

## Renewable Energy Scenario in India: A Current Status

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### Abstract

Renewable Energy Sources (RES) play an important role in the development of any nation because their energy needs and have less impact on the environment. The conventional energy resources are in limited quantities and are decreasing day by day. To support the energy requirement, there are several government schemes and policies for RES that meet energy demand. Energy security is very important for the developing country and it depends on the cost of fossil fuels and limited resources. India has a huge availability of RES with a large land mass, which provides maximum solar radiation, and is a coastal area that provides air velocity for wind farms. Renewable Energy (RE) attracts the attention of all energy producers because low maintenance and operational features. The main source of the RE are solar photovoltaic, wind energy, biomass power, small hydro power, etc. This paper gives an overview of the RE scenario in India and current status of RE in India.

**Keywords:** Renewable energy source, solar energy, wind, biomass, small hydro, energy.

### Introduction

For industrial, social and economic development of any country, energy is the main source. The energy consumption is increasing day to day. To meet the energy demand, the RES is the best opportunity to fulfil the energy demand because the conventional energy sources are depleting. The RES has large potential of green and clean energy without affecting the environment and have very high-power generation capacity because of larger land and coastal areas across the country. In last few years, the growth of RES is increasing very rapidly and corresponding the power generation from these sources are also in a sufficient amount. Renewable energy is generated from natural resources such as wind, solar (sunlight), rain, tides, and geothermal heat [1,2]

Renewable energy does not cause pollution or discharge toxic substances into the atmosphere but some renewable energy systems have environmental problems such as hydroelectric dams cause damage to plants and land area. Wind turbines can be hazardous to flying birds, which has seen the destruction of salmon populations. Renewable energy sources provide relatively low-intensity energy, so in order to convert them into useful energy; the collection needs to be distributed over large areas [3]. The advantages of renewable energy are that they are sustainable global

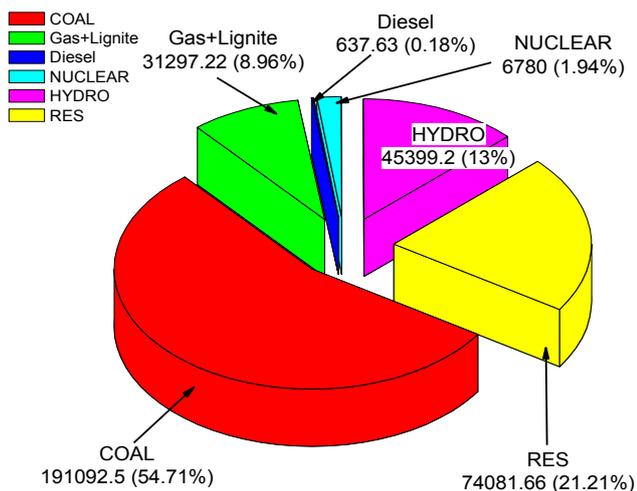
(found everywhere across the world, in contrast to fossil fuels and minerals), essentially non-polluting and less harmful for the environment. Energy cannot be created or destroyed. Energy crisis in India is due to a very limited quantity of available fossil fuels, which are our main energy sources today. The problem is increased due to overpopulation and overconsumption of electricity [4,5].

The energy is required in every sector like household applications, agriculture, industry, commercial and transport uses. In India, the energy requirement is increasing day to day due to fast growing economic in the world. Renewable energy is the most important sources to meet the energy demand and energy generation from RES are increasing very hastily in last decade. The overall position of India in RE is 4<sup>th</sup> (without hydro power plant) and 5<sup>th</sup> (with hydro power plant), 4<sup>th</sup> position in wind power generation and biogas and cogeneration power and 3<sup>rd</sup> position in solar PV generation [6]. The total contribution of RE source is 20% of the total power generating. The total installed capacity of India is 349.22 GW as shown in Fig. 1 and the total renewable energy is 70.08 GW and the breakup of renewable energy is shown in Fig.2 [7]

