

## Present and Future Trends of Renewable Energy in India

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### ABSTRACT

In recent years, India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development. Rapid urbanization and improving standards of living for millions of Indian households, the demand is likely to grow significantly. There is an urgent need for transition from existing fossil fuel based energy systems to one based on renewable resources to decrease reliance on depleting reserves of fossil fuels with the objective to assess whether India can sustain its growth and its society with renewable resources.

Current centralized energy planning of India is dependent on coal and fossil fuel sources. The main concern arises on how to protect the fossil fuel for our coming generation with simultaneously utilizing the different resources of energy for high and sustained economic growth. Pressure to increase its energy supplies and the consequent negative environmental impact of fossil fuels has led India to a conscious policy toward renewable sources. Thus, renewable energy including large scale hydro-power currently adds up to more than 33% of the total installed power capacity in India. India is one of the countries with the largest production of energy from renewable sources. In the electricity sector, renewable energy (excluding large hydro) accounted for 20% of the total installed power capacity (71.325 GW) as of 30 June 2018. Large hydro installed capacity was 45.29 GW as of 31 March 2018, contributing to 13% of the total power capacity. India was the first country in the world to set up a ministry of non-conventional energy resources, in the early 1980s. Solar Energy Corporation of India is responsible for the development of solar energy industry in India.

### 1. Introduction

India is the fourth largest energy consumer in the world after the United States, China, and Russia. In recent years, India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development. Rapid urbanization and improving standards of living for millions of Indian households, the demand is likely to grow significantly. In order to sustain the production, industries have opted for inefficient diesel-fuelled back-up power.

The domestic power demand of India was 918 billion units in 2012. It is expected that at 9.8% annual growth the demand will reach 1,640 billion units by 2020. At this pace, India will require 390 GW in the next eight years which is almost double its current installed capacity of 210 gigawatts (GW). There is growing energy inequity between rural and urban areas and also between the developed and developing states.

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India is one of the countries with the largest production of energy from renewable sources. In the electricity sector, renewable energy (excluding large hydro) accounted for 20% of the total installed power capacity (71.325 GW) as of 30 June

2018. Large hydro installed capacity was 45.29 GW as of 31 March 2018, contributing to 13% of the total power capacity. Unlike most countries, India does not count large hydro power while accounting for renewable energy targets as it comes under the older Ministry of Power instead of Ministry of New and Renewable Energy. Thus, renewable energy including large scale hydro-power currently adds up to more than 33% of the total installed power capacity in India.

India has set a new target of achieving 100 GW of solar power by 2022. Four of the top seven largest solar parks worldwide are in India including the second largest solar park in the world at Kurnool, Andhra Pradesh, with a capacity of 1000 MW. The world's largest solar power plant, Bhadla Solar Park is being constructed in Rajasthan with a capacity of 2255 MW and is expected to be completed by the end of 2018. Biomass power from biomass combustion, biomass gasification and biogas co-generation reached 8.3 GW installed capacity as of 31 March 2018. Family type biogas plants reached 3.98 million.

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### 2. Present Scenario in India

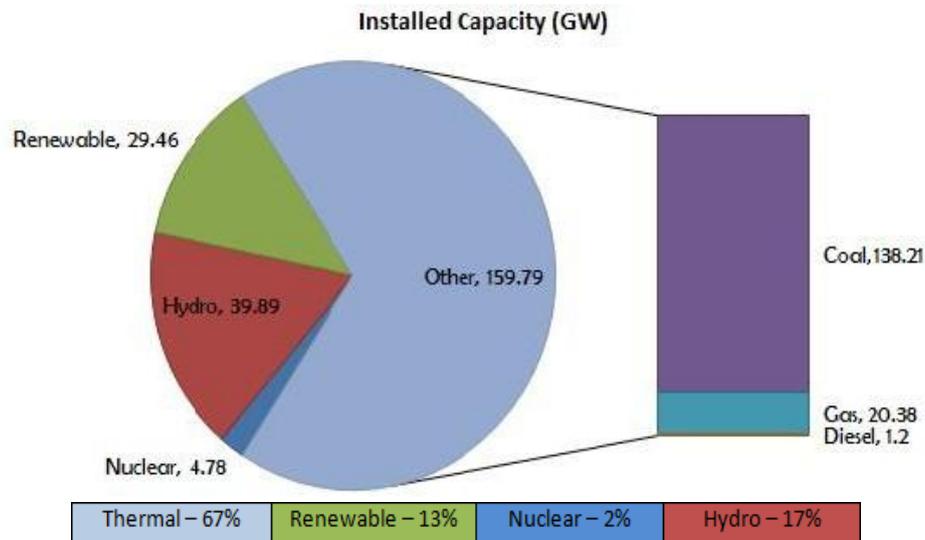
India has transitioned from being the world's seventh-largest energy consumer in 2000 to fourth-largest one within a decade. The country has the fifth-largest power generation portfolio worldwide. India's energy basket has a mix of all the

resources available including renewables. The dominance of coal in the energy mix is likely to continue in near future. At present India's coal dependence is borne out from the fact that ~58 % of the total installed electricity generation capacity is coal based. Out of total thermal installed capacity 86% capacity is coal based. Other renewables such as wind, geothermal, solar,

and hydroelectricity represent a 2% share of the Indian fuel mix. Nuclear holds a 2% percent share.

