one blade pointing downward if it is raised as a unit, so it is more difficult to get the larger wind turbines off the ground as a unit for mounting.

Three-Blade Wind Turbines

The majority of large horizontal-axis wind turbines use three blades, with the rotor position maintained upwind by the yaw control. Figure 8 shows a three-blade wind turbine.

The three blades provide the most energy conversion while limiting noise and vibration. The three blades provide more blade surface for converting wind energy into electrical energy than a two-blade or single-blade wind turbine.

The blades for the larger horizontal-axis wind turbines are so large they must be transported individually by a truck and trailer. This also means that one or more very large cranes are needed to set the tower and turbine in place.

The tower to hold the larger three-blade turbine must also be larger and reinforced to support the weight and to withstand the increased wind power that is harvested to produce its maximum output.

The blades on larger three-blade wind turbines are typically installed one at a time after the nacelle is mounted on the tower.

On smaller three-blade turbines, the blades can be mounted to the rotor while the rotor is on the ground. Then the entire rotor assembly is lifted with a crane and attached to the shaft after the nacelle is mounted on the tower

Five-Blade Wind Turbines

A few wind turbines have five blades to produce electrical energy efficiently from low-speed winds. Figure 9 shows a five-blade wind turbine.

A five-blade wind generator normally has narrower and thinner blades, which creates issues with strength. While they are excellent in low-speed winds, they become inefficient in high-speed winds and they are noisier.

The tower and base are mounted into the roof of the building, which is a concrete-reinforced building. This type of five-blade wind turbine needs a very strong base and tower to hold the wind turbine in the wind.

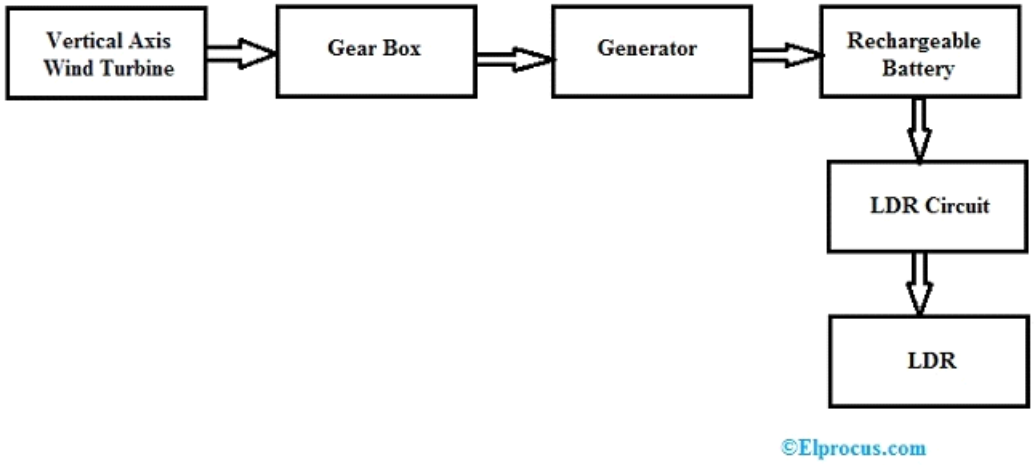
Notice the thickness of the tower and the cowling around the blades, which helps direct wind directly into the blades.

28. Sketch the diagram of a VAWT, and explain the function of its main components.

The Vertical Axis Wind Turbine is a type of wind turbine and it is most frequently used for residential purposes to provide a renewable energy source to the home. This turbine includes the rotor shaft and two or three blades where the rotor shaft moves vertically. So, this turbine movement is related to the spinning of coins on the edge. In this turbine, the generator is placed at the bottom of the tower whereas the blades are covered around the shaft.

Vertical Axis Wind Turbine Block Diagram

The block diagram of a vertical axis wind turbine is shown below. The output energy generated from this can be used by any type of load. Here, the automatic lighting system is used as a load. This block diagram includes a Vertical Axis Wind Turbine (VAWT), gearbox, generator, battery, LDR circuit and LED.




Vertical Axis Wind Turbine

The type of Vertical Axis Wind Turbine used in this system is savories VAWT.

Gear Box

A gearbox in a wind turbine is mainly used to enhance the rotating speed from a low sped shaft to a high-speed shaft connecting through an electrical generator. Gears within the gearbox of a wind turbine are subjected to severe cyclic loading because of uneven wind loads that are stochastic within the environment.

Generator

The generator in the wind turbine converts the energy from mechanical to electrical. These generators are a bit strange as compared to generators used in electrical grids.

Rechargeable Battery

The output electric energy generated by the generator will be stored in the rechargeable battery of the wind turbine.

LDR Circuit

The LDR circuit is used to turn ON/OFF the light.

29. What is the effect of solidity on the performance of wind turbine?

As the solidity of turbine increases the rotor shaft torque also increases. This is because the more area of rotor strikes with wind. By increasing the turbine solidity; it increases the static torque coefficient.

30. Comment on relative features of HAWT and VAWT.

HAWTs have the entire rotor, gearbox and generator at the top of the tower and must be turned to face the wind direction. VAWTs, on the other hand, are omnidirectional which means the rotor can accept wind stream from any direction. Hence, no yaw mechanism is required.

31. Comment on the environmental impact of wind energy.

As with all energy supply options, wind energy can have adverse environmental impacts, including the potential to reduce, fragment, or degrade habitat for wildlife, fish, and plants. Furthermore, spinning turbine blades can pose a threat to flying wildlife like birds and bats.

32. What do you understand by energy farming?

Energy crops are low-cost and low-maintenance crops grown solely for energy production by combustion (not for food). The crops are processed into solid, liquid or gaseous fuels, such as pellets, bioethanol or biogas. The fuels are burned to generate electrical power or heat.

33. What are bio-mass energy resources and what is energy yield from each ofthem?

Biomass energy is energy generated or produced by living or once-living organisms. The most common biomass materials used for energy are plants, such as corn and soy, above. The energy from these organisms can be burned to create heat or converted into electricity

34. Explain the process of commercial production of ethanol from biomass?

To produce ethanol from biomass feedstocks, a pretreatment process is used to reduce the feedstock size, break down the hemicellulose to sugars, and open up the structure of the cellulose

component. The cellulose portion is broken down (hydrolyzed) by en- zymes into glucose sugar that is fer- mented to ethanol.

35. What is the origin of biomass energy? What is its global potential? What is average

efficiency of photosynthetic conversion of solar energy in to biomass?

Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals. The most common biomass materials used for energy are plants, wood, and waste. The potential efficiency of each step of the photosynthetic process from light capture to carbohydrate synthesis is examined. This reveals the maximum conversion efficiency of solar energy to biomass is 4.6% for C3 photosynthesis at 30 degrees C and today's 380 ppm atmospheric [CO2], but 6% for C4 photosynthesis.

36. What is the main advantage and disadvantage of biomass energy?

| Advantages of Biomass Energy | Disadvantages of Biomass Energy |
|---|---|
| It is Renewable | It's Not Completely Clean |
| Carbon Neutrality | High Costs In Comparison To Other Alternatives |
| Less Dependency On Fossil Fuels | Possible Deforestation |
| It Is Versatile | Space |
| Availability | It Requires Water |
| Low Cost In Comparison To Fossil FUEL | It Has Inefficiencies |
| It Reduces Waste | It's Under Development |

37. Explain the process of photosynthesis? How much energy is stored through the

process? In what range of frequency spectrum of solar light photosynthesis is most

marked?

During photosynthesis, plants take in carbon dioxide ($CO_2$) and water ($H_2O$) from the air and soil. Within the plant cell, the water is oxidized, meaning it loses electrons, while the carbon dioxide is reduced, meaning it gains electrons. This transforms the water into oxygen and the carbon dioxide into glucose

Therefore, the estimated maximum energy efficiency of photosynthesis is the energy stored per mole of oxygen evolved, 117 kcal, divided by 450—that is, 117/450, or 26 percent. The actual percentage of solar energy stored by plants is much less than the maximum energy efficiency of photosynthesis.

The best wavelengths of visible light for photosynthesis fall within the blue range (425–450 nm) and red range (600–700 nm).

38. What is the main advantage and disadvantage of biogas, what is the main

constituents and heating value? In witch countries these plants are most popular?

Biogas is a biofuel derived from the natural process of anaerobic decomposition, which happens in the absence of oxygen. When the organic matter decomposed, a blend of gases is released, primarily methane and carbon dioxide. Food wastes, animal manure, wastewater, and crop residue are some of the organic materials used for biogas.

Biogas contains 40%-60% methane, a biofuel with deep blue flame, which produces energy. Biogas is used as fuel in generating electricity, further process to produce biomethane (use as fuel for cars), and the by-product digestate to be used as fertilizer.

It is gaining momentum today as people are becoming environmentally conscious, add to that the rising problem of wastes disposal.

Despite obvious reasons to invest in biogas, it is worthwhile to assess further how the project works and its advantages and disadvantages.

Advantages of Biogas

1.Renewable Source of Energy

Organic materials are derived from plants, animals, and humans. Raw materials can be reproduced, making biogas a green energy source. It also lessens the damaging impact and improper wastes disposal.

2.Utilization of Waste

Instead of letting the wastes rot in landfills, it is more advantageous to utilize and turn them into biogas. An environmental hazard is reduced due to lesser methane, carbon dioxide, and other greenhouse gases produced. Wastes are turned into energy to utilize for electricity, heating, cooking, and as fertilizers.

3.Produces a Circular Economy

Animal manure, food wastes, wastewater, and crop residue are wastes produced by humans and animals. These wastes can cause harm if not process correctly. By turning these organic wastes into

biogas, the wastes are converted into a more helpful way. The wastes are made into biogas for electricity and heating use, natural gas for cars and cooking, and digestate as fertilizers.

4.A Good Alternative for Electricity and Cooking in Rural Areas and Developing Countries

Some areas have limited access to electricity, hampering their way of living. Biogas can provide them a good alternative. It is economical to set up and possible both for small- and large-scale production.

Disadvantages of Biogas

1.Few Technological Advancements

The biogas industry is not yet advanced. Additional research is needed to develop new technology and make production efficient. Also, governments provide more support on established energy sources such as solar, geothermal, wind, and hydropower.

2.Weather Dependence

Like other intermittent energy sources (solar, wind), biogas production is also affected by the weather. Anaerobic digestion happens in an environment with a temperature of 37°C. Heat energy is required in cold climates to produce biogas continually.

3.Foul Odor Emitted from Biogas Power Plant

Biogas plant emits foul odor from the wastes they process. Power plants should be built in a location away from residences and other industrial areas.

Methane is the major constituent of biogas

39. Explain the process of gasification of solid bio fuels? What is the general

composition of gas produced and what is heating value? What its main application?

Gasification is a process that converts organic or fossil-based carbonaceous materials at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam into carbon monoxide, hydrogen, and carbon dioxide.

Producer gas is a gas mixture containing carbon monoxide hydrogen, carbon dioxide and nitrogen. The nitrogen in the air remains unchanged and dilutes the gas, so producer gas has a low heating value 5800 KJ/m3 (Basu et al., 2000; Ray et al., 2005).

The product gas from gasification can for example be used as a fuel in boilers and kiln ovens for high temperature heating purposes or upgraded in more advanced applications such as synthesis of chemicals and biofuels.

40. What are the factors affecting on the performance of biogas digester?

The major parameters affecting methanogenic reactions in a digester are the C/N ratio, temperature, pH value, presence of volatile substance, biological oxygen demand (BOD), chemical oxygen demand (COD) etc

41. Compare the relative performance of a floating drum and fixed one type biogas

plants?

The idea of biogas as a diesel fuel substitute is a very old concept and is a very attractive option.

It has a bright prospect in a country rich in agricultural products and poor in petrol resources.

A study on this aspect was and the report concluded that while running a diesel engine in dual fuel mode i-e on a combination of diesel and biogas about 62% to 64% of diesel fuel is saved as well as an annual saving is obtained at Rs. 3486/m3 and 3379/m3 capacity when running on dual fuel mode also, with respect to gas produced from fixed dome and floating drum biogas digesters respectively.

The less saving in floating type design is due to gas losses from the plant as compared to fixed dome biogas digester where a system is sufficiently leakproof preventing gas leakage.

Therefore airtight.

Fixed dome biogas digester save the money and also environment-friendly.

Running engine by using floating type biogas digester consumed 6.35% more diesel than fixed dome design.

