

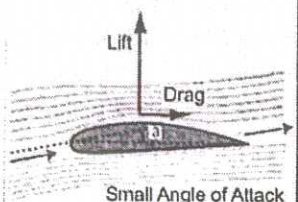
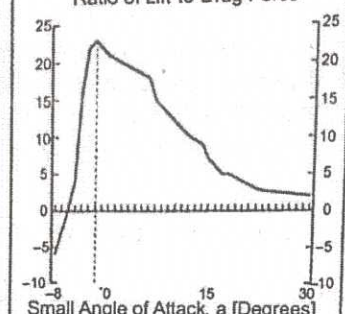
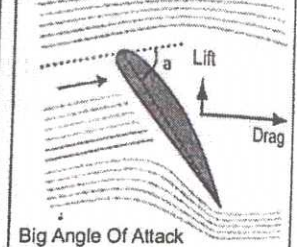
SCHEME OF VALUATION

(Scoring indicators)

Revision: 2015		Course Code: 5024		
Course Title: ALTERNATIVE ENERGY SOURCES & MANAGEMENT				
Q.No	Scoring indicator	Split up score	Sub Total	Total
I.1	Solar, wind, hydro(water),biomass, geothermal	0.5 x 4	2	10
I.2	The <u>solar hour angle</u> is an expression of time, expressed in angular measurement, usually degrees, from solar noon. At solar noon the hour angle is 0 degree.	2	2	
I.3	Power Coefficient, C_p , is the ratio of power extracted by the turbine to the total power available in the wind resource. $C_p = P_{max}/P_{total}$	2	2	
I.4	<ul style="list-style-type: none"> • Grain and starch crops • Animal/human waste • Food crops • Grassy and woody plants • Urban and suburban wastes • Residues from agriculture or forestry • Organic component of municipal and industrial wastes • Energy crops/plantations 	0.5 x 4	2	
I.5	Geothermal energy is energy from the earth. It lies deep within the Earth. The hot magma near the surface will cause active volcanoes, hot springs and geysers. It also causes steam to vent through the fissures in the form of geothermal energy.	2	2	
II.1	<p>Renewable resources are resources that are replenished by the environment over relatively short periods of time. This type of resource is much more desirable to use because often a resource renews so fast that it will have regenerated by the time when used it up.</p> <p>In contrast to renewable resources, non-renewable resources are resources that are not easily replenished by the environment. The fuels one uses to heat the homes and drive the cars are non-renewable resources because there is just no way that the earth can regenerate them in a usable time frame. Minerals are also considered non-renewable resources because, not only do they take millions of years of heat and pressure to form deep underground, but they're also found in a very limited quantity on Earth. Not all non-renewable resources are usable only once, though.</p>	3+3	6	

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II.2	<ol style="list-style-type: none"> 1. Education 2. Zero energy balance 3. Alternative power 4. Cap and trade agreements 5. Reduced demand 6. Research & Development 	6	6	
II.3	<p>A typical flat-plate collector is a metal box with a glass or plastic cover (called glazing) on top and a dark-colored absorber plate on the bottom. The sides and bottom of the collector are usually insulated to minimize heat loss.</p> <p>Sunlight passes through the glazing and strikes the absorber plate, which heats up, changing solar energy into heat energy. The heat is transferred to liquid passing through pipes attached to the absorber plate. Absorber plates are commonly painted with "selective coatings," which absorb and retain heat better than ordinary black paint. Absorber plates are usually made of metal-typically copper or aluminum-because the metal is a good heat conductor. Copper is more expensive, but is a better conductor and less prone to corrosion than aluminum. In locations with average available solar energy, flat plate collectors are sized approximately one-half- to one-square foot per gallon of one-day's hot water use.</p>	6	6	
II.4	<p style="text-align: center;">The principles of conversion :</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div data-bbox="209 936 507 1305" style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; font-size: small;">Lift Force Streamlined Objects Experience Lift</p>  <p style="text-align: center; font-size: small;">Small Angle of Attack</p> </div> <div data-bbox="512 936 858 1305" style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; font-size: small;">Ratio of Lift-to-Drag Force</p>  <p style="text-align: center; font-size: x-small;">Small Angle of Attack, a [Degrees]</p> </div> <div data-bbox="863 936 1161 1305" style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; font-size: small;">Drag Force 'Obstacles' in Wind Flow Cause Drag</p>  <p style="text-align: center; font-size: small;">Big Angle Of Attack</p> </div> </div> <p style="text-align: center; font-size: small; margin-top: 10px;">Fig. 3.2 Lift and Drag Forces w.r.t Angle of Attack</p> <p>There are two forces in play: Lift and Drag. The Lift Force is perpendicular to the wind direction. It is caused by a pressure difference between the air on either side of the blade. The Drag Force is in the same direction as the wind. The ratio between lift and drag largely depends on the shape of the blade and the angle of the main line of the blade (chord line) and the main wind direction - the angle of attack. The lift force is largest for streamlined</p> <p>Depending on the design of the turbine, either drag or lift moves the blades. Most wind turbines today use the principle of lift rather than drag.</p>	6	6	

