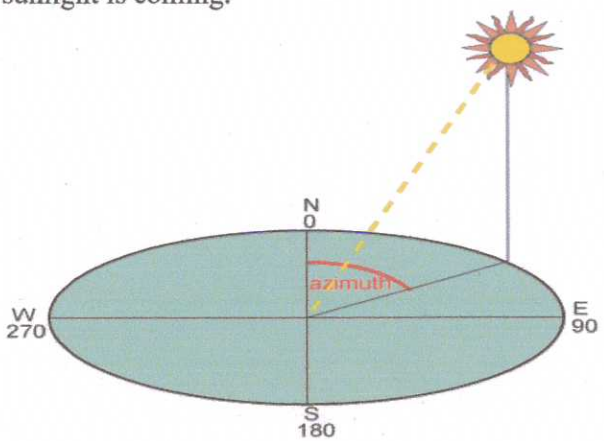
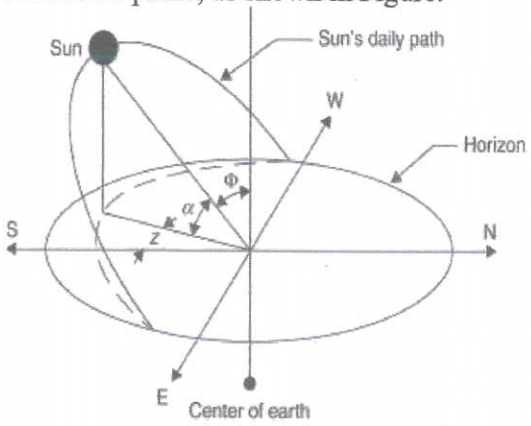
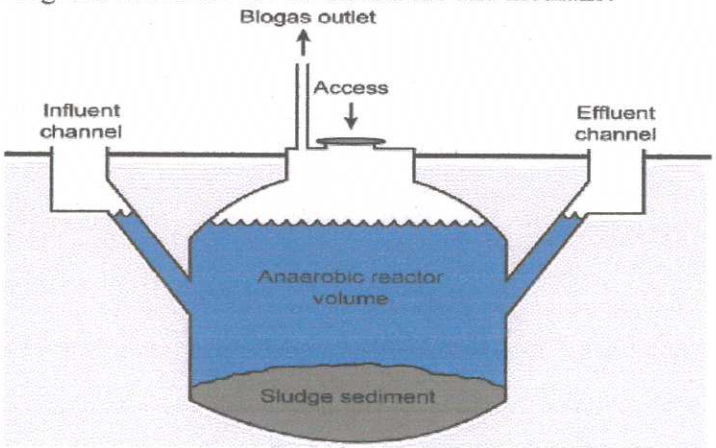
SCHEME OF EVALUATION

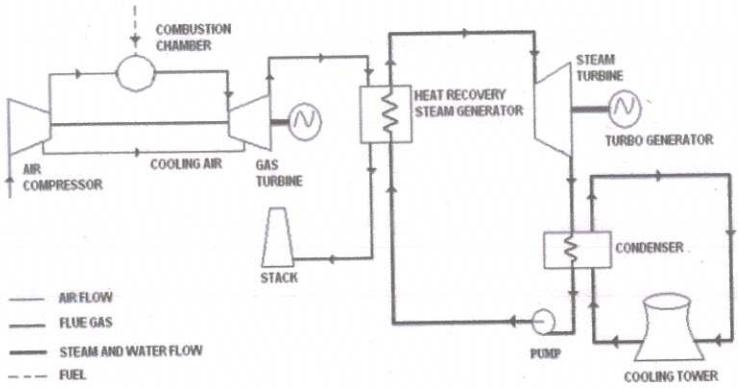
(Scoring Indicator)