42. Explain different type of bio fuels?

The two most common types of biofuels in use today are ethanol and biodiesel, both of which represent the first generation of biofuel technology. The Bioenergy Technologies Office (BETO) is collaborating with industry to develop next-generation biofuels made from wastes, cellulosic biomass, and algae-based resources

43. What is the present status of development of biomass energy resources in India?

As on 30.06. 2021, a total capacity of 10170 MW has been installed in Biomass Power and Cogeneration Sector.

44. What is the source of tidal energy? Which is the minimum tidal range required for a

practical tidal plant? How much is the potential in tides?

Tidal energy is a renewable energy powered by the natural rise and fall of ocean tides and currents. Some of these technologies include turbines and paddles. Tidal energy is produced by the surge of ocean waters during the rise and fall of tides. Tidal energy is a renewable source of energy

45. What are the main hurdles in the development in the tidal energy?

The largest barrier to tidal energy is the high cost associated with building tidal power stations. Another major concern is the potentially negative environmental effects on marine life. Spinning blades can injure living organisms, as can water fouling resulting from various system components

46. What is the effect of pumping on the output of tidal plant?

The principle that the net energy delivered by a tidal pool can be increased by pumping extra water into the pool at high tide or by pumping extra water out of the pool at low tide is well known in the industry. On paper, pumping can potentially enhance the net power delivered by a factor of about four

47. What are the potential sites for tidal energy in India?

The potential areas with low/medium tidal wave strength are in the Gulf of Khambat, Gulf of Kutch & southern regions in Gujarat, Palk Bay- Mannar Channel in Tamil Nadu, and Hoogly river, South Haldia & Sunderbans in West Bengal.

48. What are the main advantages and disadvantages of ocean wave energy?

Wave Energy Advantages

Renewable

Environment Friendly

Abundant and Widely Available

Variety of Ways To Harness

Predictable

Less Dependency on Foreign Oil Companies

No Damage to Land

Reliable

Vast Amounts of Energy can be Produced.

Offshore Harnessing of Wave Power

Small Footprint

Size Advantage

Minimum Visual Impact

Efficient Energy Production

Low Operational Cost and Fewer Maintenance Issues

Wave Energy Disadvantages

Suitable to Certain Locations

Effect on Marine Ecosystem

Source of Disturbance for Private and Commercial Vessels

Wavelength

Weak Performance in Rough Weather

Noise and Visual Pollution

High Costs

Hard To Scale

Slow Technology Improvements

Difficult To Transmit

Few Implemented

49. What types of sites are considered suitable for wave power development?

The methodology for site selection proposed in this paper is an approach based on sequential steps, relating to different levels of detail in the information that needs to be gathered. The first step of the methodology aspires to list all the relevant items of information and to provide guidance on where to find this information. In most cases this should be publicly, but not necessarily freely, available. As a result of this first step, a preliminary assessment of the suitability of the area should be obtained. This will include identification of excluded and permitted zones inside the interest area (i.e. whether it is worth investing time and money planning a project in the area). Firstly, a step zero or a ground level action has been defined. This includes two activities: • The definition of a general area of interest for the project; this will be a particular stretch of coastline off which the project may be implemented, and which will be the subject of the proceeding detail studies. • The definition of the characteristics and requirements of the project as a whole. Factors such as overall power, type of wave energy devices expected to be installed; orientation and size of the delimited area, or no-go sea zones and operation depth range among others must be considered.

50. What are the main advantages and disadvantages of OTEC system?

Advantages of OTEC system :

Power from OTEC is continuous, renewable, and pollution-free.

Unlike other forms of solar energy, the output of OTEC shows very little daily or seasonal variation.

Drawing of warm and cold seawater and returning

the seawater, close to the thermocline, could be accomplished with minimal environmental impact.

Disadvantages of an OTEC system

Capital investment is very high.

Conversion efficiency is very low about 3-4% due to the small temperature difference between the surface water and deep water

The low efficiency of these plants coupled with high capital cost and maintenance cost makes them uneconomical for small plants.

51. Explain the technology available for OTEC.

Ocean Thermal Energy Conversion (OTEC) systems use a temperature difference (of at least 20° Celsius or 36° Fahrenheit) to power a turbine to produce electricity. Warm surface water is pumped through an evaporator containing a working fluid. The vaporized fluid drives a turbine/generator.

52. What is the fuel cell and what are its main advantages?

A fuel cell may use the chemistry between hydrogen and oxygen to create power. This type of cell was utilised in the Apollo space program and had two purposes: as a source of fuel and as a supply of drinking water (the water vapour produced from the cell, when condensed, was fit for human consumption)

Good reliability- quality of power provided does not degrade over time. Noise- offers a much more silent and smooth alternative to conventional energy production. Environmentally beneficial- greatly reduces CO2 and harmful pollutant emissions. Size reduction- fuel cells are significantly lighter and more compact

53. What are potential applications of fuel cell?

Some portable fuel cell applications include laptops, cellular phones, power tools, military equipment, battery chargers, unattended sensors, and unmanned aerial and underwater vehicles. A notable difference between rechargeable batteries and fuel cells is that a fuel cell needs a continuous supply of fuEL.

54. What are the main hurdles in the way of common use of fuel cell?

The three main obstacles to the spread of fuel cells have been their price, the cost of producing hydrogen, and the difficulty of storing hydrogen.

55. Describe the classification of the fuel cells.

Fuel cells are categorized mainly by the kind of electrolyte they employ. This classification determines the kind of electro-chemical reactions that take place in the cell, the kind of catalysts required, the temperature range in which the cell operates, the fuel required, and other factors. These characteristics, in turn, affect the applications for which these cells are most suitable. There are several types of fuel cells currently under development, each with its own advantages, limitations, and potential applications. The following types of fuel cells are Polymer electrolyte membrane fuel cells, direct methanol fuel cells, alkaline fuel cells, Phosphoric acid fuel cells, molten carbonate fuel cells, Solid oxide fuel cells, Reversible fuel cells.

Polymer electrolyte fuel cells

Alkaline fuel cell

Phosphoric acid fuel cell

Molten carbonate fuel cell

Solid oxide fuel cell

Solid oxide fuel cell

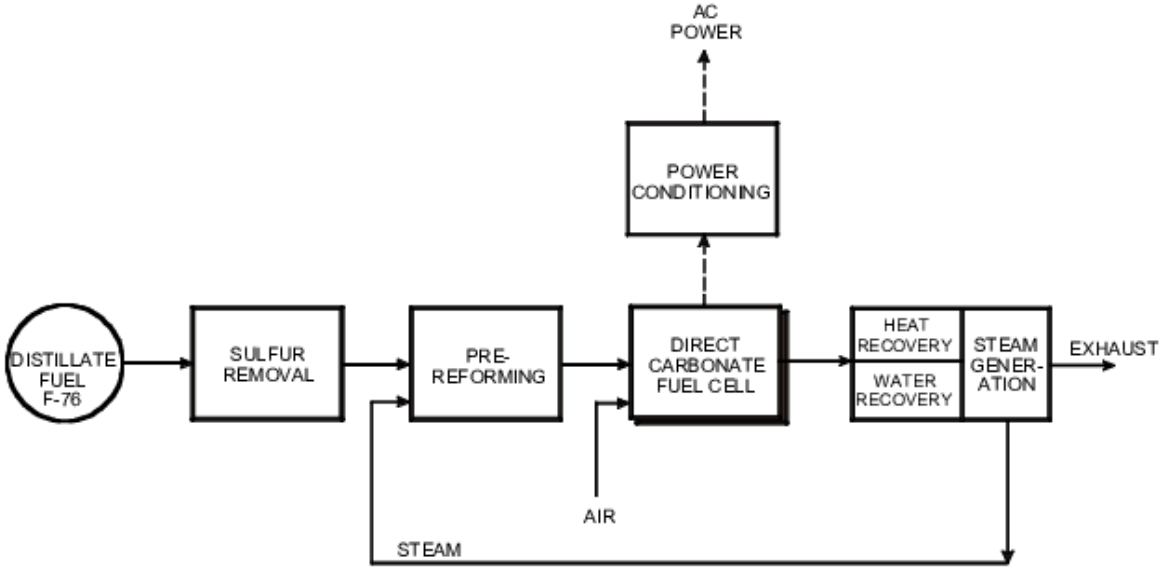
Proton exchange membrane fuel cell

Hydrogen-oxygen fuel cell

56. Explain the principal of operation of Alkaline fuel cell.

The alkaline fuel cell uses an alkaline electrolyte such as 40% aqueous potassium hydroxide. In alkaline fuel cells, **negative ions travel through the electrolyte to the anode where they combine with hydrogen to generate water and electrons**. It was originally used by NASA on space missions.

57. Draw a conceptual block diagram of a fuel cell power plant and explain the detail of each block.




A fuel cell is **a device that converts chemical potential energy (energy stored in molecular bonds) into electrical energy**. A fuel cell is a lot like a battery. It has two electrodes where the reactions take place and an electrolyte which carries the charged particles from one electrode to the other.

58. What is the present state of development in the fuel cell technology?

What are the recent developments in the fuel cell technology?

Recent catalyst developments are key to the future of fuel cell technology, and the large-scale commercialization of clean electric power for transportation and industry, as they: **Reduce fuel cell costs, by reducing the use of precious metals**. Improve durability through innovative catalyst layer designs.

Fuel cells are currently **under development** for both stationary and mobile applications in response to the need for sustainable energy technology.

59. Comment on environmental effect of fuel cell.

Hydrogen fuel cells have been widely touted as an environmentally-friendly alternative to conventional fossil fuels. By oxidising molecular hydrogen, the only direct by-product of their energy generation is water, which means **they could significantly reduce pollution and man-made greenhouse gases**

60. Describe the basic principle of operation of an MHD generator. Derive expression
for maximum power generation per unit volume of generator

The **working principle of MHD generator** is based on Faraday's Law. It states that when a conductor is moved in a magnetic field an EMF is induced in the conductor. In an MHD system, hot gases act as the conductor.

When gases are heated to sufficient temperature by burning of fuel, one or more of the valence electrons are displaced from their orbit in which they are spinning. Thus, the neutral atoms are split into the positive and negative ion. These ions are the electrical conductors.

After that, ionized gases are moved in a duct known as the MHD duct at very high velocity. This movement of gas ions in the MHD duct in which strong magnetic field is applied leads to the electromagnetic induction and an EMF is induced in the pair of electrodes. The electrodes are connected to the external circuit and they deliver current to the external load.

61. What are the major advantages and limitation of MHD generating plant?

**Advantages of MHD System :**

1. It converts heat energy directly into electrical energy at higher conversion efficiency compared to convectional type of power plants.
2. These systems are reliable and produces power pollution free.

3. Large amount of power is generated with small sized plants as compared to conventional power plants . It reaches to almost full power as soon as it is started.
4. The capital cost is comparable to conventional power plants. Thus the cost of power generation per unit is less.
5. The operational and maintenance costs are low.
6. The efficiency of MHD plants is 50% as compared to maximum of 40% of the most efficient conventional power plants It can work on any type of fuel.