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II.5	<p>The site selected for wind mills development need to have many positive attributes including :</p> <ul style="list-style-type: none"> (i) Superior wind speed (ii) Good road access to sites (iii) Suitable terrain and geology for onsite access (iv) Low population density (v) Minimum risk of agro-forestry operations (vi) Close to suitable electrical grid (vii) Supportive land holders (viii) Good industrial support for construction and ongoing operations (ix) Significant potential for revalidation <p>Geographic information systems (GIS) and Multicriteria decision making (MCDM) techniques have been used in solving site selection problems. Geographic Information Systems (GIS) Geographic information systems (GIS) have emerged as useful computer-based tools for spatial description and manipulation. Although often described as a decision support system, there have been some supporting modules for site selection based on various area conditions, and conflicting objectives.</p> <p>The techniques adopted in the various approaches of decision analysis are called multi criteria decision methods (MCDM). These methods incorporate explicit statements of preferences of decision-makers. Such preferences are represented by various quantities, weighting scheme, constraints, goal, utilities, and other parameters. They analyze and support decision through formal analysis of alternative options, their attribute, evaluation criteria, goals or objectives, and constraints. MCDM used to solve various site selection problems. MCDA results can be mapped in order to display the spatial extent of the best areas or index of land suitability.</p>	6 x 1=6	6	
II.6	<ul style="list-style-type: none"> 1. Not widespread source of energy 2. High installation costs 3. Can run out of steam 4. Suited to particular region 5. May release harmful gases 6. Transportation 	6 x 1=6	6	
II.7	<ul style="list-style-type: none"> 1. Geophysics 2. Earthquakes 3. Astrophysics 4. Sensors 5. Engineering 6. Magnetic drug targeting 	6 x 1=6	6	

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III.a

Mechanism :

Combined cycle power plant as in name suggests, it combines existing gas and steam technologies into one unit, yielding significant improvements in thermal efficiency over conventional steam plant. In a CCGT plant the thermal efficiency is extended to approximately 50-60 per cent, by piping the exhaust gas from the gas turbine into a heat recovery steam generator. However the heat recovered in this process is sufficient to drive a steam turbine with an electrical output of approximately 50 per cent of the gas turbine generator. The gas turbine and steam turbine are coupled to a single generator. For startup, or 'open cycle' operation of the gas turbine alone, the steam turbine can be disconnected using a hydraulic clutch.

Working principle of CCTG plant :

First step is the same as the simple cycle gas turbine plant. An open circuit gas turbine has a compressor, a combustor and a turbine. For this type of cycle the input temperature to turbine is very high. The output temperature of flue gases is also very high. This is therefore high enough to provide heat for a second cycle which uses steam as the working medium i.e. thermal power station.

