ENERGY RESOURCES

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Submitted by-

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-PRINCE SAHA

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1. INTRODUCTION

With the phenomenal rise in human population, natural resources are being heavily taxed all over the world. No doubt at present, total global production is nearly enough to match the human demands for energy and materials if we judiciously distribute the resources available to us. However, looking forward to future scenario, the situation appears pretty grim.

Up to 1700AD most of the power available to human society was limited to solar energy trapped by green plants which produced organic matter. It was the biological oxidation of this organic matter, which fuelled the muscle power while combustion of organic matter provided energy for other purpose such as lightning, cooking, heating etc.

The formation of fossil fuels (coal, oil and natural gas) is also due to photosynthesis carried on by plants, which occurred millions of years ago.

These were, however, not in general use before the beginning of industrial revolution. Energy requirements of man were modest and could be fulfilled by solar energy 'recently' fixed by green plants. The situation has now changed drastically….

2. MEANING

Natural resources form the very basis of entire life on this planet.

A resource can be renewable or nonrenewable. Renewable resources are those resources which can be regenerated, whereas non-renewable cannot be regenerated once they are exhausted.

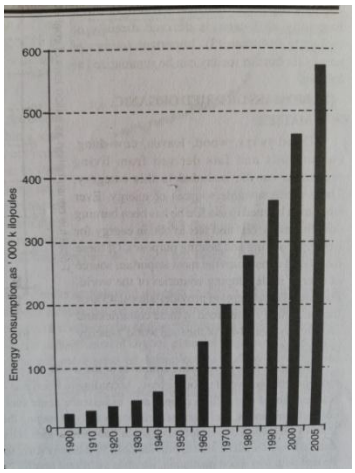
Our high-grade mineral deposits and deposits of fossil fuels are non-renewable resources as a finite quantity of mineral elements, coal, oil and natural gas is present on our planet, which may be consumed completely. There formation requires millions of years, which cannot occur within the human scale time. Unlike fossil fuels, mineral elements are inexhaustible, i.e., we cannot consume them irrecoverably, yet the concentrated deposits, which occur today, can disappear at some point of time in future.

Neither energy nor matter can be created or destroyed. No one, howsoever advanced technologically, can create something out of nothing nor can anything be so discarded as to become nothing. A constant flow of materials is needed to maintain living beings, a society or an economy, which must come from somewhere, whereas a continuous stream of discarded wastes has to go somewhere. The total amount of matter present on our planet is fixed – except for some cosmic particles entering and some gases leaving form outer atmosphere.

The enormous changes, which take place every day, involve changes in the state, mix and distribution of material on earth. Plant communities grow, die, or burn away. Large quantities of water evaporate, condense and rain back to earth's surface. Volcano erupt, emit, ash and gases, create new islands or bury cities. Each year man extracts billions of tons of earth, transform them chemically creating new molecular combinations, which never existed before. All these activities require energy, which come only from just three sources-the incoming solar radiations, energy from nuclear fission and the residual heat of earth's core. Fusion energy is the only source of energy which man has not been able to harness till date

In other words, as far as the matter is concerned, our planet is nearly a closed system-nothing enters or leaves it. It is this finite quantity which circulates again and again in repeating channels to sustain life on this planet. However, for energy, earth is an open system. It receives large amount of energy from sun, much of which is to be radiated back to space in order to maintain a control temperature. Mankind's immediate environment, therefore, the planet earth, is limited in size and space as well as in its material resources.

3. GLOBAL ENERGY CONSUMPTION



Minimum per capita energy requirement of man is about 2000 kcals which is the quantity required to keep him alive and is obtained from food he eats. In a primitive society, apart from cooking, lighting, heating etc. there was little need of more energy.

Industrial revolution has, brought in an era of concentrated use of large amounts of energy. Per capita energy consumption, which was a little more than 2000 kcals has now shot up to about 100 times in technologically advanced countries of the world. There has been a rapid and steady rise in global energy consumption ever since the fossil fuels came into the widespread use. We have entered an 'Age' of rapid consumption of fossil fuels, which represents the photosynthesis of millions of years ago. Per capita consumption of energy is not the same all over the world. It is the highest in advanced Western countries. Only 20% of the world people consume about two-third of the total energy produced by man while the rest of the population has to live with only one-third of the energy supply. To millions of people living in developing countries of the world electricity is still a dream, fossil fuels are difficult and costly to obtain and biomass constitutes the only source of energy

Energy sources are also classified as Conventional and Non-conventional sources.

A) Conventional Sources of Energy

- The sources of energy which have been in use for a long time, e.g., coal, petroleum, natural gas and water power.

- They are exhaust able except water.

- They cause pollution when used, as they emit smoke and ash.

- They are very expensive to be maintained, stored and transmitted as they are carried over long distance through transmission grid and lines.

B) Non-Conventional Sources of Energy

- The resources which are yet in the process of development over the past few years. It includes solar, wind, tidal, biogas, and biomass, geothermal.