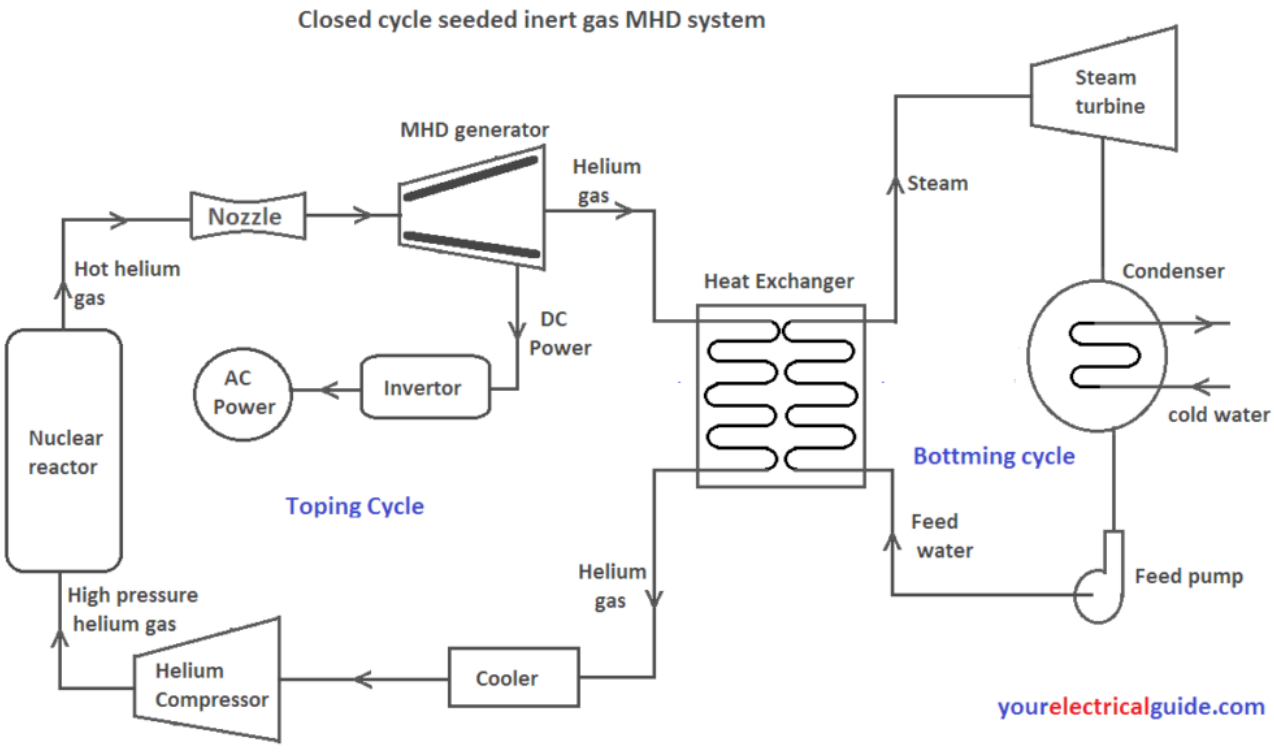
**Disadvantages of MHD System :**

1. It has high fluid friction losses and heat transfer losses.
2. MHD generators operate at very high temperatures to obtain ionisation of gases and to make it electrically conductive. But the electrodes must be relatively at lower temperature.
3. It increases the resistance of gases in vicinity of electrodes since the gases in vicinity of electrodes are comparatively colder.
4. It causes large voltage drop across the gas film.
5. It needs large sized magnets which increases the cost of MHD systems.

62. With the help of schematic diagram, explain the operation of closed cycle MHD generating plant.

A **closed cycle MHD system** can either operate on seeded inert gas (helium or argon) or liquid metal.

**Seeded Inert Gas Closed Cycle MHD System**




A *closed cycle MHD system* using helium or argon gas seeded with Cesium is shown in Figure. Step by step working of the system is as under:

In this system, helium gas seeded with Cesium is heated to a very high temperature in a nuclear reactor.

The hot helium gas is passed through a nozzle to increase its velocity and then supplied to MHD duct to produce DC power. Here, some part of the internal energy of the gas is directly converted into DC power.

In next step, the gas is passed through the heat exchanger (i.e. steam generator) to convert feed water into steam. Now, this steam is used in a conventional steam power plant to generate electricity.

The exhausted helium gas from steam generator is cooled in the cooler and compressed in the compressor. Thereafter, it is supplied back to the nuclear reactor and complete cycle is repeated again.

## Liquid metal Closed Cycle MHD System

It is similar to the inert gas system except that it uses liquid metal (potassium) in place of helium gas as the working fluid.

Liquid potassium is heated in the nuclear reactor and is passed through the nozzle to increase its velocity. Thereafter, the high-velocity liquid metal is

passed through the MHD duct to produce DC power.

The liquid potassium leaving the MHD duct is fed to the heat exchanger where it transfers heat to feed water and feed water is converted into steam. This steam is used in a conventional steam power plant.

The liquid potassium, leaving the heat exchanger is supplied back to the nuclear reactor and complete cycle is repeated again.

A closed-cycle system can provide more useful power conversion at lower temperatures (around 1900 K as compared to 2500 K for open cycle system). However, its use is still a distant dream.

The heat exchanger design is one of the difficulties because the heat exchanger works up to the highest temperature of the gas. Moreover, the working fluid must be kept pure.

63. What are the limitations of harnessing Geo-thermal energy? What are the advantages and disadvantages of Geo-thermal energy?

**What are the Advantages of Using Geothermal?**

1. Environmentally Friendly

Geothermal energy is more environmentally friendly than conventional fuel sources such as coal and other fossil fuels. In addition, the carbon footprint of a geothermal power plant is low. While there is some pollution associated with geothermal energy, this is relatively minimal when compared to fossil fuels.

2. Renewable

Geothermal energy is a source of renewable energy that will last until the Earth is destroyed by the sun in around 5 billion years. The hot reservoirs within the Earth are naturally replenished, making it both renewable and sustainable.

3. Huge Potential

Worldwide energy consumption is currently around 15 terawatts, which is far from the total potential energy available from geothermal sources. While we can’t currently use most reservoirs there is a hope that the number of exploitable geothermal resources will increase with ongoing research and

development in the industry. It is currently estimated that geothermal power plants could provide between 0.0035 and 2 terawatts of power.

4. Sustainable / Stable

Geothermal provides a reliable source of energy as compared to other renewable resources such as wind and solar power. This is because the resource is always available to be tapped into, unlike with wind or solar energy.

5. Heating and Cooling

Effective use of geothermal for electricity generation requires water temperatures of over 150°C to drive turbines. Alternatively, the temperature difference between the surface and a ground source can be used. Due to the ground being more resistant to seasonal heat changes than the air, it can act as a heat sink/ source with a geothermal heat pump just two metres below the surface.

6. Reliable

Energy generated from this resource is easy to calculate since it does not fluctuate in the same way as other energy sources, such as solar and wind. This means we can predict the power output from a geothermal plant with a high degree of accuracy.

7. No Fuel Required

Since geothermal energy is a naturally occurring resource there is no fuel required, such as with fossil fuels that are a finite resource which needs mining or otherwise extracting from the earth.

8. Rapid Evolution

There is a great deal of exploration into geothermal energy at the moment, meaning that new technologies are being created to improve the energy process. There are an increasing number of projects to improve and grow this area of industry. With this rapid evolution many of the current cons of geothermal energy will be mitigated against.

**What are the Disadvantages of Geothermal Energy?**

1. Location Restricted

The largest single disadvantage of geothermal energy is that it is location specific. Geothermal plants need to be built in places where the energy is accessible, which means that some areas are not able to exploit this resource. Of course, this is not a problem if you live in a place where geothermal energy is readily accessible, such as Iceland.

2. Environmental Side Effects

Although geothermal energy does not typically release greenhouse gases, there are many of these gases stored under the Earth's surface which are released into the atmosphere during digging. While these gases are also released into the atmosphere naturally, the rate increases near geothermal plants. However, these gas emissions are still far lower than those associated with fossil fuels.

3. Earthquakes

Geothermal energy also runs the risk of triggering earthquakes. This is due to alterations in the Earth's structure as a result of digging. This problem is more prevalent with enhanced geothermal power plants, which force water into the Earth's crust to open up fissures to greater exploitation of the resource. However, since most geothermal plants are away from population centres, the implications of these earthquakes are relatively minor.

4. High Costs

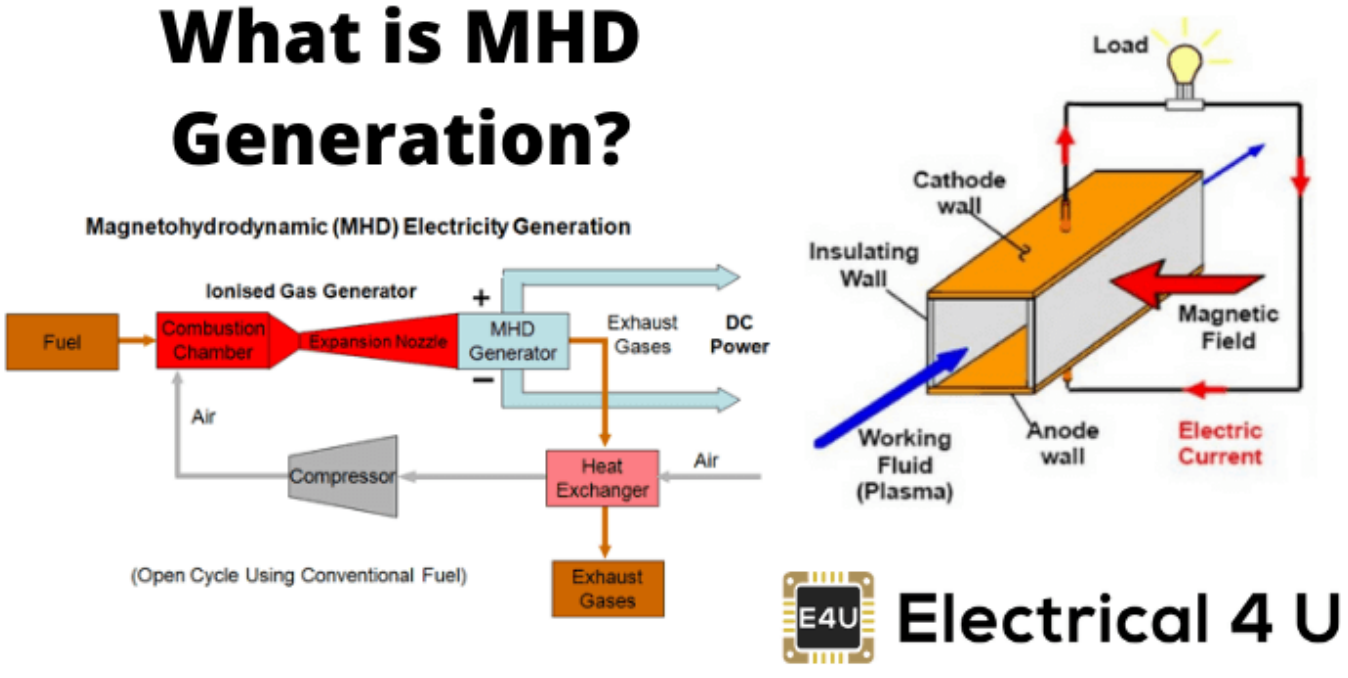
Geothermal energy is an expensive resource to tap into, with price tags ranging from around $2-$7 million for a plant with a 1 megawatt capacity. However, where the upfront costs are high, the outlay can be recouped as part of a long-term investment.

5. Sustainability

In order to maintain the sustainability of geothermal energy fluid needs to be pumped back into the underground reservoirs faster than it is depleted. This means that geothermal energy needs to be properly managed to maintain its sustainability.

It is important for industry to assess the geothermal energy pros and cons in order to take account of the advantages while mitigating against any potential problems.

64. With a neat sketch explain the working of Magneto Hydro Dynamics Generator. Write any three each advantages and limitations of MHD generating plant?




The **MHD generation** or, also known as **magneto hydrodynamic power generation** is a direct energy conversion system which converts the heat energy directly into electrical energy, without any intermediate mechanical energy conversion, as opposed to the case in all other power generating plants. Therefore, in this process, substantial fuel economy can be achieved due to the elimination of the link process of producing mechanical energy and then again converting it to electrical energy.

65. Mention the merits of thermionic converter. On what parameter do the output voltage and current depend?

thermionic power converter, also called thermionic generator, thermionic power generator, or thermoelectric engine, any of a class of devices that **convert heat directly into electricity using thermionic emission rather than first changing it to some other form of energy**.
Thermionic energy conversion (TEC) is **the direct conversion of heat into electricity by the mechanism of thermionic emission, the spontaneous ejection of hot electrons from a surface**

66. Comment on type of materials required in thermionic converter.

**Alkali metals** are used to produce a readily ionizable vapour. Cesium is used in the most efficient converters because of its low ionization potential (3.89 electron volts). Potassium, rubidium, and various other elements may also be used.

67. What are the potential applications of thermionic converters?

The converter may be used as **an electrical power generator or high-temperature sensor in space, airborne, ground, or sub-surface systems**. In many of these systems, the heat source selected may be chemical, nuclear, or solar energy. Application requirements and limitations are discussed for these various systems.

68. What do you understand by energy conservation? Explain its various aspects.

Energy conservation is **the effort made to reduce the consumption of energy by using less of an energy service**. This can be achieved either by using energy more efficiently (using less energy for a constant service) or by reducing the amount of service used (for example, by driving less).
Energy conservation is **the decision and practice of using less energy**.
Turning off the light when you leave the room, unplugging appliances when they're not in use and walking instead of driving are all examples of energy conservation.

