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Future Aspects of Renewable Energy Development in India

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ABSTRACT— *Electricity consumption will comprise an increasing share of global energy demand during the next two decades. In recent years, the increasing prices of fossil fuels and concerns about the environmental consequences of greenhouse gas emissions have renewed the interest in the development of alternative energy resources. Renewable energy sources(RES) and technologies have a large potential to provide solutions to the longstanding energy problems being faced by the developing countries like India. Renewable energy derived from nature is a sustainable and clean source of energy. The use of RES technologies are recognized as an important part of the solution to address energy security concerns and ensure economic growth in an environment friendly manner. Deregulation has changed the conventional mandates of power utilities in complex ways, and had large impacts on environmental, social, and political conditions for India. The renewable energy based power generating systems can play a major role towards the fulfillment of energy requirements of restructured electricity market. In this paper, efforts have been made to summarize the availability, current status, environmental effects, promotion policies and future potential & strategies of renewable energy options to develop India.*

Key words: Solar Photovoltaics, Wind Energy ,Biomass, Geothermal

I. INTRODUCTION

Competitive power market has changed the traditional mission and mandates of power utilities and had large impacts on environmental, social, and political conditions for any particular country. India, being a developing county, has witnessed a rapidly growing energy need owing to the fast industrialization and increasing demographic profile. Starting from the base of merely 1700 MW in 1950 the installed generating capacity has now risen to 330 GW approximately. Around 85% of villages are enjoying the benefit of electricity. Despite the progress achieved, the consumption is increasing at an annual growth rate of 4 to5% and at the other side the conventional energy sources are exhausting. The Renewable energy source is only solution for future energy crises, which is cheap and clean as compare to non-renewable energy sources. The economy of the nation can be improved by utilizing such easily managed energy sources. The main sources are solar thermal, solar PV, wind, geothermal, ocean thermal, ocean wave, ocean tide, mini hydro, biomass, chemical, waste fuel etc. India has a vast supply of renewable energy resources, it has large potential for deploying renewable energy based products and systems. Power industry is moving rapidly from regulated conventional setup to a deregulated environment. In the deregulation environment, generation, transmission, and distribution are independent activities. There is a competition among generators for managing different customers. Main benefits from the deregulation include cheaper electricity, efficient capacity expansion planning, cost minimization, more choice, and better service.

II. OVRVIEW OF INDIAN POWER SECTOR

The utility electricity sector in India has one National Grid with an installed capacity of 330.15 GW as on 31 July 2017. Renewable power plants constituted 30.8% of total installed capacity. During the fiscal year 2016-17, the gross electricity generated by utilities in India was 1,236.39 TWh and the total electricity generation (utilities and non utilities) in the country was 1,433.4 TWh .The gross electricity consumption was 1,122 kWh per capita in the year 2016-17. India is the world's third largest producer and fourth largest consumer of electricity. Electric energy consumption in agriculture was recorded highest (17.89%) in 2015-16 among all

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countries. The per capita electricity consumption is low compared to many countries despite cheaper electricity tariff in India.

In order to address the lack of adequate electricity availability to all the people in the country by March 2019, the Government of India launched a scheme called "Power for All".This scheme will ensure continuous and uninterrupted electricity supply to all households, industries and commercial establishments by creating and improving necessary infrastructure. Its a joint collaboration of the Government of India with states to share funding and create overall economic growth. Draft National Electricity Plan, 2016 prepared by the Government of India states that India does not need additional non-renewable power plants till 2027 with the commissioning of 50,025 MW coal based power plants under construction and additional 100,000 MW renewable power capacity.

III. CURRENT STATUS OF RES IN INDIA

According to nearly every measure, renewable energy is gaining ground. For the vast majority of renewable energy technologies, capacity and output continue to grow as renewable in the power sector far outpace growth in conventional technologies. New markets and centres of manufacturing are emerging in every region of the world. More jobs are to be found in the renewable energy sector than ever before, and their numbers continue to rise. Years of policy support for renewable energy in key countries, momentum to mitigate climate change and enhance access to modern sources of energy, as well as improved cost-competitiveness, all have propelled renewable energy to become the engine of sustained economic prosperity.

