7. It should be cheaper.
8. Their transport and storage should be easier.

Types of Energy Resources

On the basis of pattern of their use, energy resources are of two types -conventional and non-conventional sources of energy. Resources are of two types-conventional sources and non-conventional sources.

(A). CONVENTIONAL SOURCES OF ENERGY

Energy resources that are being used by man since long back are called **conventional sources of energy**. E.g. Fossil fuels (eg. Coal, petroleum and natural gas) and firewood. These sources of energy are also called as **non-renewable** sources of energy as they are available in limited quantities.

1. Fossil fuels

Fossils fuels are the remains of plants and animals that were buried in the earth millions of years ago. Actually it was the radiant energy of the sun that caused the growth of these plants, which were then later on converted into fossil fuels. Without sunlight, there could have no coal, petroleum, natural gas, wood or any other fuel in this world. Today we burn fossil fuels, we are actually making use of the sunlight energy that was stored by plants millions of year ago.Fossil fuels like coal, petroleum and natural gas are non-renewable sources of energy, which, if exhausted, cannot be replenished in short time. This is because of the fact that fuel, which we use today took millions of years to be formed and if they are exhausted today they will again take millions of years to be formed. This is why fossil fuels are very precious and should be used with care and caution and not wasted so that the existing resources of fossil fuels can be used over long period.

(I). Coal : Coal is a fossil fuel. It is a conventional source of energy, which is a complex mixture of carbon, hydrogen and oxygen. It contain small amount of sulphur and nitrogen also. The coal deposits are the remains of those plants, which were found in large marshy place before 300 million years ago. These plants were buried in the earth and converted in to coal. The process of coal formation is called carbonization, is very slow process, which takes millions of years. To day coal is extracted from coal mines to fulfill our energy need. In India coal deposits are found mainly in Bihar, Jharkhand, Orrisa, Madhya Pradesh, Chattisgarh and Bengal. Coal is mainly found in three forms, lignite (brown coal), bituminous and anthracite coal. The amount of combustible substances and moisture contents vary in different forms. Foe e.g. Lignite coal contains 38% carbon, 19% combustible substances and 13% moisture contents. Bituminous coal contains 96% carbon, 1% combustible substances and 3% moisture contents whereas anthracite coal contains 96% carbon, 2% combustible substances and 1% moisture contents. It is the most important fuel.

Environmental Consequences

1. Mining of coal results in to large-scale destruction of vegetation, animal habitat and land degradation.
2. Mining activities results in water pollution in neighbouring water bodies.
3. The combustion of coal leads to the emission of carbon dioxide gas, which is a green house gas.
4. After burning it also releases carbon monoxide and sulphur dioxide like gas, which are responsible for environmental pollution. Carbon monoxide gas is very injurious to human health. Sulphur dioxide gas is gas is very injurious to human health and also responsible for acid rain.

5. The smoke emitted due to the combustion of coal causes smog especially in the cold winters is severe environmental problem.

(ii). Petroleum: Petroleum is also a fossil fuel. It provides more energy than coal. Their use is also easier and comfortable therefore its utility is increasing day by day. Overall reserves of petroleum in the world are about 356.2 billion tones. 40% of the total energy of the world is obtained from petroleum substance. The rate of consumption of petroleum oil is too high and if it is continued then it should be exhausted within 50-60 years. In India oil exploration is increasing rapidly. During 90s more than 322 lakh tones of oil has been produced on an annual basis.

Petroleum is formed inside the earth by the decomposition of the remains of marine organisms which died millions of years ago got covered with layers of sediments. Anaerobic bacterial breakdown of organic remains of animals and plants liberate nitrogen, oxygen and fatty acids. These under pressure and heat of overlapping sediments are converted in to oil droplets. Petroleum oils are extracted in the form of crude oil from its underground reserves. It is a brownish-black thick, viscous liquid with a greenish appearance, which is present deep inside the earth at a depth of about 1000meters in between the layers of impervious rocks. It is also known as crude oil. Usable petroleum oils are obtained from the distillation and refining of crude oil at deferent temperatures. The various products obtained at different temperatures are petrol, diesel, kerosene oil, fuel oil, naphtha etc. 65% of global reserves belong to Asia. 14% to North America and rest 19-21% belongs to other parts of the world. Important Indian oil producing regions are-

1. North-Eastern regions: Digboi, Nahar, Shivsagar, Lunel
2. Gujrat: Ankaleshwar, Kalol.
3. Mumbai high region: It is situated in the Arabian sea 200 km away from west from Mumbai.

