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Current Trends in Renewable Energy: An Overview

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ABSTRACT

The energy system based on renewable, on one hand, presents a unique opportunity to overcome the current challenges regarding the global climate warming and on the other hand, it helps tremendously in increasing economic growth, creating new employment avenues and causing a lot of enhancement of human quality and health. Hence in recent times for the sake of energy security, access to clean energy and climate change, the role of renewable energy has become very significant. This paper overviews the current trends of renewable energy globally and particularly in India as well as their growth and environmental issues. Here all forms of renewable energy such as wind energy, hydropower, solar energy, biomass energy and geothermal energy have been discussed in detail regarding its technologies, their future potentials, and scopes particularly in the context of India. The current installed capacity of wind power in India is of 22645 MW and it is expected to grow up to 60000 MW by 2020. In hydropower, it has the potential of producing 84000 MW with 60% load factor which is globally one of the largest. It has been observed that it has a huge potential for development of solar energy. Currently, Govt. of India has made an ambitious target to achieve 175 GW of clean energy through renewables by 2022 in which 100 GW only through solar energy. India is also very rich in biomass and it can provide more employment particularly in rural areas as it is widely available, carbon-neutral and renewable. Currently, Govt. of India took cognizance in that respect and started massive drive and actions to develop this form of energy more efficiently so that the larger mass of people can derive maximum benefits. The potential of geothermal energy is estimated around 10000 MW and further studies and explorations are still going on particularly in the Puga Valley of Ladakh as these locations are lying in the low surface temperature range from 350 to 980 C which is most suitable for the direct heating application.

Keywords–*Environmental issues, Growth of renewable energy, Renewable Energy Sources.*

1. INTRODUCTION

Renewable energy sources are in general described those sources of energy which are regenerated naturally during the short period of time and are usually derived either directly or indirectly from the sun such as thermal energy, solar energy, wind energy, hydropower, biomass energy etc. It also generates through natural movement and mechanism of surrounding environment such as geothermal energy, tidal energy etc. It does not include any sources which involve the conventional fossil fuels.

Renewal energy mainly addresses four areas:

- In generation of electricity
- In heating water and accommodation space
- In transportation sector such as running Metro/ Rail and road vehicles
- In meeting rural areas energy requirements

As per the 2015 report of Global Status on Renewal Energy Policy Network for the 21st century (REN21), the share of renewable energy are as shown in Fig 1.

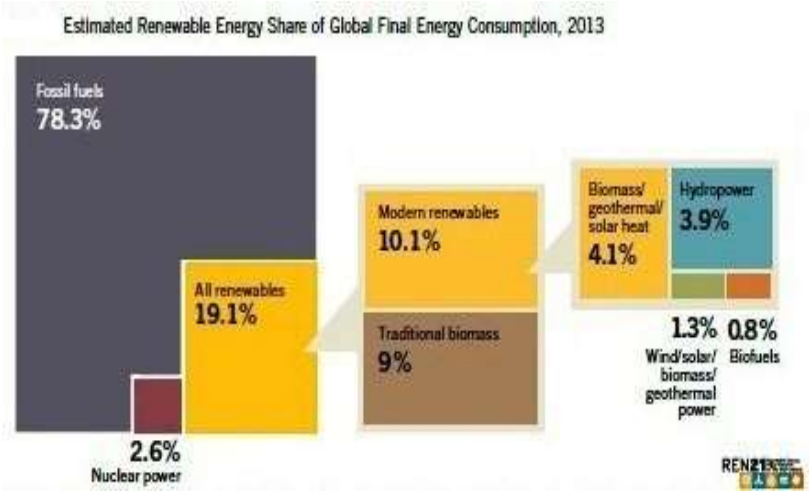

Fig 1 Share of renewable energy (Source – REN21 Global Status Report 2015)

As per REN21′s 2015 report, worldwide 22.8% of total electrical generation is done through renewable energy source, out of which contribution of hydropower alone stands to16.6% as shown in Fig 2.

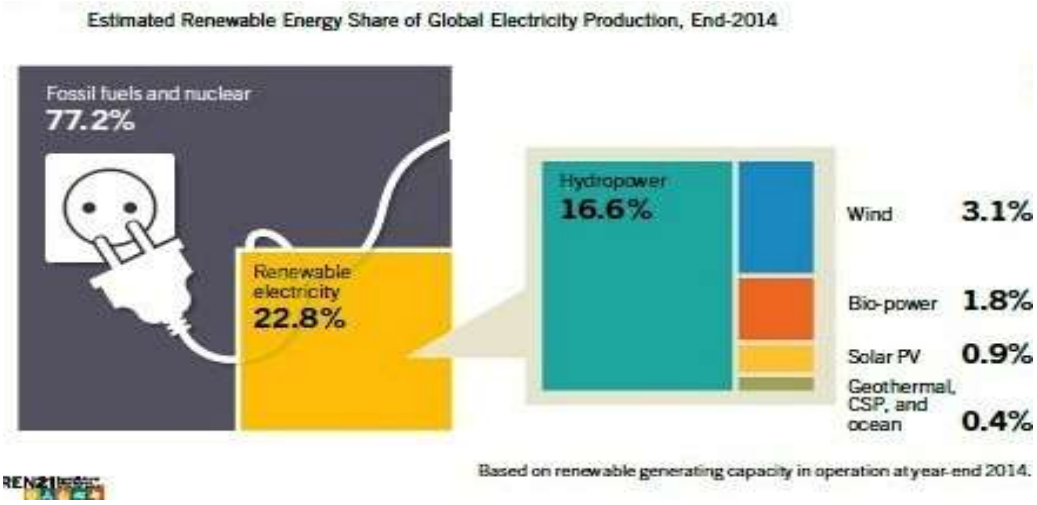

Fig 2 Renewable energy share towards total Electric Production (Source – REN21)

Some of the Europian countries produce more than 50% of energy as renewable energy like Sweden (54%), New Zealand (65%), Austria (62%), Brazil (86%), Norway (98%) and Iceland (100%).