Revision: 2015 Course Code:5024 Course Title: Alternate Energy Sources and Management				
Qst No.	Scoring Indicator	Split Up score	Sub Total	Total
I.1	Renewable energy sources are energy sources that are always being replenished. Some examples of renewable energy sources are solar energy, wind energy, hydropower, geothermal energy, and biomass energy.	2	2	
I.2	Primary energy (PE) is an energy form found in nature that has not been subjected to any human engineered conversion process. It is energy contained in raw fuels, and other forms of energy received as input to a system. Primary energy can be non-renewable or renewable.	2	2	
I.3	The solar zenith angle is the angle between the zenith and the centre of the Sun's disc.	2	2	
I.4	Biomass gasification involves burning of biomass in a limited supply of air to give a combustible gas consisting of carbon monoxide, carbon dioxide, hydrogen, methane, water, nitrogen, along with contaminants like small char particles, ash and tars.	2	2	
I.5	Magneto hydrodynamic power generator, any of a class of devices that generate electric power by means of the interaction of a moving fluid (usually an ionized gas or plasma) and a magnetic field.	2	2	10
II.1	1. Install CFL Lights 2. Install LED Lights 3. Lower the Room Temperature 4. Fix Air Leaks 5. Use Maximum Daylight 6. Get Energy Audit Done 7. Use Energy Efficient Appliance 8. Drive Less, Walk More and Carpooling 9. Switch Off Appliances when Not in Use 10. Plant Shady Landscaping 11.Install Energy Efficient Windows 11. Education 12. Zero Energy Balance 13. Alternative Power 14. Cap and Trade Agreements 15. Reduced Demand 16. Research & Development.	1x6	6	6

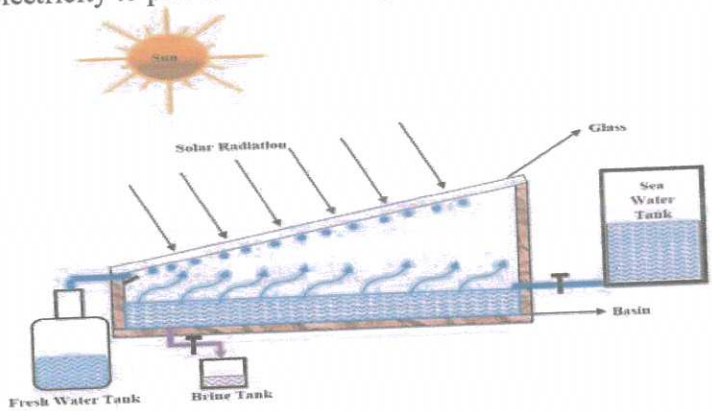
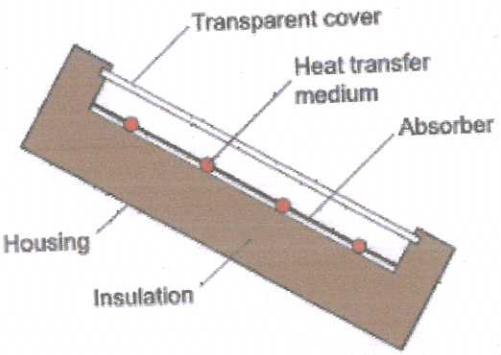
II.2	Alternative energy is any energy source that is an alternative to fossil fuel. These alternatives are intended to address concerns about fossil fuels, such as its high carbon dioxide emissions, an important factor in global warming. Marine energy, hydroelectric, wind, geothermal and solar power are all alternative sources of energy. The process of producing oil, coal, or natural gas fuel is a difficult and demanding process that requires a great deal of complex equipment, physical and chemical processes. On the other hand, alternative energy can be widely produced with basic equipment and natural processes. Wood, the most renewable and available alternative fuel, emits the same amount of carbon when burned as would be emitted if it degraded naturally. Renewable energy is a super-smart choice for humans and the environment. Here are some of the big benefits of using renewable sources for our energy supply: Never run out. These natural energy sources can replace themselves, making them sustainable and abundant natural resources. They don't damage our planet. These clean energy sources are non-pollutant, produce minimal or no waste products, and don't contribute to global warming - great news for the environment! They're low-maintenance energy sources. Renewable energy facilities tend to require less maintenance than traditional generators. They're good news for regional areas. As most renewable energy projects are located in regional areas - away from the big cities - they can bring economic benefits to these places.	6	6	6
II.3	a) Solar Azimuth angle. The solar azimuth angle is the angular distance between the zero azimuth (either due South or due North, depending on what you select on the input screen) and the projection of the line of sight to the sun on the ground. The azimuth angle is the compass direction from which the sunlight is coming.  b) Altitude angle	3 3	 6	 6