(iii). Natural Gas: Natural gases are the gases found with petroleum reserves in the rocks. It is mainly composed a hydrocarbons 85% methane (CH_4), 10% ethane, propane and butane. Methane is the main component of natural gas. Many oil wells also provide natural gas as a co- product along with petroleum oil. Some wells are known only for natural gas. The coastal regions of Khambat and in the Arabian sea of Maharastrian coasts are major oil and natural gas producing regions of India. India has about 0.4% of the world's natural gas reserves. Presently some other reserves of natural gas are also discovered, which are situated in the off shores of Jaisalmer and Mumbai and in the delta of river Krishna and Godavari. The availability of petroleum and natural gas governs the energy growth and status a country.

(iv). Liquefied Petroleum Gas (LPG): LPG is a natural gas, which is a mixture of ethane, propane and butane. Butane is the chief component of LPG. It burns very easily with the release of a very high amount of energy. It is obtained from the fractional distillation of petroleum and also from natural gas. At high butane is converted into liquid state. The gas used for domestic cooking is termed as liquefied petroleum gas (LPG) because it is liquefied before filling into cylinders. When we opens the valve of cylinder then it comes out of the cylinder and get converted into gaseous state due to low pressure and flowing towards burners. It burns with blue flame. LPG is a superior quality of cooking fuel commonly used for domestic heating purposes.

Advantages of natural gas

1. It is a good fuel and can be used directly.
2. It burns without any smoke and not release any polluting gas.
3. Its burning capacity is very high; hence it is an excellent fuel.
4. The gas can be transported to the consumers with the help of pipelines.

Efforts for the Conservation of Petroleum

Petroleum products are very important for us and their reserves are just enough to last us for only about two to three decades. Hence priority will be given to conservation of petroleum products. Petroleum and Gas ministry of India have been proposed the following measures for the conservation of petroleum-

1. Development of awareness among public for the conservation of petroleum products.
2. Encouragement of misuse preventive measures of petroleum products.
3. To improve the oil utilizing efficiency of engines, instruments and vehicles.
4. Researches for the development of oil utilizing efficiency of consumers.
5. Encouragements for the use of inter fuel substitution or alternate sources of fuels, such as use of C.N.G. in road transport.

(iv). Fire wood: Firewood has been an important source of energy since the earliest times of human history. Forests are the chief source of firewood. Even today in many poor and developing countries, firewood is used for cooking and heating. In rural areas of India, firewood along with agricultural wastes provides the basic source of energy. It is estimated that the annual demand of firewood in India is increased up to 300-330 Mt. and we get only 50 Mt. firewood from our forests. The plantation of more and more trees in wastelands can fill up this gap of demand and supply of firewood.

(B) NON-CONVENTIONAL SOURCES OF ENERGY

The energy resources are alternatives that are discovered to save us from the energy crisis the world is facing due to depletion of fossil fuels are called **non-conventional sources of energy**. These are those sources of energy, which can be renewed and are being available for long time. Due to this property these sources of energy are also called as **renewable sources** of energy. E.g. biomass energy, solar energy, wind energy, ocean energy, hydel energy, geothermal energy and nuclear energy. Today we are facing energy crisis because our natural sources of petroleum, natural gas and coal are dwindling day by day. If we want to maintain our standard of life in the face of expanding population, we will have to develop new sources of energy. Approximately 80 years is the time limit for exhaustion of resources of petroleum and natural gas. So it becomes necessary to turn us to discover other sources of energy i.e. non-conventional sources of energy.

1. Biomass Energy

Biomass is the waste material of living beings. It includes wood, grasses, cattle dung, sewage, agricultural waste, and crop residue, like bagasse (remaining part of sugarcane after juice has extracted), rice husk etc. The sources of biomass can be divided into following two categories:

(i). Wastes of agricultural, forestry and town corporations,

(ii). Energy crops.