- They are inexhaustible.

- They are generally pollution free.

- Less expensive due to local use and easy to maintain.

Energy Sources Conventional Sources	**Non-Conventional Sources**
Coal Oil and Natural Gas Thermal power Firewood (Fuel wood) Hydropower Nuclear (Nuke) energy	Solar energy Wind energy Ocean (Tidal) energy (Water) Geothermal energy Bio energy (Biomass)

Keeping in view, the growing energy needs, use of non-conventional energy sources, over conventional should be promoted. A brief account of the various conventional and non-conventional sources of energy with special reference to Indian scenario is presented as follow.

4. Conventional sources of energy

The conventional sources of energy are generally non-renewable sources of energy, which are being used since a long time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a great extent. At the same time it is becoming increasingly difficult to discover and exploit their new deposits. It is envisaged at known deposits of petroleum in our country will get exhausted by the few decades and coal reserves are expected to last for another hundred years.

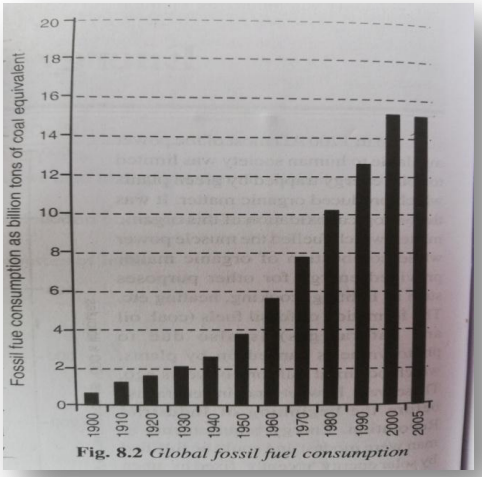


Fig. 8.2 *Global fossil fuel consumption*

Along with the coal, petroleum and natural gas, electricity is conventional source of energy, which is playing a barometer of a nation's economic well-being. Availability of abundant electricity means unrestricted growth of industries, transport and agriculture. Depending upon raw material used, various types of electricity are hydroelectricity, thermal electricity (steam, gas, oil) and nuclear electricity.

4.1. Coal

Coal is one of the most important sources of energy and is being used for various proposes such as heating of housed, as fuel for boilers and steam engines and for generation of electricity by thermal plants.

Coal has also become a precious source of production of chemical of industrial importance coal is and will continue to be the mainstay of power generation in India. It constitutes about 70% of total commercial energy consumed in the country.

Coal was formed around 255-350 million years ago, during the Carboniferous age, in hot damp regions of the earth. The plants and animals that occurred during this period, along the banks of rivers and swamps, got buried alive or after their death into the soil and due to heat accompanied by pressures gradually got converted into peat and coal over a millions of years of period. Partially decomposed vegetation deeply buried in sedimentary environments slowly transformed into solid, brittle, carbonaceous rocks commonly known as coal.

The coal is mainly of three types: anthracite (hard coal), bituminous (soft coal) and lignite (brown coal). There properties are discussed in Table

Table -: Types of Coal

Type of coal	***% C (Carbon)***	***% O (Oxygen)***	***Volatiles %***	***% Moisture***	***Calorific Values***
Lignite	60-70	16-18	45	35	5000-6000
Sub-bituminous	75-83	14-15	40	17	6100-6500
Bituminous	78-90	9-10	20	06	6600-7500
Anthracite	92-98	2-3	05	01	7500-8100

Since independence, coal production has steadily been rising in India. From a meager 32.3 million tons in 1950, annual coal production jumped to about 162.3 million tons in 1985. The upward trend continues even today. In the year 1994 we produced about 262.7 million tons of coal of all type. Coal reserves in India have been estimated to be about 200 billion metric tons. About 26.2 billion metric tons of this quantity occurs below a depth of about 600 meters in India collieries, for our practical purpose the total reserves available are approximately 173.8 billion metric tons. Future coal demand is expected to rise to about 340 million tons by 2000 A.D., 430 million tons by 2010 AD. So if we compare the project demands with our available reserves, it is apparent that India has

plenty of coal to last for at least four or five centuries. Most of the coal produced in India, about 65% is used to produce electricity.

4.2. Oil and Natural Gas

a) Crude oil or Petroleum

We produce only 2.3 lakh tons of petroleum crude at the time of independence. Within a span of about 25 years, we were able to raise our crude oil production by about a hundred times. In 1985 the production was 302 lakh tons. The rising trend was maintained till 1990 in which year we extracted about 341 lakh tons of crude oil, after which there was a slow decline which continued for a period of about four years. This downward trend has now stopped and a slow and steady increase is expected in years to come (Fig 8.4).