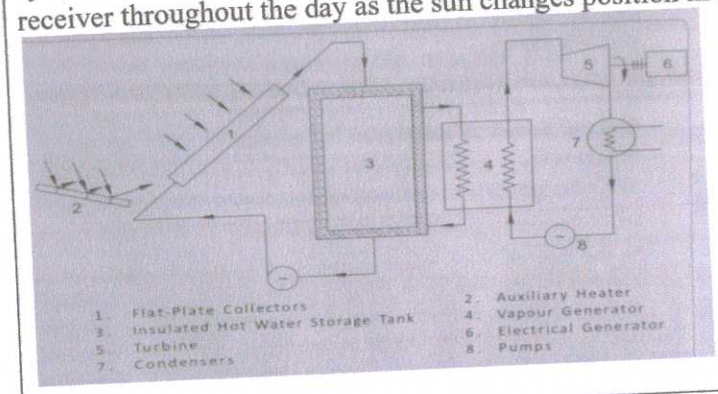
	The solar altitude angle is the angle between the sun's rays and a horizontal plane, as shown in Figure.  	3		
II.4	1. High annual average wind speed 2. Availability of anemometry data 3. Availability of wind V(t) Curve at the proposed site 4. Wind structure at the proposed site 5. Altitude of the proposed site 6. Terrain and its aerodynamic 7. Local Ecology 8. Distance to road or railways 9. Nearness of site to local centre/users 10. Nature of ground 11. Favourable land cost	4 1x6	7 6	7 6
II.5	A biogas digester (also known as a biogas plant) is a large tank where inside Biogas is produced through the decomposition/breakdown of organic matter through a process called anaerobic digestion. It's called a digester because organic material is eaten and digested by bacteria to produce biogas. Biogas is produced by the breaking down of organic, biodegradable waste or material (also known as biomass) such as vegetables, leaves, grass, weeds, leftover food scraps etc. When this organic breakdown happens it produces a gas, called biogas. Biogas is a mixture of carbon dioxide and methane.  	3 3	6	6

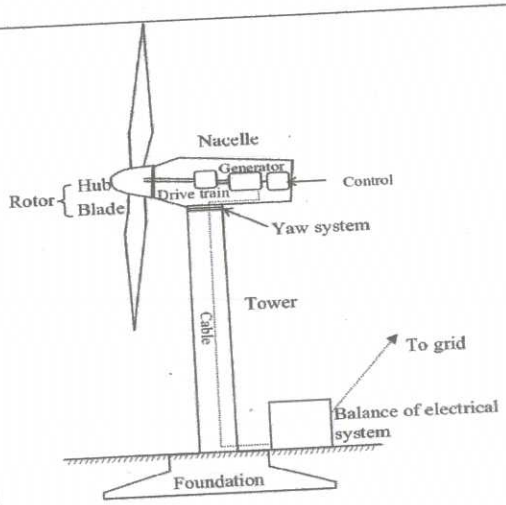
II.6	Geothermal energy is a renewable energy source because heat is continuously produced inside the earth. People use geothermal heat for bathing, to heat buildings, and to generate electricity. Geothermal energy is the heat that comes from the sub-surface of the earth. It is contained in the rocks and fluids beneath the earth's crust and can be found as far down to the earth's hot molten rock, magma. To produce power from geothermal energy, wells are dug a mile deep into underground reservoirs to access the steam and hot water there, which can then be used to drive turbines connected to electricity generators.	6	6	6
II.7	Advantages of Fuel Cells i) High efficiency – Most fuel cells are 60%-80% energy efficient. However, this efficiency can increase to 85%, when these fuel cells are used in a cogeneration system. ii) Clean – Fuel cells work with little to no emissions, the only by products being electricity, heat and water. They are thus, much cleaner than traditional power generation, producing 97% less nitrogen oxide emissions than the thermal power plants. iii) Scalable – can be stacked onto one another iv) No Noise – More silent in operation when compared to the conventional sources of power generators. There are no moving parts in a fuel cell stack, making them quieter. v) Low Maintenance – Though the initial cost is higher, fuel cell technology does not involve much maintenance. Fuel cells do not degrade over time, unlike batteries, and can, therefore, provide electricity continuously.	3		
	Disadvantages of Fuel Cells The fuel cell technology has failed to gain much popularity and some have reasons to believe that they might not become economically competitive with other clean technologies. One of the major criticisms of this technology is the challenge in production, transportation, flammability and storage of hydrogen gas, which is the main constituent in the fuel cells. Though the technology has been around three decades now, still much work/ research is yet to be done. As such, the technology is still costly to use. Moreover, critics argue that fossil fuel is still needed to separate hydrogen and oxygen atoms. The fuel cell technology would not be viable if there was no fossil fuel. However, one may still argue that the amount of fossil fuel used will be way lesser than what is used in the conventional vehicles. Lack of proper infrastructure in the form of recharging stations also stunts the growth of fuel cell vehicles. The absence of proper hydrogen infrastructure to supply hydrogen fuel is a major disadvantage.	3	6	6