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Water heating through solar system contributes significantly towards heating requirements. Globally China takes lead in this and out of the total production of 180 GW globally, it alone produces 70%. Currently for heating purposes, use of geothermal is becoming more popular, particularly geothermal heat pump which is used both for heating and cooling purposes.

There are three different ways by which renewable energy intervenes in the transport sector:

- Use of biofuel (liquid or blended)
- Growing role of natural gas
- Increasing electrification for transportation.

Now-a-days there is a focus by the industries and market to use bioethanol and biodiesel. Both can be used as a pure fuel or as an additive to improve the level of the emissions of vehicles. It is very popular in USA, Brazil and in other European nations.

Renewable energies are also used as electricity for running trains, trams and both two- and four-wheeled electric vehicles. This type of vehicle is either completely powered by electricity or uses direct solar energy. Basically here, the energy of the sun is directly converted into electrical energy through photovoltaic cells contained in solar panel.

2. ISSUES LED TO THE RENEWABLE ENERGY DEVELOPMENT

All energy using stakeholders generally face four challenges in the energy sector:

- Problems of Energy Security
- Effect of climate change
- Hazard of pollution and their effect on public health
- Concern over energy poverty.

2.1 ENERGY SECURITY

The demand of energy is continuously increasing with the increase of the quality of life. The world′s population will grow at the rate of 1.4% up to 2035 as per the International Energy Agency's Current Policies Scenario estimate. The growth at the rate of 2.2% is projected for Non- Organization for Economic Co-operation and Development countries (OECD) particularly in India, China and other Middle East Asia. Continuous increase in demand raises the concern of energy security which includes availability, reliability and affordability. Use of new and modern technologies will lead to rapid improvement in energy security and would also result in economic benefit because of reduction in energy prices.

2.2 CLIMATE CHANGE

Burning of fossil fuels causes environmental pollution due to emission of CO_2, which in turn raises average global temperature. At the UN Copenhagen Conference in 2009 on Climate Change, still there were large uncertainties that how the target of average global temperature increase up to 2^0C and the emission of Greenhouse Gas emission level up to 450 ppm by 2050 can be achieved as the goal set by IPCC 2007 and IEA 2008. Only option that appears to be very promising is to shift from conventional fossil fuel source to renewable energy source. As per the IEA estimate, if the contribution of renewable energy is enhanced up to 27%, then the above stated target can be achieved. Other mitigation measures should also be explored such as sequestration, carbon capture etc.

2.3 HAZARD OF POLLUTION AND THEIR EFFECT ON PUBLIC HEALTH

Human health is adversely affected by the combustion of conventional and traditional fuels. Global findings have shown that the pollution levels in the household due to use of traditional biomass fuel are very high causing serious health problems. It is considered as the major cause of various health related problems due to the lack of unavailability of portable drinking water and proper hygienic sanitary conditions. As per World Health Organization (WHO) 2006 report, majority of the causalities had

occurred in South East Asia, Africa and some of Pacific countries, where large number of people prepare meal by using traditional conventional fuel sources. Further, as per WHO 2009 report, public health is also very much affected by the use of kerosene which is generally used in lantern for lightning purposes.

The promotion of renewable energy may mitigate most of the health issues caused by burning of fossil fuels. Further by the access and use of modern technologies, various infectious and new emerging diseases can be controlled.

2.4 CONCERN OVER ENERGY POVERTY

Any modern society requires reliable, cheap and modern energy techniques to develop modern education system and to mitigate health problems and poverty. As the demand is increasing day by day, scarcity of energy will increase. The challenge is very enormous as still globally 140 crores of household are not having access to electricity and 270 crores people yet today depends on conventional and traditional fuels. The problem is more acute particularly in the developing countries. As per the UNDP and IEA 2010 estimate, this magnitude will further escalate. Enhanced use of renewable energy appears to be only solution for energy poverty.

3. CURRENT SCENARIO

Currently use of renewable energy source is getting more drive and incentive due to the concern of climate change and global warming. New Government policies, legislations and regulations in this regard are helping the industries a lot working in that area. As per the 2011 projection of IEA, within 50-60 coming years, most of the electricity will be produced by solar power generators which will help a lot in controlling the global warming. At present globally more than 30 countries are already producing some form of renewable energy. In the coming 10-20 years, the market of renewable energy will grow exponentially. Majority of the global countries have made target to achieve 20% of all electricity generated as renewable energy by 2020. Some of the European countries have even made target of 100% as renewable energy.

4. DETAILS OF EMERGING TECHNOLOGIES IN RENEWABLE ENERGY SYSTEM

4.1 WIND ENERGY

Airflow of wind (Fig 3) is utilized to generate electricity according to equation $P_{wind} = \frac{1}{2} C_P \rho A V^3$.

Fig 3 Wind Turbines

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The kinetic energy of wind is converted into mechanical energy through rotor which in turn converts it into electrical energy. First, wind resource assessment at the site is to be done to ascertain the capability of generating cost effective reliable energy. Experts recommend at least of 12 months of consistent observations and recording the wind data. Annual average wind speed of at least 4 m/sec is required for small turbines and 6 m/sec for utility scale power plants.

Commercial wind turbines are generally of either horizontal axis type with propeller like blades or vertical axis type with curved blades. Horizontal axis types are more common.

4.1.1 Growth Rate

The installed capacity of wind energy has increased manifold from 47GW to 369 GW during the period of 2004 to 2014. During 2014, the wind power generation has gone to peak value of 51 GW. Further in 2014 wind energy alone generated almost 4% of the world's total electricity. USA, Europe and China are the leader in the wind power generation. On commercial basis, more than 80 countries in the world are producing energy through wind power. The market and industry of wind energy is growing dynamically. According to the US Department of Energy projection, this market can go up to 580 trillion KWh each year. World′s largest wind turbine of unit size 7MW is developed and installed in Germany. Current globally average installation trends is of 1.5- 2.5 MW unit size.