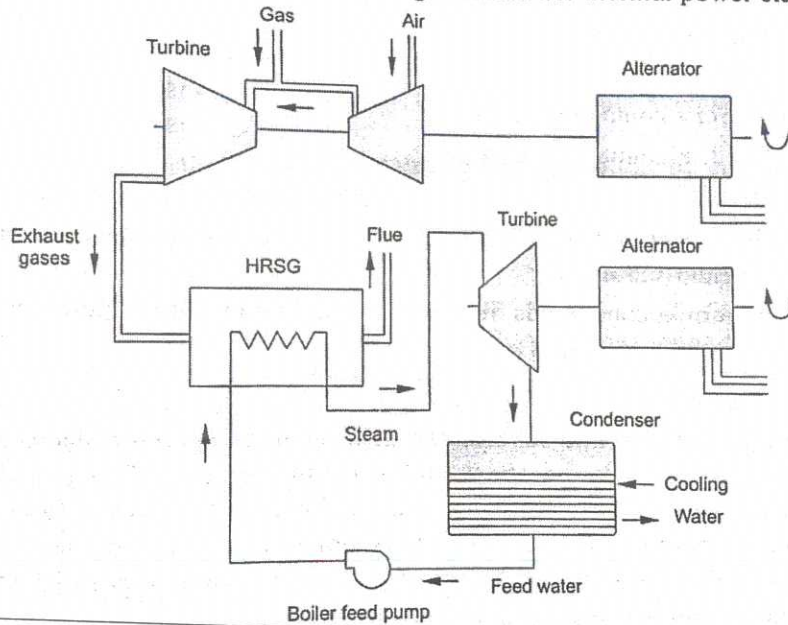


Fig - 4
Exp - 4

8 m

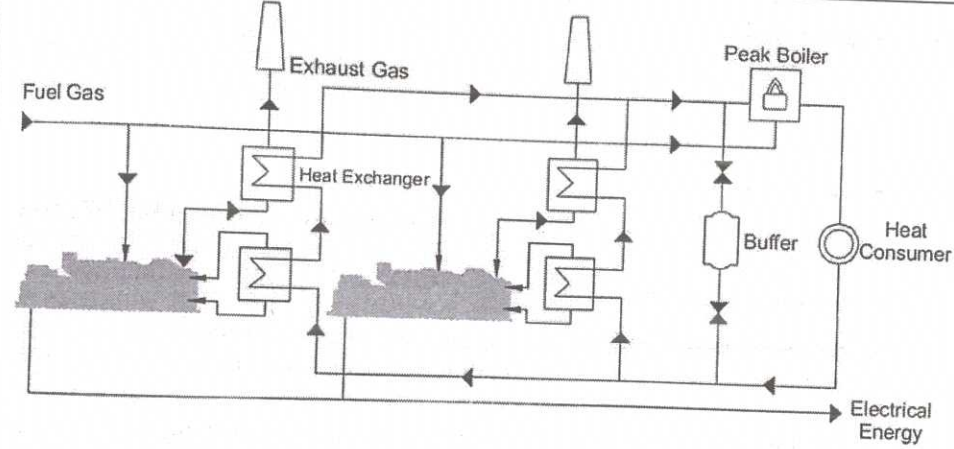
III.b

Cogeneration (cogen) through combined heat and power (CHP) is the simultaneous production of electricity with the recovery and utilisation heat. Cogeneration is a highly efficient form of energy conversion and it can achieve primary energy savings of approximately 40% by compared to the separate purchase of electricity from the national electricity grid and a gas boiler for onsite heating. Combined heat and power plants are typically embedded close to the end user and therefore help reduce transportation and distribution losses, improving the overall performance of the electricity transmission and distribution network (see district energy for more details). For power users where security of supply is an important factor for their selection of power production equipment and gas is abundant, gas-based cogeneration systems are ideally suited as captive power plants (i.e. power plants located at site of use).

4-m

SCHEME OF VALUATION

(Scoring indicators)

	 <p style="text-align: center;">Fig. 1.1</p>	3-m	7-m
IV.a	<p>Over the past three years, the World Energy Council has explored the likely futures and outcomes for the Grand Transition. The findings indicate :</p> <ol style="list-style-type: none"> 1. The World's Primary Energy Demand Growth : Will slow and per capita energy demand will peak before 2030 due to unprecedented efficiencies created by new technologies and more stringent energy policies. 2. Demand for Electricity : Will double to 2060. Meeting this demand with cleaner energy sources will require substantial infrastructure investments and systems integration to deliver benefits to all consumers. 3. The Phenomenal Rise of Solar and Wind Energy : Will continue at an unprecedented rate and create both new opportunities and challenges for energy systems. 4. Demand Peaks for Coal and Oil : Have the potential to take the world from "Stranded Assets" to "Stranded Resources". 5. Transitioning Global Transport : Forms one of the hardest obstacles to overcome in an effort to decarbonise future energy systems. 6. Limiting Global Warming : To no more than a 2°C increase will require an exceptional and enduring effort, far beyond already pledged commitments, and with very high carbon prices. 7. Global Cooperation, Sustainable Economic Growth and Technology Innovation : are needed to balance the Energy Trilemma. 	8.m	

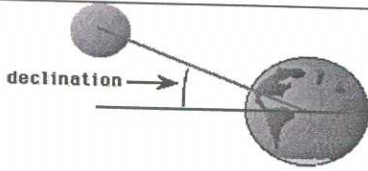
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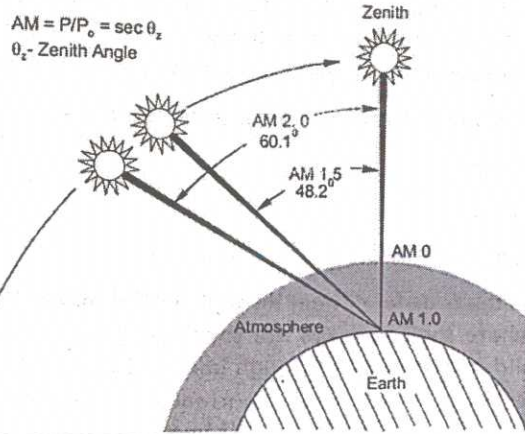
IV.b	<p>Energy management includes planning and operation of energy production and energy consumption units. Objectives are resource conservation, climate protection and cost savings, while the users have permanent access to the energy they need. It is connected closely to environmental management, production management, logistics and other established business functions.</p> <p><i>The some of the energy management techniques are :</i></p> <ul style="list-style-type: none"> ◆ Analysis of input ◆ Reuse and recycling of waste ◆ Energy education ◆ Conservative technique and energy audit <p>It is important to understand what is the type of inputs that can consuming the energy and analysis how it is effecting the environment, cost etc, thereby proper management of energy is very crucial.</p> <p>Recycling involves the collection of used and discarded materials processing these materials and making them into new products. It reduces the amount of waste that is thrown into the community dustbins thereby making the environment cleaner and the air more fresh to breathe.</p> <p>Most of the garbage generated in the household can be recycled and reused. Organic kitchen waste such as leftover foodstuff, vegetable peels, and spoilt or dried fruits and vegetables can be recycled by putting them in the compost pits that have been dug in the garden.</p> <p>Energy education is the most important for the energy management techniques that can be used. Education is about more than teaching people the importance of managing the energy by its proper conservation, and exploring the alternative choices that can be used in various fields.</p> <p>An energy audit is an inspection, survey and analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the output(s). In commercial and industrial real estate, an energy audit is the first step in identifying opportunities to reduce energy expense and carbon footprints.</p>		7 m	
V.a	<p>(1) <u>Declination</u> is the tilt of earths axis measured from perpendicular to the suns rays. This angle is 0 degrees at the spring and autumn equinox. Maximum declination is reached at the summer,(23.45 deg) and winter(-23.45 deg.) solstice</p> <p>$d = 23.45 * \sin [360 / 365 * (284 + N)]$ $d = \text{declination}$ $N = \text{day number, January 1} = \text{day 1}$</p>		4-m	

SCHEME OF VALUATION

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"Incidence Angle" is measured between the angle of the sun's direct rays and a line normal (perpendicular in all directions) to the surface of the window. At high angles of incidence, the path length of solar energy through glazing becomes very long and more energy is reflected and absorbed. Thus the angle of incidence has an effect on the shading coefficient and visible light transmittance of windows and skylights.