III a	A combined-cycle power plant uses both a gas and a steam turbine together to produce up to 50 percent more electricity from the same fuel than a traditional simple-cycle plant. The waste heat from the gas turbine is routed to the nearby steam turbine, which generates extra power.	1		
		4		
	Gas turbine burns fuel. The gas turbine compresses air and mixes it with fuel that is heated to a very high temperature. The hot air-fuel mixture moves through the gas turbine blades, making them spin. The fast-spinning turbine drives a generator that converts a portion of the spinning energy into electricity. **Heat recovery system captures exhaust.** A Heat Recovery Steam Generator (HRSG) captures exhaust heat from the gas turbine that would otherwise escape through the exhaust stack.The HRSG creates steam from the gas turbine exhaust heat and delivers it to the steam turbine. **Steam turbine delivers additional electricity.** The steam turbine sends its energy to the generator drive shaft, where it is converted into additional electricity.	3	8	8
III b	An energy audit is an inspection survey and an analysis of energy flows for energy conservation in a building. It may include a process or system to reduce the amount of energy input into the system without negatively affecting the output. In commercial and industrial real estate, an energy audit is the first step in identifying opportunities to reduce energy expense and carbon footprint.	4		
	Energy Audit helps in • energy cost optimization, • pollution control, • safety aspects and • suggests the methods to improve the operating & maintenance practices of the system. • It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipment's,instrumentation and technology.	3	7	7

IVa	Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution. Diversifying energy supply and reducing dependence on imported fuels. Creating economic development and jobs in manufacturing, installation. The use of these sources contributes to the more efficient use of their own potentials in energy production, reduction of greenhouse gas emissions, reduction of fossil fuel imports, development of local industry and job creation. One major advantage with the use of renewable energy is that as it is renewable it is therefore sustainable and so will never run out. Renewable energy facilities generally require less maintenance than traditional generators. Their fuel being derived from natural and available resources reduces the costs of operation.	8	8	8
IV b	**Recycling** is the process of converting waste materials into new materials and objects. It is an alternative to "conventional" waste disposal that can save material and help lower greenhouse gas emissions. Recycling can prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, thereby reducing: energy usage, air pollution (from incineration), and water pollution (from landfilling).	2		
	Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy.Thus, recycling aims at environmental sustainability by substituting raw material inputs into and redirecting waste outputs out of the economic system.	2		
	Reuse of waste means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived. The differentiation between the terms reuse, recycling and recovery is important for the understanding and application of the targets stated in EU waste legislation. Definitions for recycling and reuse in waste specific Directives partially deviate from the corresponding definitions of the Waste Framework.	3	7	7
V a	The basic principle of solar thermal utilization is the conversion of short-wave solar radiation into heat (photo thermal conversion process). If radiation incidences on material a certain part of the radiation is absorbed. A solar collector captures the radiant energy from the Sun and converts it into heat. The basic idea is that the solar energy passes through a layer of glazed glass where it is absorbed by the underlying material. The solar energy excites the molecules in the underlying material resulting in heat. The glazing of the glass prevents the heat from escaping, thereby effectively capturing the heat.	4		
	Solar-powered photovoltaic (PV) panels convert the sun's rays into electricity by exciting electrons in silicon cells using the photons of light from the sun.	4	8	8

