Energy Resources

Energy may be defined as the capacity to do work.

Both energy production and energy utilization are the indicators of a country's progress as it is a primary input for industrial operation.

1. **Growing Energy Needs**

   Energy consumption of a nation is usually considered as an index of its development, because almost all the development activities are directly or indirectly dependent upon energy. Power generation and energy consumption are crucial to economic development as economy of any nation depends upon availability of energy resources. There are wide disparities in per capita energy use of developed and the developing nations. With increased speed of development in the developing nations energy needs are also increasing.

- The very original form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes.
- Wind and hydropower has also been used. Invention of steam engineers replaced the burning of wood by coal and coal was further replaced by oil.
- The oil producing has started twisting arms of the developed as well as developing countries by dictating the prices of oil and other petroleum products.
- Energy resources are primarily divided into two categories viz. renewable and non-renewable sources.
- Renewable energy resources must be preferred over the non-renewable resources.
- It is inevitable truth that now there is an urgent need of thinking in terms of alternative sources of energy, which are also termed as non-conventional energy sources which include:

1. Solar energy needs equipments such as solar heat collectors, solar cells, solar cooker, solar water heater, solar furnace and solar power plants.
2. Wind energy

3. Hydropower, Tidal energy, ocean thermal energy, geothermal energy, biomass, biogas, biofuels etc.

- The non-renewable energy sources include coal, petroleum, natural gas, nuclear energy.

2. Energy Scenario

Energy is a key input in the economic growth and there is a close link between the availability of energy and the future growth of a nation. Power generation and energy consumption are crucial to economic development.

In India, energy is consumed in a variety of forms such as fuel wood; animal waste and agricultural residues are the traditional sources of energy. These non-commercial fuels are gradually getting replaced by commercial fuels i.e. coal, petroleum products, natural gas and electricity.

Out of total energy, commercial fuels account for 60% whereas the balance 40% is coming from non-commercial fuels. Of the total commercial energy produced in the form of power or electricity,

- 69% is from coal (thermal power),
- 25% is from hydel power,
- 4% is from diesel and gas,
- 2% is from nuclear power, and
- Less than 1% from non- conventional sources like solar, wind, ocean, biomass, etc.

Petroleum and its products are the other large sources of energy. In a developing country like India, in spite of enhanced energy production, there is still shortage due to increased demand of energy. In spite of the fact that there is a phenomenal increase in power generating capacity, still there is 30% deficit of about 2,000 million units.

Policy makers are in the process of formulating an energy policy with the objectives of ensuring adequate energy supply at a minimum cost, achieving self-sufficiency in energy supplies and protecting environment from adverse impact of utilizing energy resources in an injudicious manner. The main

features of this policy are

1. Accelerated exploitation of domestic conventional energy resources, viz., oil, coal, hydro and nuclear power;
2. Intensification of exploration to achieve indigenous production of oil and gas;
3. Efficient management of demand of oil and other forms of energy;
4. To formulate efficient methods of energy conservation and management;
5. Optimisation of utilisation of existing capacity in the country
6. Development and exploitation of renewable sources of energy to meet energy requirements of rural communities;
7. Organisation of training for personnel engaged at various levels in the energy sector.
8. Government private partnership to exploit natural energy resources

3. Renewable Resources

- The resources that can be replenished through rapid natural cycles are known as renewable resource.
- These resources are able to increase their abundance through reproduction and utilization of simple substances.
- Examples of renewable resources are plants (crops and forests),and animals who are being replaced from time to time because they have the power of reproducing and maintain life cycles.
- Some examples of renewable resources though they do not have life cycle but can be recycled are wood and wood-products, pulp products, natural rubber, fibres (e.g. cotton, jute, animal wool, silk and synthetic fibres) and leather.

- In addition to these resources, water and soil are also classified as renewable resources. Solar energy although having a finite life, as a special case, is considered as a renewable resource in as much as solar stocks is inexhaustible on the human scale.

4. Non-Renewable Resources

- The resources that cannot be replenished through natural processes are known as non-renewable resources.
- These are available in limited amounts, which cannot be increased. These resources include fossil fuels (petrol, coal etc.), nuclear energy sources (e.g. uranium, thorium, etc). Metals (iron, copper, gold, silver, lead, zinc etc.), minerals and salts (carbonates, phosphates, nitrates etc.).
- Once a non-renewable resource is consumed, it is gone forever. Then we have to find a substitute for it or do without it.
- Non-renewable resources can further be divided into two categories, viz. Recyclable and non-recyclable

4.1 Recyclable resources

These are non-renewable resources, which can be collected after they are used and can be recycled. These are mainly the non-energy mineral resources, which occur in the earth's crust (e.g. ores of aluminium, copper, mercury etc.) and deposits of fertilizer nutrients (e.g. phosphate sock and potassium and minerals used in their natural state (asbestos, clay, mica etc.)

4.2 Non-recyclable resources

These are non-renewable resources, which cannot be recycled in any way. Examples of these are fossil fuels and nuclear energy sources (e.g. uranium, etc) which provide 90 per cent of our energy requirements.