In India, crude oil was first recovered from Makum in North East Assam. Later, drilling for crude oil was done at Digboi, Dibrugarh, Narharkatiya and Surma valley in the north east. The oil field also lies around Bay of Cambay, Gujarat. The most important achievement was the exploration of oil in Bombay High on the continental shelf of Maharashtra, located at a distance of 167 km north-west of Mumbai. Recently oil has been located on the off-shore area of the deltaic coasts of Godavari, Krishna, Cauvery and Mahanadi. Oil prospects in India are not so high as coal. But the demands are very high and the country has to import oil from OPEC countries at higher rates.

Indian oil reserves are about 4.45 billion tones out of which about 1257 million tones are recoverable. Since 483 million tones have been extracted, the recoverable balance is now about 774 million tones which shall last within next 25 years with the condition that crude oil production rate of about 30 million tones per year is maintained.

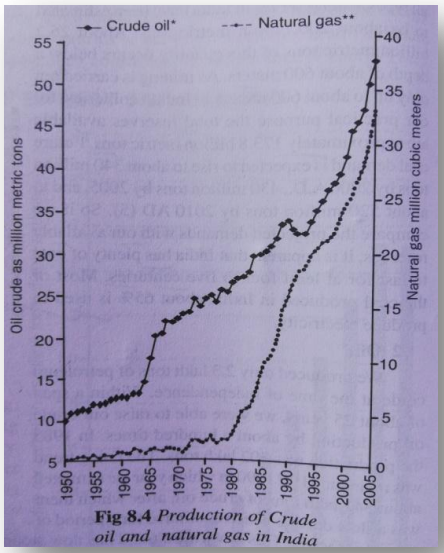


Fig 8.4 *Production of Crude oil and natural gas in India*

b) Natural Gas

India has a huge reserve of natural gas of which a large amount flares up due to lack of adequate storage, compression and transportation facilities as a result about 17 million cubic meters of gas a day is wasted or burnt. Now the gas is distributed from Bombay High to Rajasthan, Gujarat, Madhya Pradesh and Utter Pradesh by a 1730 km pipeline, the Hazira-

Vijapur-Jagdishpur pipeline. A similar pipeline is proposed for South India to feed the natural gas of Bombay High and the gas imported from West Asia to southern states. A gas grid is also proposed for Assam.

The production of natural gas was about 2.2 billion cubic metres in 1980-81. Between the years 1980-1990, its production rose from 2.2 to about 17 billion cubic metres. After 1990the production has somewhat slowed fluctuating between 17 to 20 billion cubic metres. This leaves a recoverable balance of about 714 billion cubic metres only.

LPG: Liquefied Petroleum Gas (LPG), widely used as a domestic fuel for cooking, has its main content as odorless butane to which other gases like propane and ethyl mercaptan are added to give fowl smell to identify leakage. It is obtained by converting petroleum into liquid from under pressure.

CNG: Compressed Natural Gas (CNG) is used as an alternative to petrol and diesel for transport of vehicles. CNG is a cleaner fuel than diesel, used currently in many cities and long distance transport across the country. It contains mostly methane, compressed to 80 atmosphere. It is an ideal cleanest burning alternative fuel.

4.3. Thermal Power

Thermal power plants use coal, petroleum and natural gas to produce thermal electricity. These fossil fuels are exhaustible and polluting. Electricity is the most convenient and versatile form of energy. This is in great demand in industry, agriculture, transport and domestic sectors.

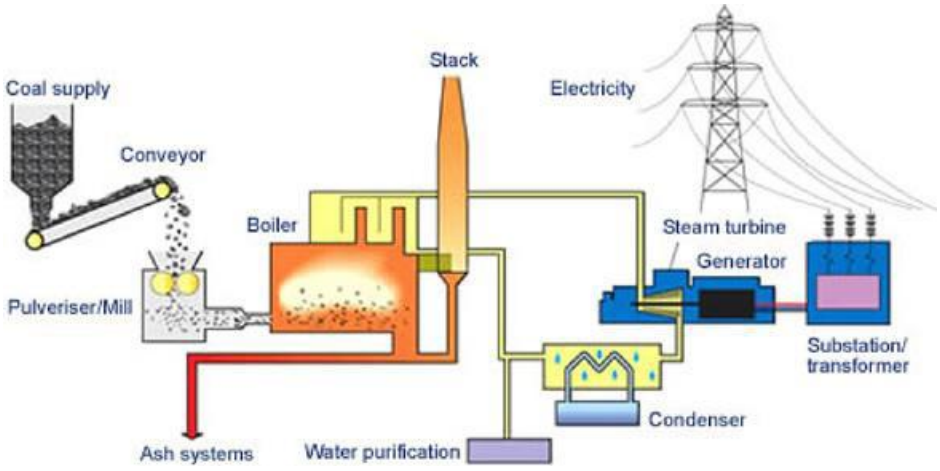


Fig. – Thermal power plant

In thermal power plant, fossil fuel is blown into the combustion chamber of a boiler where it is burnt at high temperature (Fig). The hot gases and heat energy produced converts water – in tubes lining the boiler – into steam. The high pressure steam is passed into a turbine containing thousands of propeller-like blades. The steam pushes these blades causing the turbine shaft to

rotate at high speed. A generator is mounted at one end of the turbine shaft and consists of carefully wound wire coils. Electricity is generated when these are rapidly rotated in a strong magnetic field. After passing through the turbine, the steam is condensed and returned to the boiler to be heated once again.

