

CHAPTER-09

RENEWABLE ENERGY RESOURCES : A FUTURE ASPECT OF ENERGY

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9.1 INTRODUCTION

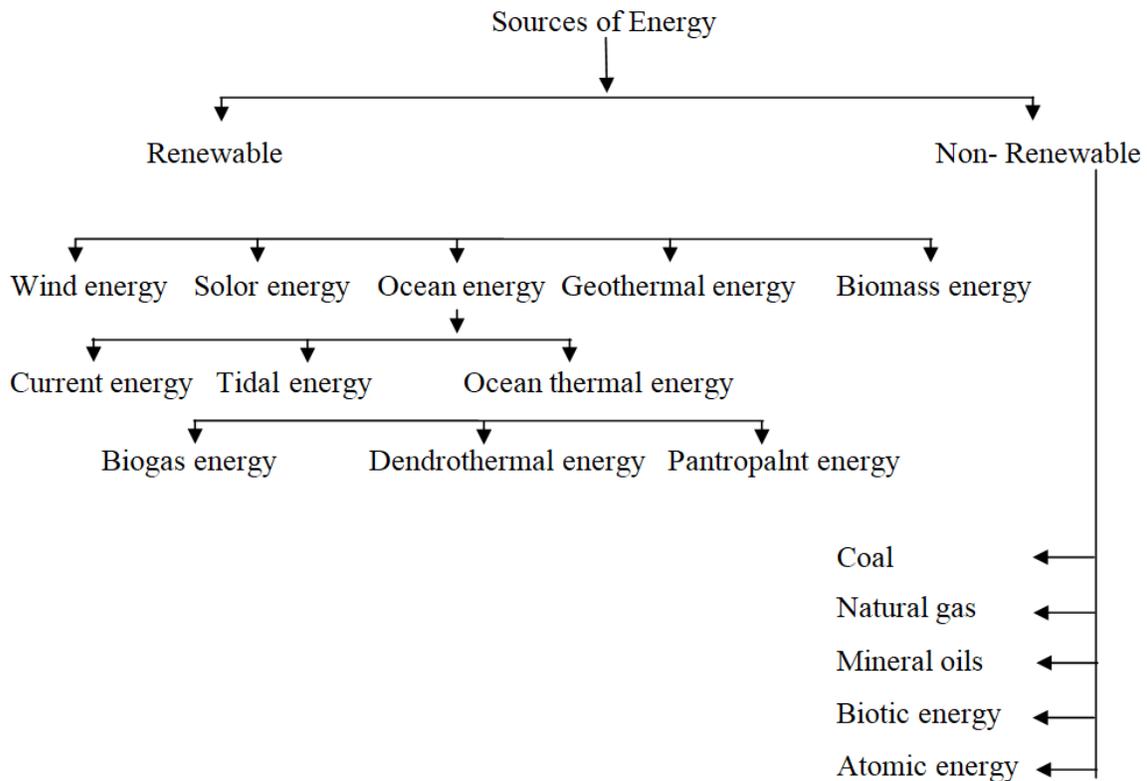
Energy is the fundamental need of any society. The economic development is directly linked with the energy resources. The demand for energy has increased with the economic development of the world. It is a power which is needed in one form or the other to do work. In the older days, man used his muscular power. Later on, domesticated cattle power was used for doing the work. In 1750 Machine power was used in the development sequence of human civilization, for the improvement of traditional skills and for the development and improvement of new techniques. On account of industrialization, urbanization, agricultural technology transmission and transport, the demand of energy has increased tremendously. Increase in population is also the main cause of increase in energy demand. On one side the demand of energy has increased, while on the other side the energy sources are depleting fast. It is essential there to reduce dependence on such energy sources and the need of the hour is to explore and exploit. The renewable or alternative sources of energy which can save us from the energy crisis and the major source of energy in future include wind energy, solar energy, tidal energy, geothermal energy and Biomass energy.

Over 80% of India's energy needs are met by three fuels: coal, oil and solid biomass. Coal has underpinned the expansion of electricity generation and industry, and remains the largest single fuel in the energy mix. Energy is primarily tanned from oil and four of these energy sources are free from causingsame impacts on environment enable development in search impacts and taking recreationally steps to minimize them in order to safeguard the environment. It is also evident that environmental sources of energy getting depleted rapidly. At present energy is an important input for development. Energy is needed by all the living organisms and vegetation for biochemical reaction of their cells. It aims at human welfare covering household agriculture transport and Industrial complex like other natural resources. Non-renewable energy resources are available in Limited amounts and develop over a longer period as a result of unlimited use they is likely to be exhausted these include coal, Mineral oil, nuclear power, Petroleum and natural gas. In other words, we can say that

- 1) Any heat or material/substance which is used in any activities can be called as energy resources.
- 2) Such resources from which capacity to do work is obtained are called as energy resources.

9.1.1 TYPES OF SOURCES OF ENERGY

There are two major renewable energy sources -



❖ Renewable /Non-conventional/Exhaustible Energy Resources

Renewable energy is energy from sources that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. It is sustainable - something that can't run out, or is endless, like the sun. When you hear the term 'alternative energy' it's usually referring to renewable energy sources too. It means sources of energy that are alternative to the most commonly used non-sustainable sources. Renewable energy sources are energy sources that are collected from renewable resources that are naturally replenished on a human time scale, they can never be depleted. Some examples of renewable energy sources are solar energy, wind energy, hydropower, rain, tide waves, geothermal energy, and biomass. Although most renewable energy, comes from natural sources or process that are constantly replenished.