Offshore Wind Power – For large scale generation, wind turbines are required to be installed over large areas having high wind velocity like offshore farm. As the average velocity of wind in offshore farm is 90% more in comparison with the land, these types of farm produces more electricity than the land based turbines. As per 2014 report, the global installed capacity of offshore wind power was 8771 MW. The London Array of UK is the leader in the offshore wind power development producing 630 MW. The Alta Wind Power Centre of USA produces largest wind farm energy of magnitude 1020 MW.

4.1.2 Current Trend In India

In India, the wind power development was started since 1990 and during the last few decades its growth has increased tremendously. Till 31st Dec 2014, National Institute of wind energy, Chennai had monitored and installed approximately 794 wind monitoring stations of height varying from 20 m to 120 m throughout the country. On the basis of analysis of data, it was found that approximately 237 stations have potential of generating more than 200W per sqm of wind power economically. In wind power potential utilization, Tamil Nadu, Rajasthan, Madhya Pradesh and Maharashtra take lead. At Muppandal in Tamil Nadu State, the largest wind farm of India of capacity 1500 MW is commissioned. As per 2015 report of Ministry of New and Renewable Energy (MNRE), the current installed capacity of wind power in India is of 22645 MW and by the year 2020, it is expected to grow up to 60000 MW as shown in Fig 4.

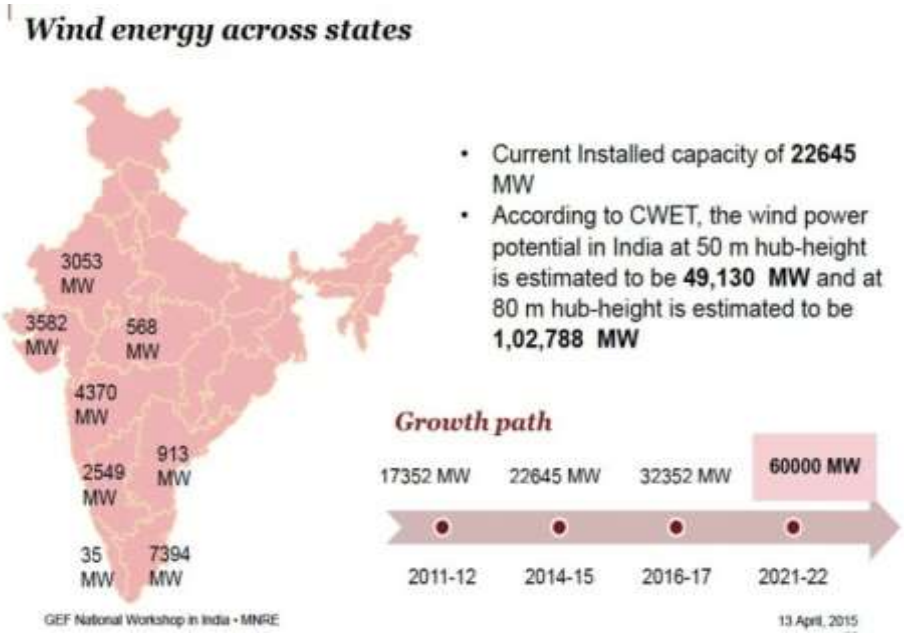

Fig 4 Wind Energy Status across Indian States (Source – MNRE 2015)

In India, at present, dozen manufacturers are producing the wind electric generators which have the annual production capacity of domestic wind turbines of approximately 9500 MW.

4.1.3 Environmental Impact Issues

Wind power turbine generates very little adverse impact on environment as it is indigenous and renewable. It is hailed as Green Technology as it produces no global warming emissions. It takes up little ground space.

Wind turbines sometimes may kill flying birds and its blades cause noises. It also interferes with natural beauty particularly at outstanding beautiful sites.

4.2 HYDRO POWERS

4.2.1 Growth Rate

Since ancient times, hydropower is utilized for irrigation purpose and also for running textile mills, sawmills, lifts, dock cranes etc. In 1878, first hydropower was developed in Cragside, Northumberland and in 1879 first commercial hydropower plant was developed at Niagara Falls. The street lamps of the city of Niagara Falls were lit in the year 1881 through hydropower scheme. From late 19th century, it became a prominent source of generating electricity.

By 2013, the world′s total electricity production by hydropower has reached up to 16% of total production. Due to natural topography, Asia, Africa and Latin America are having very high potential, generating about 25% of the world′s estimated potential. The Three Gorges Dam in Hubei (China) produces 22,500 MW of hydropower, highest in the world, followed by Itaipu Dam (Brazil/Paraguay) producing 14000 MW alone. At present, 150 countries are producing hydropower with the Asia-Pacific region alone generating more than 32% of global hydropower.

4.2.2 Current Trend In India

In India in 1900, Jamshed Ji Tata developed the first hydropower dam in the Western Ghats of Maharashtra to supply electricity to Bombay's Cotton and Textile Mills. By taking the permission from British Government, he constructed dams in the Western Ghats by utilizing high rainfalls in the hills as storage.

India has immense potential of generating hydropower and in terms of exploitable potential, it ranks 5th in the world. Economically viable potential in India has been assessed to be about 148,701 MW. Medium and low head hydel schemes having

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capacity less than 25 MW are also getting very prominence and its potential has been assessed to about 148,710 MW. In addition to this, for pumped storage schemes, 25 sites have already been identified which can produce 94000 MW additional electricity.

Ministry of New and Renewable Energy, Govt. of India has been given the responsibility of developing small hydro power (SHP) up to 25 MW. It has identified 6474 potential sites mostly located in Karnataka, Arunachal Pradesh, Uttarakhand and Himachal Pradesh. It has been well recognized that the SHP project can play a very vital role in improving the overall power scenario in the country particularly in rural and inaccessible areas. At present, there are 28 equipment manufacturers who fabricate almost the entire range and type of SHP turbine equipment.

Globally India is the 7th largest producer of electricity through hydropower scheme. It has the capacity of producing 84000 MW with load factor 60% which is globally one of the largest. During 2014-15, 24500 MW with 60% capacity factor was produced. Up to 31st March 2016, India′s hydropower installed capacity was estimated at 42783 MW.