Potential

It is estimated that about 300 million tones of crop residues are produced in India every year, which theoretically can generate about 40,000 MW of electricity. The place where sufficient crop residue is not available, the only viable option would be a mix of crop residue and plantation wood. The concept of energy plantation with fast growing species of trees has come up especially for this reason. This yields about 25-30 tones of dry biomass per hectare per year in poor soils with good irrigation facilities.The technology for biomass based power plants is the same as that of a coal based plant. If power plant is fueled by 50% wood from energy plantations and 50% biomass residue, the electricity cost will be about Rs 1.45 kw/hr

for recondition plans and Rs 2.25 kw/hr for new plants. Today the power generated from these plants can be directly fed into the national grid. The following efforts have been made in India to get energy from biomass transformation-

1. A pilot project is started in Delhi (Timarpur) for the generation of electricity from the corporation waste.
2. Establishment of rice husk based heating plants with 10 MW capacity.
3. Production of fuel tablets by using corporation wastes. The production of these fuel tablets is started in Mumbai.
4. Establishment of sugar water based electricity-generating plants with 15 kw capacity.

Advantages of Biomass

1. It is a very cheap, eco-friendly and convenient conventional source of energy.
2. It generates employment to people in rural areas.
3. It fulfils the energy requirement of the villages.

Limitations : It is confined to a small area and cannot be transported to remote places.

2. Biogas

Microorganisms can easily degrade the residues of plants and animal origin in the presence of water contents. In this process the produce methane, carbon dioxide, hydrogen sulphide like gases. The mixture of these gases of biological origin is called biogas. Biogas contains about 65% methane gas, which is a best fuel. It is used for cooking of gases and lightening of houses and roads. It is also used in engines as a fuel.

Structure of Biogas plant: A biogas pant has following components-

(i). Foundation: It is made up of concrete.

(ii). Digester: It is a well like ditch on the foundation. Its wall has two holes situated opposite to each other. First hole is called inlet and second one is called outlet. Digester is used for the digestion of slurry of dung.

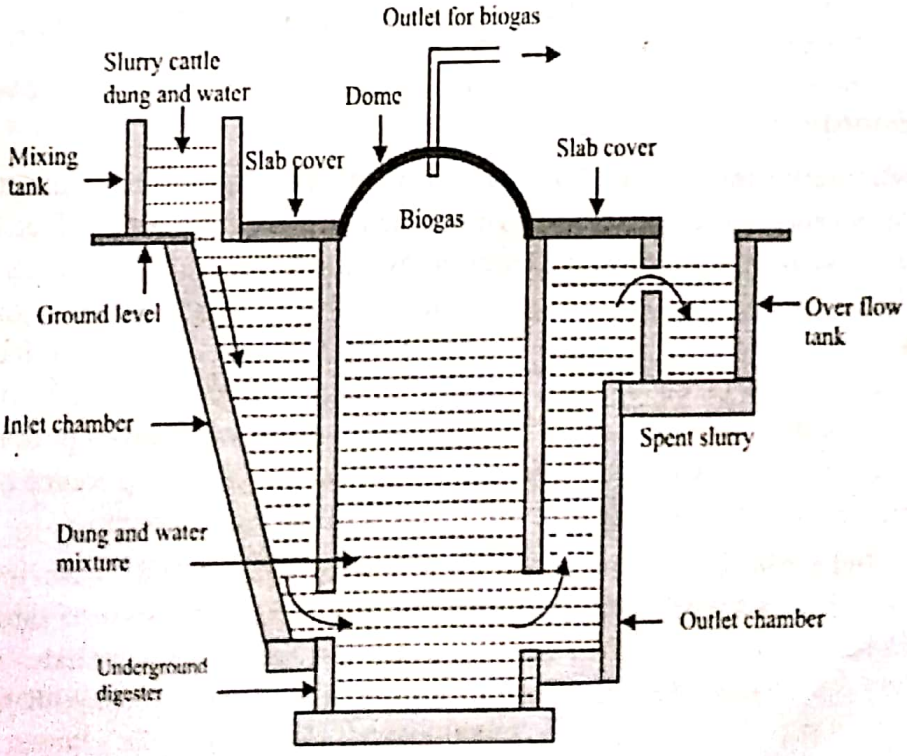

Fig- 1.2- Fixed dome type biogas plant

(iii). Dome: It is a dome shaped structure fitted over digester. It is meant for storage of biogas.

(iv). **Inlet:** It is a pipe like structure meant for filling the mixture of dung and water.
(v). **Outlet:** It is a wide mouthed structure for removal of digested slurry.
(vi). **GI pipe:** It is connected with the upper part of the dome. The other end is connected with gas supply pipe.