69. Explain various aspects of energy conservation.

1. **Turn your refrigerator down.** Refrigerators account for as much as 13.7% of the total household energy use. To increase energy savings, set your fridge to 37 degrees Fahrenheit and your freezer to 3 degrees Fahrenheit.
2. **Use energy-efficient light bulbs.** Install energy-saving CFL or LED bulbs in your lighting fixtures to use 25-35 percent less energy, compared to regular incandescent bulbs.
3. **Clean or replace air filters as recommended.** The air conditioner and heater are the biggest energy users in most homes, and these appliances have to work even harder with dirty air filters. Write the date of

installation on the filter to help you remember when it needs to be replaced.

4. **Do full loads.** Make sure your dishwasher and washing machine are full before running them to get the most energy-saving use from each run cycle.
5. **Use smart power strips.** Even when not in use, household electronics still draw power from outlets. This phenomenon is called "phantom load". Energy-saving smart power strips, which shut down appliances that have gone into standby mode, help you cut down on phantom-load costs, potentially resulting in money and energy savings.
6. **Air-dry dishes and clothes.** Instead of using your dishwasher's drying feature, consider letting the dishes air-dry. And instead of using the dryer on a nice day, hang your clothes outside to dry.
7. **Bake with glass or ceramic pans.** You can set the oven's temperature 25 degrees lower than indicated in the recipe when you do this.
8. **Cook using the right-sized burner.** Conserve energy by using your stove's small burners for small pots and large burners for large pots.
9. **Cut down on air leaks in your home.** You're paying for warm air in the winter and cool air in the summer — don't let that money escape! Check your windows and doors for cracks and gaps, and seal them up with new weather stripping or caulk.
10. **Keep your house a little hotter in the summer and a little cooler in the winter.** Opt for wearing lighter clothes in the summer and wearing a few extra layers in the winter in exchange for those few degrees' change in temperature. A good rule of thumb is to set the thermostat to 68 degrees Fahrenheit in the winter and to 78 in the summer.

70. What is various principal of energy conservation?

The principle of energy conservation states that **energy is neither created nor destroyed**. It may transform from one type to another. Like the mass conservation principle, the validity of the conservation of energy relies on experimental observations; thus, it is an empirical law.

71. Explain the concept of daylight saving as a means for energy conservation

Daylight Saving Time (DST) is the practice of turning the clock ahead as warmer weather approaches and back as it becomes colder again so that people will have one more hour of daylight in the afternoon and evening during the warmer season of the year.

- There's more light to enjoy in the evening. ...
- The crime rate drops during daylight saving time. ...
- It minimizes energy consumption (and lowers your costs). ...
- It lowers the incidence of traffic accidents. ...
- Reset your clocks the night before. ...
- Catch some extra ZZZs. ...
- Get your house prepared.

72. What do you understand by cogeneration?
Cogeneration is **a technique for producing heat and electricity in one process that can save considerable amounts of energy**. Cogeneration is often associated with the combustion of fossil fuels but can also be carried out using some renewable energy sources and by burning wastes.

73. What are fossil fuels? What was the most common source of heat energy in ancient times?

**Sources of heat energy**

- Sun, which is the main source of heat energy. Sun will be used as light energy, food resources, for electricity production.
- Electricity which will produce heat energy through stove, gas burner, incandescent lamp.
- Chemical energy is used to produce heat energy through chemical process
- Nuclear energy is used to produce heat energy through nuclear processes like nuclear fusion.

So heat is the process to do work. The heat is converted to various forms for some useful process.

Fossil fuels are **made from decomposing plants and animals**. These fuels are found in the Earth's crust and contain carbon and hydrogen, which can be burned for energy. Coal, oil, and natural gas are examples of fossil fuels.

74. What was the main source of energy during the industrial revolution?

Coal came into use as a major energy source during the Industrial Revolution of the 1700s and 1800s. During this period, steam-powered engines with coal-fueled boilers were used to power ships and trains.

That source was **fossil fuels** — coal, oil, and natural gas, though coal led the way — formed underground from the remains of plants and animals from much earlier geologic times. When these fuels were burned, they released energy, originally from the Sun, that had been stored for hundreds of millions of years.

75. Which fuel meets the growing demand of energy nowadays and the past?

**Solar generation** (including distributed), which made up 3.3 percent of total U.S. generation in 2020, is the fastest-growing electricity source. Globally, renewables made up 29 percent of electricity generation in 2020, much of it from hydropower (16.8 percent).

76. What made us to look for alternative source of energy?

The main reason why we are searching for an alternate source of energy is because **fossil fuels are non-renewable sources of energy which means they are not available in abundant quantities and cannot be replenished**. Fossil fuels will continue to get exhausted if their consumption is not controlled.

77. Why fossil fuels are called non-renewable sources of energy?

Non-renewable energy **comes from sources that will run out or will not be replenished in our lifetimes**—or even in many, many lifetimes. Most non-renewable energy sources are fossil fuels: coal, petroleum, and natural gas. Carbon is the main element in fossil fuels.

78. What are main disadvantages of using fossil fuels and how can we minimize it?

**Fossil fuel cons**

- Fossil fuels are not renewable energy sources. If we do not reduce consumption, we will run out of them, very quickly. ...
- Fossil fuels pollute the environment. ...
- In the case of irresponsible use, they can be dangerous. ...
- Easier to store and transport. ...

- It is really cheap. ...
- It is more reliable than renewable energy.

79. What kind of gases are released while burning fossil fuels?

Carbon dioxide, methane, nitrous oxide etc

80. Explain how hydro and wind energies are the indirect sources of solar energy?

All the energy in wood and foodstuffs also comes from the sun. **Movement of the wind (which causes waves at sea), and the evaporation of water to form rainfall which accumulates in rivers and lakes, are also powered by the sun**. Therefore, hydroelectric power and wind and wave power are forms of indirect power energy

81. Why most of the thermal power plants are set near coal or oil mines?

Thermal power plants required coal and oil, which they burn to generate the required power. Since **transmission of electricity is more efficient than transporting coal or oil over the same distance**, So thermal power plants are generally located near coal fields.

82. Why hydro power plants are associated with dams?

A hydro power-plant requires the construction of a dam because: **Hydro power plants need continuous supply of water to generate electricity**. Dams store the river water and can be released over the turbine whenever required. The potential energy of water is converted to electrical energy.

83. Give the reason for the coining of the word thermal power plant?

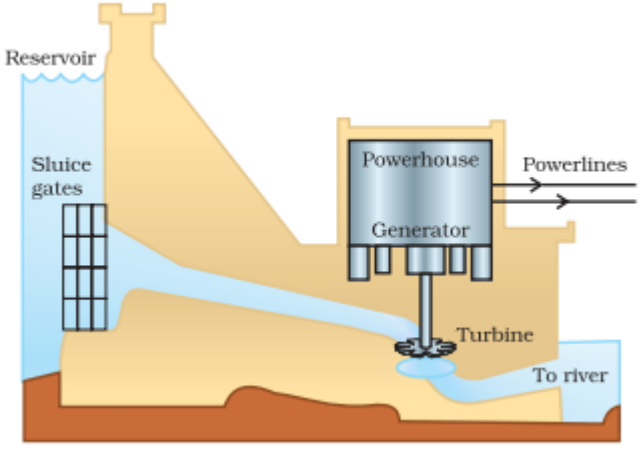
A thermal power station is a power station in which heat energy is converted to electric power. ... Some prefer to use the term energy center because such facilities convert forms ... Power stations in such ships also provide steam to smaller turbines driving ..... For this purpose, a storage tank is installed from which DM water is ...

84. Write the sequence of energy transformation taking place in the following places
a) Nuclear power plant b) Thermal power plant c) Hydro power plant d) Tidal power plant e) Geo-thermal power plant
Three mutual conversions of energy forms occur at nuclear power plants: **nuclear energy is converted into thermal energy, thermal energy is converted into mechanical energy, and mechanical energy is converted into electric energy**.
Hydropower plants capture the energy of falling water to generate electricity. **A turbine converts the kinetic energy of falling water into mechanical energy**. Then a generator converts the mechanical energy from the turbine into electrical energy.
**Nuclear energy originates from the splitting of uranium atoms – a process called fission. This generates heat to produce steam, which is used by a turbine generator to generate electricity**.
At hydropower plants **water flows through a pipe, or penstock, then pushes against and turns blades in a turbine to spin a generator to produce electricity**. Conventional hydroelectric facilities include: Run-of-the-river systems, where the force of the river's current applies pressure on a turbine Geothermal energy is produced by the heat of Earth's molten interior. This energy is harnessed to **generate electricity when water is injected deep underground and returns as steam (or hot water, which is later converted to steam) to drive a turbine on an electric power generator**.

85. Of the major requirement of different forms of energies write which one is the greater requirement of India and which is the least?
India requires **tidal energy** on a larger scale as it is covered with water on all the three parts and on the other hand it requires the nuclear energy the least as it has less reserves of nuclear raw material.

86.What is the percentage of the hydro energy requirement of India?
The total primary energy consumption from coal (452.2 Mtoe; 45.88%), crude oil (239.1 Mtoe; 29.55%), natural gas (49.9 Mtoe; 6.17%), nuclear energy (8.8 Mtoe; 1.09%), hydro electricity (31.6 Mtoe; 3.91%) and renewable power (27.5 Mtoe; 3.40%) is 809.2 Mtoe (excluding traditional biomass use) in the calendar year 2018.

87. Write the working of a hydro power plant with a neat diagram?




1. Hydro power plants convert the potential energy of falling water into electricity. Since there are very few water-falls which could be used as a source of potential energy, hydro power plants are associated with dams.
2. 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. The water level rises and in this process the kinetic energy of flowing water gets transformed into potential energy. The water from the high level in the dam is carried through pipes, to the turbine, at the bottom of the dam.

88. What are the advantages and disadvantages of using energy from water?

Hydroelectricity, which is created by hydropower plants, is a popular form of renewable energy that uses the flow of water to generate electricity.
...
Pros and cons of hydroelectric energy.

| **Pros** | **Cons** |
|---|---|
| Renewable | Environmental consequences |
| Low emissions | Expensive to build |
| Reliable | Drought potential |
| Safe | Limited reserves |

89. What are the limitations of constructing dams across rivers?

Exact the opposite of advantages, dams also have some negative effects. One must know the problems of dams to have a clear idea on the effects of dams on humans, society, and environment.  of dams such as:

1. **Submergence Problem**: A large area gets submerged due to the rise in the water levels and turned into a reservoir. The owners of those lands have to be relocated, adequately compensated, and well settled somewhere else. This requires an extra budget for planning a dam construction.
2. **Failure of Dams**: Dam failures may be caused either due to many reasons. Neglecting possible forces or unexpected forces is the main reason for the failure. The faulty design or occurrence of unanticipated floods can also be the cause of failure. Not maintaining proper guidelines during design and construction is also a reason for dam failures. Dams may sometimes fail due to excessive and unanticipated earthquakes. The failure of dams can bring enormous hazards to the life of people in that locality.
3. **Water wastage**: Sometimes water used in excess of evapotranspiration requirements. This water appears in the system as surface or groundwater. But it degrades in quality, mainly due to fertilizers and pesticides, besides minerals drawn from soils. Such waste has to be minimized.
4. Life cycles of habitats living in the water (like fish) get affected due to the construction of dams. Their life cycles are adapted to natural river habitat and flow regimes. By altering the flow, the physical surroundings are altered.
5. Cycles and variation of flow downstream are established.
6. Standing water (reservoir) habitats replace flowing water habitats.
7. Nutrients are unable to procedure downstream.
8. Coastal erosion is enhanced because of the loss of debris transportation.
9. Productivity and species diversity of waterways are often reduced because of the reduction of fresh flow.
10. A reduction in diversity happens.

90. What is bio- mass and write few examples of bio mass?
Biomass is **renewable organic material that comes from plants and animals**. Biomass was the largest source of total annual U.S. energy consumption until the mid-1800s. Biomass continues to be an important fuel in many countries, especially for cooking and heating in developing countries.

92. What is the Indian name of bio-gas and why is it called so?
Ans:

The Indian name of biogas is gobar gas. Cow dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are

decomposed in the absence of oxygen to give bio-gas. Since the starting material is mainly cow-dung, it is popularly known as gobar gas.