Every day we rely on energy to provide us with electricity, hot water, and fuel for our cars. Most of this energy comes from fossil fuels, such as coal, oil, and natural gas. These are non-renewable energy sources, which mean that if we use them all up, we can never get more during our lifetime. Fossil fuels also contribute greatly to global climate change by releasing

carbon dioxide into the air when they are burned. Because fossil fuels can run out and are bad for the environment, it is important that we start switching to other energy sources, like renewable energy source. These energy sources are constantly being replenished, such as sunlight, wind, and water. This means that we can use them as much as we want, and we do not have to worry about them running out. Additionally, renewable energy sources are usually much more environmentally friendly than fossil fuels. Overall, they release very few chemicals, like carbon dioxide, that can harm the environment.

Currently, less than 10% of all the energy we use comes from renewable sources. So, you might be wondering, 'if renewable energy sources do not harm the environment and will not run out, then why are we not using them everywhere and all the time?' It is because many of them are currently expensive to harness, are inefficient, or have other disadvantages. For example, using energy from the wind might be great in an area that is really windy all year-round, but it wouldn't work so well in an area with very little wind.

❖ **Advantages of Renewable Energy**

- Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution. It has numerous environmental benefits.
- Diversifying energy supply and reducing dependence on imported fuels.
- Creating economic development and jobs in manufacturing, installation, and more.
- Renewable energy won't run out.
- Renewable energy has lower maintenance requirement.
- Renewable energy save money.
- Renewable energy lower reliance on foreign energy sources
- Renewable energy leads to cleaner water and air.
- Renewable energy can cut down on waste.

❖ **Disadvantages of Renewable Energy**

- Renewable energy has high upfront costs.
- Renewable energy is intermittent.
- Renewable energy has storage capabilities.
- Renewable energy sources have geographic limitations
- Renewable energy isn't always 100% carbon-free.

9.2 TYPES OF RENEWABLE ENERGY REOURCES

Energy generated by using wind, tides, solar, geothermal heat and Biomass including farm and animal waste as well as human excreta is known as non-conventional energy. All these sources are renewable or inexhaustible and do not cause environmental pollution. Moreover, they do not require heavy expenditure.

The most popular renewable energy sources currently are:

- Solar energy.
- Wind energy.
- Tidal energy.
- Geothermal energy
- Biomass

9.2.1 SOLAR ENERGY

Sun is the source of all energy on the Earth. It is most abundant inexhaustible and universal source of energy. All other sources of energy draw their strength from the sun. India is blessed with plenty of solar energy because most part of the country receive bright sunshine throughout the year except a brief monsoon period. Most of the energy received from the sun is in the form of short-wave radiations of light. When this radiation strikes a solid or liquid, it gets absorbed and transformed into heat energy. Electric energy or electricity can be produced directly from solar energy by means of photovoltaic cells. The photovoltaic cell is an energy conversion device which is used to convert photons of Sunlight directly into electricity. The Solar thermal route uses radiation in the form of heat that in turn may be converted to mechanical, Electrical or chemical energy. Solar thermal devices like solar cookers, solar water/air heaters, solar dryers, solar wood seasoning kilns and silicon systems have been developed. a solar cooker consisting of an aluminum reflector (10 square feet in area) has been tried and introduced by DNES in extremely cold and remote areas of Laddakh. IITs have been successful in developing the technology to trap solar and wind energy on the icy continent of Antarctica and remote area of Leh and Laddakh.

❖ **Application :** There are many applications of solar energy namely solar water heating, solar distillation and Solar pumping, solar furnaces, solar electric power generation, solar greenhouse, solar cooking.

❖ Advantages of Solar Energy

Some very popular advantages of the solar energy is given here

- Solar equipment does not create pollution.
- Most solar equipment does not require any serious attention for their working. for example, the food will be cooked simply by putting a solar cooker in sunlight. The taste of the cooked food remains quite natural and its nutritional value is also not affected.
- In most solar equipment the maintenance cost is negligible.

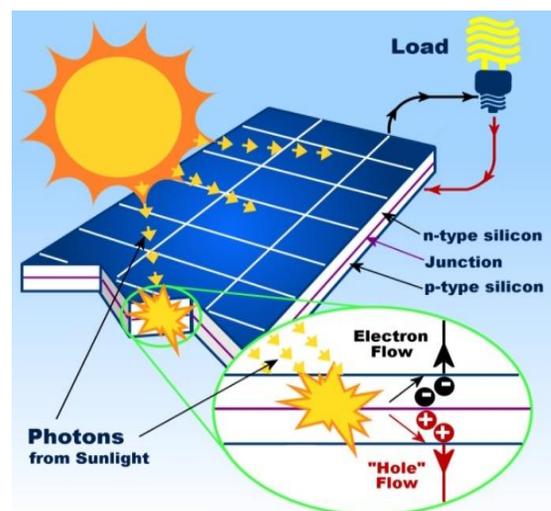


Figure : 9.1, Source : www.mrsolar.com/what-is-a-solar-panel

- No need of containers to store the fuel
- Occupies less space on floor as there is no need of storage vessels
- Noiseless operation