### Solar Photovoltaic

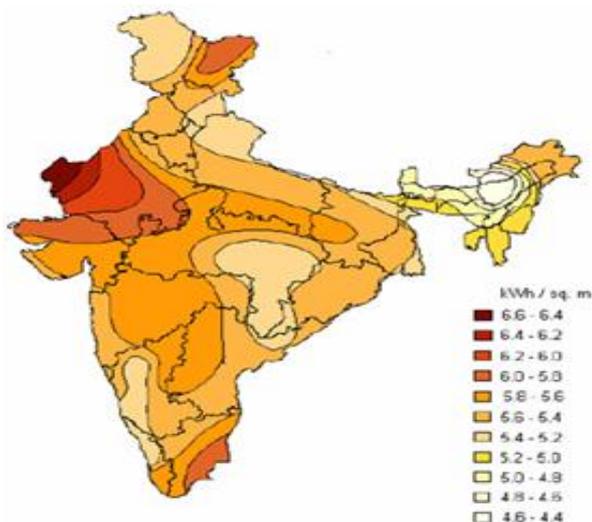
The Sun is the world's essential source of energy and emits electromagnetic waves. It has imperceptible infrared or warmth waves, just as light waves. Solar power, a clean inexhaustible energy with zero emission, has got great potential of energy which can be harnessed using a diversity of devices. Solar energy system simply exists in the recent developments for domestic and industrial use with minimum maintenance [8]. Solar energy is the first energy source when people think of renewable sources of energy. The solar energy is converted photon energy in to electrical energy with different two ways are as Solar photovoltaic (PV), where sunlight is directly converted into electricity via solar cells, and solar thermal power (STP) where the energy is used in terms of heat. PV is a proven technology that is most appropriate for small-scale applications to provide heat and power to individual houses and businesses [9].

Sunlight falls on a layer of semiconductors, which pushes electrons and create an electrical current that can be used as a source for electricity. Due to the low cost and minimum maintenance, the PV system is used for future technology to fulfil the energy requirement. The solar energy can be grid connected and stand alone, depends on the requirement of the uses [10].



**Figure 1:** Total energy installed capacity

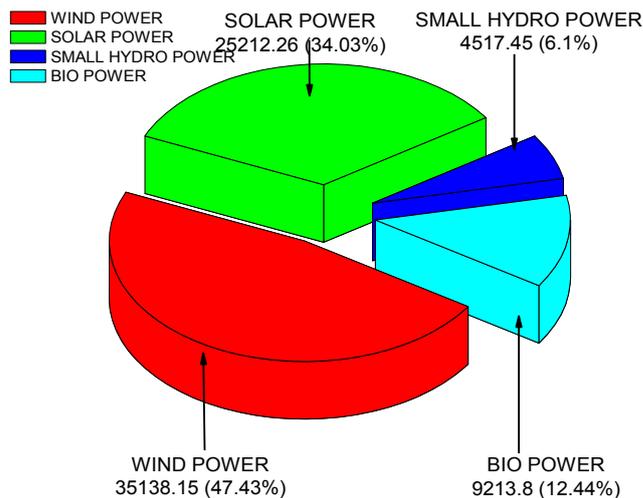
On average, the India has 300 sunny days/year and 200 MW/km<sup>2</sup> irradiation has received in one hour on average. Sunlight is defined by irradiance means radiant energy of light. The India Energy Portal estimates that around 12.5% of India's land mass, or 413,000 km<sup>2</sup>, could be used to extract the solar energy [11]. An extensive program is planned as part of the JNNSM (Jawaharlal Nehru National Solar Mission) in which the 75 GW power is generated by RE sources till 2020, which is achieved in 2019 (approximatively). The mission is increased in 2015 and the