4-m

8-m

SCHEME OF VALUATION

(Scoring indicators)

V.b

A solar water pump system is essentially an electrical pump system in which the electricity is provided by one or several PhotoVoltaic (PV) panels. A typical solar powered pumping system consists of a solar panel array that powers an electric motor, which in turn powers a bore or surface pump. The water is often pumped from the ground or stream into a storage tank that provides a gravity feed, so energy storage is not needed for these systems. A typical installation is illustrated in Fig. 2.16.

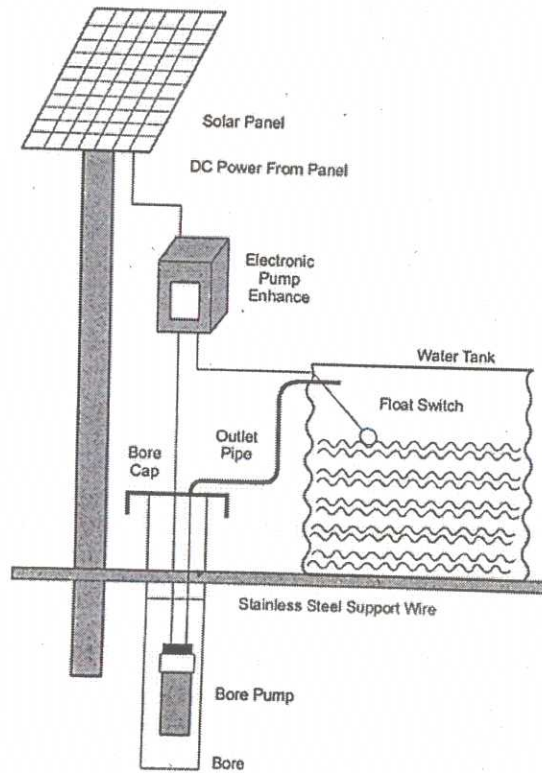


Fig. 2.16 A Solar Water Pump System

There are two main types of solar water pump technologies: a) the centrifugal pump, which uses high speed rotation to suck water in through the middle of the pump. Most conventional Alternating Current (AC) pumps use such a centrifugal impeller. However, when operating at low power the performance of the pump drops dramatically. This makes centrifugal pumps less suitable for solar applications, since low power due to cloudy weather is to be expected; and b) the positive displacement pump, which usually uses a piston to transfer water.

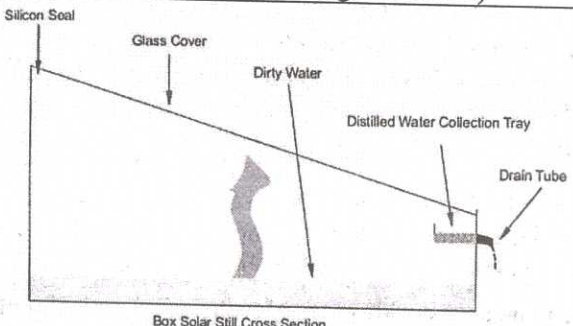
Fig 3

Exp 4

7-m

SCHEME OF VALUATION

(Scoring indicators)

VI.a	<div style="text-align: center;">  <p style="text-align: center;">Box Solar Still Cross Section Fig. 2.11 Solar Distillation Setup</p> <p>Solar powered distillation of water can be defined as measures to separate and extract clean water by vaporization. This can be particularly useful to turn seawater, brackish or even contaminated water into clean water safe for drinking.</p> <p>Distillation of water with solar energy is quite simple. The Sun heats and evaporates water, which at the same time is separated from salt, dirt or anything else for that matter. When the temperature and pressure is right, the water molecules reforms and returns to liquid. Regardless of where in the World you are located, if you catch rain before it hits the ground, it is considered safe to drink.</p> <p>Devices that are built around the concept of solar distillation all mimic the natural process of rain formation and can be described in two simple steps:</p> <ol style="list-style-type: none"> 1. Evaporation to remove impurities. 2. Condensation to collect the water. </div>	<p>Fig-4</p> <p>Exp-4</p>	<p>8-m</p>
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VI.b

Solar-Thermal plants work like this :