Limitations of Solar Energy : The limitations of solar energy is given here

- a) Solar equipment fails to work in nights or during cloudy days.
- b) Solar equipment is costly.
- c) All sorts of food cannot be cooked in solar cooker.
- d) Solar cooking takes more time so it is therefore not suitable for quick needs.
- e) Computers powered by solar panels- Devices designed to charge laptops and mobiles through solar energy. Through these computers and mobile can be charged anywhere where sunlight is available.
- f) Heat of water
- g) Using technology based on solar energy which can be used to heat mobile for commercial and industrial use.
- h) Through solar energy, vehicles are now being manufactured by means of solar energy by NASA HELIOS by a multinational company War machine Odysseus A solar car Quant And airplane Impulse have been manufactured, solar appliances, solar lanterns, lights and music players, etc. Various types of household appliances are being used, the use of long distances has increased and solar panels were used by India Mass orbiter mission (MOM) in the mission.
- i) Solar power is being built to meet the increasing demand for energy The world's largest solar plant has been built in Tamil Nadu. Its capacity is 648 megawatts.

9.3 SOLAR POWER IN INDIA

India's dense population and high solar energy make solar energy an ideal energy source for India, but solar energy is constantly expensive and this but it requires huge investment and its form is stable, due to this it has to be organized. Lack of public awareness High cost of production and limitations of existing energy release and transmission network have been considered as the main impediments towards full exploitation of solar energy potential across the country 250 to 300 Indus in 1 year in most part of India and the solar radiation of 4 to 7 kWh is received per square meter per day. Despite having 30 to 50 MW per square kilometer area in the country, the exploitation of solar energy in the country is less as compared to the available capacity.

National Institute of Solar Energy has assessed the Country's solar potential of about 748 GW assuming 3% of the waste land area to be covered by Solar PV modules. Solar energy has taken a central place in India's National Action Plan on Climate Change with National Solar Mission as one of the key Missions. National Solar Mission (NSM) was launched on 11th January, 2010. NSM is a major initiative of the Government of India with active participation from States to promote ecological sustainable growth while addressing India's energy security challenges. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. The Mission's

objective is to establish India as a global leader in solar energy by creating the policy conditions for solar technology diffusion across the country as quickly as possible. The Mission targets installing 100 GW grid-connected solar power plants by the year 2022. This is line with India's Intended Nationally Determined Contributions (INDCs) target to achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources and to reduce the emission intensity of its GDP by 33 to 35 percent from 2005 level by 2030. In order to achieve the above target, Government of India have launched various schemes to encourage generation of solar power in the country like Solar Park Scheme, VGF Schemes, CPSU Scheme, Defence Scheme, Canal bank & Canal top Scheme, Bundling Scheme, Grid Connected Solar Rooftop Scheme etc.

Various policy measures undertaken included declaration of trajectory for Renewable Purchase Obligation (RPO) including Solar, Waiver of Inter State Transmission System (ISTS) charges and losses for inter-state sale of solar and wind power for projects to be commissioned up to March 2022, Must run status, Guidelines for procurement of solar power through tariff based competitive bidding process, Standards for deployment of Solar Photovoltaic systems and devices, Provision of roof top solar and Guidelines for development of smart cities, Amendments in building bye-laws for mandatory provision of roof top solar for new construction or higher Floor Area Ratio, Infrastructure status for solar projects, Raising tax free solar Floor Area Ratio, Infrastructure status for solar projects, Raising tax free solar bonds, Providing long tenor loans from multi-lateral agencies, etc.

9.3.1 WIND ENERGY

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electrical power, windmills for mechanical power, wind pumps for water pumping or drainage or sails to propel ships. Wind energy is a renewable source of non-polluting energy. Turbines Wind energy may be converted into mechanical and electrical energy. Ed, it has tremendous potential and it can easily satisfy the energy demands of our country.

Large wind farms consist of hundreds of individual wind turbines which are connected to the electric power transmission network. Offshore wind is steadier and stronger than on land and offshore farms have less visual impact but construction and maintenance costs are considerably higher. Small onshore wind farms provide electricity to isolated locations. Utility companies buy surplus electricity produced by small domestic wind turbines. When the energy has been utilized for pumping water in rural areas and may also be useful in remote areas. About 20,000 MW electricity can be generated in India from wind.

According to DNES, the wind farms with a total capacity of 3.3 MW have already been setup in Mandvi, 1.1 Mw in Kutch; 550 KW in Okha (Gujarat), 550 KW in Deogarh (Maharashtra), 550 KW in Tuticorin (Tamilnadu) and 550 KW in Puri (Orissa). The type of the wind mills developed are 12 PU-500 sail type, Vertical Axis type etc. Areas with constantly high wind speed preferably about 20 km/hour well suited for harnessing wind energy.

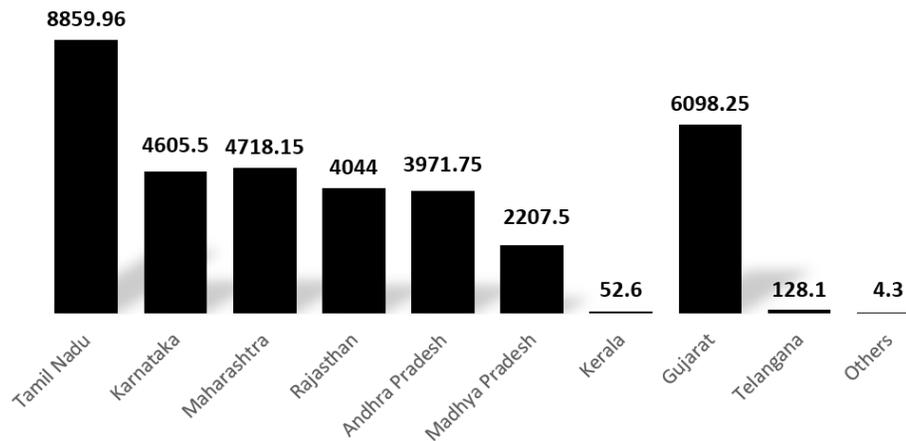


Figure 9.2 : Wind power installed capacity, Source: <https://www.indianwindpower.com/wind-energy-in-india.php>