4.2.3 Environmental Impact Issues

Hydro power is relatively inexpensive and leaves no harmful chemicals. It does not consume any water. After passing through turbine, it can be used for any purposes like irrigation, domestic water supply etc.

Construction of dam across the river changes the pattern of co-habitation of both human and other species residing in the areas. The reservoir may cause submergence of large areas which may result in migration of people living in the surrounding areas.

4.3 SOLAR ENERGY

Solar form of renewable energy is the solar radiation of the sun that reaches the surface of earth (fig 5).

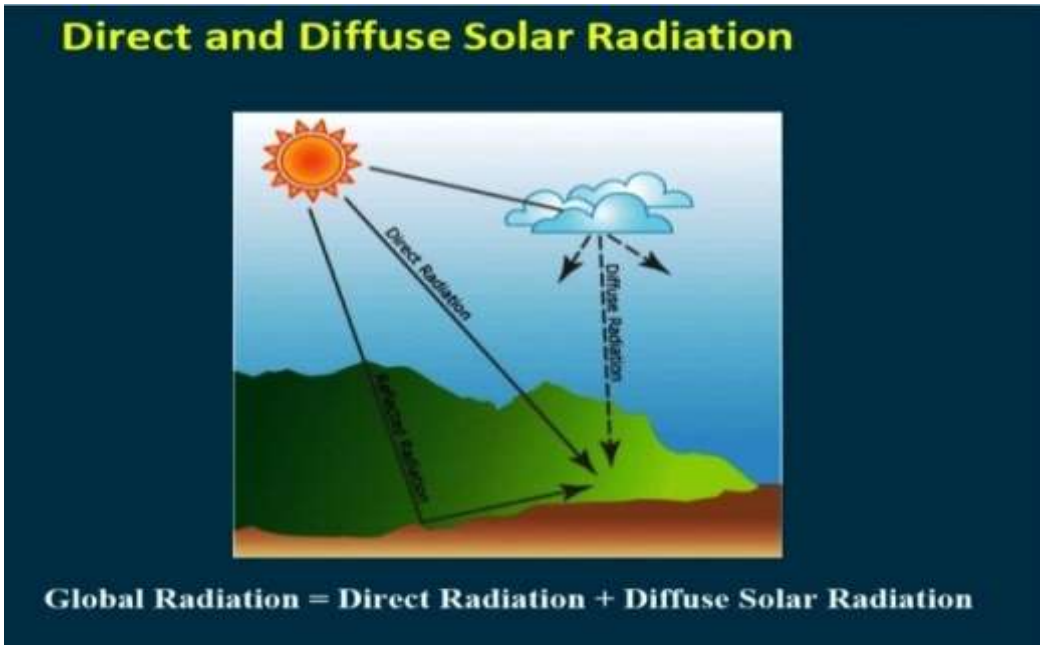

Fig 5 Direct and Diffuse Solar Radiation

The energy of the sun is utilized by using modern technologies to harness it such as solar heating, photovoltaic, concentrated solar power (CSP), concentrator photovoltaic (CPV) etc.

Generally solar technologies are broadly classified as either passive solar or active solar depending upon how the energy of the sun is captured and converted into electricity. Passive system uses the heat of the sun while the active one utilizes the radiation of the sun through photovoltaic system. Photovoltaic technology converts sunlight into electricity by using semiconductor material.

Pure silicon, an excellent semiconductor, is most commonly used. This system is commonly used in lighting, refrigeration, telecommunication etc. and also in centralized grid electricity production as shown in Fig 6 and 7.