5. Use of Alternate Energy Sources

There is a need to develop renewable energy sources which are available and could be utilized (solar or wind) or the sources which could be created and utilized (bio-mass). The main renewable energy sources for India are solar, wind, hydel, waste and bio-mass. Bio-mass are resources which are agriculture related like wood, bagasse, cow dung, seeds, etc.

5.1. Solar energy

India being a tropical country has potential to use solar energy on commercial bases. According to estimates, 35 MW of power could be generated from one sq km. With such potential, solar energy has bright future as energy source for the development of the country. Initial cost is the biggest limitation which has led to the low realization of its potential. For solar energy to become one of the front runners, it will require lot of research, cheap technology and low capital.

The energy that we get directly from the sun is called solar energy. The nuclear fusion reactions occurring inside the sun release enormous amount of energy in the form of heat and light. The solar energy received by the near earth space is approximately1.4 kJ/m2/s known as solar constant.

Methods of Harvesting Solar Energy

Solar cells (or) photovoltaic cells (or) PV cells

Solar heat collectors

Solar water heater

Solar cells

Solar cells consist of a p-type semiconductor (such as Si doped with B) and n-type semi-conductor (Si doped with P). When the solar rays fall on the top layer of p-type semi-conductor, the electrons from the valence band get promoted to the conduction band and cross the p-n junction into n-type semi-conductor.There by potential difference between two layers is created, which causes flow of electrons (ie.,an electric current)

Solar cell Uses

Used in calculators, electronic watches. Street lights, water pumps to run radios and TVs.

Solar Battery

When a large number of solar cells are connected in series it form a solar battery.Solar battery produce more electricity which is enough to run water pump, to run street-light, etc., They are used in remote areas where conventional electricity supply is a problem.

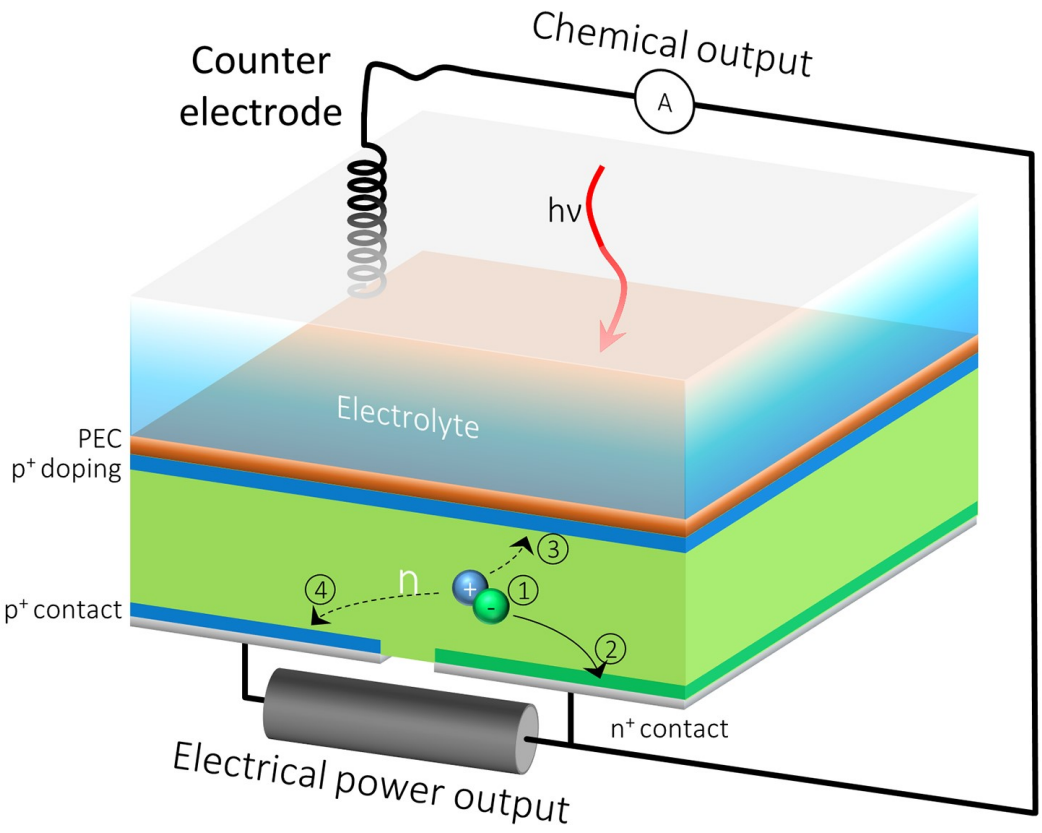


Fig. Solar cell working principle

Solar heat collectors

Solar heat collectors consists of natural materials like stones, bricks, (or) materials like glass, which can absorb heat during the day time and release it slowly at night.