Advantages of Wind Energy : The advantages of wind energy are described here

- Abundance availability for no price.
- Nonpolluting and eco-friendly.
- Useful at remote places also for electricity generation.
- Cheaper installation cost and almost negligible recurring expenditure.

Limitations of Wind Energy : The limitations of wind energy are given below

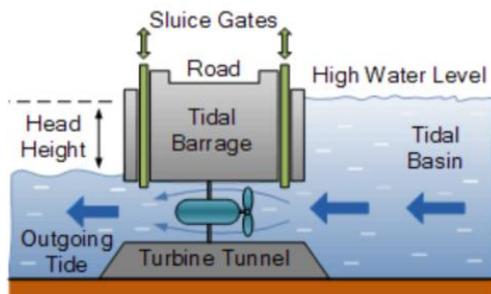
- Unreliable, intermittent and erratic as the wind energy may not be available regularly and uniformly. Their use for a continuous supply Power Station is not feasible.
- Less favorable in city locations, as the wind is available at higher location.
- Due to fluctuating nature of wind blowing, the produced mechanical energy has to be stored in by some means example battery storage.

9.3.2 TIDAL ENERGY

Tidal energy is a renewable energy powered by the natural rise and fall of ocean tides and currents. Some of these technologies include turbines and paddles. just like the Wind Mills, Tidal Energy was used for the mechanical crushing of grains in grain mills. To crush grains. Here, the movement of the turbines powered by tidal energy was used. Tidal Energy is also used to store energy in hydroelectric dams, which act as large energy storage. Tidal energy is produced by the surge of ocean waters during the rise and fall of tides. Tidal energy is a renewable source of energy. During an incoming high tide, water flows over the turbines as the water rises. Then, the water flows back through the turbines as it becomes low tide. The turbines are connected to a generator which produces the electricity. In other words, we can say that Tidal energy is a form of hydropower that converts the energy of tides in to useful forms of power. Tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power. Among sources of renewable energy, tidal

power has traditionally suffered from relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities, thus constricting its total availability of tidal power may be much higher than previously assumed, and that economic and environmental costs may be brought down to competitive levels.

Tidal Barrage Ebb Generation



Tidal Barrage Flood Generation

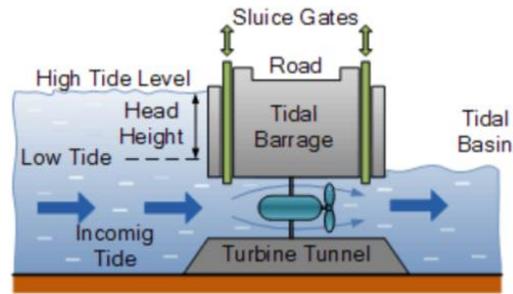


Figure 9.3, Source : <https://www.mdpi.com/1996-1073/14/19/6123/htm>

Advantages of Tidal Power : The advantages of tidal energy are described here

- Cleanliness : Tidal energy is green. It does not pollute the atmosphere with greenhouse gases.
- Wave turbines are relatively quiet to operate and to not affect wildlife.
- Consistency
- Permanence
- Long-term Economy
- Energy Efficiency
- Intermittence
- Startup costs
- Biofouling

Disadvantages of Tidal Energy : The limitations of tidal energy are described here

- Initial construction cost is very high.
- Formation of silt behind the barrage.
- Effect on animals and plants living near tidal stations.
- Very few suitable sites for constructing barrages.
- Disturbs migration of living creatures in the ocean.

9.3.3 GEOTHERMAL ENERGY

The word Geothermal comes from the Greek words geo (earth) and thermal (heat). Geothermal energy is heat within the earth. 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. We utilize the heat in the interior of the earth. Geothermal energy is

thermal energy generated and stored in interior of the Earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the Earth's crust originates from the original formation of the planet 20% and from radioactive decay of minerals 80%.

There is an increase in temperature of the earth with increasing depth below the surface. All the heat stored in the earth's crust as thermal energy constitutes an inexhaustible source of energy termed as geothermal energy. Hot molten magma is present (25-40 km depth) in the Core of the earth. This molten magma is sometimes pushed up towards the surface resulting in volcanic action. When the ground water finds its way into such a rock having molten lava then it gets heated up and comes to the surface of the earth as a steam in the hot water (200 -300 °C). This hot geothermal water or steam is used to operate turbines to generate electricity. Geothermal energy sources are also being exploited for non-power sectors like space heating, poultry farming, mushroom cultivation and chemical industries. Hot water from geothermal energy resources (well) at Laddakh is used to heat the soil and environment of a Greenhouse supporting the growth of more than 40 varieties of plants even at the peak of winter.