**Figure 3:** Solar radiation Map

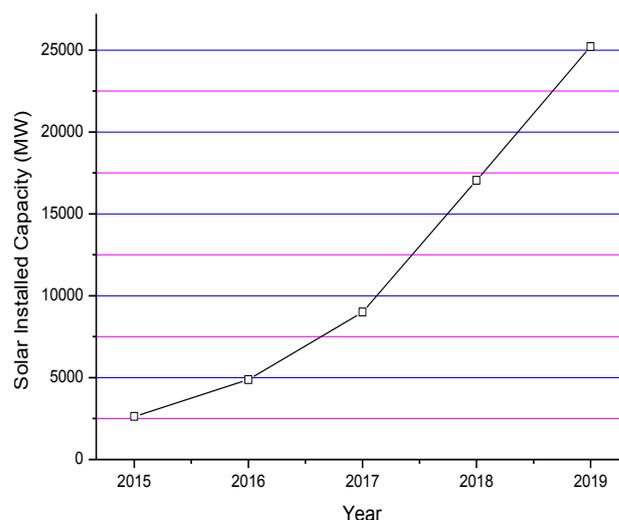
### Wind energy

The growth of wind energy is gaining all over world. The fast development of wind energy technology is much importance because of the other non-renewable sources decreases day by day. Currently, five countries: China, USA, Germany, India and Spain are the top leading country in the worldwide wind energy capacity [6]. The utilization of wind energy had in practice since last 3000, and it was used for pumping water, grinding grain, and long-distance transportation (sailing ships) etc. The first wind turbines for electricity generation had been developed already in early twentieth century. The technology was improved step by step from the early 1970s. By the end of the 1990s, wind



**Figure 2:** Total renewable energy installed capacity

175 GW energy is generated till 2022, in which share of solar PV is 100 GW. There is a huge potential for solar energy applications in grid interactive solar power generation plants, solar thermal industrial applications, rural electrification, roof top-based applications and mobile towers in off grid areas, and domestic water heating. The figure 3 shows the solar radiation map of India. In last five years the solar energy is growing very fast rate, in 2015 the total installed capacity of solar was 2631.93 MW and in 2019 it is 25212.26 MW as shown in figure 4.



**Figure 4:** Solar Installed capacity

energy has re-emerged as one of the most important sustainable energy resources [11].

At the opening of modern industrialization, the use of the variable wind energy resource was replaced by fossil fuel fired engines or the electrical grid, which provided a more dependable power source. Wind energy is clearly on the rise and could become a major source of electricity in years to come because wind is widely available and often abundant in many parts of the world. Wind energy is a viable alternative to fossil fuels – it doesn't emit greenhouse gases or other pollutants. Within less than one year of operation, a WTG can offset all emissions from its construction to run almost carbon free for the remainder of its 20-year lifetime. The total wind resource is sufficient to

meet global energy requirements several times over, and many more times the current total global electricity consumption. Wind power is already making a significant contribution to emissions reductions in both industrialized and developing countries. According to GWEC, the total wind power generation is 539.13 GW, and 72.12% share of the total wind installed capacity come from top five leading countries. The wind turbine is classified in to two types based on the location as [12]

- i. Onshore turbine installations are frequently in upland environment to exploit the higher wind speeds. However, wind farm permitting and siting onshore can be difficult as high wind-speed sites are often of high visual amenity value and environmentally sensitive.
- ii. Offshore development, particularly of larger wind farms, generally takes place more than 5 km from land to reduce environmental impact. The advantages of

offshore wind farms include reduced visual intrusion and acoustic noise impact and also lower wind turbulence with higher average wind speeds.

Most wind power capacity is connected to electricity supply network, and this is possible to continue for the expected future [13]. The advantages of connection to a grid include:

- The capability to locate wind farms where the wind resource is abundant, irrespective of demand;
- The ability of an interconnected grid to absorb variations in wind generation unrelated to overall demand variation;
- Provision of excitation, enabling simple induction machines to be used as generators.

The wind power density and the total installed capacity of wind in last five years are shown in figure 5 and figure 6 respectively.