Solar heat collector Uses

Used in cold places, where houses are kept in hot condition using solar heat collectors

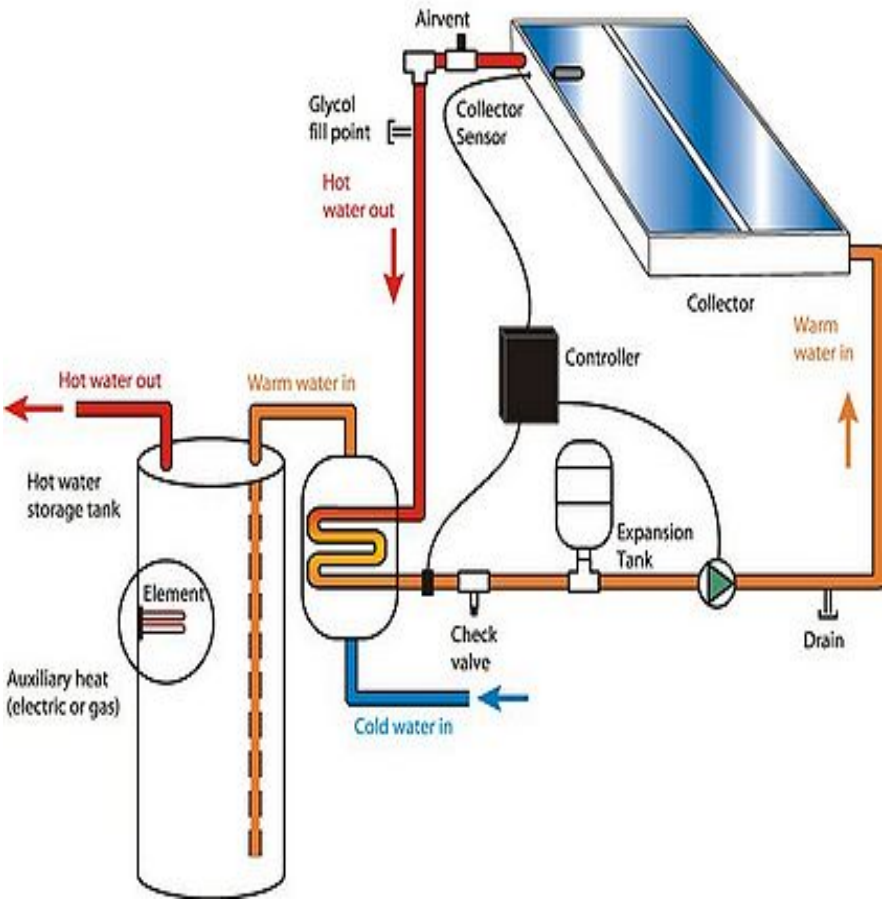
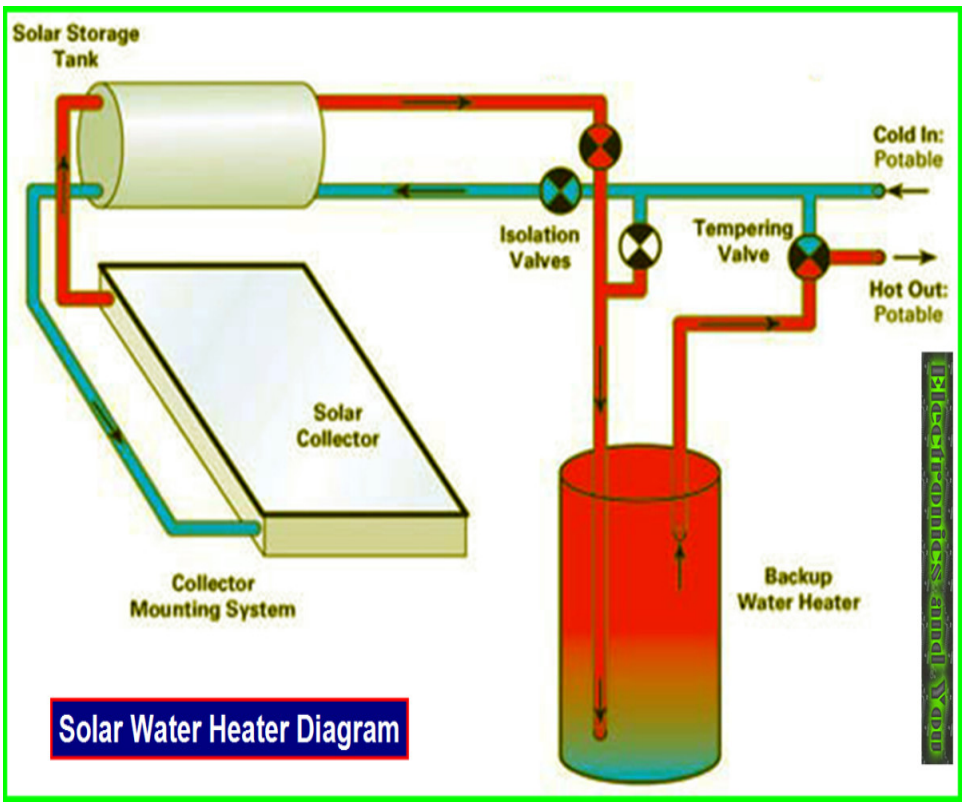


Fig. Solar heat collectors

Solar Water heaters



5.2 Wind energy

Moving air is called wind. Energy recovered from the force of the wind is called wind energy. The energy possessed by wind is because of its high speed. The wind energy is harnessed by making use of wind mills.

The wind power potential of India is about 45,000 MW out of which capacity of 8748 MW has been installed in India till 2008. India is one of the leading countries in generating the power through wind energy.