94. With a neat diagram of a bio-gas plant write its construction and working?

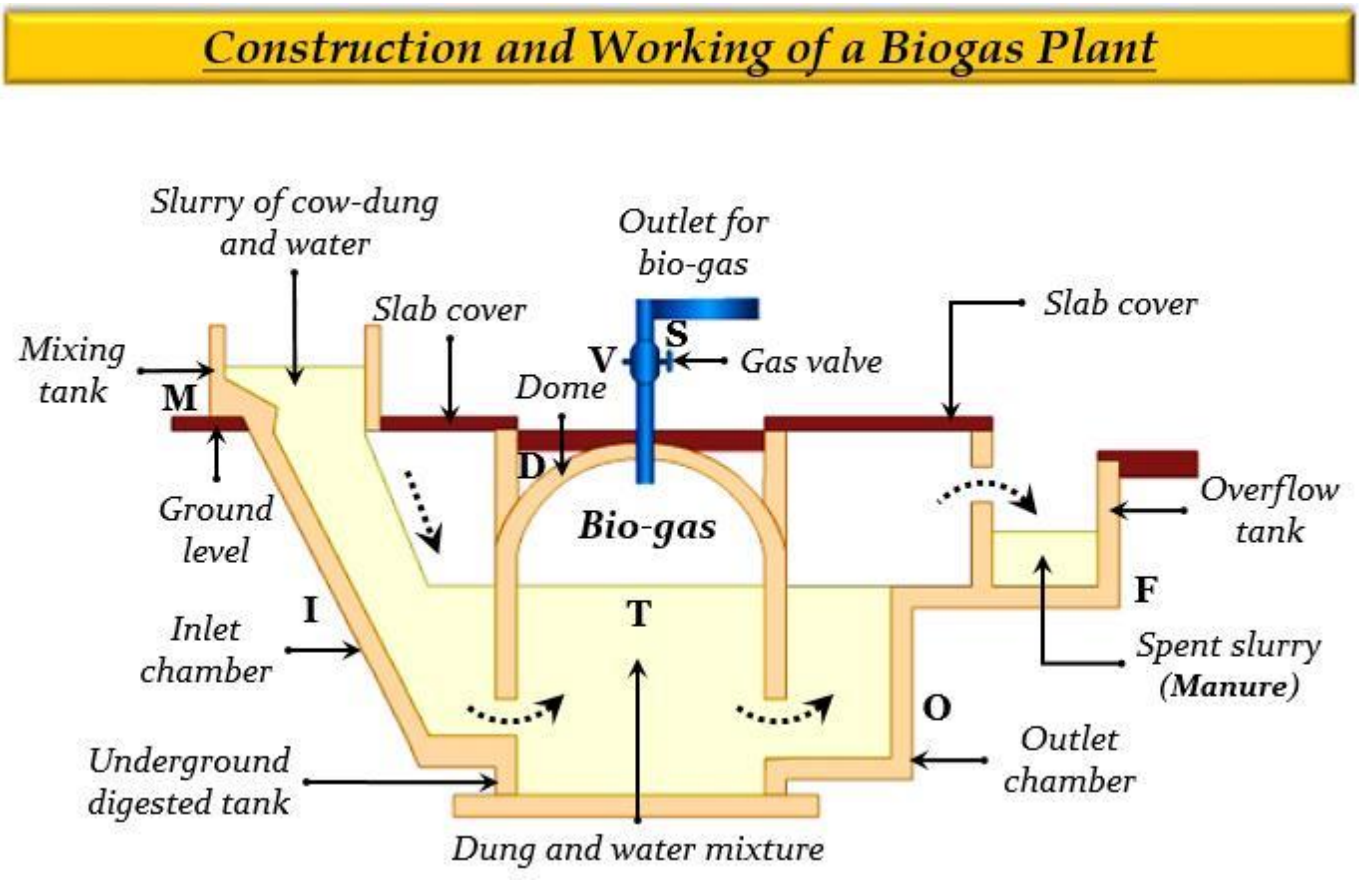
Ans:

Construction of a biogas plant

A biogas plant consists of a wall-shaped underground tank known as ‘digester’ which is made of bricks and cement and has a dome-shaped roof ‘D’. The dome acts as a storage facility for biogas. On the top of the dome, there is a gas outlet ‘S’ that has a valve ‘V’. There is a sloping inlet chamber ‘I’ which is connected to a mixing tank ‘M’ on the left side and a rectangular outlet chamber ‘O’ is connected to the overflow tank ‘F’ on the right side.

Working

First of all, a slurry is made by mixing cow dung and water in equal proportions in the mixing tank ‘M’. This slurry is fed into the digester tank ‘T’ through the inlet chamber ‘I’ to fill the tank up to the cylindrical level, and the dome is left free for the collection of biogas. Then, in 50-60 days, the cow dung undergoes degradation by anaerobic bacteria, and the gradual evolution of biogas get collected in the dome. Now, the collected biogas in the dome exerts pressure on the slurry which forces the spent slurry to go into the overflow tank ‘F’ through outlet chamber O, from where it is removed.




95. What is the major disadvantage of bio-mass and how can it be overcome?

Ans:

- The Disadvantages of Biomass Energy
- It's Not Completely Clean.
- High Costs In Comparison To Other Alternatives.
- Possible Deforestation.
- Space.
- It Requires Water.
- It Has Inefficiencies.
- It's Under Development.

97. What are the advantages and disadvantages of establishing wind mills?

Ans:

Advantages of windmill:

- It is a clean fuel source.
- It contains zero carbon emission which is associated with the operation of wind turbines.
- The loss for farmers or any living beings doesn’t occur that is why wind turbines use only a fraction of land.
- It depends on the combustion of fossil fuels.
- Windmill doesn’t pollute the air like a power plant.
- Wind energy is free.

Disadvantages of windmills:

- It is not a continual energy source.

- It produces noise pollution.
- It also produces visual pollution.
- Birds have been killed by flying into rotational turbine blades.
- The travel and maintenance cost of turbines increases.
- It is time-consuming.

99. Write the differences between renewable and non-renewable resources of energy

Ans:

Renewable resources of energy

- There is no depletion in them with continuous consumption.

- These emit low carbon and thus have a low carbon footprint.

- The upfront cost is high.

- In order to harvest renewable energy, the cost of infrastructure is very high.

- It requires a huge area for wind farms, etc.

Non Renewable resources of energy

- These get depleted with continuous consumption.
- These emit comparatively higher carbon and thus have a higher carbon footprint.
- The upfront cost is low.
- In order to harvest non-renewable resources, the cost of infrastructure is low and cost-effective.
- It requires a smaller area, comparatively.

100. Write a similarity and a dissimilarity between hydro energy and thermal energy.

Ans:

Hydro power plant works with potential energy of stored water at higher elevation. Thermal, plants works with fossil fuels.

Operating cost of hydro power plant is very less. Thermal plants require fuel and so cost of operation is high.

Thermal ,plants produce carbon di oxide which is a green house gas. Hydro, plant needs lot of space to build the dam and reservoir.

Hydro plants can be started quickly and loaded very fast. Thermal ,plant requires time to heat up the turbine/boiler to follow the expansion curves More skilled operators are required for thermal, plant.Hydro plant can be operated from remote control room.

113

➡It can not be used in absence of the light from any source.
➡It incurs very high initial cost for installation.
➡During cloudy weather, less power is being generated.
➡Very large geographical area is needed in order to deploy solar panels or cells.
➡Off grid applications require energy storage.
➡Photo-Voltaic solar cells generate direct current (DC). It requires DC appliances or inverters (to convert DC to AC) for use with solar cells based plants.

115

## Uses of Solar Cell

Biogas Solar cells are portable, durable and the maintenance cost is low. It was discovered in the year 1950 and its first use was in communication satellite Let's see some Solar cell applications for different purposes:

1. Transportation
2. Solar cells in calculators
3. Solar cell panels
4. Solar cell advantages

### 1. Solar Cell for Transportation

Solar energy is used in cars. This solar power is created by photovoltaic cells. This electricity is transferred to the storage battery or powers the motor. Ed Passerini was the first person to build a solar car. The first powered car was created in the year 1977

### 2. Solar Cells in Calculators

Solar-powered calculators use photovoltaic cells. These calculators work with solar energy. The light from sun gives power for the operation of calculators. Solar calculators work very well in outdoor light

### 3. Solar Cell Panels

On the rooftop, solar panels are kept. It is used as a solar heater which heats the water. This water can be used for bathing. Also, another use it helps in generating power. People can store this energy in the backup battery and can use during power cut issues. Or people can store this energy and use it to generate electricity in their house and save money by reducing the electricity bill

### 4. Solar Cell Advantages

Solar energy is a renewable form of energy. Saves money as it reduces the electricity bill. Maintaining is simple and affordable so the maintenance cost is also low. It is one of the best alternatives for non-renewable energy.

117

A solar panel is a flat construction resembling a window, built with technology that allows it to passively harvest the heat of the sun or create electricity from its energy through photovoltaics.

Passive solar panels include those used to heat water for home heating and to provide hot water on tap. Most commonly, photovoltaics are assumed when speaking of solar panels. Photovoltaic solar panels use positively- and negatively-doped silicon working in conjunction with conductors on the alternately-charged surfaces. Electricity is created when photons strike the surface and excite electrons to the point that they leave their valence.

Solar panels are increasingly in popularity as solar power has reached price parity with oil and, simultaneously, more and more jurisdictions mandate the use of solar panels or other renewable energy sources in construction of new buildings.

121

- High tidal power plant construction costs because they need to be incredibly sturdy to withstand the force of the sea.

- To harness ocean thermal energy efficiently, the difference in the temperature of surface water (hot) and the water at depth (cold) must be ºº20ºC or more.
- Negative influence on marine life forms
- Limits arising from the location due to limited availability of sites with sufficiently high tidal ranges or flow velocities. Very strong waves are required to obtain electricity from wave energy.
- Tidal energy depends on the relative positioning of the Earth, moon, and Sun.
- The variable intensity of sea waves.

122

The energy available due to the difference in the temperature of water at the upper surface and the deeper layers of ocean is known as ocean thermal energy. Ocean thermal energy is used to generate electricity in an Ocean Thermal Energy Conversion power plant (OTEC power plant). A temperature difference of 20oC or more between the surface water and deeper water is needed for the operation of these plants. The warm surface water of ocean is used to boil a liquid like ammonia or chlorofluorocarbon. The high pressure of liquid vapours is used to turn the turbine of a generator and produce electricity.

124

cean thermal energy conversion (OTEC) is a process or technology for producing energy by harnessing the temperature differences (thermal gradients) between ocean surface waters and deep ocean waters.

Energy from the sun heats the surface water of the ocean. In tropical regions, surface water can be much warmer than deep water. This temperature difference can be used to produce electricity and to desalinate ocean water. Ocean Thermal Energy Conversion (OTEC) systems use a temperature difference (of at least 20° Celsius or 36° Fahrenheit) to power a turbine to produce electricity. Warm surface water is

pumped through an evaporator containing a working fluid. The vaporized fluid drives a turbine/generator. The vaporized fluid is turned back to a liquid in a condenser cooled with cold ocean water pumped from deeper in the ocean. OTEC systems using seawater as the working fluid can use the condensed water to produce desalinated water.

125

Geothermal energy utilizes the accessible thermal energy from the Earth's interior. Heat is extracted from geothermal reservoirs using wells or other means.

Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems.

Once at the surface, fluids of various temperatures can be used to generate electricity. The technology for electricity generation from hydrothermal reservoirs is mature and reliable, and has been operating for more than 100 years.

128

This geothermal power plant generates electricity for the Imperial Valley in California. Credit: Warren GretzMost power plants need steam to generate electricity. The steam rotates a turbine that activates a generator, which produces electricity. Many power plants still use fossil fuels to boil water for steam. Geothermal power plants, however, use steam produced from reservoirs of hot water found a couple of miles or more below the Earth's surface. There are three types of geothermal power plants: *dry steam, flash steam,* and *binary cycle*.

Dry steam power plants draw from underground resources of steam. The steam is piped directly from underground wells to the power plant, where it is directed into a turbine/generator unit. There are only two known underground resources of steam in the United States: The Geysers in northern California and Yellowstone National Park in Wyoming, where there's a well-known geyser called Old Faithful. Since Yellowstone is protected from development, the only dry steam plants in the country are at The Geysers.