V b	Solar desalination is a technique to desalinate water using solar energy. There are two basic methods of achieving desalination using this technique; direct and indirect. Sunlight may provide heat for evaporative desalination processes, or for some indirect methods, convert to electricity to power a membrane process.  	4 3	7	7
VI a	 main components of a typical flat-plate solar collector: Black surface - absorbent of the incident solar energy Glazing cover - a transparent layer that transmits radiation to the absorber, but prevents radiative and convective heat loss from the surface Tubes containing heating fluid to transfer the heat from the collector Support structure to protect the components and hold them in place Insulation covering sides and bottom of the collector to reduce heat losses. Flat-plate collectors are installed facing the equator (i.e. South oriented in the Northern hemisphere and North oriented in the Southern hemisphere). The optimal tilt of the collector plate is close to the latitude of the location (+/- 15o). If the application is solar cooling, the optimum installation angle is Latitude - 10o, so that the solar beam is perpendicular to the collector during summertime. If the application is solar heating, the optimum installation angle is Latitude + 10o. It was found however, that for year-round hot water application, the optimum angle is Latitude + 5o, which provides somewhat better performance during winter, when the hot water is more needed	4 4	8	8

VI b	Solar thermal power (electricity) generation systems collect and concentrate sunlight to produce the high temperature heat needed to generate electricity. All solar thermal power systems have solar energy collectors with two main components: reflectors (mirrors) that capture and focus sunlight onto a receiver. In most types of systems, a heat-transfer fluid is heated and circulated in the receiver and used to produce steam. The steam is converted into mechanical energy in a turbine, which powers a generator to produce electricity. Solar thermal power systems have tracking systems that keep sunlight focused onto the receiver throughout the day as the sun changes position in the sky.	4		
		3	7	7
VII a	The most important component of a Wind Energy Converter is the rotor. The efficiency of a rotor is characterized by its profile (airfoil section) and the corresponding aerodynamic design. The NACA 4415 is selected as an aerofoil for the rotor due to its increased efficiency. A light with a good strength is used for the blades. The blade is carved at different blade angles.Alternator is made of two components, magnet rotor and stator. Magnet rotor is mild steel disk with magnets positioned on it using molding process. Stator is made of 9 coils. Each coil with 220 turns number of turns. The stator is sandwiched between the magnet rotors. With the rotary motion of magnet rotors, flux is generated and hence AC voltage is in the coil which is converted into DC voltage with the help of bridge rectifiers. The output in the form of DC volt is used to charge the battery. The furling system is used for rotating the turbine to the desired direction of the wind.	4		
VII b		4	8	8



Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called transesterification. Largest possible source of suitable oil comes from oil crops such as mustard (rapeseed), palm or soybean. Biodiesel production is the process of producing the biofuel, biodiesel, through the chemical reactions of transesterification and esterification. This involves vegetable or animal fats and oils being reacted with short-chain alcohols (typically methanol or ethanol).
As mentioned above biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste oils.
Almost all biodiesel is produced using **base catalyzed transesterification** as it is the most economical process requiring only low temperatures and pressures and producing a 98% conversion yield. The Transesterification process is the reaction of a triglyceride (fat/oil) with an alcohol to form esters and glycerol. A triglyceride has a glycerine molecule as its base with three long chain fatty acids attached. The characteristics of the fat are determined by the nature of the fatty acids attached to the glycerine. The nature of the fatty acids can in turn affect the characteristics of the biodiesel. During the transesterification process, the triglyceride is reacted with alcohol in the presence of a catalyst, usually a strong alkaline like sodium hydroxide.