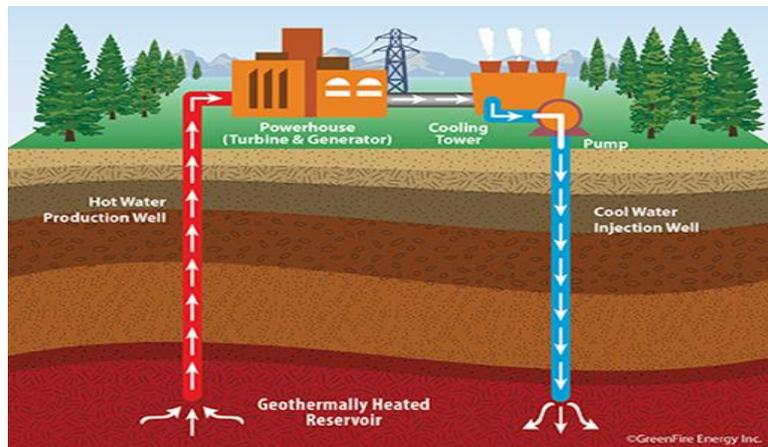


Figure 9.4 : Convolution Geothermal, Source : <https://www.greenfireenergy.com/how-does-geothermal-energy-work/>

❖ **Advantages of Geothermal Energy :** The advantages of thermal energy are described here-

- It offers an inexhaustible and versatile source of energy
- It causes negligible pollution
- It is less expensive, since it is naturally available

❖ **Limitations of Thermal Energy :** The limitations of thermal energy are described here -

- Generally, they are located at far-off distance from the place where use of energy is required.
- Noise pollution results from drilling operation
- Air Pollution results due to release of CO_2 , H_2O , NH_3
- The overall efficiency for power production is quite low (15%) only

9.3.4 BIO-GAS

Biogas is produced by the anaerobic decomposition or fermentation of organic and biodegradable materials such as manure, sewage, Municipal waste, green waste, plant material and crops. Biogas

comprises primarily Methane CH_4 and carbon dioxide CO_2 and may have small amounts of hydrogen sulphide (H_2S) moisture and siloxanes. It is a renewable energy sources like solar and wind energy. furthermore, biogas can be produced from regionally available raw materials and recycled waste and is environmentally friendly. Biogas is practically produced as landfill gas and LFG or digested gas. A biogas plant is an anaerobic digester that treats farm wastes or energy crops. These plants can be fed with energy crops such as maize or biodegradable wastes including sewage sludge and food waste. During the process and air tight tank transforms biomass waste into Methane and producing renewable energy that can be used for heating electricity and many other operations.

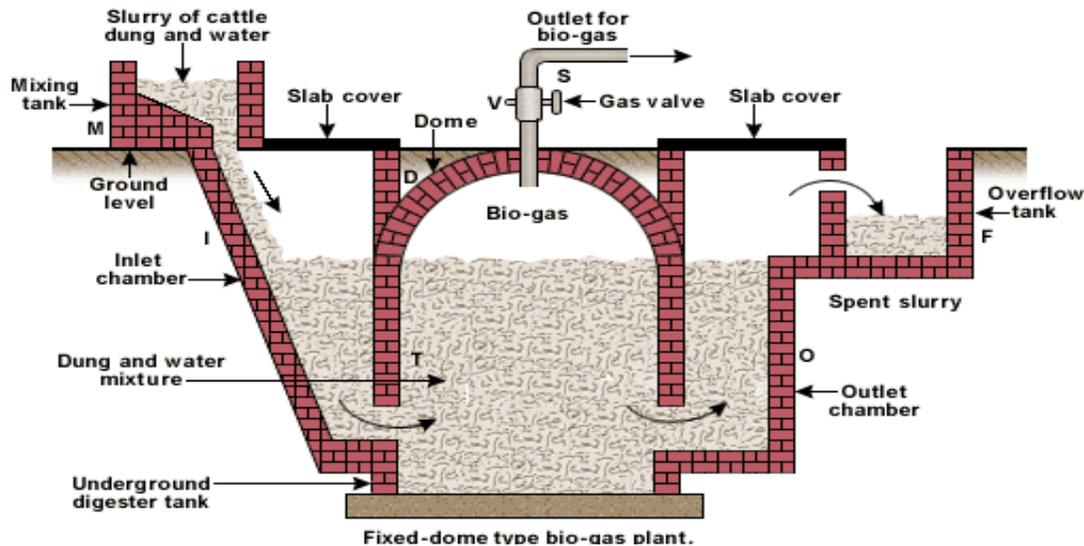


Figure 9.5 : Biogas Unit, Source : https://www.researchgate.net/figure/Fixed-Dome-Type-Biogas-Plant_fig2_275645496

❖ **Advantages of Biogas** : The advantages of biogas energy are described here

- It is clean, non-polluting and cheap
- Supply of gas is direct from the plant hence no storage problem
- The sludge leftover is a rich fertilizer containing bacterial Biomass with most of the nutrients preserved as such
- Air tight digestion/ degradation of the animal wastes is safe as it eliminates health hazards which normally pure in case of direct use of dung due to direct exposure to faecal pathogens and parasites
- Heating biogas has 5000 to 5500 kcal/kg calorific value. It can be used for operating small engines for pumping water for lighting

In rural areas biogas can be used for providing power to agriculture pumps and to run machines like threshers, straw choppers etc.

❖ **Limitations of Biogas** : The limitations of biogas energy are described here

- The process of digestion reduces the total solids content in the sludge and thus there is a volume loss of the organic waste compared to composting, however both can produce a fertilizer.
- Biogas contains contaminant gases which can be corrosive to gas engines and boilers.