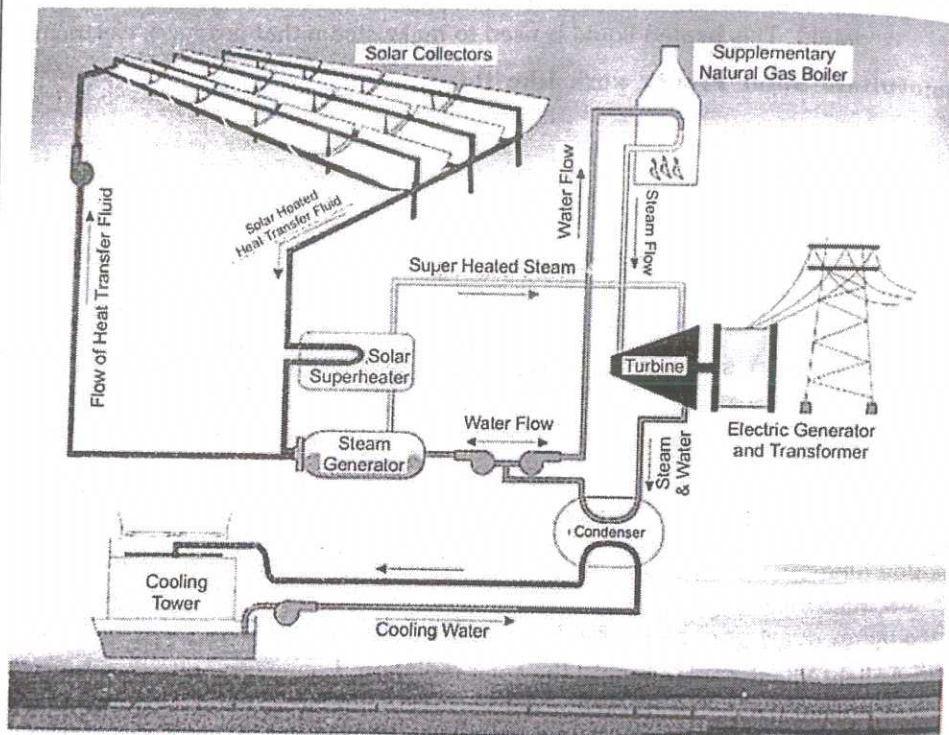


Fig. 2.19 Solar Thermal Plant Setup Details

Solar collectors capture and concentrate sunlight to heat a synthetic oil called therminol, which then heats water to create steam. The steam is piped to an onsite turbine-generator to produce electricity, which is then transmitted over power lines. On cloudy days, the plant has a supplementary natural gas boiler. The plant can burn natural gas to heat the water, creating steam to generate electricity.

Fig-4

Exp-3

7-m

SCHEME OF VALUATION

(Scoring indicators)

VII. a	<p>Advantages of Wind Energy :</p> <ol style="list-style-type: none"> 1) Wind Energy is an inexhaustible source of energy and is virtually a limitless resource. 2) Energy is generated without polluting environment. 3) This source of energy has tremendous potential to generate energy on large scale. 4) Like solar energy and hydropower, wind power taps a natural physical resource. 5) Windmill generators don't emit any emissions that can lead to acid rain or greenhouse effect. 6) Wind Energy can be used directly as mechanical energy. 7) In remote areas, wind turbines can be used as great resource to generate energy. 8) In combination with Solar Energy they can be used to provide reliable as well as steady supply of electricity. 9) Land around wind turbines can be used for other uses, e.g. Farming. <p>Disadvantages of Wind Energy :</p> <ol style="list-style-type: none"> 1) Wind energy requires expensive storage during peak production time. 2) It is unreliable energy source as winds are uncertain and unpredictable. 3) There is visual and aesthetic impact on region. 4) Requires large open areas for setting up wind farms. 5) Noise pollution problem is usually associated with wind mills. 6) Wind energy can be harnessed only in those areas where wind is strong enough and weather is windy for most parts of the year. 7) Usually places, where wind power set-up is situated, are away from the places where demand of electricity is there. Transmission from such places increases cost of electricity. 8) The average efficiency of wind turbine is very less as compared to fossil fuel power plants. We might require many wind turbines to produce similar impact. 9) It can be a threat to wildlife. Birds do get killed or injured when they fly into turbines. 10) Maintenance cost of wind turbines is high as they have mechanical parts which undergo wear and tear over the time. <p>Even though there are advantages of wind energy, the limitations make it extremely difficult for it to be harnessed and prove to be a setback.</p>	<p>Adv 4-m</p>	<p>Dis Adv 4-m</p>	<p>8m</p>
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VII.