Flash steam power plants are the most common. They use geothermal reservoirs of water with temperatures greater than 360°F (182°C). This very hot water flows up through wells in the ground under its own pressure. As it flows upward, the pressure decreases and some of the hot water boils into

steam. The steam is then separated from the water and used to power a turbine/generator. Any leftover water and condensed steam are injected back into the reservoir, making this a sustainable resource.

Binary cycle power plants operate on water at lower temperatures of about 225°-360°F (107°-182°C). These plants use the heat from the hot water to boil a *working fluid,* usually an organic compound with a low boiling point. The working fluid is vaporized in a *heat exchanger* and used to turn a turbine. The water is then injected back into the ground to be reheated. The water and the working fluid are kept separated during the whole process, so there are little or no air emissions.



# Advantages of Using Geothermal

## 1. Environmentally Friendly

Geothermal energy is more environmentally friendly than conventional fuel sources such as coal and other fossil fuels. In addition, the carbon footprint of a geothermal power plant is low. While there is some pollution associated with geothermal energy, this is relatively minimal when compared to fossil fuels.

## 2. Renewable

Geothermal energy is a source of renewable energy that will last until the Earth is destroyed by the sun in around 5 billion years. The hot reservoirs within the Earth are naturally replenished, making it both renewable and sustainable.

## 3. Huge Potential

Worldwide energy consumption is currently around 15 terawatts, which is far from the total potential energy available from geothermal sources. While we can't currently use most reservoirs there is a hope that the number of exploitable geothermal resources will increase with ongoing research and development in the industry. It is currently estimated that geothermal power plants could provide between 0.0035 and 2 terawatts of power.

## 4. Sustainable / Stable

Geothermal provides a reliable source of energy as compared to other renewable resources such as wind and solar power. This is because the resource is always available to be tapped into, unlike with wind or solar energy.

## 5. Heating and Cooling

Effective use of geothermal for electricity generation requires water temperatures of over 150°C to drive turbines. Alternatively, the temperature difference between the surface and a ground source can be used. Due to the ground being more resistant to seasonal heat changes than the air, it can act as a heat sink/ source with a geothermal heat pump just two metres below the surface.

### 6. Reliable

Energy generated from this resource is easy to calculate since it does not fluctuate in the same way as other energy sources, such as solar and wind. This means we can predict the power output from a geothermal plant with a high degree of accuracy.

### 7. No Fuel Required

Since geothermal energy is a naturally occurring resource there is no fuel required, such as with fossil fuels that are a finite resource which needs mining or otherwise extracting from the earth.

### 8. Rapid Evolution

There is a great deal of exploration into geothermal energy at the moment, meaning that new technologies are being created to improve the energy process. There are an increasing number of projects to improve and grow this area of industry. With this rapid evolution many of the current cons of geothermal energy will be mitigated against.

## Disadvantages of Geothermal Energy

### 1. Location Restricted

The largest single disadvantage of geothermal energy is that it is location specific. Geothermal plants need to be built in places where the energy is accessible, which means that some areas are not able to exploit this resource. Of course, this is not a problem if you live in a place where geothermal energy is readily accessible, such as Iceland.

### 2. Environmental Side Effects

Although geothermal energy does not typically release greenhouse gases, there are many of these gases stored under the Earth’s surface which are released into the atmosphere during digging. While these gases are also released into the atmosphere naturally, the rate increases near geothermal plants. However, these gas emissions are still far lower than those associated with fossil fuels.

### 3. Earthquakes

Geothermal energy also runs the risk of triggering earthquakes. This is due to alterations in the Earth's structure as a result of digging. This problem is more prevalent with enhanced geothermal power plants, which force water into the Earth's crust to open up fissures to greater exploitation of the resource. However, since most geothermal plants are away from population centres, the implications of these earthquakes are relatively minor.

## 4. High Costs

Geothermal energy is an expensive resource to tap into, with price tags ranging from around $2-$7 million for a plant with a 1 megawatt capacity. However, where the upfront costs are high, the outlay can be recouped as part of a long-term investment.

## 5. Sustainability

In order to maintain the sustainability of geothermal energy fluid needs to be pumped back into the underground reservoirs faster than it is depleted. This means that geothermal energy needs to be properly managed to maintain its sustainability.

It is important for industry to assess the geothermal energy pros and cons in order to take account of the advantages while mitigating against any potential problems.

133

Nuclear fusion and nuclear fission are two different types of energy-releasing reactions in which energy is released from high-powered atomic bonds between the particles within the nucleus. The main difference between these two processes is that fission is the splitting of an atom into two or more smaller ones while fusion is the fusing of two or more smaller atoms into a larger one.

Nuclear Fission

- Fission reaction does not normally occur in nature
- Fission produces many highly radioactive particles
- The energy released by fission is a million times greater than that released in chemical reactions; but lower than the energy released by nuclear fusion
- One class of nuclear weapon is a fission bomb, also known as an atomic bomb or atom bomb
- Fission is the splitting of a large atom into two or more smaller ones
- Critical mass of the substance and high-speed neutrons are required
- Takes little energy to split two atoms in a fission reaction
- Nuclear fission is the splitting of a massive nucleus into photons in the form of gamma rays, free neutrons, and other subatomic particles. In a typical nuclear reaction involving 235U and a neutron:
  23592U + n = 23692U followed by 23692U = 14456Ba + 89 36Kr + 3n + 177 MeV

Nuclear Fusion

- Fusion occurs in stars, such as the sun
- Few radioactive particles are produced by fusion reaction, but if a fission "trigger" is used, radioactive particles will result from that

- The energy released by fusion is three to four times greater than the energy released by fission
- One class of nuclear weapon is the hydrogen bomb, which uses a fission reaction to “trigger” a fusion reaction
- Fusion is the fusing of two or more lighter atoms into a larger one
- High density, high temperature environment is required
- Extremely high energy is required to bring two or more protons close enough that nuclear forces overcome their electrostatic repulsion
- Nuclear fusion is the reaction in which two or more nuclei combine together to form a new element with higher atomic number (more protons in the nucleus). The energy released in fusion is related to E = mc^2 (Einstein’s famous energy-mass equation). On earth, the most likely fusion reaction is Deuterium–Tritium reaction. Deuterium and Tritium are both isotopes of hydrogen. 2 1Deuterium + 3 1Tritium = 42He + 10n + 17.6 MeV
- Fusion of deuterium with tritium creating helium-4, freeing a neutron, and releasing 17.59 MeV of energy

134

A chain reaction refers to a process in which neutrons released in fission produce an additional fission in at least one further nucleus. This nucleus in turn produces neutrons, and the process repeats. The process may be controlled (nuclear power) or uncontrolled (nuclear weapons). If each neutron releases two more neutrons, then the number of fissions doubles each generation. In that case, in 10 generations there are 1,024 fissions and in 80 generations about 6 x $10^{23}$ (a mole) fissions.

136

The major hazard of nuclear power generation-

(1) Expensive to set up a nuclear plant

(2) Storage and disposal of used or spent fuels.

(3) High risk of environmental contamination.

(4) Risk of accidental leakage of nuclear radiations.

(5) Misuse of this energy is modern time.

# Advantages of Nuclear Power

## Overall low cost of operation

Nuclear power is relatively one of the most cost-effective and reliable energy compared to other sources. Other than the initial cost of construction, the cost of generating electricity is cheaper and more sustainable than other forms of energy such as oil, coal, and gas. One of the additional benefits of nuclear power is that it experiences minimal risk of cost inflation instead of traditional power sources that regularly fluctuate over periods.

## Consistent source of energy

Nuclear power has a consistent and predictable output. It is not affected by weather conditions compared to other sources such as wind and solar power.

Nuclear fission generates far more energy than fossil fuel combustion such as coal, oil, or gas. The process produces almost 8,000 times more power than typical fossil fuels, resulting in less material used and causing less waste. All-year-round energy production is feasible, allowing for favorable returns on initial investment due to no energy production delays.

It is estimated the world has enough uranium to produce electricity for the next 70-80 years. It does not seem like a long enough period, but in comparison to fossil fuels, they are expected to diminish in a far less period. Additionally, there are current investigations into alternative power sources for nuclear energy.

Nuclear power is the lowest carbon emission energy source and a lower carbon footprint compared to other sources such as fossil fuels.

The majority of carbon dioxide emissions primarily occur during the fueling process and construction of the plant but not during electricity generation. The overall pollutant generation from nuclear plants is relatively modest compared with fossil fuel energy generation.

Currently, nuclear energy usage cuts more than 555 million metric tons of carbon production each year. The greenhouse reduction is an excellent sign of how crossing over to nuclear energy will reduce the long-term impact on global climate change**.**

# Disadvantages of Nuclear Power

Nuclear energy is a promising alternate and reliable energy resource for future electricity needs. However, there are numerous drawbacks to nuclear energy to consider, particularly its environmental impact in the future.

## Expensive to Construct

Nuclear power plants are affordable to operate but are relatively expensive to construct. The expected cost of nuclear plant construction has increased from $2- $4 billion to $9 billion between 2002 and 2008 and often, their cost estimates are surpassed during construction.

Aside from the cost of constructing a power plant, nuclear reactors must allocate funds for waste that is generated, which must be stored in cooled facilities with strict security protocols. All the costs and expenditures make nuclear power rather costly upfront.

## Generation of radioactive waste

While no emissions are produced in nuclear energy generation, a bi-product of radioactive waste is developed. The waste must be stored in secure facilities to avoid polluting the environment. Radiation is not harmful in small quantities, but radioactive waste from nuclear plants is hazardous

Storage of radioactive waste is a significant concern and cost for nuclear power plants. There is no way to destroy nuclear waste; the only current solution is to seal and store it in deep underground facilities. As technology improves, there will hopefully be the development of better ways of storing radioactive waste in the near future.

## Restricted fuel supply

Nuclear power plants are heavily dependent on thorium and uranium to generate electricity. Before the supply of thorium and uranium is depleted, a nuclear fusion or breeder reactor will have to be created, otherwise, power generation will not be possible. Currently, nuclear power is only an expensive short-term option for power generation due to diminishing resources.

## Impact on the environment

The most significant impact on the environment stems from the destructive process of uranium mining. Both open-pit and underground mining can mine uranium.

Open-pit mining is generally a safe process for miners but generates radioactive waste while causing erosion and, on some occasions, polluting water supplies. Underground mining exposes miners to a far greater risk of radiation poisoning than open-pit mining. While also producing large amounts of the radioactive waste rock during both processing and extraction.



Reasons why nuclear energy is not allowed in large scale:
1) The accidents that involve nuclear reactors are quite devastating. The accidents that involve core melt down due to overheating causes a lot of death and one can only imagine if the nuclear reactor was quite and such an accident take place.
2) The radioactive waste are quite harmful to living organisms. Proper ways of disposing off these waste have still not been discovered, therefore the rate of generation of the radioactive wastes has to be limited.
3) Nuclear energy can be used to make very powerful nuclear bombs. This requires that such energy be kept under check.

139

Various factors to be kept in mind while choosing a source of energy are:

1. the ease of extracting energy from that source

2. the cost of extracting energy from that source

3. the efficiency of technology available for extracting energy from that source

4. the damage to environment caused by using that sourceRead more on

141. Define energy.

Ans:

In Electrical Engineering, **Energy** is derived as a result of movement of electrically charged particles. When used loosely, electrical energy refers to energy that has been converted from electric potential energy. This energy is supplied by the combination of electric current and electric potential that is delivered by an electrical circuit (e.g., provided by an electric power utility).

142. Explain why it is necessary to develop non-conventional method of generating electrical energy.

Ans:

As the consumption of energy grows, the population depends more and more on fossil fuels such as coal, oil and gas day by day. There is a need to secure the energy supply for future since the prices of gas and oil keep rising by each passing day.

143. What are the prospects of renewable energy sources in India?

Ans:

India is one of the most dynamic and vibrant markets in the world for renewable energy. This key emerging market, home to 16% of the global population in 2017, is poised for some of the fastest energy demand growth over the coming decades. Development of renewables is happening on many fronts, from

on-the-ground innovation and technological breakthroughs to policy measures at all levels.

This working paper provides a perspective on the changes needed for India to further accelerate the adoption of renewables, and thereby achieve an affordable, secure, inclusive and environmentally friendly energy system that can address expanding energy demand and socio-economic needs.

The country possesses a wealth of renewable resources, particularly for solar and bioenergy development. Greater integration of renewables would improve energy access for poor communities and boost overall energy security.