The electricity generated is transformed into the higher voltages (up to 400,000 volts) used for economic, efficient transmission via power line grids. When it nears the point of consumption, such as our homes, the electricity is transformed down to the safer 100-250 voltage systems used in the domestic market. Both, big and small power stations are scattered all over the country. Electricity produced by them is fed into regional grids. It is proposed to have a single national grid.

Improvements continue to be made in conventional thermal power station design and new combustion technologies are being developed. These allow more electricity to be produced from less coal - known as improving the thermal efficiency of the power station. Efficiency gains in electricity generation from coal-fired power stations will play a crucial part in reducing CO2 emissions at a global level.

4.4. Firewood (Fuel wood)

Firewood (biomass) is a used as energy source since historical time. It is widely used for cooking and heating. In our country more than fifty per cent of the energy used by villagers comes from fire wood. It may be seen that nearly 70 % of the firewood demand pertains to the rural areas. Only 50 Mt. of the fuel wood may become available from natural resources. According to a report, for next 15 years or so the average fuel wood contribution from natural forest would be 0.75 t/ha/yr and the rest is to be met from the plantations. Whole of the required plantations is to be non-agricultural land, degraded forest land, culturable waste land, barren/inculturable land, permanent pasture and grazing lands.

4.5. Hydro-Power

The energy of flowing waters can be used to drive turbines to convert it into electricity. In India the generation of hydro-electricity has been emphasized right from the beginning of our First Five Year Plan . By the end of IV Plan in the year 1974 we were able to develop an installed hydro-electricity generation capacity of about 6.9 thousand megawatts which constituted about 42% of the total installed power generation capacity. However, as the demand for electric power grew hydro-electricity could not keep pace with the power generation from other sources and by 1995, the last year of VII Five Year Plan, its share in total installed power generation capacity fell down to about 25%.

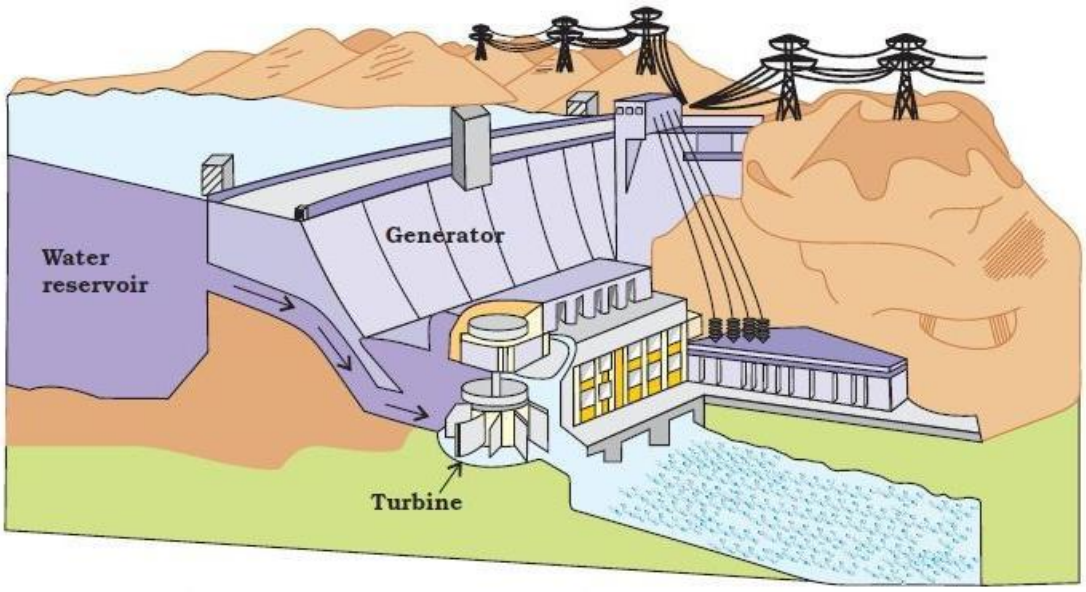


Fig. - Hydroelectric Power

The clean, renewable energy resource has some drawbacks. The initial cost of hydro-electricity generation is high and there is a long period after which the expenditure incurred pays dividends. The huge volumes of water which have to be stored for power generation sub-merge large portions of land, displace natural communities and could be hazardous for people living down-streams in case of earth quacks, accidents or sabotage as a breach in the dam may wash away and destroy the entire area below. This has caused a lot of controversy about a number of important projects in India in the face which some very important projects proposed for power generation and irrigation have been slowed down.