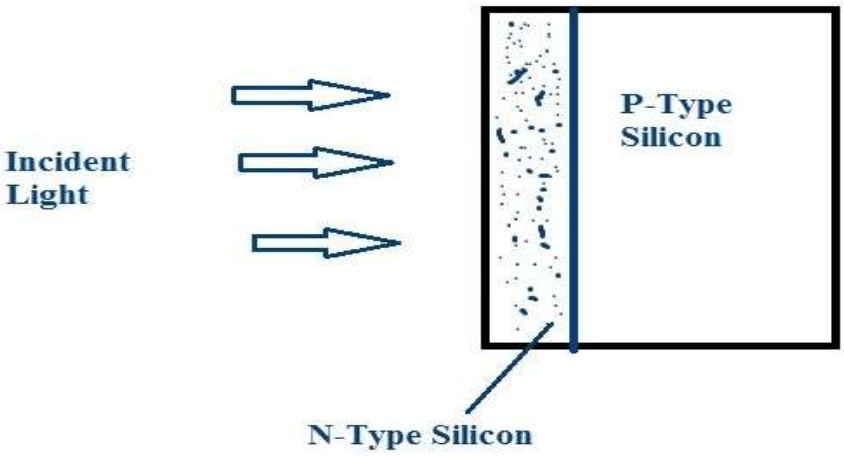

Fig 6 Single PV Cells

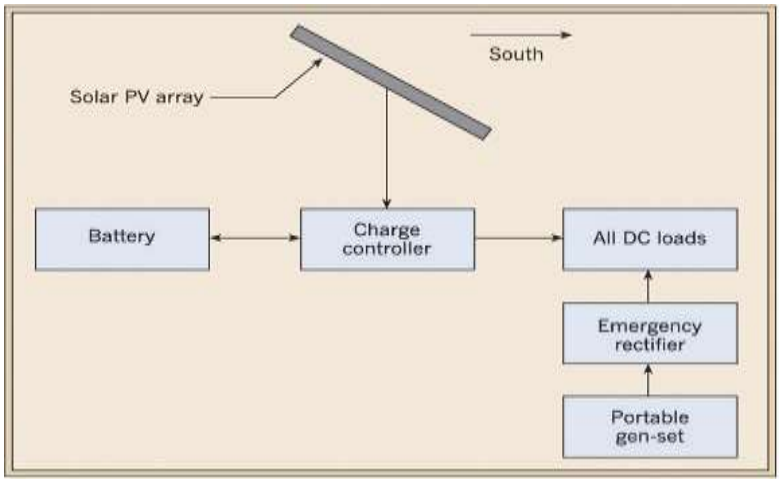

Fig 7 Pv System Utility

4.3.1 Growth Rate

China is the leader in producing photovoltaic (PV), followed by Japan and USA. Overall photovoltaic power generation is highest in Germany, contributing 7% of the overall electricity generation. It is estimated that the world′s capacity will reach 430 GW by 2018 and by 2050; globally it will become one of the main source of supplying electricity. This can be achieved by increasing the installed capacity of photovoltaic (PV) to 4600 GW, 50% of which is expected to be produced by India and China. In 1980, first commercial concentrated solar power plant came into existence. With the time as the generation cost of electricity through solar system is decreasing, the numbers of grid concentrated solar photovoltaic system are increased in millions and also a number of utility scale solar power plants with large production capacity are also developed. Hence this system is becoming more popular because of its low production cost and more environmental friendly. World′s largest PV station is developed in USA of capacity 579 MW. Some of the plants have been developed based on daily sun′s path tracking system to trap large magnitude of solar energy so that more electricity can be generated than the fixed mounted system. During operation, these plants do not require any

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consumption of fuel and hence no costs of fuels are incurred. Further, there is no any type of emission of harmful gasses to the environment.

Earlier researches were conducted by United States in developing PV (photovoltaic) and CSP (concentrated solar power plant) system. At present, USA is the leading country in generating electricity through solar energy. In the southwest desert of USA, most of their plants have been developed and 354 MW oldest solar power plants are located in California. In the year 2013, Solana Solar Plant in Arizona of capacity 280 MW was commissioned, which after completion became largest parabolic trough plant in the world. Further in USA, it is the first plant based on molten salt thermal energy storage system. This industry of solar power plant is now developing rapidly. Currently Spain is taking the lead with 873MW under construction and 271 MW is under development.

4.3.2 Current Scenario In India

In India on an average per year 300 clear sunny days are available. On the basis of theoretical estimate, it has been found that if exploited properly, it has the potential of generating approximately 5000 trillion KWh solar energy which is much larger than the possible generation of energy through the available traditional and conventional forms of fossil fuel energy reserves. As per the radiation climatology of India about 3300 to 3700 hours per year of bright sunshine are available in the Northwest and West Central region and 2900 hours per year in Central Peninsula except Assam, Kerala and Kashmir where it is lower. With the commercially available technologies, the average daily solar energy generation capacity in India is of 0.25 KWh per Square metre of used land area.

As per 2015 report of MNRE, the current solar energy installed capacity is of 3744 MW and its potential stands at 748 GW as shown in Fig 8.

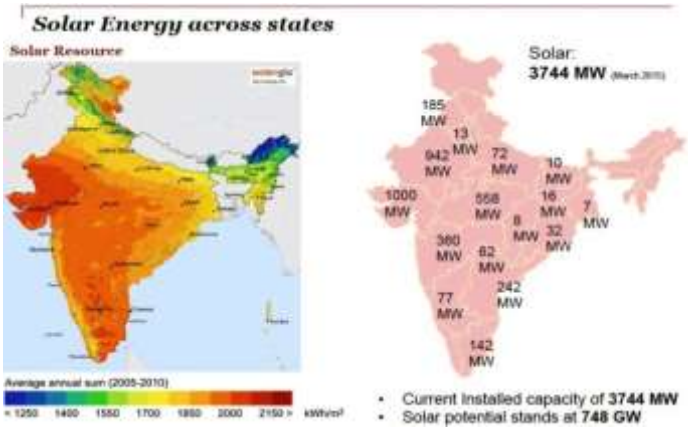

Fig 8 Solar Energy across Indian States (Source- MNRE 2015)

From 2015 Govt. of India has expanded its solar plan and set a target of 100 GW by the year 2022. In Paris Climate Conference, the Prime Minister Narendra Modi has said that the world must turn to the sun for the future power. In 2016, Govt. of India in collaboration with Govt. of France has laid foundation stone of headquarter of International Solar Alliance (ISA) in Gwal Pahari, Gurugram, Haryana. This will essentially focus on promoting and developing solar energy and solar products for the country.

At present India is ranked 11th in the solar power generation in the world. The main hindrance in the development is the cost of production, availability of land and lack of modern technologies. Now the cost of solar energy has come down from Rs. 17/90 per unit in 2010 to about Rs. 7/- per unit in 2015. With the increase of modern technologies, its cost will be further reduced.

4.3.3 Environmental Impact Issues

Solar energy technology offers clean energy as it does not cause emission of CO_2 or other greenhouse gasses during their use. Further no waste is produced during their operation. However this system has some negative impacts on environment particularly during production and operation. As the solar cells have toxic substances, which in case of fire may release chemicals to the environment. By taking proper precautions, this can be minimized. Other problems are related with land area to be covered for installations. Approximately 1 sq. km of land area is required for every 20-60 MW generation. This can be reduced by erecting it on roof top of buildings, skyscrapers etc. Hence, by taking various precautionary measures, negative impacts can be minimized very much.

4.4 BIOMASS FORM OF RENEWABLE ENERGY

Biomass is a biological form of material derived from living organisms, particularly from plants or plant-derived materials which are usually known as lignocelluloses biomass. As a source of energy, it can be used either directly by combustion to produce heat, or indirectly by converting it into various forms of biofuel. The energy is basically generated from biofuel which stores energy derived from sun through photosynthesis process. There are four methods by which energy can be extracted from biofuel namely Direct Combustions, Gasification, Anaerobic Digestion and Fermentation. At present, all of these methods are in use.

4.4.1 Growth Rate

Biomass is still considered as the main source of energy in the developing countries which approximately accounts to 35% of energy consumption and in some countries its consumption even goes up to 70%. It is mainly used for cooking purpose but its consumption and production are usually done in more inefficient manner. Throughout the developing world, all efforts are going on to improve the process of its production and use.