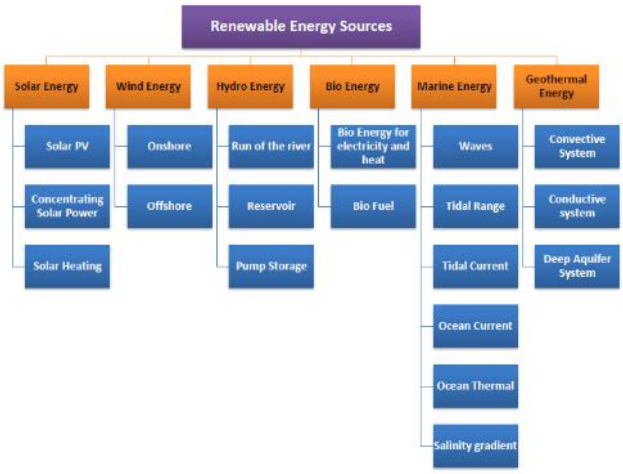

Figure 1: Renewable Energy Sources

India is the fourth largest energy consumer in the world after the United States, China, and Russia.6 To better understand the current situation in India and the potential of the renewable energies market, it is essential to look at the trends in energy consumption, growth of the current grid, and the availability of transport and equipment used there. At present, for renewable energy India has one of the world's largest programmes. The Ministry of Non Conventional Energy Sources has been supporting R&D for technology and manpower development in renewable energy. Current emphasis is on reduction in cost and increase in efficiency. For sustained development of this sector, efforts are being made so that the market and the consumer drive renewable energy to a large extent.6 The activities include all main renewable energy sources of concern to India, such as solar energy, wind energy, biogas, biomass, small hydropower and other promising technologies. India's Renewable Energy Potential: - Presently India has enormous renewable energy potential through solar, wind, biomass, small hydro etc. The potential is concerted in certain parts of country. The solar and wind potential is mainly in the southern and western States viz. Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Gujarat and Rajasthan, however the work out on mapping of potential is continuing in several

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other areas in the country. Installed capacity of power in India:-As mentioned in report of power sector of india of April 2017 is 330 GW , total thermal installed capacity in India stood at 189 GW. Following figure shows the Installed power capacity of India in(GW) from different sources as shown in table 1

Table 1: **Grid connected installed capacity from all sources**

Source	Installed Capacity (MW)	Share
Coal	189,047.88	59.93%
RES MNRE	50,018.00	15.86%
Large Hydro	44,413.43	14.08%
Gas	25,329.38	8.03%
Diesel	837.63	0.27%
Nuclear	5,780.00	1.83%
Total	**315,426.32**	**100.00%**

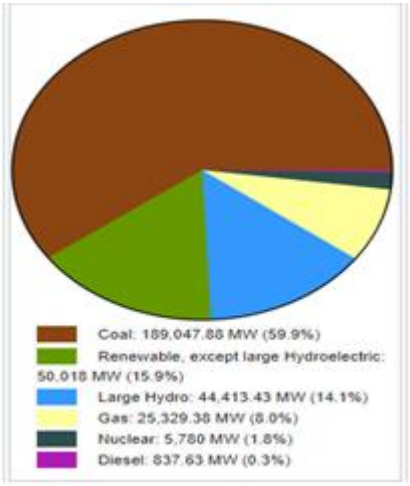

Figure 2 : **Installed grid power capacity from all sources in India**

Installed Renewable Energy Capacity in India:-India is staying true to its ambitious renewable energy targets by showing a steady growth in renewable energy installations in India, which as of April 2017 account for 17.5 percent of the total energy source. The table 2 refers to the fast growing renewable energy sources under the responsibility of the Ministry for New and Renewable Energy and slightly exceeded the installed capacity of large hydro installations. This figure is targeted to reach 175 GW by 2022. Coal power currently represents the largest share of installed capacity at just under 186 GW. Total installed capacity as of 30 April 2016, for grid connected power in India stood at a little under 303 GW

Table 2 :Installed Capacity of RES in India.

Source	Total Installed Capacity (MW)	2022 target (MW)
Wind power	32279.77	60,000.00
Solar power	12288.63	100,000.00
Biomass power (Biomass & Gasification and Bagasse Cogeneration)	8182.00	10,000.00
Waste-to-Power	114.08	
Small hydropower	4379.65	5,000.00
Total	57244.23	175,000.00