4.6. Nuclear (Nuke) Energy

Nuclear energy can be generated by nuclear fission in which nucleus of certain isotopes with large mass number is splitted in to lighter nuclei on bombardment of neutrons in order to release a huge amount of energy through a chain reaction or by nuclear fusion in which two isotopes of light elements are forced to form a heavier nucleus releasing enormous energy in the process. The heat energy produced as a result of either of the process is used to produce steam which runs electric turbine and generates electricity (Fig.). The process of nuclear fusion is difficult to initiate but releases more energy than nuclear fission.

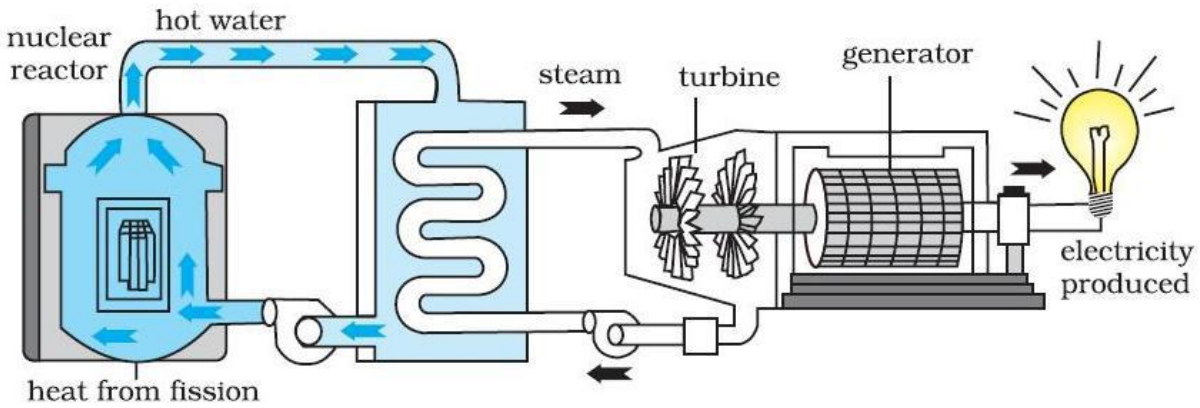


Fig. – Nuclear power reactor generating electricity

Nuclear energy has a tremendous potential but any leakage from the nuclear reactor may cause devastating nuclear pollution including world's most hazardous Chernobyl disaster. Disposal of nuclear waste is also a troublesome process. Uranium, a rare element, is the primary source of nuclear energy although thorium can also be converted into uranium isotopes and used as a fuel. Today nuclear energy accounts for about 6 percent of total commercial energy.

There are over 300 atomic power plants, operating in the world. The maximum are in USA (83), followed by USSR (40), UK (35), France (34), Japan (25), F.R. Germany (15) and Canada (13).

In India first nuclear power station was raised at Tarapore, near Mumbai in 1969. The nuclear power is still not well developed as there are only five nuclear plants, namely, Narora (UP), Rawatbhata (Rajasthan), Kakrapur, Tarapur (Maharashtra) and Kalpakkam (TamilNadu). At present country produces 2250 MW (2.6 % of the country's total installed power generation capacity) from these nuclear power generation plants. By 2050, it is expected to rise to 25 percent. In India uranium deposits are found in Gaya and Singhbhum districts of Bihar, Udaipur and Jaipur district of Rajasthan, Nellore district of Andhra Pradesh, and Palghat district of Kerla. Reserves of thorium are found in Rajasthan and Andhra Pradesh and coastal parts of India.

5. Non-Conventional Sources of Energy

The increasing use of fossil fuels is leading to its shortage. It is estimated that if the present rate of consumption continues, the reserves of these fuel will get exhausted. Moreover, their use also causes environmental pollution. Therefore, there is need for using non-conventional sources such as solar, wind, tides, geothermal heat, and biomass including farm and animal waste as well as human excreta. All these sources are renewable or inexhaustible and do not cause environmental pollution. Moreover, they do not require heavy expenditure. They are capable of solving the twin problems of energy supply in decentralized manner and helping in sustaining cleaner environment.

5.1. Solar energy

Earth receives about 75,000*10^11Kw of energy from sun every day. Just 0.1% of this energy is sufficient to meet the energy requirement of the entire world. At noon, the solar energy striking an area of 12,550sq. km if converted to electricity shall be equal to the peak power generation capacity of all power plants in the world. Only a part of the roof of an average house in India if covered with solar panels can provide sufficient energy to meet entire energy requirement of the house.