b

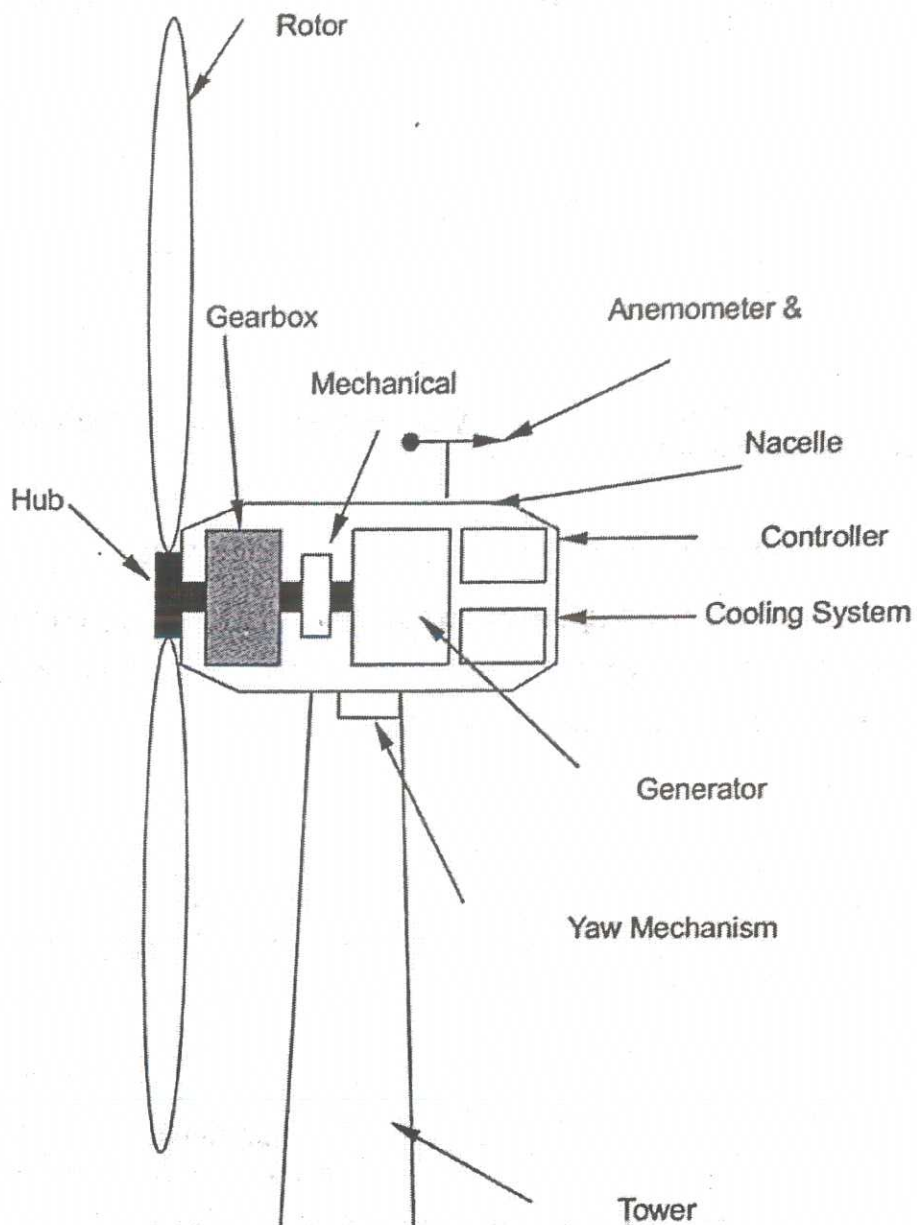


Fig-4

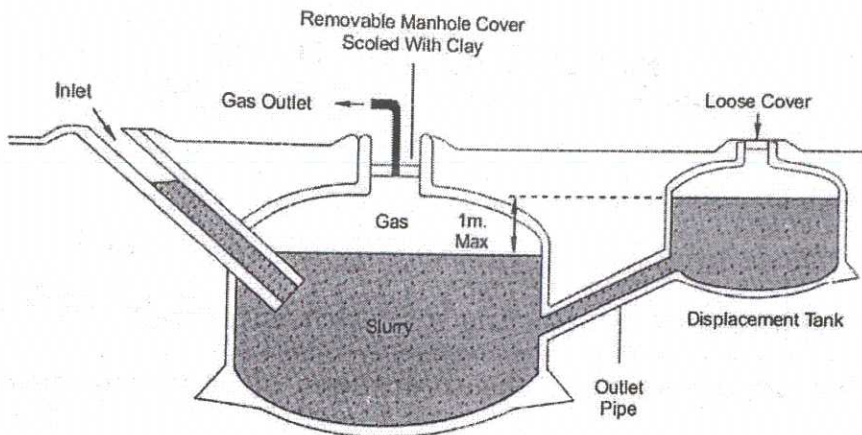
SCHEME OF VALUATION

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	<p>Horizontal Axis wind turbine :</p> <p>Horizontal axis wind turbines have the main rotor shaft and electrical generator at the top of a tower, and they must be pointed into the wind. Small turbines are pointed by a simple wind vane placed square with the rotor (blades), while large turbines generally use a wind sensor coupled with a servo motor to turn the turbine into the wind. Most large wind turbines have a gearbox, which turns the slow rotation of the rotor into a faster rotation that is more suitable to drive an electrical generator.</p> <p>Since a tower produces turbulence behind it, the turbine is usually pointed upwind of the tower. Wind turbine blades are made stiff to prevent the blades from being pushed into the tower by high winds. Additionally, the blades are placed a considerable distance in front of the tower and are sometimes tilted up a small amount.</p> <p>Downwind machines have been built, despite the problem of turbulence, because they don't need an additional mechanism for keeping them in line with the wind. Additionally, in high winds the blades can be allowed to bend which reduces their swept area and thus their wind resistance. Since turbulence leads to fatigue failures, and reliability is so important, most HAWTs are upwind machines.</p>	Exp-3	7-m	
VIII. a	<p>Pyrolysis is a processes of subjecting a biomass feedstock to high temperatures (greater than 430 °C) under pressurized environments and at low oxygen levels. In the process, biomass undergoes partial combustion. Processes of pyrolysis result in liquid fuels and a solid residue called char, or biochar. Biochar is like charcoal and rich in carbon. Liquid phase products result from temperatures which are too low to destroy all of the carbon molecules in the biomass so the result is production of tars, oils, methanol, acetone, etc.</p> <p>Gasification : Gasification is the use of high temperatures and a controlled environment that leads to nearly all of the biomass being converted into gas. This takes place in two stages: partial combustion to form producer gas and charcoal, followed by chemical reduction. These stages are spatially separated in the</p>	4-m 4-m		