Up to 2010, the contribution of biofuel as transport fuel was estimated approximately 3%. At present, 31 countries are using blended biofuel. As per the projection by IEA, by 2050, biofuel would be able to meet approximately 25% of world demand as transport fuel. Brazil has started its ethanol fuel program since 1970 and after USA; it became the world's second largest producer. At present it is the world's largest exporter. To produce heat and power, they are using modern technology and equipment as well as cheap sugarcane as feedstock and cane waste as bagasse. At present, no light vehicles in Brazil is running by using pure gasoline and up to 2008, there were 35000 filling pumping stations having at least one pump with ethanol. In USA, now-a-days, gasoline is mixed with 10% ethanol and vehicles are also manufactured to run more on blended fuels. Bigger companies like GM, Ford etc. are producing cars, trucks etc. to run on more blended fuel. They have even produced vehicles to use blended fuels ranging up to 85%.

4.4.2 Current Scenario In India

India is very rich in biomass. This energy can provide more employment particularly in rural areas as it is widely available, carbon neutral and renewable. 70% of the population of India depends upon this form of energy and approximately 32% of the total energy requirements are met through it. MNRE, Govt. of India took cognizance in that respect and started massive drive and actions to develop this form of energy more efficiently so that the larger mass of people can derive maximum benefits.

In India biomass energy generation industry has done more than Rs. 6,000/- crores investments. The production of electricity through this source is more than 5000 million units and in rural areas, it generates employment of 10 million man days per year. At present approximately 500 million MT per year biomass is available. It is having the potential of generation of about 18000 MW. Additional 7000 MW can also be generated through the country′s 550 sugar mills as bagasse based cogeneration by using modern technologies. In India use of blended gasoline and diesel is very limited. In 10 states, Government of India has made it mandatory to use 5% blended ethanol with gasoline. Presently, biodiesel is not available in the market but India plans to meet

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20% of its diesel requirements through biodiesel by 2020. A number of plants locally available in India have great potential of producing biodiesel like Neem, Mahua, and Jatropha etc. The plantation of Jatropha can be done on large scale on 40 Mha waste land available in the country. Indian Government is giving a lot of incentive for the cultivation of Jatropha plant and has a target of covering an area more than 11.2 Mha. The oil produced by these plants is considered as an excellent source for the biodiesel.

4.4.3 Environmental Impact Issues

The use of biomass energy has both positive and negative impacts on environment depending upon the source of energy, its extent of utilization and the technologies used for the conversion of energy. Burning of woods causes emission of carbon dioxide, carbon monoxide and other gases. But by planting fast growing plants which may capture a nearly equivalent amount of CO_2 while growing through photo synthesis process, can make it carbon neutral energy source. Further use of fuel efficient stoves can improve environment a lot. Certain pollution control devices such as fabric filters, electrostatic precipitators and scrubbers may also reduce the degradation of environment by capturing air pollutants.

Biofuels can also be made carbon neutral. The plants such as sugarcane, corn, palm oil trees, soya bean etc. that are generally used for biofuel, may absorbs CO_2 and may compensate the emission of CO_2 while producing and burning.

4.5 GEOTHERMAL FORM OF RENEWABLE ENERGY

Thermal Energy which is stored and generated beneath the earth surface is utilized in producing Geothermal Energy. Its origin takes place right from the original formation of planet. Radioactive decay of minerals also contributes it. The thermal energy is basically derived because of the thermal gradient that exists between the core of the earth and the earth surface. Moderate to low temperature hot springs/geysers, hot rocks within few km below the earth surface and molten rocks called magma deeper into the earth are the sources of geothermal energy.

Geothermal heat can be utilized directly by circulating the water through a well drilled to a depth of 80 to 160 m. The injected water is heated up due to warmth of earth. Then a heat pump is used to take the heat from beneath the earth surface to the point where it is required. After use, cooled water is injected back into the earth. It is most commonly used for bathing, cooking food, space heating, air conditioning, drying, hot water, resort and pools, melting of snow etc.

Hot springs are used for geothermal power plant. In this system, holes are drilled into the rock to capture the steams which run the turbines of power plants. Geothermal power plants are of following types:

- Dry Steam Plant
- Flash Steam Plant
- Binary cycle Plant

Dry Steam Plant uses the underground steam directly to run the turbine as shown in Fig 9.

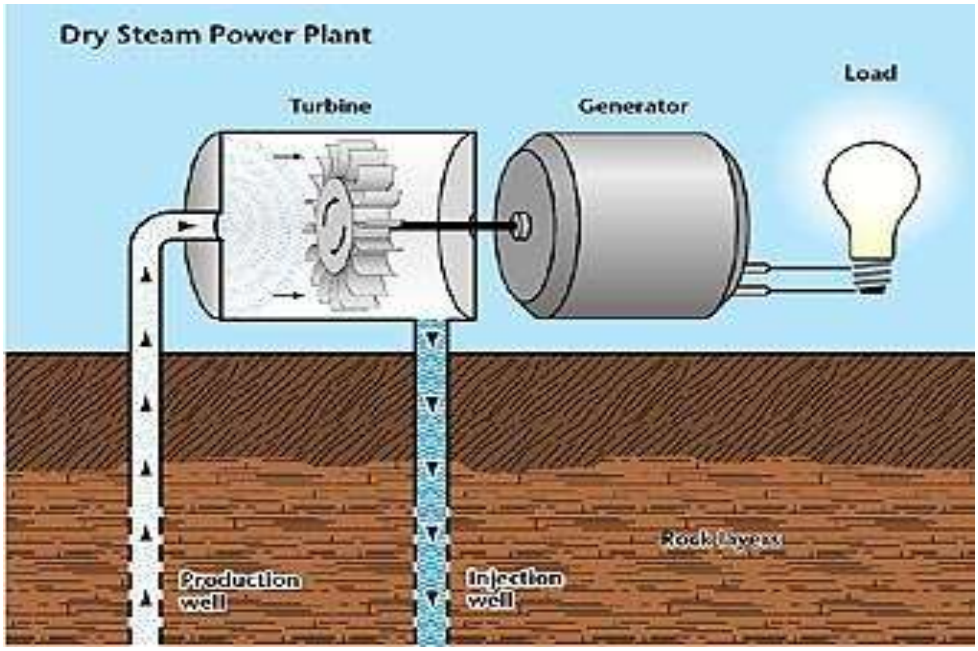

Fig:-9 Dry stream power plant

Flash Steam Plant is most common. In this system, high pressured hot water of temperature 182^0 C comes to the surface which is then transported to low pressure chamber and the resulting steams run the turbine. After using it, the steam and water are injected back into the earth as shown in Fig 10.