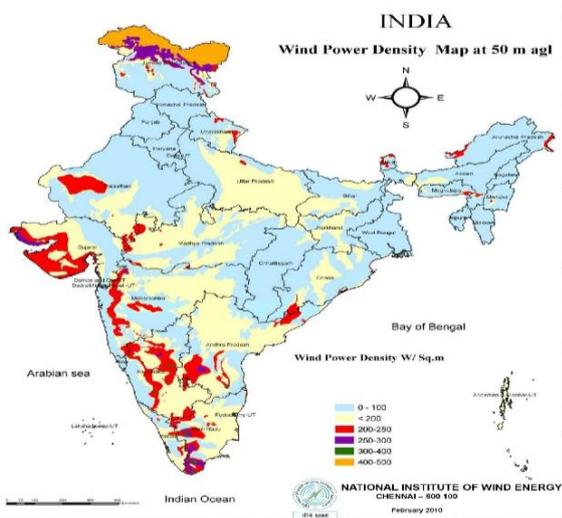


Figure 5: Wind power density

### Bio mass and co-generation energy:

Bio mass is a type of fuel that come from organic matter like agricultural and forestry residue, municipal solid waste and industrial wastes. The organic matter used may be trees, animal fat, vegetable oil, rotting waste and sewage. Bio fuel such as bio-diesel fuel is currently mixed with gasoline for fueling cars, or are used to produce heat or as fuel in power station produce electric power [14]. Biomass is plant matter used to generate electricity with steam turbines and gasifiers or produces heat usually by direct combustion. In the bio mass includes plant or animal matter that can be converted into fibers or other industrial chemicals including bio fuels. India estimates biomass availability of 600 million tons from agriculture and forest residue corresponding to 16,000 MW and 5000 MW from sugarcane bagasse [15].

Biomass has always been a significant energy source for the country considering the benefits it offers. Biomass is also capable of providing concrete energy. About 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. Ministry of New and Renewable Energy has realized the potential and role of biomass energy in the Indian context and hence has

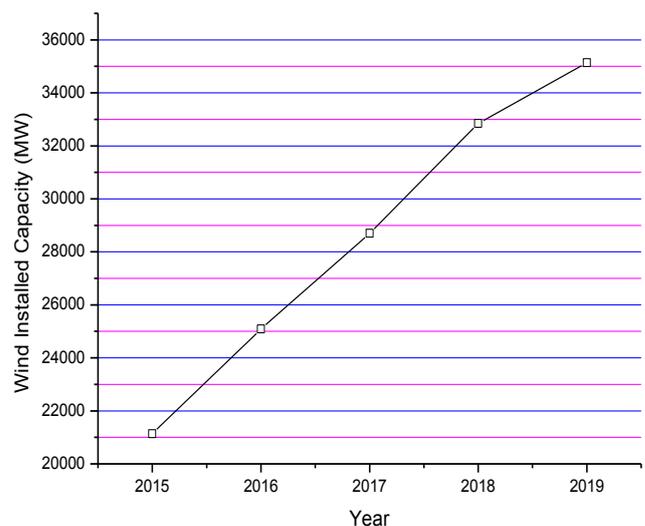


Figure 6: Wind Installed capacity

initiated a number of programmed for promotion of efficient technologies for its use in various sectors of the economy to ensure beginning of maximum benefits of biomass power generation. The total 18000 MW energy can be produced by the agricultural and forestry residues which is approximately 120 – 150 million metric tons and additional 5000 MW energy can also produce by biogas-based co-generation plant of the sugar mills.

There are mainly two technology is used to generate the electricity as [16]

- i. **Combustion:** The thermo chemical processes for conversion of biomass to useful products involve combustion, gasification or pyrolysis. The most commonly used route is combustion.
- ii. **Cogeneration in Sugar Mills:** Sugar industry has been traditionally practicing cogeneration by using bagasse as a fuel. With the advancement in the technology for generation and utilization of steam at high temperature and pressure, sugar industry can produce electricity and steam for their own requirements.

Figure 7 and 8 shows the Biomass plant and year wise increasing installed capacity in MW as below.



**Figure 7:** A biomass Plant

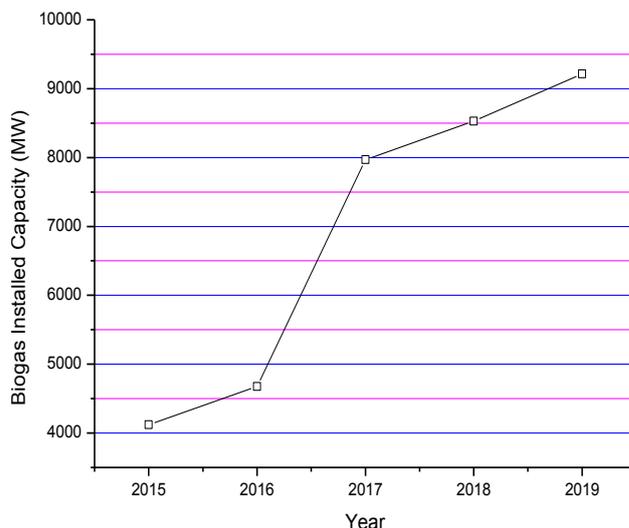
### Small Hydro Power

Hydroelectric power comes from water at work. To generate electricity, water must be in motion. This kinetic energy turns the blades of a water turbine, which changes the kinetic energy to mechanical energy. The turbine shaft turns a generator, which then converts this mechanical energy into electricity. Because water is the initial source of electrical energy, this technology is called hydroelectric power. Hydroelectric facilities offer several benefits, including the following [17]