During the production of biogas a mixture of dung and water is poured in biogas plant every day. This slurry is digested in digester by anaerobic micro-organisms. During the digestion, biogas is released, which is collected within the dome or gasholder. Domestic waste and sewage is also used in large cities to biogas in large scale. It provides not only biogas but also solves the problem of water pollution.Gobar gas is a biogas. It is very, cheap, fresh and convenient fuel, which used for cooking food, lightning of houses and roads as well as a fuel foe cottage industries and small vehicles.

Advantages

1. It solves the problem of energy of the villagers and save their labour.
2. It does not cause any pollution.
3. It is safe for human health and does not cause any disease.
4. Cutting of forests for fuel wood should also be checked.
5. It also provides a good quality of organic manure for crops.

3. Solar Energy

We know that heat loss takes place from any object by the process like conduction or radiation. To prevent the loss of heat by conduction or radiation, it would be necessary that the upper surface of glass plate is covered by a black surface and then it is placed in any heat resistant box. The glass plate prevents the visible and infra radiations to go out side. The inner walls of the box are covered by black polish to absorb more and more heat and to prevent their loss. The inner surfaces of the box along the glass plate get heated when these solar heating devices are placed in light for some time. These surfaces then start to radiate infrared radiations but the glass plate prevents them to go out side. Thus the heat energy of inner box remains in side the box. This heat energy is used in solar cooker, solar water heater, solar cells etc.

3. Wind Energy

Moving air is called wind. As we all know that energy possessed due to the motion of anything is called its kinetic energy. Thus, when air moves from one place to another it possesses kinetic energy. The energy possessed by wind depends on its velocity. If air is stationary it has no kinetic energy. However, when it starts moving it generate kinetic energy. This wind energy is fast emerging as the most cost effective source of power as it combines the abundance of a natural element with modern technology. The great advantage of wind driven power stations that, it is in harmony with the environment. A wind driven power station consumes no raw materials neither does it have any waste. Being a cheap source of energy and with simple manageable technology, it is ideal for the developing countries.

In India, efforts to use the latent power in wind began in 1985, when the joint sector Gujrat Development Agency formed winds farms on its own. In the state of Tamilnadu, wind energy has harnessed. In India, the exercise to harness wind energy includes wind pumps, wind battery chargers, wind electric generators and grid connected farms. With the help of this wind energy, it is possible to generate 20000-mws of electricity. Asia's largest wind energy based power plant with a capacity of 150-mw of electricity is established in Muppandal, Tamilnadu.

Advantages of wind energy

1. It is renewable, abundant, inexpensive and pollution free.
2. It is being used to generate electricity, to run pumps to draw water from the ground, to run flour mills to grind the grains like wheat, corns etc. at a minimum cost.
3. It can be supplied to remote areas where other sources of energy are not possible.

4. Ocean Energy

Basically, there are following six ways of generating power from the oceans water-

(i). Ocean thermal energy: There is always a temperature difference between the water at the surface and at deeper level. This difference at many places is of the order of 20° C. The energy obtained as a result of this temperature is known as ocean thermal energy. The ocean thermal energy can be converted to electric energy.

(ii). Wave energy obtained from ocean waves: Waves piled up by the wind at the surface of the oceans continuously rise up high and fall down the shorelines, this energy is known as wave energy.

(iii). Tidal energy: Tidal energy is generated by harnessing the periodic rise and fall of ocean water, which is produced by the gravitational attraction of the moon and sun. Tidal flows consist of the vertical motion of the rise and fall of the water level whereas the tidal currents are horizontal movements, which move either towards or away from the shore. Tidal power is possible along the coast where there is sufficient difference between high and low tide. Incoming and outgoing currents rotates turbine to generate electricity. At the high tide, water floes through the turbines into a bay, and during a low tide, it flows out thus running the turbine. Conversion of energy is possible only during tidal flow.

(iv). Current energy: The running water current of ocean water is passed through a series of turbines to generate electricity. The magnitude of energy generated in this way is very low and the maintenance of the movement of turbines for long time is difficult because of the irregular water currents.

(v). Ocean wind energy: The wind flowing over ocean is powerful and uninterrupted hence it should be used to generate energy.

(vi). Energy due to salinity gradient: There is difference in the concentration of salt where water from two different seas meet. This difference in salt concentration is referred to as salinity gradient. Due to this gradient water flows speedily from high concentration to low concentration, which is used to obtain energy.