- c) Digestate must meet high standards in order to be used on land without detrimental affects on agricultural uses especially food crops.
- d) Produces a limited quantity of energy and is dependent upon location, its proximity to feedstock and energy users.

There is little or no control on the rate of gas production, although the gas can, to some extent be stored and used as required.

❖ **Comparison of Renewable Energy Sources** : The comparative table is given below -

Comparison of Renewable energy sources					
Wind Energy		Solar Energy		Tidal Energy	
Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Pollution free	Noise free	Unbeatable	Expensive	Pollution free	Destruction of wildlife habitat
Once installed, low power generation cost	Expensive windmills to be installed	Pollution free	Energy wastage due to diffusion of the source	Indestructible	Difficult to harness
Safe and clean	Interference in the broadcast signals of radio and television				Affects coastal biodiversity
Less maintenance required	Harmful for the birds				

Bio Gas		Geothermal energy		Hydropower	
Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Low cost	Cause of greenhouse effect	Clean, eco-friendly and available at all times	Expensive to carry electricity due to its location far away from the city	Pollution free	Displacement of the local community
Easy to use				Promotes irrigation and fishing	Flooding of the lower surface
Use of bio-waste and production of bio-gas				Affordable	Expensive to install Loss of Bio-diversity

❖ **Non-Renewable / Conventional / Non Exhaustible Energy Resources Conventional Energy resources** : Conventional and non-conventional sources the expansion of energy sources has been directly related with the pace of Industrial and agricultural development in almost every part of the world with expansion of industry and Agriculture sector the available

energy sources within to fall in their supply besides there were associated environmental problems with the use of traditional sources conventional energy sources as most of the fuel wood as consumed for domestic purpose is mainly in rural areas very little of it was available to industrial sector pool already in use in industries became a highly prized so it was then supplemented by Mineral oil life while the use of hydroelectricity water energy became bear in the areas where running water and heated technology was really available World War one and yet another source of energy nuclear power was developed all resources of energy are known as conventional sources of energy among which pole is still active file that Central position. These natural resources are not reproducible and are obtained from the finite nonliving resources these natural resources cannot be regenerated once they are exhausted or consumed completely their formation required millions of years which cannot occur with human time Scale.

Advantages of Non-Renewable Energy : The advantages of NRE are described here

- a) Non-renewable energies are abundant and affordable. For example, oil and diesel are still good choices for powering vehicles.
- b) According to the U.S. Energy Information Administration, non-renewable energy sources cannot be replenished in a short period. They include fossil fuels such as oil, natural gas, coal, and uranium used for nuclear energy.
- c) Non-renewable energy is cost effective and easier to product and use. According to National Geographic, there are reservoirs of non-renewable energy sources throughout the world.

❖ **Disadvantages of Non-Renewable Energy :** The disadvantages of NRE are given here

- a) Once sources of non-renewable energies are gone, they can't be replaced or revitalized
- b) The mining of non-renewable energy and the by-products they leave behind causes damage to the environment. There is little doubt that fossil fuels contribute to global warming. When fossil fuels are burned, nitrous oxides cause photochemical pollution, Sulphur dioxide creates acid rain, and greenhouse gases are emitted.
- c) It is the challenge of breaking humans of their habit of leaning on it. The Union of Concerned Scientists reports it's an uphill battle to sway consumers that the so-called "public goods" of renewable energy, such as reducing pollution for everyone.
- d) As reducing pollution for everyone, may not be enough to convince them to pay more for cleaner energy.
- e) As countries disagree through wars and differences, the prices of non-renewable energies such as oil has become a commodity where price fluctuation is always eminent. The burning of fossil fuels continues to rise producing high levels of carbon dioxide.

9.3.5 Coal as a Source of Energy : Coal is a combustible black or brownish-black sedimentary rock usually occurring in rocks start in layers or veins called coal beds or coal seams. The harder forms such as school anthracite coal, can be regarded as Metamorphic rock because of later exposure to elevated temperature and pressure. Coal is highly carbonaceous matter. It is composed

primarily of carbon along with variable quantities of other elements, chiefly hydrogen, Sulphur, oxygen and Nitrogen. Coal besides a prime source of industrial energy is also a raw material. Coal including lignite even today accounts for 60% of the country's commercial power requirements. In develop the world there is a trend of shift from coal to oil or gas.

❖ **Advantages of Coal Energy** : The advantages of coal energy are described here

- a) Coal reserves are very large
- b) Mining and transportation are easy
- c) Combustion rate is controllable
- d) Even low-grade coal can be used satisfactorily

❖ **Limitations of Coal Energy** : The disadvantages of coal energy are described here

- a) It causes air pollution by emitting CO, CO₂, SO₂
- b) Extraction of coal affects human health.
- c) Ash is produced on burning which causes environmental pollution.

9.3.6 PETROLEUM FUEL ENERGY

Petroleum is a natural underground fossil energy resource. It is formed due to decomposition of micro plankton deposited the beds of sea, Lakes and rivers over a span of millions of years. The decomposition takes place by the action of bacteria under lack of oxygen and also by catalytic cracking. Petroleum is extracted by digging and oil well under the ground. The crude oil fractional distillation gives many products like (1) gasoline (petrol) 2) Naphtha 3) Heavy oil (for diesel engine) 4) kerosene 5) Jetoil (for aviation transport) 6) fueloil (for Ship transport)

❖ **Advantages of Petroleum** : The advantages of petroleum energy are given here

- Liquid fuels are clean
- Liquid fuels can be transported easily.
- There combustion rate is high

❖ **Limitations of Petroleum** : The limitations of petroleum energy are described here

- Liquid fuels are volatile and ever for a rapidly.
- They are burning produce CO₂ and add greenhouse warming.
- Petroleum also contributes to acid rain and urban air pollution.
- Extraction of Petroleum produces contamination from spills.