Gujarat, AP, Karnataka, MP and Rajasthan are states having more than 5000 MW potential each. These potentials could be improved if the technology of putting turbines in sea is embraced. There are wind farms on sea generating as high as 160 MW of power.

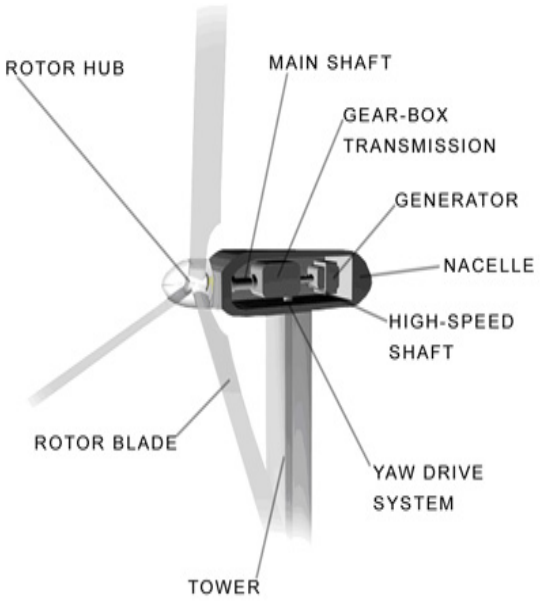
Harvesting of Wind energy.

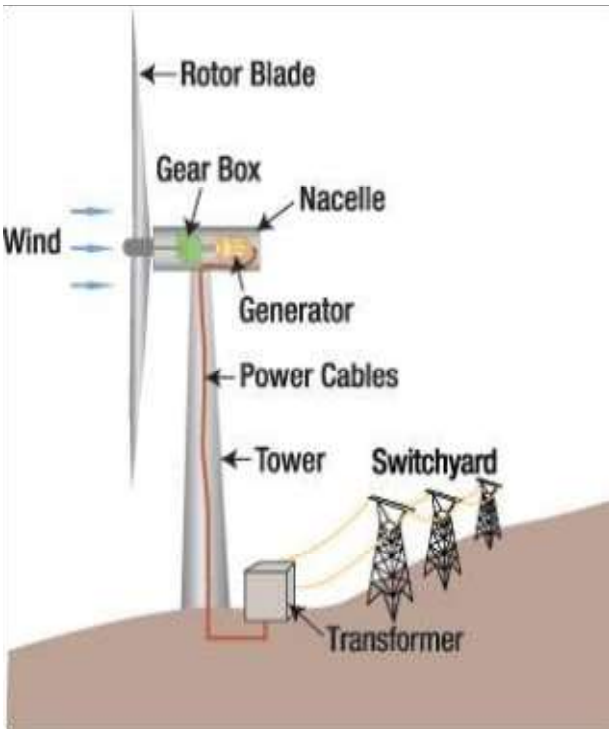
1. Wind Mills

The strike of blowing wind on the blades of the wind mill makes it rotating continuously. The rotational motion of the blade drives a number of machines like water pump, flour mills and electric generators.

2. Wind farms

When a large number of wind mills are installed and joined together in a definite pattern it forms a wind farm. The wind farms produce a large amount of electricity. The minimum speed required for satisfactory working of a wind generator is 15 km/hr.It does not cause any air pollution. It is very cheap.





5.3 Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range

and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels. Temperature of the earth increases at a rate of 20-750C per km, when we move down the earth surface.

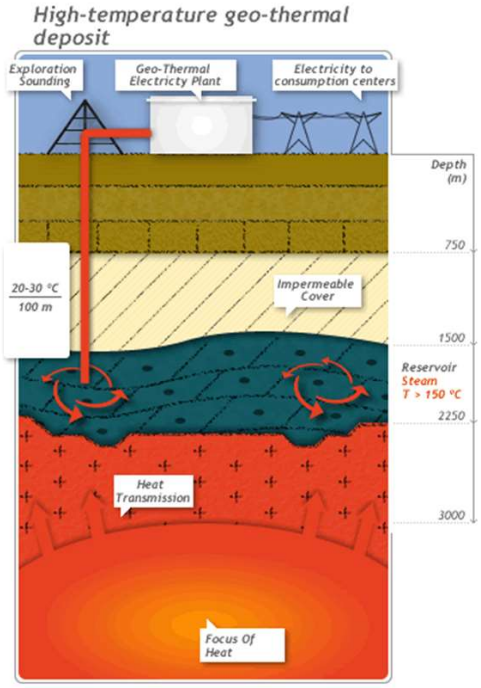
High temperature and high pressure steam fieldsexists below the earth's surface in many places. The energy harnessed from the high temperature present inside the earth is called geothermal energy.

