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Future Trends in Renewable Energy Resources

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Abstract—*Energy is the key input to drive and improve the life cycle. The consumption of energy is directly proportional to the progress of mankind. With fast growth of population, increasing standard of living, high growth of industrialization, the need for the energy has increased significantly. While fossil fuel is the primary source of energy, but that they are exhausting at a faster rate. Renewable Energy solves the problem associated with the Conventional Energy Resources. Renewable Energy has steady growth in power systems world-wide. This paper deals with what type of renewable technology are available and how it has influenced Indian power consumption and what are its future prospectus available in India.*

Keywords: *Renewable Energy,MW(Mega Watt), IREDA (Indian Renewable Energy Development Agency), MNES (Ministry of Non-Conventional Energy Sources), MNRE(Ministry of New and Renewable Energy sources)*

1. INTRODUCTION

With the industrial revolution in 19th century many technologies has emerged that has changed the living standard of people. With the advancement in industrialization use of energy also has increased as the technologies are energy driven. The energy was obtained from non-renewable energy resources. With the growing industrialization the rate of dependence on non- renewable energy also increased enormously as the requirement of energy increased. In the beginning no one thought that it will be exhaustible and harmful to the environment. Now the time has arrived that we should look for alternative energy resources as the non-renewable energy don't have a promising future. Renewable or non- conventional energy resources overcome all the problems related to non-renewable energy resources thus can be used as an alternative to that. Renewable energy resources are inexhaustible, easily available, present abundantly and harmless to nature. Thus non- conventional energy resources are referred as "clean energy and green energy". The only problem associated with them is that they are expensive as compared to non-renewable energy resources but it is hoped that with advancement in technology and more development in the field of non-conventional energy resources these will be proven cost effective.[11] The future of non-conventional energy resources is bright and will play an important role in world energy scenario.

India currently is the fifth largest producer of electricity but still is power deficit state. 70% of its energy needs are met through crude oil and natural gas that is being imported. Coming to power generation in country, India has increased installed power capacity from 1362 MW to over 112, 058 MW since independence and electrified more than 500,000 villages. This achievement is impressive but not satisfactory. It is a matter of concern that 44% of households do not have access to electricity (census 2001) and as many as 80,000 villages yet to be electrified. The electric supply is not even sufficient for those who are connected.[1]

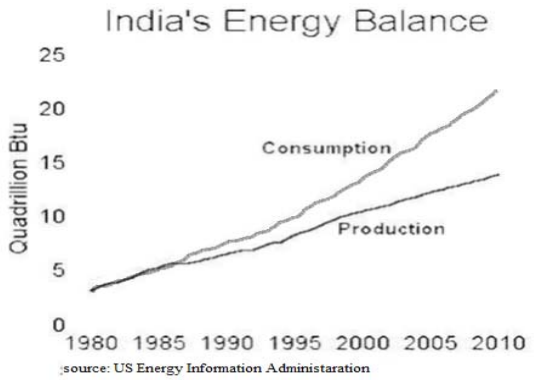
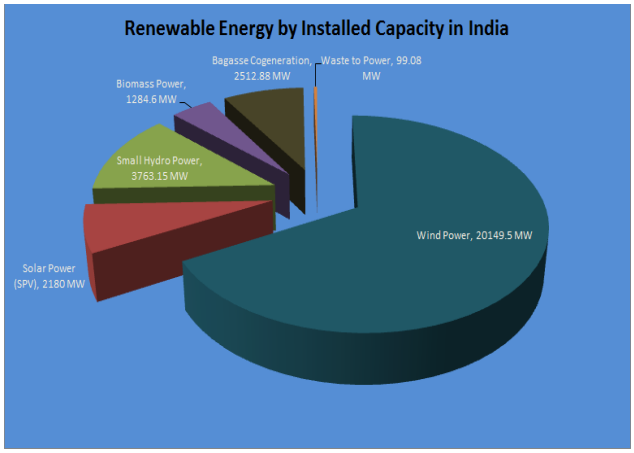


Fig. 1: India's Energy Balance

Thus concerning the energy security in India and low pollution fuel 12th Five Year Plan of the country includes plan for sustainable development of the power sector. Renewable Energy solve the sustainability problems associated with non-renewable energy as they are inexhaustible and relatively clean and it also solves the energy problems related to remote locations.[2]The key drivers for renewable energy are the following:[3]