5. Geothermal Energy

The energy released by the heat stored inside the earth is called geothermal energy. At most places on the earth, the magma are many miles below the ground, but at some locations, it comes close to the surface, creating hot spots. When ground water comes in contact with hot spots, the water turns to steam. This hot water or geothermal steam can be used to generate electricity. The steam can also be directly piped into buildings for heating.

In India 340 such hot water springs with an average temperature of 80-100°C have been identified in our country and researches are going on in this field. A geothermal pilot plant is established in Kullu district of Himanchal Pradesh, which generates 50kw electricity.

5. Nuclear Energy

The heat energy requirement of the human beings is increases with the progress of civilization. The energy generated by fission or fusion reactions of the nucleus of some heavy metals is called nuclear energy. Nuclear energy is basically stored in the nucleus of certain heavy metals, such as uranium and plutonium. The nuclear energy is generated by following two processes-nuclear fusion and nuclear fission.

(i). Nuclear fusion: The reaction in which two lighter nuclei at high temperature (10^7k) and high-pressure fuses to form a heavier nucleus is called nuclear fusion. E.g. two deuterium (isotope of hydrogen) nuclei fuse to form helium nuclei ($_2He^4$) with the release a huge amount of energy (about 21.6 MW).

$$_2He^4 + {}_2He^4 \longrightarrow {}_2He^4$$

The energy emitted is would be very higher then the burning of 6 x 108 kg of coal in the air. Nuclear fusion is a uncontrolled reaction which require very high temperature and pressure. The energy of the sun is also produced due to nuclear fusion.

(ii). Nuclear fission: The process of splitting of the nucleus a heavy metal in special machines called reactor is called nuclear fission. In this process a heavy metal is bombarded by moving neutrons to break into two lighter nuclei with the release of 2 or 3 neutrons and vast amount of heat energy. E.g. nuclear fission of uranium (U^{235}), it broke up into two lighter nuclei barium (Ba) and krypton (Kr) with the release of 2 or 3 neutrons and vast amount of heat energy. 0

$$_{92}U^{235} + {}^1n \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + {}^3n^1 + \text{energy}$$

When isotope of U^{235} absorbs a slow moving neutron then a reaction takes place between the neutron and nucleus. It results in the increase of electrostatic force of repulsion in comparison to nuclear attractive force due to which the nucleus becomes flattened. Further increase in the repulsion force results in the formation of a neck like shape and at last it breaks into lighter nuclei (Ba and Kr) with the release of a large amount of heat energy.

The heat energy produced by nuclear fusion and nuclear fission reactions is utilized in the production of heat from water. The steam in turn is used to rotate a turbine coupled with electric generators. Thus when blades of turbine rotate, the heat energy of the steam is converted into electric energy. Several nuclear power plants are functioning in India and they are situated at Tarapur (MS), Kalpakkam (Tamilnadu), Kota (Rajsthan) and Narora (U.P.). In India about 4% (2720 MW) electricity is generated by the use of nuclear energy. The first and largest nuclear power plant of the Asia was established in India in 1969.

Limitation of nuclear energy

1. It causes radioactive pollution.
2. It needs sophistically engineered safety features to safeguard against any accidents, which could cause a disaster.
3. Radioactive wastes endangered the environment and can affect living beings for a number of generations.
4. The waste products emits nuclear radiations which can cause diseases like cancer, leukemia etc.

NEEDS TO DEVELOP NON-CONVENTIONAL ENERGY SOURCES

Today energy would not become only a need to do work but also becomes a scale of the richness of the person and country. The consumption of energy indicates economic development of any country. Although the population of United State of America is only 5% of the total population of the world, it alone consumes about 80% of the total generate energy of the world. On the other hand, there are many poor countries in the world that are unable to cope its energy requirement. At present we are facing energy crisis because our traditional sources of energy such as petroleum, natural gas and coal are dwindling day by day. If we want to maintain our standard of life in the face of expanding population, we will have to develop new sources of energy. Approximately 80 years is the time limit for the exhaustion of natural

resources of energy. As these traditional sources of energy are non-renewable, it cannot be produced again hence it become necessary to turn us towards the non-conventional sources of energy. The non-conventional sources of energy contain a vast amount of energy, which cope energy need of the community of the whole world for indefinite period.