Natural geysers

In some places, the hot water (or) steam comes out of the ground through cracks naturally in the form

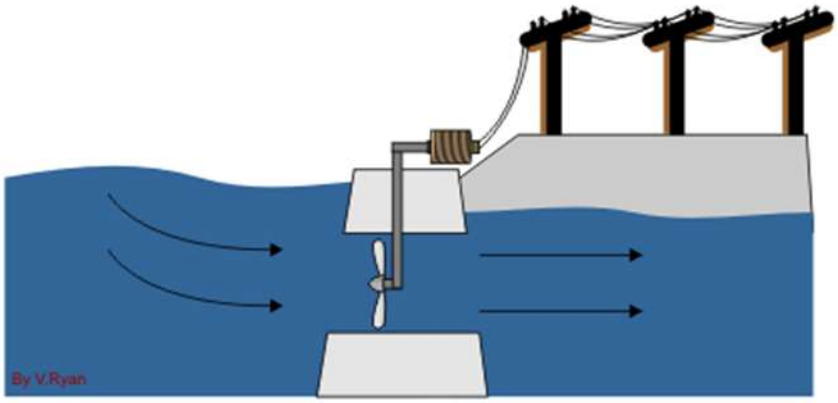
Artificial geysers

In some places, we can artificially drill a hole up to the hot region and by sending a pipe in it, we can make the hot water or steam to rush out through the pipe with very high pressure. Thus, the hot water (or) steam coming out from the natural (or) artificial geysers is allowed to rotate the turbine of a generator to produce electricity.



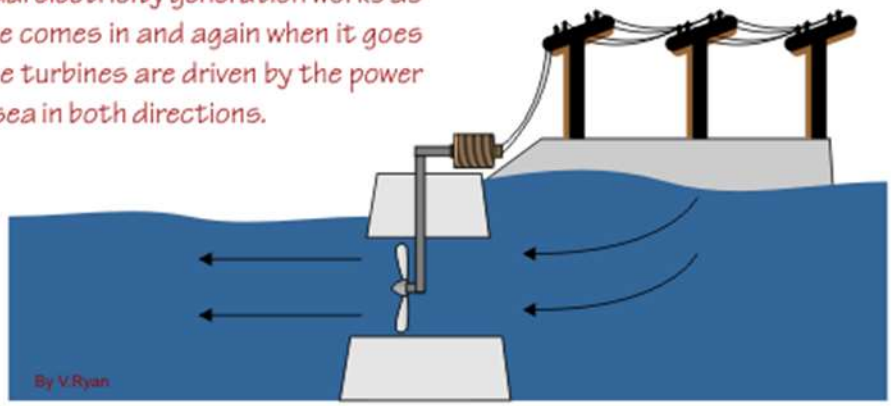
5.4. Tidal energy

Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy. The “high tide” and “low tide” refer to the rise and fall of water in the oceans.The tidal energy can be harnessed by constructing a tidal barrage.During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which intern produces electricity by rotating the generators.During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed to flow into the sea and again rotates the turbine.



TIDE COMING IN

This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.



TIDE GOING OUT

5.4 Ocean thermal energy conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity.

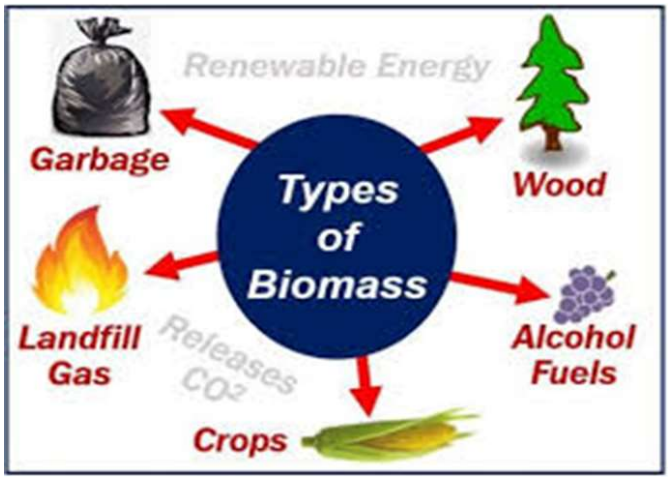
A heat engine gives greater efficiency and power when run with a large temperature difference. In the oceans the temperature difference between surface and deep water is greatest in the tropics, although still a modest 20 to 25 °C. It is therefore in the tropics that OTEC offers the greatest possibilities. OTEC has the potential to offer global amounts of energy that are 10 to 100 times greater than other ocean energy options such as wave power

5.5 Biomass energy

Biomass is the oldest means of energy used by humans along with solar energy. As soon as the fire was discovered, it was used widely among humans mainly for heat and light. Fire was generated using wood or leaves, which is basically a biomass. The biomass could be used to generate steam or power or used as a fuel. Power is generated using rice husk in Andhra Pradesh, while several bagasse based plants are there. India has a potential of 3500 MW from bagasse. Other fast growing plants could be planned over a huge area, so that it provides biomass for generating power.

Types of Bioenergy

(a)**Energy plantation**: Solar energy is trapped by green plants through photosynthesis and converted into biomass energy. Fast growing trees like cottonwood, poplar and Leucaena, non-woody crop plants like sugarcane, sweet sorghum and sugarbeet, and carbohydrate rich potato, cereal etc. are some of the important energy plantations.