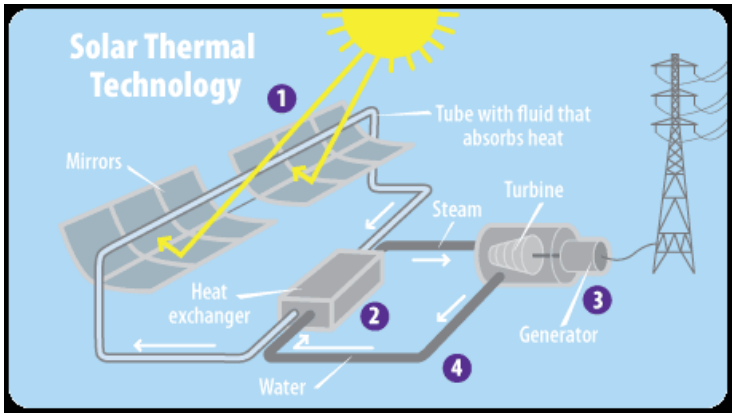


Fig. – Solar energy

In parts of the world, which receives abundant sunshine, solar heat can be used directly for heating and cooking purposes (As in solar cookers). Intense sunlight focused with reflectors, which track the sun as it moves across the sky, can save a large amount of energy, which we use to keep space warm, heat waters, and for cooking purposes. Solar energy can be converted to mechanical, chemical or electrical energy also. Silicon solar cells can convert solar radiation directly into electricity and can be used for domestic lighting, run television sets, radio-instruments and for community lighting. These systems are costly to install, however, once installed there is little expenditure involved and the device works for years and years together.

5.2. Wind Energy

Approximately 11*10^21 Joules of solar energy incident on our planet surface are used up in generating air and water currents. In a number of countries where persistent strong wind blow, wind energy has been in use since ancient times. Across the passing air current large fans are placed whose revolving motion is carried down, through a shaft to drive water pumps, wind mills, turbines etc. Wind power provides cheap, clean and inexhaustible energy to small villages, domestic establishments, small-scale industries etc.

The main drawback of wind energy is its erratic and irregular supply. However, there are places where strong blow for most the day or nights. At

these places this inexpensive, inexhaustible energy resources can be used to save power obtained from other sources by concentrating work during the periods when wind power is available.

5.3. Ocean Energy

Oceans are vast reservoirs of water covering about three-forth of earth's surface. They can also be used for generation of power in the following ways

(a) Tidal energy:

Gravitational pull exercised by sun and moon causes tides to develop. Sea level rises and falls depending upon the position of sun and moon. As the sea level rises water may be diverted through suitable channels to inshore reservoirs, driving the turbines during its entry. The stored water may gradually be released driving the turbines again during the periods of low tide. In this way an inexhaustible, clean and cheap power shall be available to mankind. Total tidal energy potential has been estimated to be about 2*10^18 Joules per year.

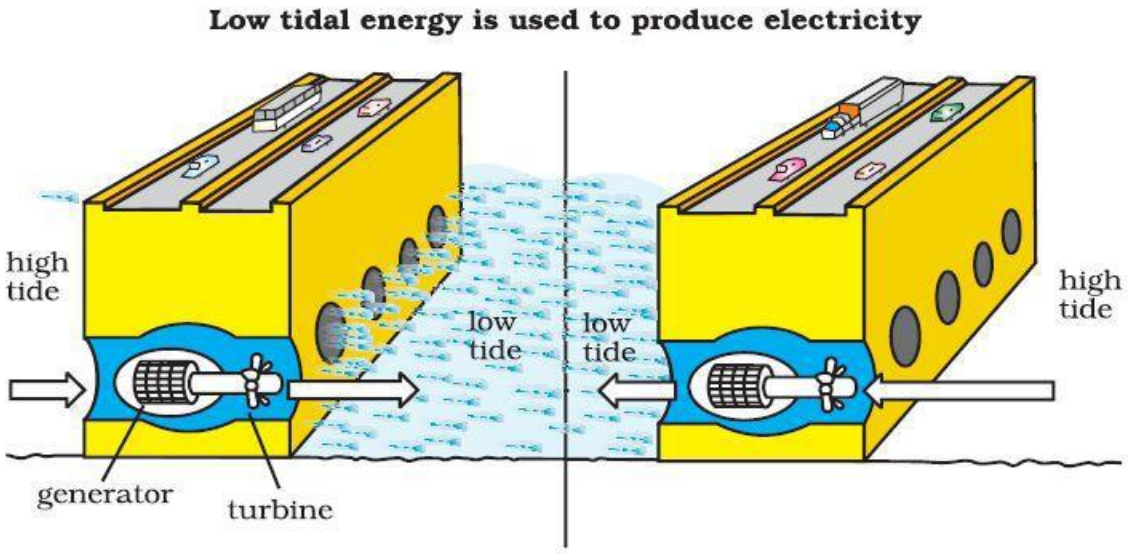


Fig. - Tidal energy

(b) Geo-thermal energy

Temperature of earth increases at a rate of 20-75 degree C per km as we move down from earth's surface. The heat could be used by circulating waters through pipes to raise steam and generate electricity. For satisfactory results, it would be useful to drill and locate the turbines near already known hot springs or thermal springs, volcanoes etc. For this reason, geothermal energy shall be of a local interest only. The total geothermal energy

potential of the world, if properly utilized could provide about 2*10^18 to 20*10^18 Joules of energy per year.