To make the most of this potential, investments in India's renewable energy capacity have to more than double. The country must mobilise affordable financing and adopt new business models; develop a skilled and knowledgeable workforce; and introduce modern renewables-based technologies into people's daily cooking, cooling and transportation routines. Achieving this requires annual renewable energy investments worth USD 42 billion over the period to 2030.

In economic terms, however, the increased use of renewables in 2030 would save India some 12 times more than it costs, when reduced environmental and health damage are taken into account. Along with ensuring cleaner air and water and helping to curb energy-related carbon dioxide emissions, the transition

to renewable energy would create more jobs, the analysis shows.

144. What is Kyoto protocol and what are its implications for developed and developing countries.

Ans:

The Kyoto Protocol, also known as the Kyoto Accord, is an international treaty among industrialized nations that sets mandatory limits on greenhouse gas emissions. The greenhouse effect is the warming effect of the sun on greenhouse gases, such as carbon dioxide, that act to trap this heat in our atmosphere.

The protocol does provide a complicated mechanism that would allow developed countries to earn credits for reducing the rate of emissions growth in developing countries. However, it would have little effect overall because developing countries are expressly exempted from Kyoto's emissions targets.

The 1992 UN climate change treaty envisions all countries as ultimately contributing to reducing greenhouse gas emissions, as do we. Our blueprint commits developing countries to participate, but caps their short-run cost at zero.

At first the allocation of long-term permits in developing countries would exceed current emissions and no annual permits would be sold. But when emissions begin to grow, annual permits would be sold, thus providing a price signal to energy producers and potential investors about the expected

future price of carbon in these economies. A developing country could also use the long-term permits (which cannot be traded internationally) to encourage direct investment in low-carbon energy generation in its economy.

Its main weakness may lay in the incapacity of Kyoto-type targets to deal with the uncertainties surrounding climate change— especially on the side of abatement costs. A mere extension of the current protocol seems unlikely to effectively tackle climate change.

145. Write a note on total solar energy received in India.

Ans:

The Indian Government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule. In 2015 the target was raised to 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022, targeting an investment of US$100 billion. India has established nearly 42 solar parks to make land available to the promoters of solar plants. The Ministry of New and Renewable Energy had stated that a further 36.03 GW (as of January 31, 2021) of solar projects are under various stages of implementation and 23.87 GW are in the tendering process.

Rooftop solar power accounts for 2.1 GW, of which 70% is industrial or commercial. In addition to its large-scale grid-connected solar photovoltaic (PV) initiative, India is developing off-grid solar power for local energy needs. Solar products have

increasingly helped to meet rural needs; by the end of 2015 just under one million solar lanterns were sold in the country, reducing the need for kerosene. That year, 1,18,700 solar home lighting systems were installed and 46,655 solar street lighting installations were provided under a national programme; just over 14 lakh (1.4 million) solar cookers were distributed in India.

With about 300 clear and sunny days in a year, the calculated solar energy incidence on India's land area is about 5 quadrillion kilowatt-hours (kWh) per year (or 5 EWh/yr). The solar energy available in a single year exceeds the possible energy output of all of the fossil fuel energy reserves in India. The daily average solar-power-plant generation capacity in India is 0.30 kWh per m2 of used land area, equivalent to 1,400–1,800 peak (rated) capacity operating hours in a year with available, commercially-proven technology.

146. Give three types of solar energy collectors.

Ans:

**Flat-plate solar collectors** are the most common ones. They consist of an absorber, a transparent cover and insulation.The main use of the technology is usually in residential buildings where the demand for hot water is big and affects bills. Commercial application of flat-plate collectors is usually seen in car washes, laundromats, military laundry facilities or restaurants.

**Evacuated-Tube Collector**

This is a type of a vacuum collector, its absorber strip is placed in an evacuated and pressure proof glass tube. The heat transfer fluid flows directly the absorber into a U-tube or in a tube-in-tube system. The heat pipe collector integrates a special fluid, which evaporates even at low temperatures, thus the steam rises in the individual heat pipes and warms up the fluid in the main pipe, generating heat. Thermodynamic panels are also based on such a refrigerant fluid but are exploiting the heat in the ambient air, and, therefore, are only suitable for hot water.

**Parabolic Dish**

What differentiates this technology is that with this solar collector, a few dishes can be utilised and they can concentrate solar energy at the same focal point. Like the other collectors, it's mainly used in solar power plants and also for researchers. The dish is aligned in a way that allows it to collect almost all of the solar radiation that hits Earth's surface. Most efficiency losses come because of slight imperfections in the shape of the dish. Losses due to weather conditions are usually minimal, however, on a rainy foggy day, sun rays are usually distributed in all directions.

147. Define PV effect.

Ans:

The photovoltaic effect can be defined as being the appearance of a potential difference (voltage) between two layers of a semiconductor slice in which the conductivities are opposite, or between a semiconductor and a metal, under the effect of a light stream.

151. With the help of a neat sketch describe a solar heating system using water heating solar collectors. What are the advantages and disadvantages of this method?

Ans:

The working of solar water heaters is very simple to understand. The solar water heaters use two common principles for its functioning.

A black surface heats up when left in the sun, by absorption of solar radiation; The good absorption property of black surfaces is used to improve solar energy absorption in a solar heater

The Inside of car/ bus parked in sun for a long time becomes hot. This is because solar radiation can pass through the glass windows of the bus but cannot come out. It is trapped inside and thus heats up the bus. Similarly water passing through insulated pipes kept in the sun becomes hot

These two phenomena are utilized in flat plate collectors of commonly available solar water heaters

**Flat plate collector:** It is the heart of a solar water heating system.

It consists of an absorber plate which is coated on its sun facing surface with an absorbent coating, also called selective coating.

The absorber consists of a grid of metallic tubes and sheets. Water flows through the tubes. Sheet absorbs the solar radiation falling on it and transfers it to water.

The absorber plate is placed in a top open box to protect it from weather. The space between back and sides of the absorber and the box is filled with insulation to reduce heat losses. The front of the box is covered with a high transmittance glass plate.

Flat plate collectors are specified on the basis of their area and are of commonly 1x2 m size.

Advantages of the flat-plate collectors are that they are:

- Easy to manufacture.
- Low cost.
- Collect both beam and diffuse radiation.
- Permanently fixed (no sophisticated positioning or tracking equipment is required)
- Little maintenance.

The principal disadvantage of a flat plate collector is that because of the absence of optical concentration, the area from which heat is lost is large. Also due to the same reason high temperatures cannot be attained and as a result the collection efficiency is generally low.

152. What is the principle of solar photovoltaic power generation? What are the main elements of a PV system?

Ans:

Photovoltaic power generation is based on the principle of photovoltaic effect, using solar cells to convert solar energy directly into electrical energy.

Photovoltaic systems generally consist of six individual components: the solar PV array, a charge controller, a battery bank, an inverter, a utility meter, and an electric grid. The correct installation of all of these components determines how efficient the solar panels are.

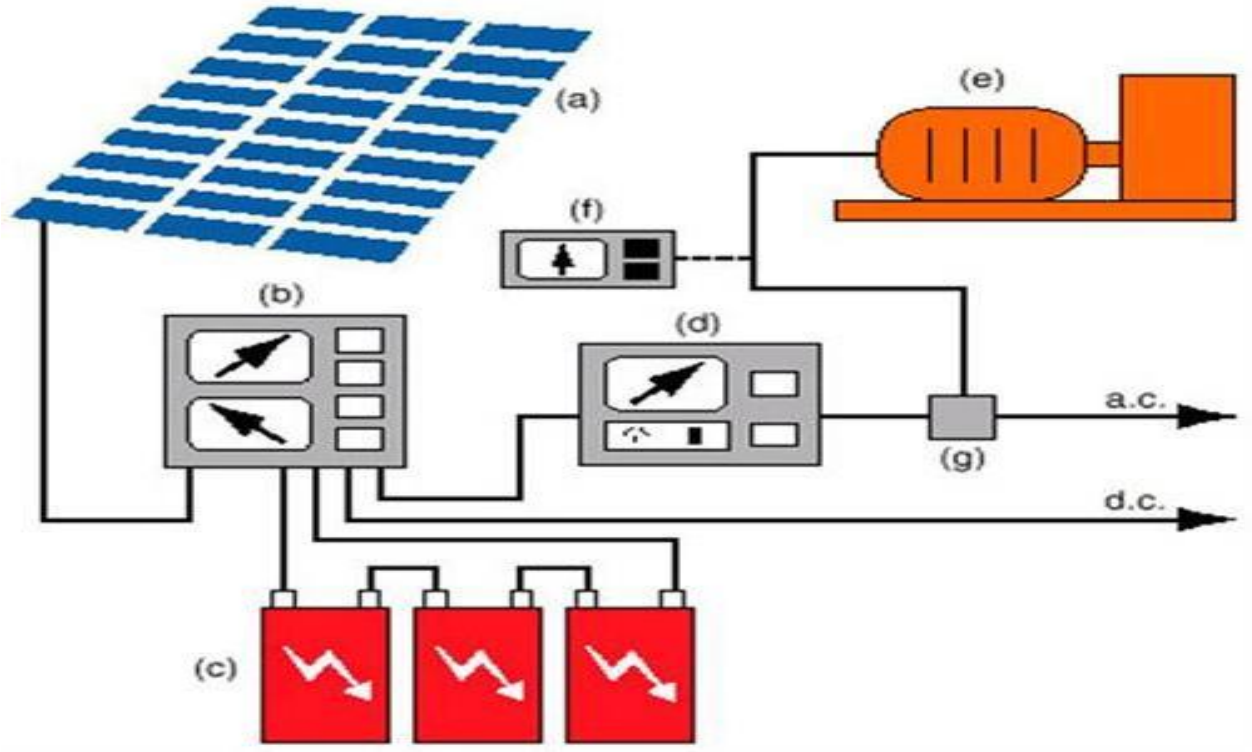
153. Explain the principle of building integrated PV system with suitable sketch.

Ans:

Photovoltaics (PV) is a truly elegant means of producing electricity on site, directly from the sun, without concern for energy supply or environmental harm. These solid-state devices simply make electricity out of sunlight, silently with no maintenance, no pollution, and no depletion of materials.

There is a growing consensus that distributed photovoltaic systems that provide electricity at the point of use will be the first to reach widespread commercialization. Chief among these distributed applications are PV power systems for individual buildings.

Building Integrated Photovoltaics (BIPV) is the integration of photovoltaics (PV) into the building envelope. The PV modules serve the dual function of building skin—replacing conventional building envelope materials—and power generator. By avoiding the cost of conventional materials, the incremental cost of photovoltaics is reduced and its life-cycle cost is improved. That is, BIPV systems often have lower overall costs than PV systems requiring separate, dedicated, mounting systems.




A complete BIPV system includes:

- The PV modules (which might be thin-film or crystalline, transparent, semi-transparent, or opaque);
- A charge controller, to regulate the power into and out of the battery storage bank (in stand-alone systems);
- A power storage system, generally comprised of the utility grid in utility-interactive systems or, a number of batteries in stand-alone systems;
- Power conversion equipment including an inverter to convert the PV modules' DC output to AC compatible with the utility grid.
- Backup power supplies such as diesel generators (optional-typically employed in stand-alone systems); and
- Appropriate support and mounting hardware, wiring, and safety disconnects.

BIPV systems can either be interfaced with the available utility grid or they may be designed as stand-alone, off-grid systems. The benefits of power production at the point of use include savings to the utility in the losses associated with transmission and distribution (known as 'grid support'), and savings to the consumer through lower electric bills because of peak shaving (matching peak production with periods of peak demand). Moreover, buildings that produce power using renewable energy sources reduce the demands on traditional utility generators, often reducing the overall emissions of climate-change glasses.

155. Explain about the applications of solar PV system in rural areas.

Ans:

Lighting up rural India

The decentralised and modular nature of solar power makes it easy to deploy for multiple rural applications, impacting key facets of rural population such as productivity, safety, health benefits, access to clean water, heating solution and livelihood.

Solar lighting, for example, not only provides a high quality solution to improve rural productivity, but also substantially reduces health hazards by enabling replacement of kerosene lamps. Even 4-5 hours of additional lighting can improve productivity and income of rural household by nearly 30 per cent.

Nearly 3.5 million solar lighting solutions have been installed till date, making it a $200-million market in FY 15.

Solar micro and mini grid are logical extensions of standalone solar lighting solutions as they have the capability to provide incremental benefits to households like powering fans, mobile charging, community television, as well as facilitating Internet access etc.