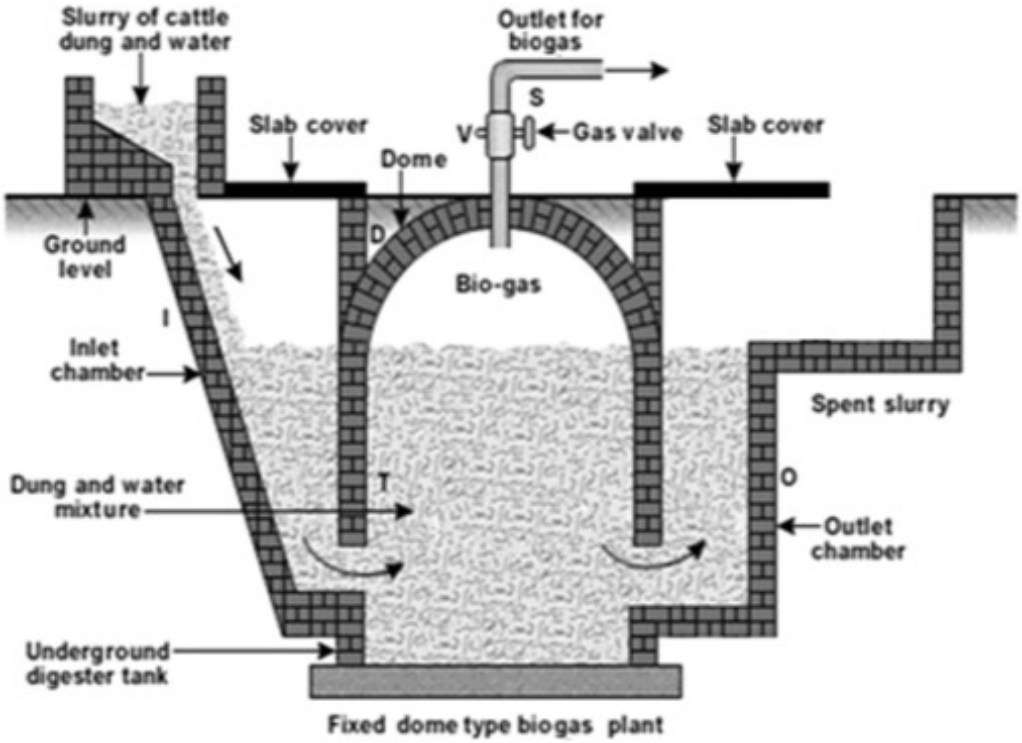
(b) Petro-crops: Certain latex-containing plants like Euphorbias and oil palms are rich in hydrocarbons and can yield an oil like substance under high temperature and pressure. This oily material may be

burned in diesel engines directly or may be refined to form gasoline.These plants are popularly known as petro-crops.

(c) Agricultural and Urban Waste biomass: Crop residues, bagasse (sugarcane residues), coconut shells, peanut hulls, cotton stalks etc. produce energy by burning. Animal dung, fishery and poultry waste and even human refuse are examples of biomass energy. In Brazil 30 % of electricity is obtained from burning bagasse. In rural India, animal dung cakes burnt to produce heat.They may produce energy either by burning directly or converted into fuels by fermentation.

Biogas

Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted by the anaerobic digestion or fermentation into a gaseous fuel called biogas. Biogas is a mixture of 65% methane (CH_4) and of 35% CO_2 and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes. It is a renewable energy resulting from biomass. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles.



Fixed dome type biogas plant

Bio-fuels

Bio-fuels are the fuels, obtained by the **fermentation** of biomass.

Eg: Ethanol, Methanol

(a) Ethanol

Ethanol can be easily produced from the **sugarcane**. Its calorific value is less when compared to petrol, and produces much less heat than petrol.

(b) Methanol

Methanol can be easily obtained from **ethanol or sugar**-containing plants.

Its calorific value is also too low when compared to gasoline and diesel.

(c) Gasohol

Gasohol is a mixture of **ethanol + gasoline**.

In India trial is being carried out to use Gasohol in cars and buses.

- ✓ Gasohol is common fuel in Brazil and Zimbabwe for running cars and buses.
- ✓ Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Due to its high calorific value, hydrogen can serve as an excellent fuel.
- ✓ Moreover it is non-polluting and can be easily produced.
- ✓ Presently H_2 is used in the form of liquid hydrogen as a fuel in spaceships.

India has more than 50 million hectare of wasteland, which could be utilized for cultivating fuel plants. Jatropha is one of the options which can be planted on arid lands and be used for production of bio fuels.