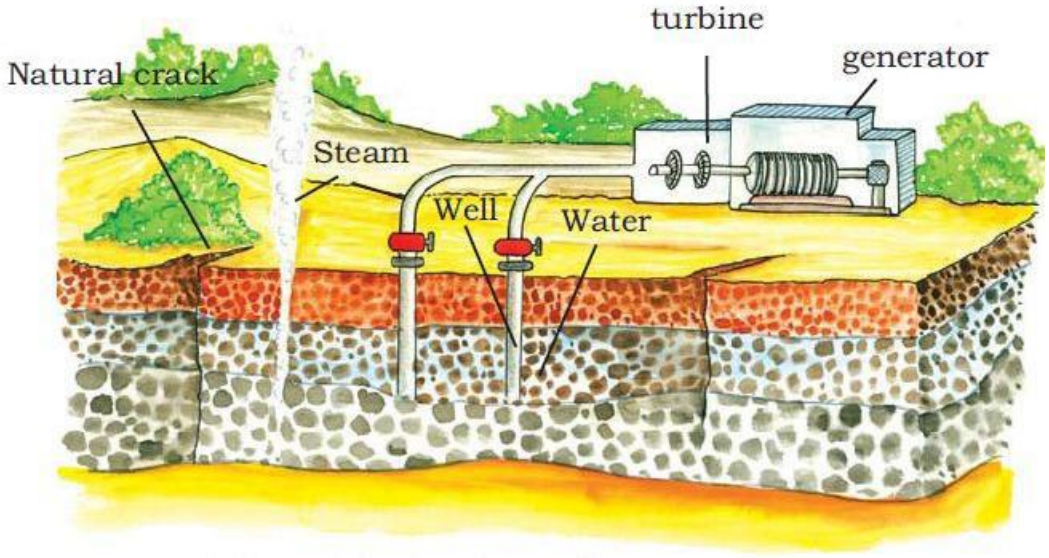


Fig. Geo-thermal energy

5.4. Energy from Biomass

Biomass generally refers to the organic matter generated by plants through photosynthesis, wherein solar energy combines with CO2 and moisture to form carbohydrates and oxygen. Materials having combustible organic matter are referred to as biomass. Biomass contains C, H and O which are oxygenated hydrocarbons. It generally contains a high level of moisture and volatile matter but has a low bulk density and calorific value.

Biomass refers to all plant material and animal excreta when considered as an energy source. Some important kinds of biomass are inferior wood, urban waste, bagasse, farm animal and human waste. Coal is the end product of a sequence of biological and geological processes that biomass undergoes.

Biomass energy is the utilization of energy stored in organic matter. It is humanity's oldest external source of energy, dating back to prehistoric man's first use of fire. And biomass is still an important part of the world's energy system; the use of traditional biomass—charcoal, firewood, and animal dung—in developing countries accounts for almost 10% of the world's primary energy supply.

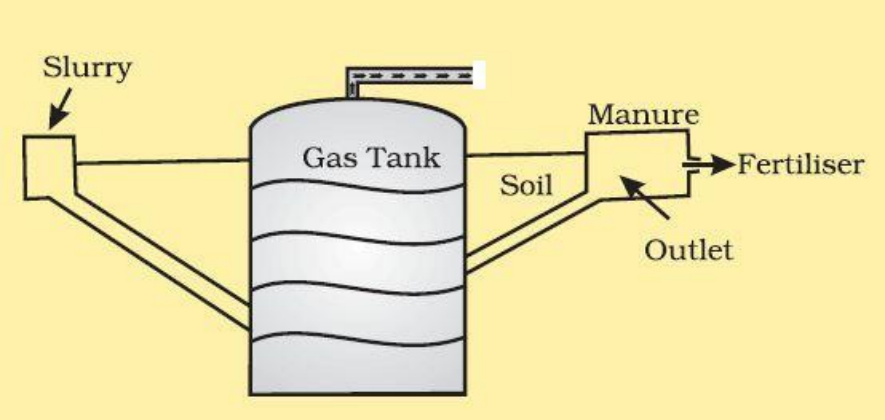


Fig. – Biogas Production

Field and plantation biomass	**Industrial biomass**	**Forest biomass**	**Urban waste biomass**	**Aquatic biomass**
Agricultural crop residues- Cobs, stalks, Straw, Cane thrashes and etc	Agro-industrial processed biomass and their wastes: Husk	Timber	Municipal solid wastes	Microalgae blooms
Edible matters from crops- Environmentally spoiled grains, pulses, fruits, nuts, spices, seeds and lint etc	Oil cake Sugar bagasses Sugar molasses, Whey Hides and skin wastes	Log residues Forest floor debris	Sewage sludges	Sea weeds (E.g. Kelp)
Dedicated energy crops- Bamboo, Prosopis, Casuarinas, Willow and poplar etc	Fruit and pulp debris Saw dust		Kitchen and canteen wastes	
Plantation debris-Leaves, stubbles, barks and trunks etc	Wood pulp and paper shavings	Animal carcass		Fresh water weeds (E.g. Water Hyacinth)
Livestock wastes from fields, slaughter houses and animal husbandries etc	Fermented microbial mass etc			Dead fishes