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IV SOLAR ENERGY STATUS

India is the largest PV market in the world today .India receives solar energy equivalent to over 5000 trillion(1012) kWh / year, which is far more than the total energy consumption of the country. India is one of the few countries with plenty of sunshine with an annual average insulation varying from 4-7 kWh per m²/day with 250-300clear sunny days per year. Various types of solar thermal devices like solar water heaters, solar cookers, solar stills ,solar dryers and so are available. According to the National Renewable Energy Laboratory, nearly 10 MW of PV modules are projected and installed during 1996. A recent drop in the interest rate (from 10.3 % to 2.5 %) from a U.S.$ 42 million grant from the World Bank in 1991 for PV market development. Recently, the World Bank agreed in principle to establish a $ 200 million second line of credit for the Indian Renewable Energy Development Agency(IREDA) achievements: The total capacity of about 4,60,000 mt2 solar thermal collector area. [3]. The total 4,80,000 nos. of solar cookers. PV systems of about 47 MW aggregate capacity (about600,000 systems) have been installed for various applications in the country. Under the PV program of MNES (ministry of non-conventional energy sources),about 3,80,000 systems aggregating to over 13 MW have been installed. This includes 2,45,000 solar lanterns; 95,000 home lighting systems; 37,000 street lighting systems, 3,100 water pumping systems and of about 1 MW aggregate capacity of stand alone power plants / packs. Solar power systems are considered to have a significant potential in Telecommunication. An experimental system of small size has been installed at Tongpal rural telephone exchange. There are 825 kW of PV power units installed. There are also 954 PV community lights / TV and community facilities; 85,000 PV domestic lighting units / Lanterns;32,872 PV street lights; and 1,373 PV water pumps. In Punjab PEDA (Punjab Energy Development agency) is providing around 500 solar water pumps at subsidies rates to the farmers for irrigation purpose. The actual cost is 4.5 lakh rupees where the farmers have to pay only Rs. 35000 only.

V WIND ENERGY STATUS

Wind power generation capacity in India has significantly increased in recent years. As of the end of March 2017 the total installed wind power capacity was 32.17 GW, mainly spread across the South, West and North regions. [1][2] By the end of 2015, India had the fourth largest installedwind power capacity in the world. [3][4] The levelised tariff of wind power reached a record low of 3.46(5.4¢ US) per kWh (without any direct or indirect subsidies) during auctions for wind projects in February 2017. [5][The development of wind power in India began in 1986 with the first wind farms being set up .In coastal areas of Maharashtra (Ratnagiri), Gujarat (Okha) and Tamil Nadu (Tirunelveli) with 55 kW Vestas wind turbines.

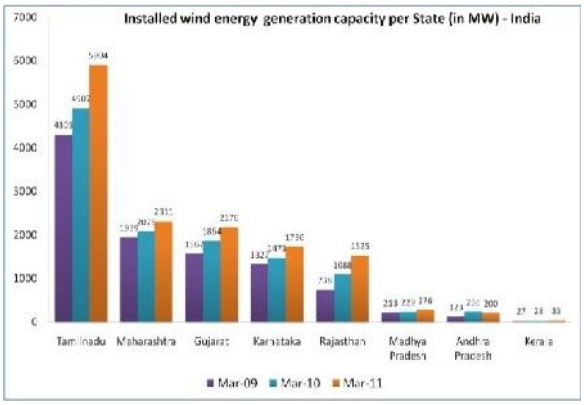

Figure 3:Wind Energy Installed Capacity In India

These demonstration projects were supported by the Ministry of New and Renewable Energy (MNRE).The potential for wind farms in the country was first assessed in 2011 to be more than 2,000 GW by Professor Jami Hossain of TERI University, New Delhi. [citation needed] This was subsequently re-validated by

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Lawrence Berkley National Laboratory, US (LBNL) in an independent study in 2012. As a result, the MNRE set up a committee to reassess the potential [7] and through the National Institute of Wind Energy (NIWE, previously C-WET) has announced a revised estimation of the potential wind resource in India from 49,130 MW to 302,000 MW assessed at 100 m hub height. [8] Wind turbines are now being set up at even 120 m hub height and the wind resource at higher hub heights of around 120 m or more that are prevailing is possibly even more. In 2015, the MNRE set the target for Wind Power generation capacity by the year 2022 at 60,000 MW.