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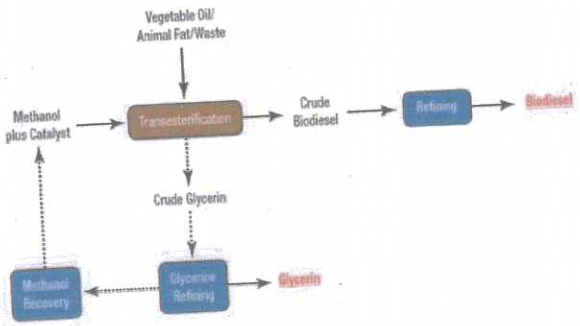
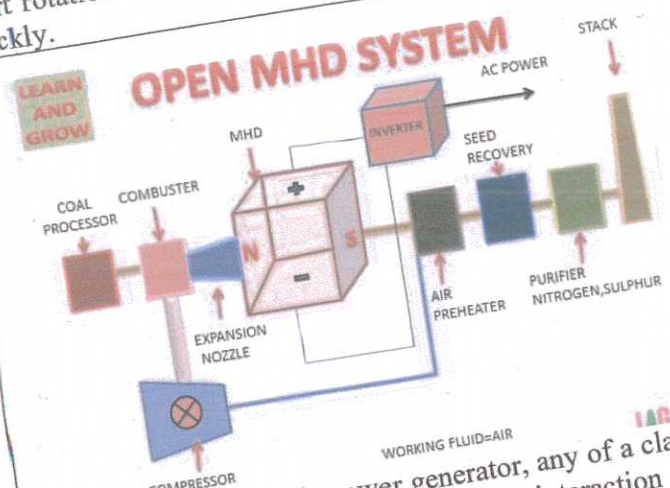
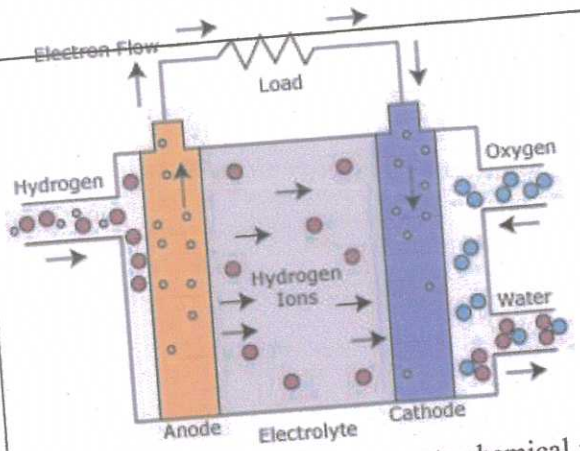
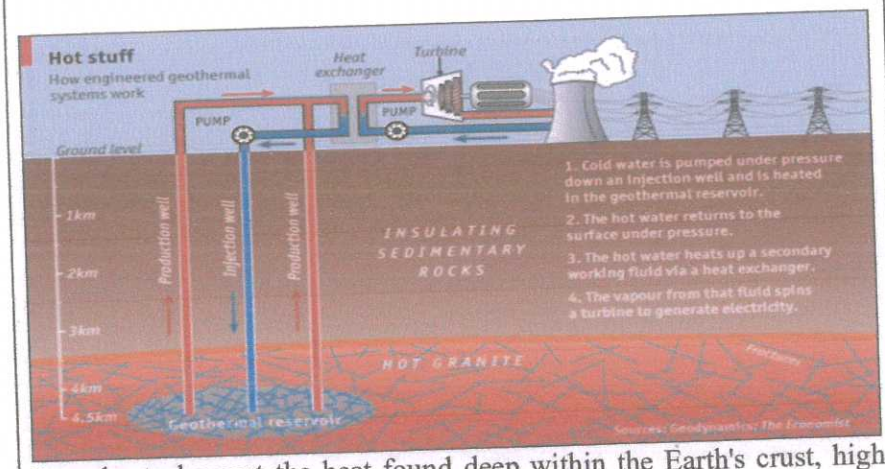
VIII a		3	7	7

Schematic of Biodiesel Production Path



VIII b	Pyrolysis is the thermal decomposition of biomass occurring in the absence of oxygen. It is the fundamental chemical reaction that is the precursor of both the combustion and gasification processes and occurs naturally in the first two seconds. The products of biomass pyrolysis include biochar, bio-oil and gases including methane, hydrogen, carbon monoxide, and carbon dioxide. Depending on the thermal environment and the final temperature, pyrolysis will yield mainly biochar at low temperatures, less than 450^{O}C, when the heating rate is quite slow, and mainly gases at high temperatures, greater than 800^{O}C, with rapid heating rates. At an intermediate temperature and under relatively high heating rates, the main product is bio-oil. Pyrolysis can be performed at relatively small scale and at remote locations which enhance energy density of the biomass resource and reduce transport and handling costs. Heat transfer is a critical area in pyrolysis as the pyrolysis process is endothermic and sufficient heat transfer surface has to be provided to meet process heat needs. Pyrolysis offers a flexible and attractive way of converting solid biomass into an easily stored and transported liquid, which can be successfully used for the production of heat, power and chemicals. The carbon dioxide in burning biomass is emitted very quickly, but only reabsorbed over the growth period of the biomass. The timescale of biomass carbon neutrality can be 20 or 30 years in the case of some trees. A significant advantage of Giant King Grass is that it is very fast growing and can be harvested every six months or less. This is called a short rotation crop and the carbon dioxide emitted is reabsorbed very quickly.	8 7	8 7	8 7
IX a	 Magneto hydrodynamic power generator, any of a class of devices that generate electric power by means of the interaction of a moving fluid (usually an ionized gas or plasma) and a magnetic field. MHD generators are also attractive for the production of large electrical power pulse. The fundamental concept behind MHD is that magnetic fields can induce currents in a moving conductive fluid, which in turn polarizes the fluid and reciprocally changes the magnetic field itself. 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			4