- The demand-supply gap, especially as population increasesA large untapped potential
- Concern for the environment
- The need to strengthen India's energy security
- A viable solution for rural electrification

The 11th Five Year Plan realized the significant role of new and renewable energy to enhance the domestic energy supply options as well as the need to diversify energy sources. The 12th Five Year plan's strategy aims to develop the RE sector through capacity addition in wind power, small hydro power, solar power, and bio-power.[2]India has vast supply of non-conventional energy resources and it has one of the largest programs in the world for deploying renewable energy products and systems. It is the only country in the world that has separate ministry for renewable energy development namely Ministry of New & Renewable Energy Sources (MNRE). India's cumulative grid interactive or grid tied renewable energy capacity (excluding large hydro) has reached 29.9 GW,[4]of which 68.9% comes from wind, while solar PV contributed nearly 4.59% of the renewable energy installed capacity in India.[5]Today, India is among the leaders in the world in utilization of several renewable energy technologies.



Sources of renewable energy in India as of December 2013, MNRE India

Fig. 2: Renewable Energy by installed capacity in India

2. POWER FROM NON-CONVENTIONALENERGY RESOURCES

Indiahas an estimated renewable energy potential of around 85,000 MW from commercially exploitable sources: Wind, 45,000 MW; small hydro, 15,000 MW and biomass/bioenergy, 25,000 MW. In addition, India has the potential to generate 35 MW per square kilometer using solar photovoltaic and solarthermal energy.[3]

Table 1: Total Renewable Energy Instlled Capacity (May 2014)[6]

Source	Total Installed Capacity MW
Wind Power	21,262.23
Solar Power	2,647.00
Small Hydro Power	3,803.65
Biomass Power	1,365.20
Bagasse Cogeneration	2,512.88
Waste to Power	106.58
Total	31,833.01

2.1 Solar Energy

Sun is the primary source of energy. The earth receives 1.6 × 10^{18} units of energy from the Sun annually, which is 20,000 times the requirement ofmankind on the earth. India is a solar rich country as it is situated near equator hence, receives large amount of solar radiation throughout the year. Theaverage solar radiation received by most parts of India range from about 4 to 7 kilowatt hours per meter square per day, with about 250- 300 sunny days in a year. This energy is sufficient to set up 20 MW solar power plant per square kilometer land area. Solar Energy can be utilized in two ways:

- Solar Thermal Energy Conversion System
- Solar Electric (Solar Photovoltaic) System

2.1.1. Solar Thermal Energy Conversion System-A solar thermal collector system gathers the heat from the solar radiation and gives it to the heat transport fluid. The heat-transport fluid receives the heat from the collector and delivers it to the thermal storage tank, boiler steam generator, heat exchanger etc. Thermal storage system stores heat for a few hours. The heat is released during cloudy hours and at night. Thermal-electric conversion system receives thermal energy and drives steam turbine generator or gas turbine generator. Applications of solar thermal energy systems range from simple solar cooker of 1 kW rating to complex solar central receiver thermal power plant of 200 MWe rating.

2.1.2. Solar Electric (Solar Photovoltaic) System- Photovoltaic is the technical term for *solar electric*. Photo means "light" and voltaic means "electric". PV cells are usually made of silicon, an element that naturally releases electrons when exposed to light.[10]The freed electrons cannot return to the positively charged sites (hole) without flowing through an external circuit, thus generating current. Solar cells are designed to absorb as much light as possible and are interconnected in series and parallel electrical connections to produce desired voltages and currents.[8]Some applications for PV systems are lighting for commercial buildings, outdoor (street) lighting, rural and village lighting etc.