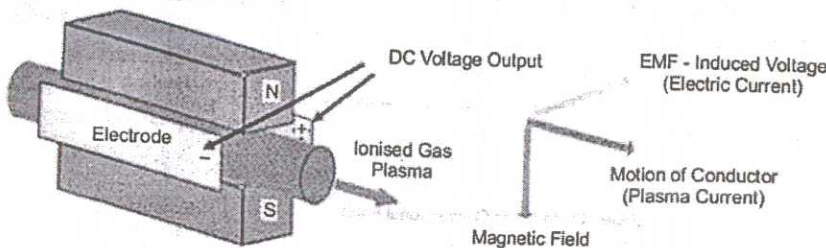
SCHEME OF VALUATION

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	<p>gasifier, with gasifier design very much dependant on the feedstock characteristics. Gasification requires temperatures of about 800°C. Gasification technology has existed since the turn of the century when coal was extensively gasified in the UK and elsewhere for use in power generation and in houses for cooking and lighting. A major future role is envisaged for electricity production from biomass plantations and agricultural residues using large scale gasifiers with direct coupling to gas turbines.</p>		8-m	
<p>VIII. b</p>	<p>A basic biogas digester consists of a tank in which the organic material is digested, combined with a system to collect and store the biogas produced. The digesters can be quite simple, and the details vary depending on available materials and the needs of the community. Biogas digester consists of a cylindrical 3000 liter tank, open on top, in which the organic material is digested. A second, slightly smaller tank is placed in the larger tank, upside-down. As biogas is produced, the inner tank fills with gas and rises, telescoping out of the outer tank. As biogas is removed for use, the inner gas storage tank sinks back into the larger, outer tank. In this system, the inner tank acts as both storage, and as a lid for the digester tank. The gap between the tank walls is narrow enough to prevent significant quantities of oxygen from entering the digester, which would kill the anaerobic bacteria that produce the methane. The amount of biogas lost though the gap is negligible.</p>	Exp 4	7m	
<p>IX.a</p>	<p style="text-align: center;">  </p> <p style="text-align: center;">Fig. 3.6 Biogas Digester</p>	Fig-3		

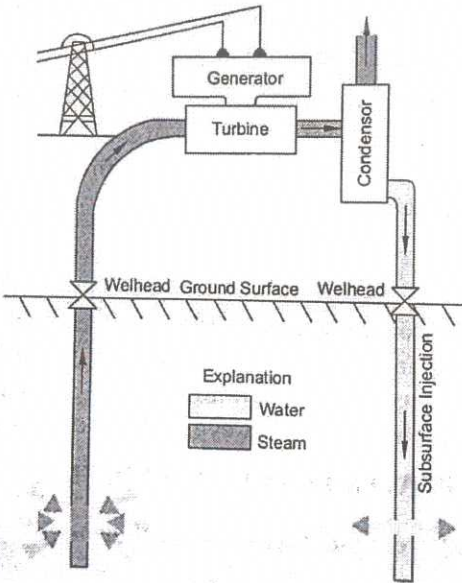
SCHEME OF VALUATION

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IX.a	<p>Magnetohydrodynamic power generation provides a way of generating electricity directly from a fast moving stream of ionised gases without the need for any moving mechanical parts - no turbines and no rotary generators. Several MHD projects were initiated in the 1960s but overcoming the technical challenges of making a practical system proved very expensive.</p> <p>MHD power generation has also been studied as a method for extracting electrical power from nuclear reactors and also from more conventional fuel combustion systems</p> <p>Working Principle :</p> <p>The MHD generator can be considered to be a fluid dynamo. This is similar to a mechanical dynamo in which the motion of a metal conductor through a magnetic field creates a current in the conductor except that in the MHD generator the metal conductor is replaced by a conducting gas plasma.</p> <p>When a conductor moves through a magnetic field it creates an electrical field perpendicular to the magnetic field and the direction of movement of the conductor. This is the principle, discovered by Michael Faraday, behind the conventional rotary electricity generator. Dutch physicist Antoon Lorentz provided the mathematical theory to quantify its effects.</p> <div style="text-align: center;">  </div> <p style="text-align: center;">Magnetohydrodynamic Power Generation (Principle)</p> <p>The flow (motion) of the conducting plasma through a magnetic field causes a voltage to be generated (and an associated current to flow) across the plasma, perpendicular to both the plasma flow and the magnetic field according to Fleming's Right Hand Rule</p> <p>Lorentz Law describing the effects of a charged particle moving in a constant magnetic field can be stated as</p> $F = QvB$ <p>where</p> <ul style="list-style-type: none"> F is the force acting on the charged particle Q is charge of particle v is velocity of particle B is magnetic field 	Exp-5		
IX.b		Fig-3	8m	

SCHEME OF VALUATION

(Scoring indicators)

IX.b	<p>Depending on the state of the water (liquid or vapor) and its temperature, different types of power plants are used for different geothermal reservoirs. Most geothermal power plants extract water, in its vapor or liquid form, from the reservoirs somewhere in the temperature-range 100-320°C (220-600°F).</p> <div style="text-align: center;">  <p style="text-align: center;">Explanation Water Steam</p> </div> <p>This type of geothermal power plant was named dry steam since water that is extracted from the underground reservoirs has to be in its gaseous form (water-vapor). Geothermal steam of at least 150°C (300°F) is extracted from the reservoirs through the production wells, but is then sent directly to the turbine. Geothermal reservoirs that can be exploited by geothermal dry steam power plants are rare.</p> <p>Dry steam is the oldest geothermal power plant type. The first one was constructed in Larderello, Italy, in 1904. The Geysers, 22 geothermal power plants located in California, is the only example of geothermal dry steam power plants in the United States.</p>	Fig-3 Exp-4	7.m
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SCHEME OF VALUATION

(Scoring indicators)

X.a

Fuel cells are electrochemical energy converters. They directly convert the energy of a chemical reaction into electrical energy - without a thermal-electric intermediate step.