	conductor through a magnetic field creates a current in the conductor except that in the MHD generator the metal conductor is replaced by conducting gas plasma. 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.	4	8	8
IX b	There are some minor environmental issues associated with geothermal power. 1. Construction of geothermal power plants has the potential to cause surface instability and trigger earthquakes. 2.There are heavy initial costs associated with both geothermal plants. 3.Very location specific (most resources are simply not cost-competitive). 4.Geothermal power is only sustainable (renewable) if the reservoirs are properly managed. 5. Possibility of Depletion of Geothermal Sources. 6. Land Requirements for Geothermal System to Be Installed. 7. Underneath the earth's surface, there is a substantial amount of greenhouse gasses. Harnessing of the heat can potentially lead to the migration of these gasses to the surface of the earth and pollute the air. 8. Although geothermal energy is a cheap alternative for heating and cooling homes, geothermal heat pumps require electricity to operate. 9. In some situations, geothermal energy sites are located further from the population, hence, requiring vast network of distribution systems. This only adds up the overall cost of setting up a geothermal system.	1x7	7	7
X a	 A fuel cell is a device that converts chemical potential energy (energy stored in molecular bonds) into electrical energy. A PEM (Proton Exchange Membrane) cell uses hydrogen gas (H2) and oxygen gas (O2) as fuel. The products of the reaction in the cell are water, electricity, and heat. A fuel cell, uses an external supply of chemical energy and can run indefinitely, as long as it is supplied with a source of hydrogen and a source of oxygen (usually air). The source of hydrogen is generally referred to as the fuel and this gives the fuel cell its name, although there	4		

	is no combustion involved. Oxidation of the hydrogen instead takes place electrochemically in a very efficient way. During oxidation, hydrogen atoms react with oxygen atoms to form water; in the process electrons are released and flow through an external circuit as an electric current. Fuel cells can vary from tiny devices producing only a few watts of electricity, right up to large power plants producing megawatts. All fuel cells are based around a central design using two electrodes separated by a solid or liquid electrolyte that carries electrically charged particles between them. A catalyst is often used to speed up the reactions at the electrodes. Fuel cell types are generally classified according to the nature of the electrolyte they use. Each type requires particular materials and fuels and is suitable for different applications. In the energy field, most hydrogen is used through Fuel Cells (FCs). A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as by-products. In its simplest form, a single fuel cell consists of two electrodes - an anode and a cathode - with an electrolyte between them. At the anode, hydrogen reacts with a catalyst, creating a positively charged ion and a negatively charged electron. The proton then passes through the electrolyte, while the electron travels through a circuit, creating a current. At the cathode, oxygen reacts with the ion and electron, forming water and useful heat.	4	8	8
X b	 In order to harvest the heat found deep within the Earth's crust, high pressure cold water is pumped down several kilometers (usually between 3 and 7 kilometers) into hot, porous rock. Once enough water has been pumped down to create a significantly large thermal reservoir, steam or hot water returns to the surface and is harnessed either directly or indirectly. Once the steam has entered the power plant, the rest of the power generation cycle is very similar to one that can be found in coal or nuclear power plant: the steam passes through a series of turbines, is condensed back to liquid water, and is pumped back into the cycle (in this case, that means that it is pumped back underground). The turbines spin shafts that are attached to the generators that make the actual electricity that is sent to homes or businesses.	4 3	7	7