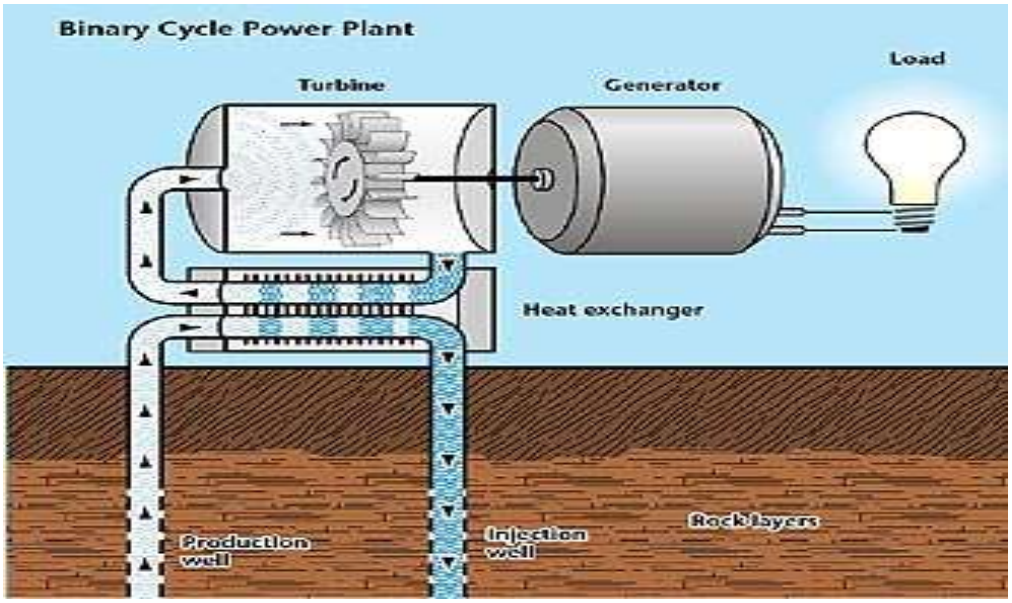

Fig:-10 Flash stream power plant

Binary Cycle Plant (Fig 11) uses moderately hot geothermal water of temperature ranging 120^0 to 180^0 C past through an organic liquid which has low boiling point. The steam produced through the organic liquid drives the turbines.

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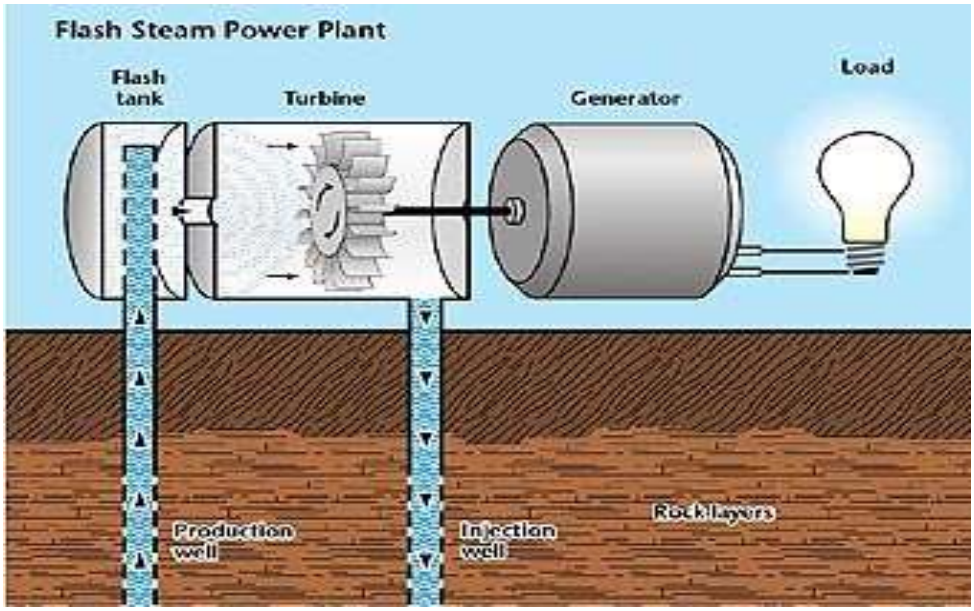

Fig:-11 Binary stream power plant

Hot Dry Rock system has one injection well and two production wells. Pressurized cool water is sent down through injection well where the hot rocks heat the water. The pressurized heated water of temperature greater than 90^0 C is then pumped to the surface and it is passed through an organic liquid having low boiling point like butane. The resulting steams run the turbine. Finally cooled water is injected back to be heated again. The extraction of energy through this system is difficult and also costly.

4.5.1 Growth Rate

The power generation due to thermal energy is reliable, environmental friendly and cost effective. However its productions are limited to areas near to tectonic plate boundaries. With the advancement of modern technologies, its range and size of viable resources have expanded tremendously and its scope of potential exploitation has widely opened. This form of energy is especially suitable for house heating applications. As per the 2012 estimates of the Association of Geothermal Energy, the total geothermal power installed capacity globally is of about 11224 MW. During 2014, 610 MW has been added by commissioning 21 new power plants. By 2015, its capability has reached up to 12.8 GW spreading over 24 countries. It is expected that by 2020, the geothermal industry will reach up to 17.6 GW spreading over 80 countries and even reach up to 30 GW by 2030, if all the producing countries will follow the goal and target strictly.

The USA, at present producing 2800 MW, is the world′s largest producer of electricity through geothermal plant. It is widely used in many countries like Iceland, Mexico, Costa Rica, Italy, Indonesia, Philippines, China and Japan.