Announced in November 2009, the Government of India proposed to launch its Jawaharlal Nehru National Solar Mission under the National Action Plan on Climate Change with plans to generate 1,000 MW of power by 2013 and up to 20,000 MW grid-based solar power, 2,000 MW of off-grid solar power and cover 20 million sq.meters with collectors by the end of the final phase of the mission in 2020.[13]

2.2 Wind Energy

Wind Energy is the conversion of wind power to electricity. Wind Power is not a new development as it has been used in conventional windmills for grinding, sailing ships and pumping water. Kinetic energy of wind can be used to run wind turbines which results in electricity. The basic wind

energy conversion device is the wind turbine which converts mechanical energy created by the rotation of blades into electrical energy; sometimes the mechanical energy from the mills is directly used for pumping water from well also.[8]The annual wind speed required by wind turbine is 15km/hr. The wind power program in India was started during 1983-84 with the efforts of the Ministry of Non-Conventional Energy Sources. [8]

India has the 5th largest wind power installed capacity in the world. As of December 2013 the installed capacity of wind power in India was 20149.50MW[4] mainly spread across Tamil Nadu (7162.18 MW), Maharashtra(3021.85 MW), Gujarat(3174.58 MW), Karnataka(2135.50 MW), Rajasthan(2684.65 MW), Madhya Pradesh(386.00 MW), Andhra Pradesh(447.65 MW), Kerala(35.10 MW), West Bengal(1.10 MW), other states (3.20 MW).[9] Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of the country's power.In its 12th Five Year Plan (2012-2017), the Indian Government has set a target of adding 18.5 GW of renewable energy sources to the generation mix out of which 11 GW is Wind Energy.[12]

2.3 Hydro Energy

Hydro Power refers to the power generated from water. The falling water has high potential of energy stored which can be converted into electricity with the help of turbine.Wherever sufficient head, or change in elevation, is found, rivers and streams are dammed and mills are built. Water under pressure flows through a turbine causing it to spin. The Turbine is connected to a generator, which produces electricity.India has immense potential for hydroelectric generation,assessed around 84,000 MW at 60% load factorand ranks 5th globally in terms of development of hydro-potential.The present installed capacity as on September 30, 2013 is approximately 39,788.40 MWwhich is 17.39% of total electricity generation in India. [15]There are 39 wind potential stations in Tamil Nadu, 36 in Gujarat, 30 in Andhra Pradesh, 27 in Maharashtra, 26 in Karnataka, 16 in Kerala, 8 in Lakshadweep, 8 Rajasthan, 7 in Madhya Pradesh, 7 in Orissa, 2 in West Bengal, 1 in Andaman Nicobar and 1 in Uttar Pradesh. Out of 208 suitable stations 7 stations have shown wind power density more than 500 Watts/ m. [10]

2.4. Biomass Power

Biomass is an important source for generating energy and represents approximately 33% of the overall volume of fuel used in the country. Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities.Biomass can be used in three ways–one in the form of gas through gasifiers for thermal applications, second in the form of methane gas to run gas engines and produce power and the third through combustion to produce steam and thereby power.With an estimated production of 350 million tons of agricultural waste every year, biomass is capable of supplementing coal to the tune of about 200 million tones producing 17,000 MW of power and resulting in a saving of about Rs.20, 000 crores every year.[8]India ranks 4th globally in power generation through biomass and it has estimated potential of 21,000 MW biomass power. Biomass power projectswith an aggregate capacity of 1,300 MW through over 100 projects have been installed in the country.[3]

2.5. Bagasse Cogeneration

Bagasse Cogeneration refers to the generation of power from sugar cane bagasse. Cogeneration improves the profitability of the sugar mills, cleans environment, cut down power costs thus sugar mills are rapidly turning to bagasse to generate electricity.According to current estimates, about 3,500 MW of power can be generated from bagasse in the existing 430 sugar mills in the country. Around 2,500 MW of power has already been commissioned and more is under construction.

2.6. Energy from Waste

Piling garbage in urban areas due torapid growth of industrialization and urbanization are also a source of energy. An estimated 50 million tons of solid waste and approximately 6,000 million cubic meters ofliquid waste are generated annually in the urban areas of India.[3] India has potential of generating 2,600MW power from urban waste and 1,300MW from industrial wastes. India currently is generating 106 MW power from 48 projects.

3. FUTURE PROSPECTUS OF RENEWABLEENERGY IN INDIA

India is one of the countries that are most involved in the development of Renewable energy resources.