India is the 7th largest country in the world spanning 328 Million hectares and amply bestowed with renewable sources of energy. It has been estimated that India produces about **450 million**

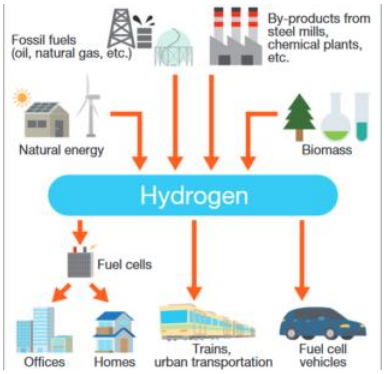
tonnes of biomass per year, of which about **200 million tonnes** is surplus. Biomass tops the list in providing 32% of all the primary energy use in the country

6. **Hydrogen as the future fuel for humanity:**

Like natural gas and oil, hydrogen can provide the concentrated energy needed in domestic establishments, factories and motor vehicles. Hydrogen when burned produces 284 kilo-joules per mole of energy (or 142 kilo-joules per gm) and the product of combustion are water vapors only.

On weight-basis hydrogen is a better fuel than methane, the common constituent of natural gas. Methane produces only 55.6 kilo-joules per gm of energy as compared to hydrogen, which yields 142 kilo-joules per gm of gas burnt. Hydrogen is a cleaner fuel than any other gas or oil as it produces water only upon combustion. However, the storage of hydrogen poses problems because of its low density. Its storage in pressurized tanks in liquid state makes the containers too heavy to carry. Its storage as metal hydride from which the gas can be recovered by heating is also expensive.

Though abundant supply of this gas occurs in the form of water(h2O), at present hydrogen is about four to five times costly to obtain than methane. Active research is underway to produce cheaper hydrogen and develop adequate and less costly means for its storage and use. The promise of inexhaustible pollution free energy resource makes hydrogen an important energy carrier of the future.



7. Conclusion

Developing renewable energy can help India increase its energy security, reduce adverse impacts on the local environment, lower its carbon intensity, contribute to a more balanced regional development, and realize its aspirations for leadership in high-technology industries. According to a report, India is the third most favoured destination globally, for investments in the renewable energy sector. The report also says that the country will be a major source of new entrants into the sector, after the US and China. The Indian renewable energy market has become increasingly dynamic in recent years as a result of strong natural resources, greater accommodation to international investments and a variety of government incentives. Solar and wind energy will be the major areas to witness overseas investments and acquisitions in the near future.

With all the attractive characteristics and potential stated above, India presents a significant market opportunity for renewable energy firms worldwide. However, these firms will need external guidance and assistance on several strategic and operational aspects before they are in a position to effectively tap into this opportunity.

8. Future scope

It was the energy crisis of 1973 and 1978, which forced people to recognize the vulnerability of oil-based economy all over the world. Sincere efforts were undertaken to develop non-conventional sources of energy. In India, also, efforts to utilize non-conventional, renewable sources of energy were started only during seventies and a separate Department of Non-conventional Energy Sources (DNES) was established.

Conventional sources of energy, coal, oil, natural gas and nuclear energy – are non-renewable and their use is invariably associated with problems of environmental pollution. Hydroelectric power generation has its own drawbacks. Large-scale use of wood, which has an important source of energy in Indian villages, leads to deforestation. Moreover, the centralized system of power generation, which we have developed, with conventional sources of energy involves huge distribution networks. These are wasteful and expensive to maintain.

Non-conventional sources provide energy in decentralized manner to small areas and can reach places where it is difficult to carry fossil fuels or power lines. Large-scale use of non-conventional energy resources tends to reduce the burden from conventional energy systems and therefore is helpful in enlarging their life span. The Indian efforts in the direction of utilizing non-conventional energy resources have been centered on utilization of solar thermal energy, conversion of solar energy into electricity, wind energy and biomass based energy resources.

India is one of the largest programs in the world for deploying renewable energy products and systems. It has definitely stepped into the world markets of renewable energy and is steadily becoming a leading destination for investors from developed countries. The government's active participation in the promotion of renewable energy projects along with key incentives offered like tax concessions managed to attract investment in this sector. The government's aim to increase the use of cleaner fuels finally bore fruit with key credit to the dedication of institutions working towards the same like the MNRE, IREDA etc.

However, the government needs to sort out its internal issues which are hindering the nation to achieve its target to tap potential energy resources. One of the thrust areas in this regard is the inter-state disputes on a particular energy resource. India is blessed to have such a huge potential in renewable energy resources and the country should exploit this to the maximum extent so as to meet its on-going energy deficit issues and reduce its dependence on other countries to acquire fuel and other resources. India has the required capabilities of becoming self reliant in energy generation and can even attain world leadership in this sector.

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