9.3.7 NATURAL GAS

Natural gas is the third major source of fossil fuel after coal and petroleum it contributes about 24% of the world energy requirement it is fast emerging as an alternate fuel to oil(diesel) Natural gas can be used both as energy source and also and industrial raw material in petrochemical industries. It takes less time to build a gas-based power plant. The gas is also used for fertilizer plants through Pipe lines. The case from Bombay and Gujarat Gas field is Now taken to M.P., Rajasthan and U.P. Hazira,

vijaipur, JagdishpurHBJ gas pipeline is 1730 km. long and carries an 18 million cubic meters of gas every day. It feeds six fertilizers and three power plants. There are already 12 refineries in India. The liquefied petroleum gas (LPG) also called the cooking gas is now very common domestic fuel. Natural gas can be used in two forms;

- ❖ **LPG (liquefied Petroleum gas)**
- ❖ **CNG (compressed natural gas)**

Natural gas is a naturally occurring hydrocarbon gas mixture of methane CH_4 propane C_3H_8 and Butane C_4H_{10} . It includes even a lesser percentage of carbon dioxide nitrogen and hydrogen sulphide. Natural gas is an energy source often used for heating, cooking and electricity generation. It is also used as fuel for vehicles and as chemical feedstock in the manufacturer of plastics and other commercially important organic chemicals.

Natural gas is found in deep underground natural rock formations are associated with other hydrocarbon reserve reservoirs in coal beds and as methane clathrates. Petroleum is also and other resources found in proximity to and with natural gas. Most natural gas was created over a long period of time by two mechanisms; biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, landfills and Shallow sediments. Deeper in the earth at greater temperature and pressure thermogenic gas is created from buried organic material.

❖ **Advantages of Natural Gas :** The advantages of natural gas are given here

- a) It is clean fuel.
- b) Less processing is required.
- c) Transportation is easy.
- d) It is eco-friendly and causes negligible pollution.
- e) Its contribution to smoke formation is less.

❖ **Limitations of Natural Gas :** The limitations of natural gas are given here

- a) Leakage of gas is of serious environmental concern.
- b) Thick-walled storage tanks are needed as these gases are Stored at high pressure.

9.3.8 MINERAL OIL

Sedimentary rocks containing plants animals remains about 10 to 20 crores year old are the source of mineral oil. Mineral oil is very unevenly distributed over space like any other mineral. There are six regions in the world which are rich in mineral oil. USA, Mexico, former USSR and the west Asian region (Iraq, Saudi Arabia, Kuwait, Iran, United Arab Emirates, Qatar and Bahrain) are the major oil producing countries of the world. In India till independence Assam was the only state where mineral oil was drilled. In India Oil was first found at Makum (North East Assam) but drilling of oil was started at the Digboi in Lakhimpur district. After independence Gujrat plains and the major reserved were found off the Bombay coast the richest oil field of the country known as Bombay High (115 km from

the shore). The latest oil deposits have been found in off shore areas off the deltaic coast of Godavari, Krishna, Kaveri and Mahanadi.

A Mineral oil is any of various colorless ,odorless life mixtures of alkyne as in the sea 15 2340 range from a non-vegetable mineral source particularly distillate of Petroleum some examples include white oil liquid paraffin and liquid petroleum Baby Oil refers to a perfumed Mineral oil is a liquid product of the distillation of Petroleum to produce gasoline and other petroleum based products from crude oil of Mineral oil in this sentence is a transparent colorless oil composed mainly of alkyne as and cyclic paraffins related to petroleum jelly it has a density of around 0.8 G cm cube Mineral oil is a substance of relative Li low value and it is produced in a very large quantity Mineral oil is available in light and heavy grades and can often be found in drug stores.

❖ **Advantages of Mineral Oil Energy Resources :** The advantages of mineral oil energy are given here

- a) It is cheaper for long-term production
- b) It can be easily transported
- c) It can be used to generate electricity

❖ **Disadvantages of Mineral Oil Energy Resources :** The disadvantages of mineral oil energy are given here

- a) It is not environment friendly as its generation leads to pollution
- b) Being highly inflammable it may cause damage to the environment
- c) Being pollution-free this is an environment-friendly source of energy

9.4 SCENARIO OF RENEWABLE ENERGY IN INDIA

The renewable energy scenario of India as well as extrapolates the future developments keeping in views the consumption, production and supply of power. India's energy sector is one of the most critical components of an infrastructure that affects India's economic growth and therefore is also one of the largest industries in India. India has the 5th largest electricity generating capacity and is the 6th largest energy consumer amounting for around 3.4 % of global energy consumption. India's energy demand has grown at 3.6 % pa over the past 30 years.