3.1. CentralGovernment Financial Activities and Incentives

The Indian Renewable Energy Development Agency (IREDA) set up under Ministry of Non-Conventional Energy Sources (MNES) is a specialized Financing agency to promote and finance renewable energy projects. At present IREDA deals with following projects:

- Solar energy technologies, utilization of solar thermal and solar photo voltaic systems
- Wind energy setting up grid connected Wind farm projects
- Small hydro setting up small, mini and micro hydro projects
- Bio-energy technologies, biomass based co-generation projects, biomass gasification, energy from waste and briquetting projects
- Hybrid systems

- Energy efficiency and conservation[10]

Following are some of new measures:

- 100 percent income tax exemption for any continuous block of power for 10 years in thefirst 15 years of operations
- providers of finance to such projects are exempt from tax on any income by way ofdividends, interest or long-term capital gains from investment made in such projects on orafter June 1, 1998 by way of shares or long-term finance
- accelerated 100-percent depreciation on specified renewable energy-based devices orprojects
- accelerated depreciation of 80 percent in the first year of operations
- interest rate subsidies to promote commercialization of new technologylower customs and excise duties for specified equipment
- exemption or reduced rates of central and state taxes.[14]

100% Foreign Direct Investment is allowed in the Non-Conventional Energy sector.

3.2. Government of India's Policy Support

2001 Energy Conservation Act focus on the energy efficiency, requirement of the consumers, gathering of energy conservation fund, standards and labeling of the energy equipment.

Section 86. (1)(e) of the Electricity Act 2003 mandates the State Commission to promote cogeneration and generation of electricity from renewable sources of energy.

The National Electricity Policy 2005 states that progressively the share ofelectricity from non-conventional sources would need to be increased.

3.3. Advancement in the field of Renewable energy

India has one of the world's largest programs in solar energy which include R&D, demonstration and utilization, testing & standardization, industrial and promotional activities. With increasing technologies in semiconductor materials the PV conversion efficiencies have increased up to 12 to 17 percent, and research laboratory cells demonstrate efficiencies above 34percent.India has an expanding solar energy sector: 9 solar cell manufactures, 22 PV module manufactures, and 50 PV systems manufacturers.[14]

India is implementing the world's largest wind resource assessment program comprising wind monitoring, wind mapping and complex terrain projects. This program covers 800 stations in 24 states with around 200 wind monitoring stations in operation at present.

3.4. Future Projects

Nagpur to have Asia's biggest solar thermal power plant- The plant will generate 10-MW (megawatt) electricity for the national grid. The plant load factor will be between 80% and 90% of the installed capacity.

Government targets 10,000 MW solar power by 2020-The MNRE is working on a comprehensive mission agenda to operationalize the plan to enhancing the contribution of solar energy in the total energy mix.

NABARD to venture into solar power sector-The state-run NABARD (National Bank for Agriculture and Rural Development), in a serious bid to give a much needed push for solar power projects, proposes to share 50% of the cost of installation up to a maximum of 20 demonstration solar power project units at important places.[18]

ATMs, mobile companies turn to solar energy- Due to acute power shortage and increasing cost of power generation solar energy is now being used to run ATMs, bank branches, and mobile phone towers.

Civic body wants solar power for parking lots-The MCD (Municipal Corporation of Delhi) is going to make it mandatory for all upcoming multi-level parking projects to use solar power.

140 MW solar thermal/naptha hybrid power plant with 35 MW solar trough components will be constructed in Rajasthan raising India to 2nd in the world in utilization of solar thermal.

Water-propelled cars may run on Indian roads- the senior researcher of the central government's ERDA, Vadodara, G S Grewal, believes that it could become a reality in a maximum of two decades or even earlier.

The Government of India through MNES and IREDAis implementing power-generating system based on biomass combustion as well as biomass gasification.

4. CONCLUSION

The population of India is growing significantly and the need for power in the technology driven era for the increasing population is increasing abruptly. The goal of Indian Government is to provide power to every household of India and the focus is on providing the clean and sustainable energy. The required need can be fulfilled by the utilization of renewable energy resources.The various forms of renewable energy such as solar energy, wind energy, hydro energy, and biomass energy are available in India that can be utilized for future generation. The government is trying to utilize the available potential to its fullest and has worked tremendously in this respect. But as the field is developing it is promoting

research and development in the field and going with the growing technologies. As renewable energy is developing, it is not popular among the population. To popularize it among the common people the Government has initiated many steps like financial aids, policy benefits etc. Thus it can be said that India is in the state of transition. It is experiencing strong economic growth at the same time attempting to provide modern power to its population. It can be concluded that all the steps (financial, technical, and social) takenhas accelerated renewable energy resources and with the growing advancement we can achieve all energy needs.

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