Simple Networks is an excellent example of a private enterprise providing commercially viable micro grid solution to the poorest of poor districts.

Smarter farming

Another important application is solar powered agri pumps, which have the potential to substantially improve productivity of Indian farmers. Solar agri pumps are an economic and environmentally-friendly alternative to nearly 26 million agri pumps installed in India, of which 10 million are diesel-fired.

Replacement of 1 million diesel pumps could, over its life, improve agricultural output by ₹30,000 crore, mitigate usage of diesel by 9.4 billion litres — translating into a reduction of diesel subsidy by ₹84,000 million and CO2 abatement of 25.3 million tonnes.

156. Describe briefly about PV system.

Ans:

A photovoltaic system, also PV system or solar power system, is an electric power system designed to supply usable solar power by means of photovoltaics. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to convert the output from direct to alternating current, as well as mounting, cabling, and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery.

PV systems convert light directly into electricity, and are not to be confused with other solar technologies, such as

concentrated solar power or solar thermal, used for heating and cooling. A solar array only encompasses the ensemble of solar panels, the visible part of the PV system, and does not include all the other hardware, often summarized as balance of system (BOS). PV systems range from small, rooftop-mounted or building-integrated systems with capacities from a few to several tens of kilowatts, to large utility-scale power stations of hundreds of megawatts. Nowadays, most PV systems are grid-connected, while off-grid or stand-alone systems account for a small portion of the market.

Operating silently and without any moving parts or environmental emissions, PV systems have developed from being niche market applications into a mature technology used for mainstream electricity generation. A rooftop system recoups the invested energy for its manufacturing and installation within 0.7 to 2 years and produces about 95 percent of net clean renewable energy over a 30-year service lifetime.

Due to the growth of photovoltaics, prices for PV systems have rapidly declined since their introduction; however, they vary by market and the size of the system. In 2014, prices for residential 5-kilowatt systems in the United States were around $3.29 per watt, while in the highly penetrated German market, prices for rooftop systems of up to 100 kW declined to €1.24 per watt. Nowadays, solar PV modules account for less than half of the system's overall cost, leaving the rest to the remaining BOS-components and to soft costs, which include

customer acquisition, permitting, inspection and interconnection, installation labor and financing costs.

157. What is the type of generator used in wind power plant?

Ans:

The type of generator most used in wind turbines are the permanent magnet synchronous generators.

158. What are wind farms?

Ans:

A wind farm or wind park, also called a wind power station or wind power plant, is a group of wind turbines in the same location used to produce electricity. Wind farms vary in size from a small number of turbines to several hundred wind turbines covering an extensive area. Wind farms can be either onshore or offshore.

159. How the wind mills are classified?

Ans:

There are two types of designs in windmill:

- Vertical axis windmills
- Horizontal axis windmills

Vertical Axis Windmills

In the early development stage, vertical axis wind mills were very popular and were in wide use. It is in such a design that the blades will be perpendicular to the ground. These vertical

axis wind mills were replaced by the horizontal axis windmills later due to its incompetence. This was mainly used for grinding grains or pumping water.

The vertical axis windmill Is called as horizontal windmills. Thus please do not confuse yourself with both the names as if you miss the word “axis”, the whole idea and meaning will change, giving you the antonym.

Horizontal Axis Windmills

Horizontal axis windmills won the hearts of many due to its efficiency and productivity. It is known for its elasticity design as it harness more wind and easy for the operating person to change the direction according to the wind flow.

160. What are the advantages of wind power?

Ans:

- Advantages of Wind Power
- Wind power is cost-effective.
- Wind creates jobs.
- Wind enables U.S. industry growth and U.S. competitiveness.
- It’s a clean fuel source.
- Wind is a domestic source of energy.
- It’s sustainable.
- Wind turbines can be built on existing farms or ranches.

161. What are the disadvantages of wind power?

Ans:

Some of the main disadvantages of wind energy include

- Unpredictability,
- It is a threat to wildlife.
- It creates low-level noise.
- They aren't aesthetically pleasing.
- There are limited locations suitable for wind turbines.

162. Define Vertical Axis Wind Turbine (VAWT).

Ans:

A vertical-axis wind turbine (VAWT) is a type of wind turbine where the main rotor shaft is set transverse to the wind while the main components are located at the base of the turbine. This arrangement allows the generator and gearbox to be located close to the ground, facilitating service and repair.

165. State the essential features of a probable site for a wind form.

Ans:

Favourable land cost:

- High annual average wind speed.
- Availability of anemometry data.
- Availability of wind V(t) Curve at the proposed site.
- Wind structure at the proposed site.
- Altitude of the proposed site.

- Terrain and its aerodynamic.
- Local Ecology.
- Distance to road or railways.

166. Why a tall tower is essential for mounting a horizontal axis wind turbine ?

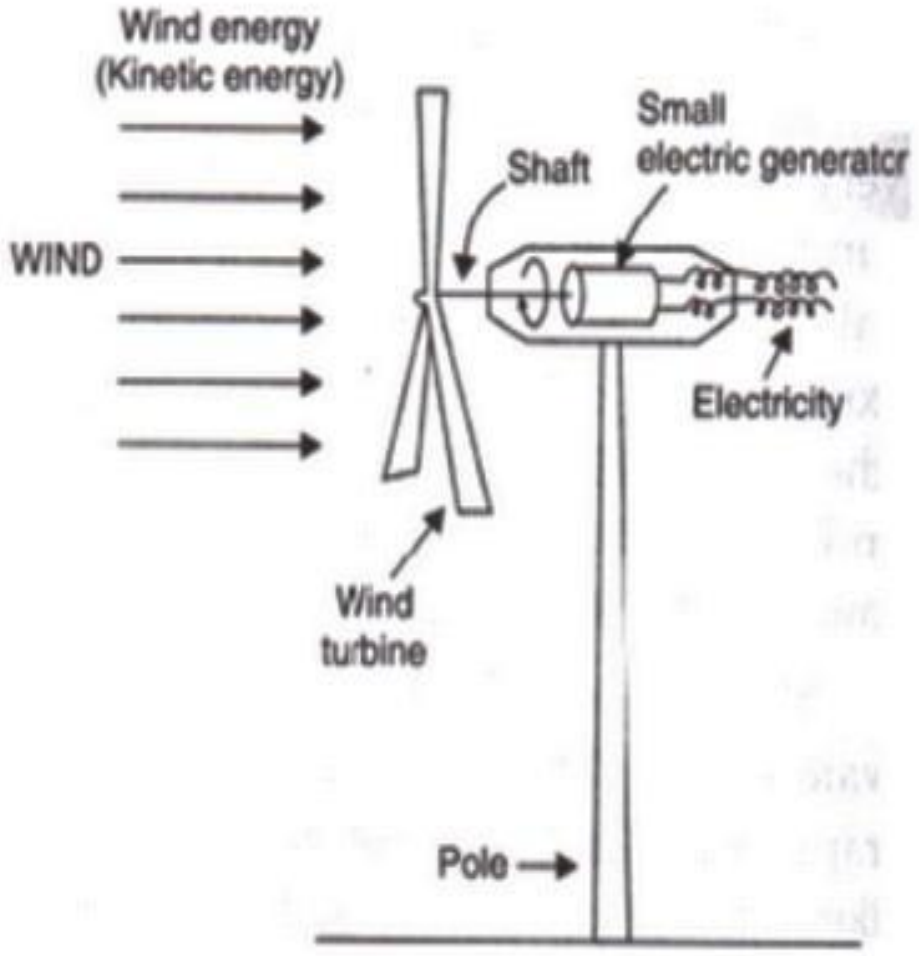
Ans:

The tall tower base allows access to stronger wind in sites with wind shear. In some wind shear sites, every ten meters up, the wind speed can increase by 20% and the power output by 34%. High efficiency, since the blades always move perpendicularly to the wind, receiving power through the whole rotation.

167. With a neat diagram, explain how wind energy can be converted into electrical energy.

Ans:

The process of generating electricity from wind energy is a bit complex. It involves two stages. In the first stage, it dictates for the conversion of kinetic energy present in the moving wind into mechanical energy that drives the shaft fixed into the wind generator. The crucial elements that play a significant role during this stage are the wind blades.




Therefore, careful designs of the blades aid in maximizing the efficiency of the turbines in electricity generation. However, diverse factors affect the amount of mechanical energy produced by the blades. For instance, the shape of blade tips and general profile of the blades determines the amount of mechanical energy produced by the blades.

The second stage of electricity generation from wind energy involves the conversion of trapped mechanical energy into electrical energy via aid of wind generators. This stage also aids

in outlining various parameters that assist in determining the conversion efficiency of the generators. For instance, it aids in calculating the efficiency of gearbox, generators, and electric appliances.

169. Name a few projects harnessing tidal power.

Ans:

There are only a few operational tidal barrages in the world. The Rance River in France and the Bay of Fundy in Canada have the only large-scale barrages in the world with generating capacities of 240 MW and 20 MW respectively. There is a small scale plant in Kislaya Guba, Russia which generates 400 kW.

170. What is geothermal power?

Ans:

Geothermal power is electrical power generated from geothermal energy. Technologies in use include dry steam power stations, flash steam power stations and binary cycle power stations. Geothermal electricity generation is currently used in 26 countries, while geothermal heating is in use in 70 countries.

171. Discuss the disadvantages of geothermal plant.

Ans:

- The largest single disadvantage of geothermal energy is that it is location specific. Geothermal plants need to be built in places where the energy is accessible, which means that some areas are not able to exploit this resource. Of course, this is not a problem if you live in a place where geothermal energy is readily accessible, such as Iceland.

**Environmental Side Effects**

- Although geothermal energy does not typically release greenhouse gases, there are many of these gases stored under the Earth's surface which are released into the atmosphere during digging. While these gases are also released into the atmosphere naturally, the rate increases near geothermal plants. However, these gas emissions are still far lower than those associated with fossil fuels.

**Earthquakes**

- Geothermal energy also runs the risk of triggering earthquakes. This is due to alterations in the Earth's structure as a result of digging. This problem is more prevalent with enhanced geothermal power plants, which force water into the Earth's crust to open up fissures to greater exploitation of the resource. However, since most geothermal plants are away from population centres, the implications of these earthquakes are relatively minor.

**High Costs**

- Geothermal energy is an expensive resource to tap into, with price tags ranging from around $2-$7 million for a plant with a 1 megawatt capacity. However, where the upfront costs are high, the outlay can be recouped as part of a long-term investment.

**Sustainability**

- In order to maintain the sustainability of geothermal energy fluid needs to be pumped back into the underground reservoirs faster than it is depleted. This means that geothermal energy needs to be properly managed to maintain its sustainability.

172. Discuss the advantages of geothermal plant.

Ans:

**Environmentally Friendly**

- Geothermal energy is more environmentally friendly than conventional fuel sources such as coal and other fossil fuels. In addition, the carbon footprint of a geothermal power plant is low. While there is some pollution associated with geothermal energy, this is relatively minimal when compared to fossil fuels.

**Renewable**

- Geothermal energy is a source of renewable energy that will last until the Earth is destroyed by the sun in around 5 billion years. The hot reservoirs within the Earth are

naturally replenished, making it both renewable and sustainable.

**Huge Potential**

- Worldwide energy consumption is currently around 15 terawatts, which is far from the total potential energy available from geothermal sources. While we can't currently use most reservoirs there is a hope that the number of exploitable geothermal resources will increase with ongoing research and development in the industry. It is currently estimated that geothermal power plants could provide between 0.0035 and 2 terawatts of power.

**Sustainable / Stable**

- Geothermal provides a reliable source of energy as compared to other renewable resources such as wind and solar power. This is because the resource is always available to be tapped into, unlike with wind or solar energy.

**Heating and Cooling**

- Effective use of geothermal for electricity generation requires water temperatures of over 150°C to drive turbines. Alternatively, the temperature difference between the surface and a ground source can be used. Due to the ground being more resistant to seasonal heat changes than the air, it can act as a heat sink/ source with

a geothermal heat pump just two metres below the surface.

174. Give the advantages of tidal power plant.

Ans:

- It’s a Renewable Source of Energy
- It is Environmentally Friendly
- Tides Are Predictable
- It Generates Energy at Low Speeds
- Durable Equipment

175. Mention some organic materials used in bio-mass plant.

Ans:

Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals. The most common biomass materials used for energy are plants, wood, and waste. These are called biomass feedstocks. Biomass energy can also be a non-renewable energy source.