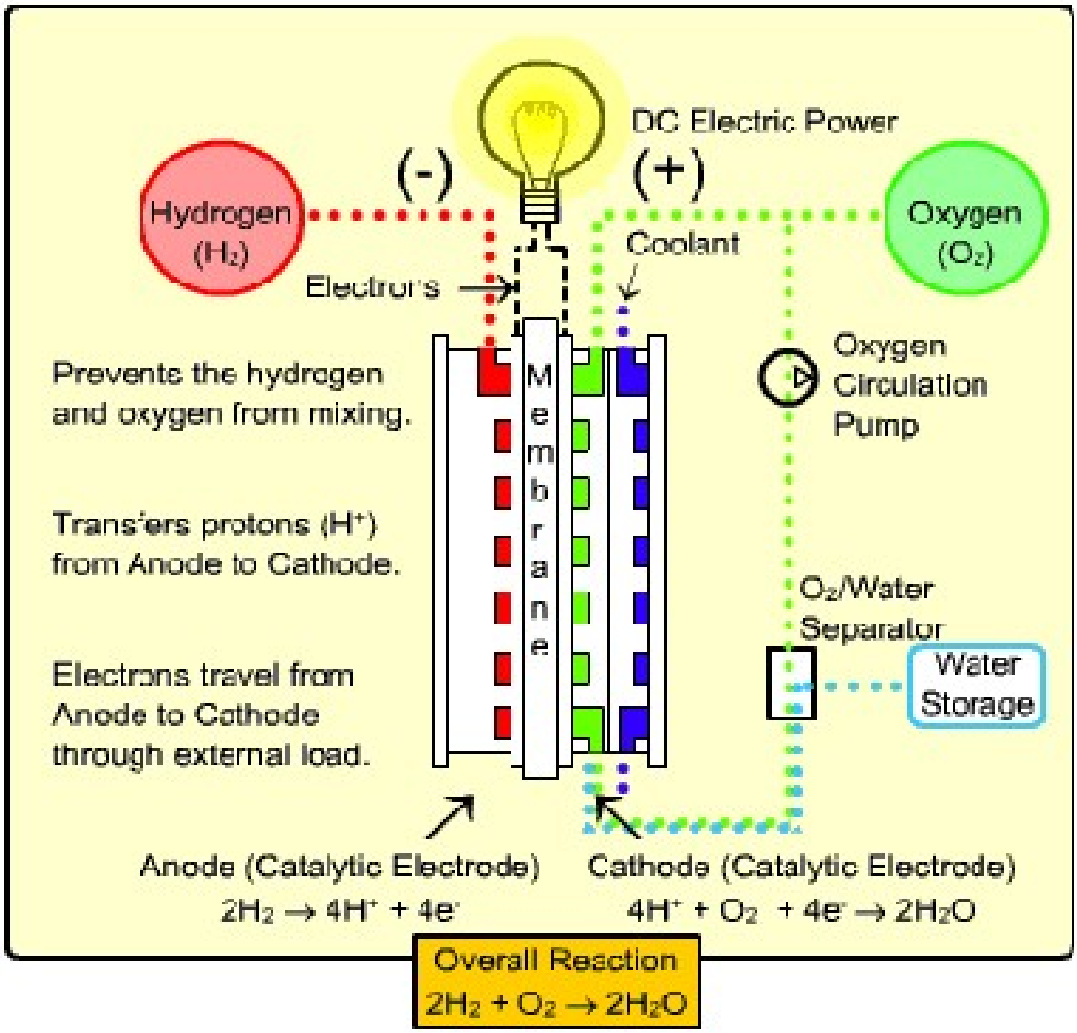
5.6. Hydrogen Energy:

- ▶ Hydrogen can be produced by **thermal dissociation** or **photolysis** or **electrolysis** of water.
- ▶ It possesses high calorific value.

- It is non polluting, because the combustion product is water.
- $2H_2+O_2$---->$2H_2O$+150KJ

Disadvantages of hydrogen fuel

- Hydrogen is highly inflammable and explosive in nature
- Safe handling is required
- It is difficult to store and transport.Highest calorific value, hydrogen can serve as an excellent fuel. Moreover, it is non-polluting



6. Problems Relate To the Use of Energy Resources

6.1 Fossil fuel

- Global warming
- Acid rains
- Dangers posed by leaded fuels ,Oil spills
- Water pollution caused by poorly managed coal mines
- Air pollution.

6.2 Alternate energy resources

- The initial cost of establishment of alternate energy generation is costlier than conventional resources.
- Maintenance of these structures is difficult.
- It requires more space.
- Energy supply is unpredictable during natural calamities.

7. Case Study

Importance of the energy resources in present economy and as a base for our future can be underlined by the fact that recent confrontations between some powerful nations of the world have primarily been attributed driven by objective to secure their energy supplies. Examples of this have been the two gulf wars. It was the hunger for energy resources that drove Iraq to lead an offensive over Kuwait and also reason for second Gulf war has been attributed to energy security by defence experts. In recent times, world has witnessed a confrontation at South China Sea between India, Vietnam and China over the issue of exploring natural gas and petroleum under the sea bed.

Non Renewable energy

Coal

Coal is a solid fossil fuel formed in several stages as buried remains of land plants that lived 300-400 million years ago were subjected to intense heat and pressure over millions of years.

Various stages of coal

Wood >>> Peat >>> Lignite >>> Bituminous coal >>> Anthracite

- The carbon content of Anthracite is 90% and its calorific value is 8700 k.cal.
- The carbon content of bituminous, lignite and peat are 80, 70 and 60% respectively
- India has about 5% of world's coal. Indian coal is not good because of poor heat capacity.