VI BIOMASS STATUS

Biomass is a complex class of feed stocks with significant energy potential to apply different technologies for energy recovery. Typically technologies for biomass energy are broadly classified on the basis of principles of thermo chemistry as combustion, gasification, pyrolysis and biochemistry as anaerobic digestion, fermentation and trans-esterification. Each technology has its uniqueness to produce a major calorific end product and a mixture of by-products. The range of this technology covers plants of few watts to a few hundred MW. For example a domestic Chulla,which burns wood or charcoal is rated less than 2 kW, a large urban waste incineration power plant is rated 150MW. Biogas plants are available in sizes from 3 m3/day to 2000 m3/day of biomass feed. The potential for bio energy is estimated by IREDA at 17,000 MW. There is also an estimated additional 8,000 MW of cogeneration.[4]

Types of Biomass

Biomass is highly diverse in nature and classified on the basis of site of origin, as follows:

a. Field and plantation biomass
b. Industrial biomass
c. Forest biomass
d. Urban waste biomass
e. Aquatic biomass

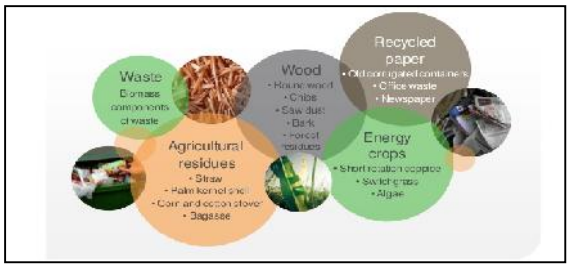

Figure 4:Biomass Generation

VII GEOTHERMAL ENERGY STATUS

Geothermal power plants operated in at least 24 countries in 2010, and geothermal energy was used directly for heat in at least 78 countries. These countries currently have geothermal power plants with a total capacity of 10.7 GW, but 88% of it is generated in just seven countries: the United States, the Philippines, Indonesia, Mexico, Italy, New Zealand, and Iceland. The most significant capacity increases since 2004 were seen in Iceland and Turkey. Both countries doubled their capacity. Iceland has the largest share of geothermal power contributing to electricity supply (25%), followed by the Philippines (18%).

The number of countries utilizing geothermal energy to generate electricity has more than doubled since 1975, increasing from 10 in 1975 to 24 in 2004. In 2003, total geothermal energy supply was 20 MToE (metric Tonne Oil Equivalent), accounting for 0.4% of total primary energy supply in IEA member countries. The share of geothermal in total renewable energy supply was 7.1%. Over the last 20 years, capital costs for geothermal power systems decreased by a significant 50%. Such large cost reductions are often the result of

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solving the "easier" problems associated with science and technology improvement in the early years of development.

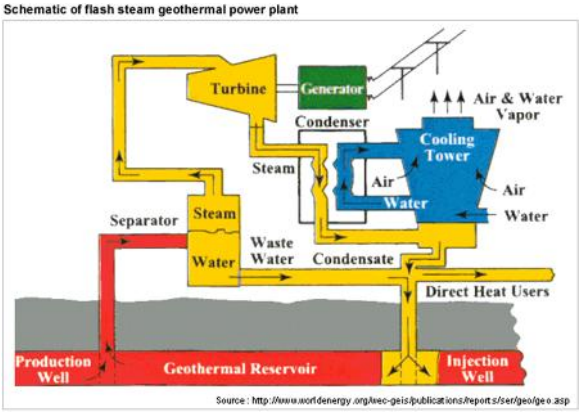

Figure5:Block Diagram of Electricity Generation by Geothermal

Indian Government Funding

A favorable fiscal/policy environment exists in India for the development of renewable energy sources economically. From central government: Income tax holiday, Accelerated depreciation, Concessional custom duty, Capital/interest subsidy. The state government also formed some policies like: Energy buyback, Power wheeling and Banking facility etc.

Other International Funding Sources The Government of Netherlands has sanctioned a grant-in aid of 10 million Guilders for promoting NRSE technologies through IREDA, which has been trebled into 30 million Guilders in the second phase

VIII CONCLUSION

Many scientists believe that by the year 2030, when students in school today are grown and have their own families, they will be using new sources of energy. Instead of building new coal-burning power plants to generate electricity for your home, your house may have a roof with special shingles that convert sunshine into electricity. Or out in the countryside, there will be farms with something new. Among the grazing cattle and fields of crops will be huge towers with slow-turning propellers that convert wind energy into electricity. Your house could have large, south facing windows that gather free light and heat from the sun. Renewable energy technologies have important advantages to utilities: they use a fuel source that is either free (such as sun or wind) or relatively inexpensive (such as wood waste or municipal solid waste); their project construction lead times can be significantly shorter than those of traditional power plants, thus reducing utility risks; their capacity can be increased incrementally to better match load growth; and they are environmentally cleaner than fossil fuels .

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