At present India has seen an annual growth rate of about 22% for renewable energy in the last decade. The production from non-conventional sources in India during 2013–2014 is about 53.22 billion units and the major contributors are wind and solar with 31.26 billion units and 3.35 billion units respectively (Barpatragohain, 2015). Alternate energy also payback to investment in the form of carbon credit for clean development mechanism. Wind and solar power do not produce. The consumption of the energy is directly proportional to the progress of manpower with ever growing population, improvement in the living standard of the humanity and industrialization of the developing countries. Very recently smart grid technology can attribute important role in energy

scenario. Smart grid refers to electric power system that enhances grid reliability and efficiency by automatically responding to system disturbances.

Government endeavor and achievement-The government has taken several measures to spread awareness for solar and wind energy systems. These include publication of book, magazine, organizing workshop and seminar, etc. Global Wind Day has been celebrating since, 2007 to create awareness and achievements in wind energy sectors. Ministry of New and Renewable Energy (MNRE), 2009 is the first ministry of its kind, completely dedicated toward renewable energy.(MNRE is implementing Remote Village Electrification (RVE) Program)

❖ **Public Sectors Initiatives**

The public sector undertakings in India have been contributing substantially in economic and social development for the nation since inception. A MoU between Ministry of New & Renewable Energy and Ministry of Petroleum & Natural Gas (MoPNG) has been signed to improve energy security along with clean energy development through investments in large solar, wind and other renewable energy projects by developing two special purpose vehicles (SPV).

❖ **Participation of Private Sector**

To promote the growth of renewable energy sources, several strategies have been formulated and implemented jointly by governments, local institutions, NGOs and private sectors. Although, the manufacturer of solar and wind sectors is by and large dominated by large players, there is a significant presence of small and medium enterprises, particularly in manufacturing of rural energy devices like solar cookers and solar lamps.

9.5 CURRENT RENEWABLE ENERGY POLICIES

These energy policies are set by Government.

- a) Provision of renewable purchase obligation (RPO) under the National traffic policies
- b) Notification of the long-term growth trajectory of RPO for solar and non-solar energy for three years from 2016-2019.
- c) Development of solar parks and ultra-mega solar power projects
- d) Development of power transmission network through green energy corridorproject.
- e) Making rooftop solar as part of housing loan provided by banks.
- f) Waiver of Inter- state transmission charges at losses.
- g) Repowering of wind power projects for optimal utilization of wind resources.
- h) Offshore wind energy policies for development of offshore wind energy in the Indian exclusive economic zone.
- i) Supporting research and development on various aspects of renewable energy including with industry participation.
- j) Financial incentives for off-grid and decentralized renewable energy system and devices for meeting energy needs for cooking, lighting and productive purposes.

- k) Permitting 100% foreign direct investment in sector through automatic route.
- l) The Government of India has setup a target of installing 175 GW capacity through renewable by 2022.

9.6 CAUSES OF ENERGY CRISIS (PROBLEMS)

- a) On account of excessive population growth, rapid expansion and development of towns and urbanization, there is always conflict between demand and supply. In comparison to demand of energy, the supply is very less
- b) Increasing use of energy for domestic and commercial purposes due to increased population and industrialization is also a major cause of energy crisis
- c) Even after observing the demand of energy neither any attention is given towards the alternative energy sources nor any development is done in this direction
- d) Energy/power/electricity theft increases the cost
- e) Transmission loss due to defective power distribution system
- f) On account of rapid expansion of cities, towns and establishment of new industries, life style of general public has changed totally, so the demand of electricity, petrol, diesel etc. is increasing day by day
- g) Due to environmental pollution, there is decline in average rainfall so the level of water reservoirs is reducing gradually day by day which is the main reason for less production of hydroelectric power
- h) On account of rapid expansion of cities, towns and establishment of new industries. Life style of general public has changed totally, so the demand of electricity petrol, diesel etc. is increasing day by day
- i) There is lack of awareness in society; the fire wood is unnecessarily burned during Holi festival. Similarly at the time of Diwali, other festival and marriages the power energy is wasted

9.7 SOLUTIONS OF ENERGY PROBLEMS

- a) Expansion and development of industries and cities should be done by estimating the future power supply.
- b) By using wind mills properly, the electricity can be produced.
- c) By utilizing the atomic energy correctly and properly, the energy problem can be improved to some extent.
- d) Solar energy can be used for room heating, warming of water, preparation of food and also in the form of light.
- e) By utilizing the Geo-thermal energy, the energy problem of towns and cities can be solved.
- f) Public schools be made aware to save energy.
- g) Effective measures to be adopted for transmission loss and energy theft.
- h) The Govt. should help the electric transmission or distribution corporation that are running in loss.

- i) Develop renewable sources of energy such as – wind power, hydel-power, solar radiation, atomic/nuclear power, biogas & biomass etc.
- j) Technical development and dependence on alternative source of energy is the only solution of energy crisis.
- k) Non-renewable energy resources should be used only when no non-conventional source of energy is available.
- l) Alternative and pollution free sources- Solar energy, Geo-thermal energy, atomic energy, Biogas, should be tapped.
- m) The conservation of existing energy sources as well as exploration of alternate resources should be done immediately.

Renewable energy is a term for clean, sustainable energy that's derived from naturally regenerating sources. Using a combination of these natural sources and intelligent technology, we can generate enough heat and electricity for all our homes, businesses and production needs. The renewable energy sector (RES) often receives financial, institutional or educational support from the government. A significant challenge for the actors in the RES field is policy consistency. When investments are carried out, a prognosis for future policies must be made. If the future is uncertain, larger risk margins should be included in the investment appraisals. Sudden, unexpected policy changes are one type of uncertainty that makes it more difficult to attract capital.

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