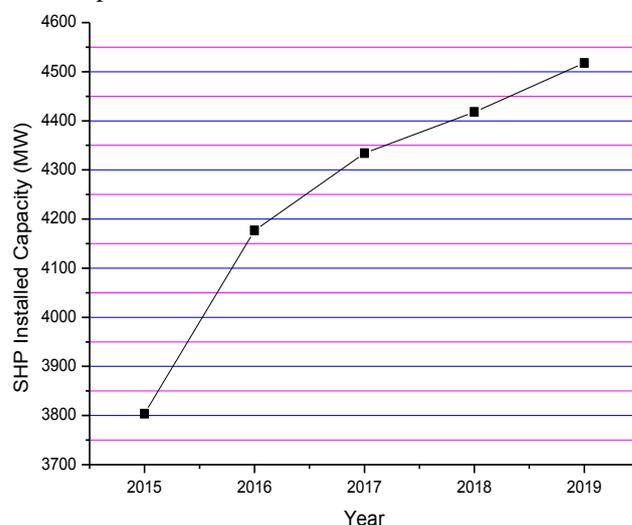
- i. use a renewable resource to generate power;
- ii. are highly reliable and have low operating costs; and
- iii. Can start up quickly and have the capability to adjust their output (load following) capability and peak capacity.

Small hydropower, one of the least expensive and most attractive forms of renewable energy lies largely untapped. It is a very attractive renewable energy source because it uses mature and largely indigenous technology and its maximum power production is in the summer, which coincides with peak seasonal demand in India. Small hydropower-rich north and north-eastern states have lagged in tapping this resource. With their perennial Himalayan rivers, Himachal Pradesh, Jammu and Kashmir, and Uttarakhand have 65 percent of India's small hydropower resource and among the lowest generation costs [18].

The small hydro plants have a capacity of 25 MW or less and are further subdivided into micro (100 kW or less), mini (between 100 kW and 2 MW), and small (between 2 MW and 25 MW). Small hydropower plants are generally run-of-river, with only small amounts of water stored, if any. These projects are considered environmentally benign, particularly when compared to large hydro plants with storage reservoirs, which can cause habitat destruction and community displacement. Both the central government and the state governments provide incentives for the construction of small hydropower plants. High capacity factors have been observed at small hydro plants in remote, mountainous regions of India, and small hydro has the lowest levelized costs of energy of any renewable technology in India [19,20]. The figure 9 shows the increment of SHP generation of last five years. In 2015, the total SHP generation is 3803.68 MW and then



**Figure 8:** Biomass and cogeneration Installed capacity reached upto 4517.45 MW in Jan. 2019.



**Figure:9** Installed capacity of SHP

### Conclusion:

The Renewable energy is a major source electric energy and high potentials. Wind and solar power are the main source of RE. The renewable energy projects in ordinal entail implementing, generating and utilization in a constructive way to defeat the energy crisis in future and so as to reduce inclement threat of global warming. The endorsement of renewable energy projects should continue with new technologies and various researches such a way that it overcomes all barriers and move towards the target. The renewable energy has the prospective to create many employment opportunities at all levels, especially in rural areas. The renewable energy is growing rapidly, with market such as wind, solar cell and bio-mass annual with highly growth. The development of renewable energy source is increasing very fast in last few years to fulfil the energy demand. The solar PV generation is increasing very fast due to different promotional schemes and subsidies provided by the government. In the total installed renewable energy, Wind energy is the leading with 35.13 GW followed by solar which is 25.21 GW installed capacity. The biomass and cogeneration are 9.21 GW installed capacity and small-hydro is 4.51 GW installed capacity from the total renewable energy.

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