Disadvantages

- When coal is burnt it produces CO_2 causes global warming
- Since coal contains impurities like S and N, it produces toxic gases during burning.
-

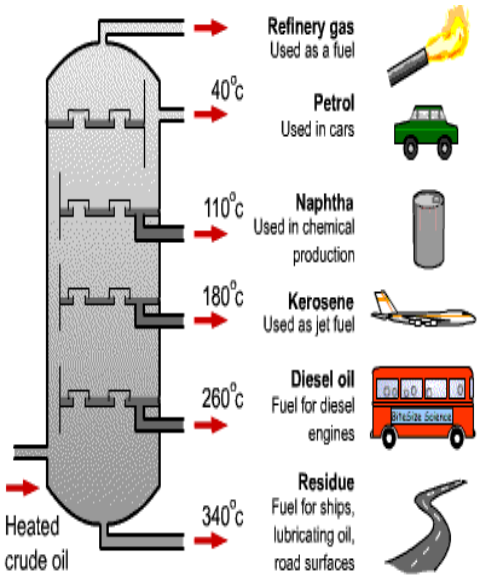
Petroleum

Petroleum or crude oil = hydrocarbons + small amount S, O, N.

Occurrence

- The fossil fuel formed by the decomposition of dead animals and plants that were buried under lake and ocean at high temperature and pressure for million years
- **Fractional distillation**
- Hydrocarbons are separated by fractioning the crude oil.
- **Petroleum World Scenario**
- 67% oil reserves.
- 25% of the oil reserves in Saudi Arabia.

At the present rate of usage, the world's crude oil reserves are expected to get exhausted in just 40 years.



LPG and Natural Gas

LPG (Liquefied Petroleum Gas)

- The petroleum gas, **converted into liquid** under high pressure as LPG
- LPG is colorless and odorless gas.
- During bottling some **mercaptans** is added, to detect leakage of LPG from the cylinder.

Natural Gas

- Mixture of **50-90% methane** and small amount of other **hydrocarbons.**
- Its calorific value ranges from 12,000-14,000 k-cal/$m^{3.}$

1. Dry gas

If the natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas.

2. Wet gas

If the natural gas contains higher hydrocarbons like propane, butane along with methane it is called wet gas.

Occurrence

Formed by the decomposition of dead animals and plants, those were buried under lake and ocean, at high temperature and pressure for millions of years.

Nuclear Energy

Dr. H. Bhabha –father. India has 10 nuclear reactors, which produce 2% of India's electricity.

Nuclear Fission

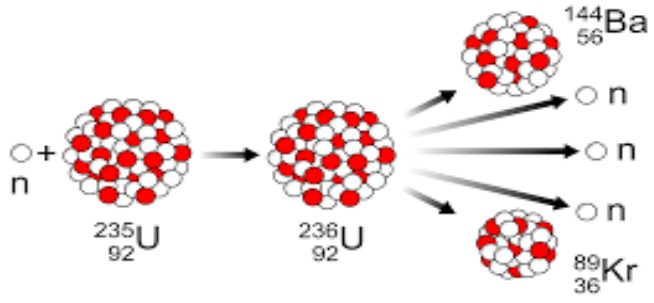
- Heavier nucleus is split into lighter nuclei, on bombardment by fast moving neutrons, and a large amount of energy is released.

Eg: Fission of U^{235}

- When U^{235} nucleus is hit by a thermal neutron, it undergoes the following reaction with the release of 3 neutrons.

$$U_{92}^{235} + n_{0}^{1} \rightarrow Ba_{56}^{139} + Kr_{36}^{94} + 3n_{0}^{1} + \text{Energy}$$

- Each of the above 3 neutrons strikes another U^{235} nucleus causing (3x3) 9 subsequent reactions.
- These 9 reactions further give rise to (3x9) 27 reactions.
- This process of propagation of the reaction by multiplication in threes at each fission is called **chain reaction.**



Nuclear Fusion

- Lighter nucleuses are combined together at extremely high temperatures to form heavier nucleus and a large amount of energy is released.
- Eg: Fusion of H^2_1 .Two hydrogen-2 (Deuterium) atoms may fuse to form helium at 1 billion^{0}C with the release of large amount of energy

  $_1H^2 + _1H^2 \rightarrow {}_3He^2 + {}_0n^1 + \text{energy}$
- **Nuclear power of India**
- Tarapur(Maharashtra),
- Ranapratap Sagar (Rajasthan)
- Kalpakkam (Tamilnadu)
- Narora (U.P).

Why Alternate (Renewable) Energy Sources are required?

The importance of solar energy can be emphasized particularly in view of the fact that fossil fuels and other conventional sources are not free from environmental implications.

- **Least pollution, safety and security** snags and are **universally available** have the best enhance of large scale utilization in future
- **Hydro-electric power** generation is expected to upset the ecological balance existing on earth
- Besides space heating, hydel power plants critically pollute the aquatic and terrestrial biota.
- **Radioactive pollutants** released from nuclear power plants are chronically hazardous.
- The commissioning of boiling water power reactors (BWRS) have resulted in the critical accumulation of large number of long lived radionuclides in water.
- The **dangerous radiowaste** cannot be buried in land without the risk of polluting soil and underground water.
- Nor the waste can be dumped into the rivers without poisoning aquatic life and human beings as well
- The burning of **coal, oil, wood, dung cakes and petroleum** products has well debated environmental problems. The smoke so produced causes respiratory and digestive problems leading to lungs, stomach and eye diseases.
- The **disposal of fly ash** requires large ash ponds and may pose a severe problem considering the limited availability of land. Thus the non-conventional sources of energy are needed.