4.5.2 Current Scenario In India

Geothermal Energy′s study and exploration in India was started in 1970 and 350 geothermal locations were identified by Geological Survey of India, in which Puga Valley of Ladakh has the maximum potential. Most of these locations are lying in low surface temperature range from 35^0 to 98^0 C which is most suitable for direct heating application. In Puga valley, the temperature of hot springs varies from 30^0 to 90^0 C and its discharge is of approximately 300 L/minute. Other prominent areas are Chumathang in Ladakh, Manikaran in Himachal Pradesh, Tapoban in Uttarakhand, Tattapani in Chhattisgarh, Ratnagiri in Maharashtra and Rajgir in Bihar. First geothermal power plant of the country is coming in Tattapani area of Balrampur district of Chhattisgarh. In India, Its total potential is estimated around 10000 MW.

4.5.3 ENVIRONMENTAL IMPACT ISSUES

Geothermal Energy is a clean, inexpensive and sustainable source of energy. For installing the plants, it requires less land. Approximately 400 sqm of land can produce a Gigawatt of energy over 30 years. It does not produce any harmful emissions to the

environment and can be used to produce electricity 100% of time in a day. The running and maintenance cost of the plant are very low as no fuel is used to generate power. Though, the initial installation cost of plant is very high. Further at every place, prime hot spots for developing geothermal energy are not available which causes costly long distance transmission.

Geothermal energy productions also pose some concern with respect to environment. The extraction of energy causes release of H_2S gas if cooled water is not injected back into the ground which creates unpleasant smell like rotten egg. Further extraction of large amount of water can cause land subsidence which may lead to seismic activity. To prevent this, cooled water must be injected back into the ground in order to maintain the constant water pressure. Due to drilling of wells, large amount of rocks, mud etc. comes to the earth surfaces which add pollutant to the atmosphere and it also causes noise pollution.

5. CONCLUSION - INDIA′S POTENTIAL IN RENEWABLE ENERGY

The entire development and proliferation of renewable energy in India comes under the MNRE. India was pioneer in establishing a separate Ministry under Government of India in early 1980 as New and Renewable Energy (MNRE). India′s total production of renewable energy has reached up to 42 GW. 66% of the total production is alone from wind energy source, followed by14.59% from solar energy and rest through hydropower, biomass and geothermal. There is a very high potential of generating renewable through wind and solar system. As per the estimate of MNRE up to 31.03.2014, the total potential of renewable has reached up to 147615MW as shown in Fig 12 and 13.

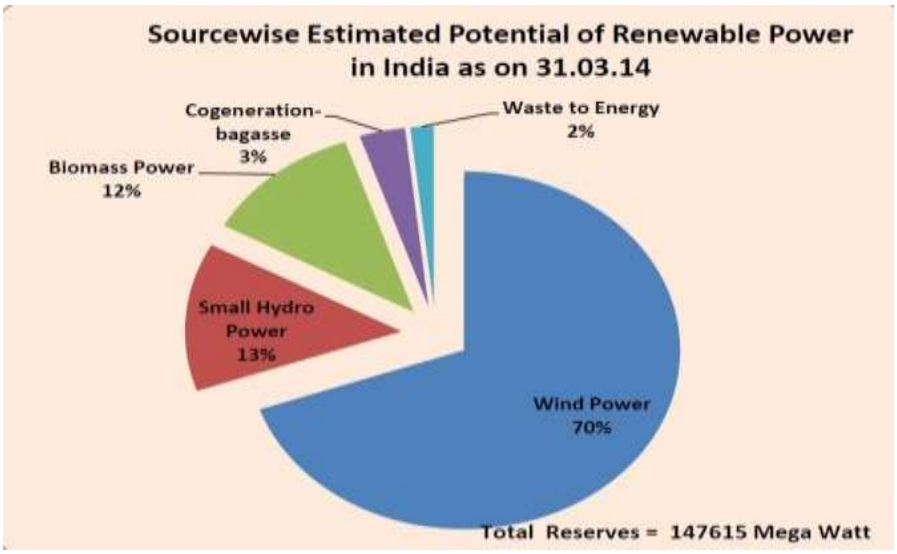

Fig 12 Source wise India′ Renewable Energy Potential

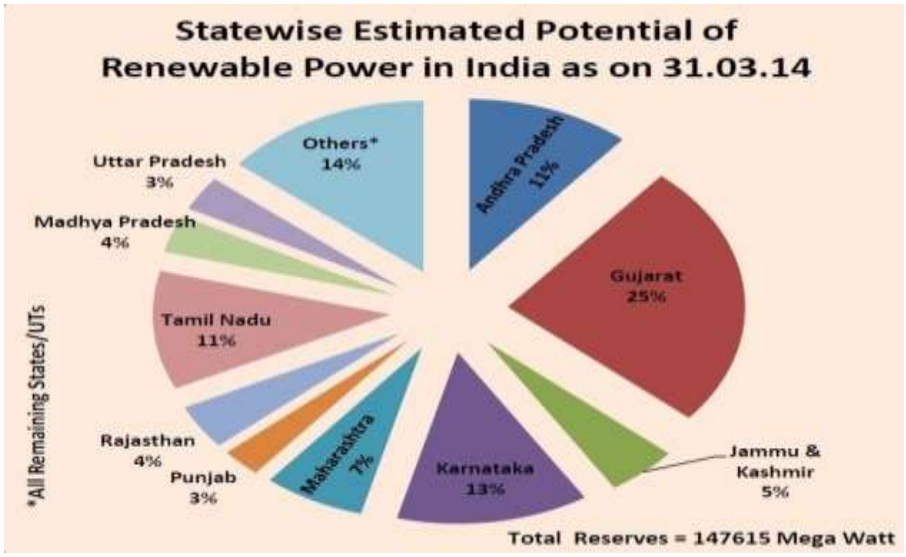

Fig 13 Indian State′s Renewable Energy Potential Estimate

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Currently, through the ministry of MNRE, the Govt. of India has undertaken massive expansion plan of clean energy through renewables. It has made a target to build renewable capacity of generation in India of 175 GW by 2022, which comprises 100 GW from solar energy, 60 GW from wind energy, 10 GW from biomass sources and 5 GW from small hydro power plant.

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