General Principle :

In an exothermic chemical reaction the electrons or the electrical charges are directly exchanged between the reacting molecules or atoms. Hydrogen, for example, reacts spontaneously with oxygen with the high energy content of the oxidation of hydrogen being completely released as heat.

In a fuel cell the fuel does not react directly with the oxidant, but instead delivers its electrons to the anode. The electrons then flow to the cathode where they are taken up by the other reaction partner, typically atmospheric oxygen. By this, the reaction can be controlled and carried out with high current efficiency.

Design :

Fuel cells consist of two electrodes that conduct electrons - the anode and the cathode. The electrodes are separated by an electrolyte that conducts ions. In a battery the electrical energy is chemically stored in the electrode. In a fuel cell the energy source is brought in from externally. The electrodes only have a catalytic role in the conversion.

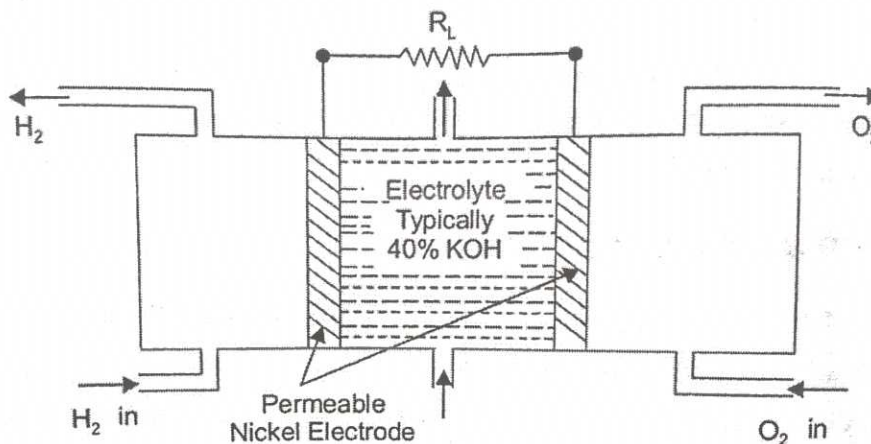


Fig-4

Exp-4

The most simple and favored reactants are hydrogen as fuel and oxygen as oxidant. Also hydrocarbons such as natural gas and alcohols like methanol are used as fuels. In technical systems fuel cells are coupled to stacks to achieve higher electrical voltage and meet demand. Fuel cell systems have a high efficiency which, in principle, can outperform those of combustion engines.

Fuel cells are subdivided in low temperature (LT) and high temperature (HT) fuel cells. LT fuel cells work in a range from room temperature to approx. 120°C and HT fuel cells from approx. 600 to 1,000°C. The phosphoric acid fuel cell operates at a temperature in between, at 200°C.

Fuel cells are usually named according to the electrolyte used. The different electrolytes significantly affect the characteristic properties of the fuel cells like operating temperature and mechanism of conductivity. Directly related to this is the selection of the catalyst, demand of the process gas, etc.

S.m

SCHEME OF VALUATION

(Scoring indicators)

X.b	<p>Advantages :</p> <p><i>The following are the advantages of hydrogen fuel cells :</i></p> <ol style="list-style-type: none"> 1. Efficient conversion to electricity - in comparison to other electrical generating technologies, fuel cells are able to efficiently convert the fuel into electricity because there isn't any form of combustion involved. 2. Extremely reliable - the different parts of the fuel cells are stacked well including the controls, pumps, and fans; unlike generators that are noisy, fuel cells are quieter and more reliable. 3. Does not degrade - fuel cells can provide a continuous source of reliable electricity unlike their battery counterparts. 4. Doesn't require huge facilities or power plants - a great advantage of fuel cells is that it is also suitable for transportation, residential, and portable use; you can expect high efficiency rates regardless of scale. 5. Clean and efficient - fuel cells can be used in both rural and urban areas, providing reliable and robust electricity while enhancing key infrastructures' security including water and communication systems. 6. Flexible and easy installation - it is an economical solution to the increasing demand for a more reliable energy source since it is flexible and easy to install, thereby making the whole process less costly for any user. <p>Disadvantages :</p> <p>If there are benefits to using hydrogen fuel cells, there are also potential drawbacks. Below are the disadvantages of using fuel cells :</p> <ol style="list-style-type: none"> 1. Extremely expensive and large - this was a great disadvantage several years ago, but things are changing now that the industry is in the transition period; new fuel cell varieties are being developed for mass manufacturing. 2. Lacks supply and coast-to-coast delivery is unavailable - the industry still needs to address alternative storage facilities and efficient delivery methods. 3. Can't be implemented right away - it will take many years in order to perfect these conversion solutions since the development of newer fuel cell technologies are still in the transition period. 	<p>Adv - 4m</p>		<p>8-m</p>
		<p>DisAdv 4m</p>		