Total installed capacity in the country stands at ~234 GW of which

- i. Thermal power accounts for 67%
- ii. Renewable energy accounts for 13%



**Figure 3: All India Installed Capacity**

### 3. Wind energy

Wind energy is one of the most promising alternative energy technologies of the future. During recent years, the amount of energy produced by wind-driven turbines has increased rapidly due to considerable advancement in turbine technologies, making wind power economically compatible with conventional sources of energy. The use of wind power in India has been gaining importance with rapid installation in the last few years. Wind energy makes up the majority about 68 per cent of the total renewable energy capacity installed in India.

By the end of October 2013, India had a total installed capacity of 19,933 megawatt (MW), with 1,699 MW installed in 2012-13. The total wind power generation in 2011-12 was 23,399.5 gigawatt hour (GWh), or about three and a half times the output of a new 1,000-MW nuclear reactor. The 12th Five Year Plan aims to install 15,000 MW between 2012 and 2017, which will almost double the total capacity of wind power in India. The development of **wind power in India** began in the 1990s, and has significantly increased in the last few years. 30 June the installed capacity of wind power in India was 34,293 MW, mainly spread across Tamilnadu (7,26.50 MW), Maharashtra (4,100.40 MW), Gujarat (3,454.30 MW), Rajasthan (2,784.90 MW), Karnataka (2,318.20 MW), Andhra Pradesh (746.20 MW) and Madhya Pradesh (423.40 MW). Wind power accounts for 10% of India's total installed power capacity. India

has set an ambitious target to generate 60,000 MW of electricity from wind power by 2022.

### 4. Geothermal Energy

The Geothermal energy of the Earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. At the core of the Earth, temperatures may reach over 5000 degrees Celsius. Geothermal energy comes from the natural heat of the Earth primarily due to the decay of the naturally radioactive isotopes of uranium, thorium and potassium. Because of the internal heat, the Earth's surface heat flow averages 82 mW/m<sup>2</sup> which amounts to a total heat of about 42 million megawatts.

### 5. Solar Energy

Using solar power to produce electricity is not the same as using solar to produce heat. Solar thermal principles are applied to produce hot fluids or air and photovoltaic principles are used to produce electricity. A solar cell is a semi-conductor device designed to turn solar irradiance into electricity. The solar power on the surface of earth is 10<sup>16</sup>W. The total worldwide power demand of all needs of civilization is 10<sup>13</sup>W. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require.

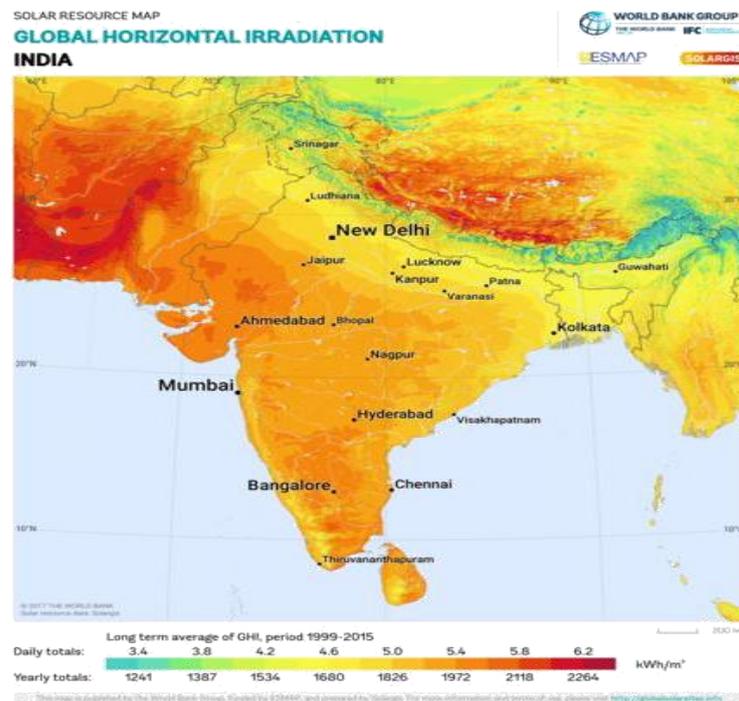


Fig: Global Horizontal Irradiance in India

Among the various renewable energy resources, solar energy potential is the highest in the country. The equivalent energy potential is about 6,000 million GWh of energy per year. As compared to this, the present level of generation of electricity in 2008-09 from all resources was 0.7 million GWh. The National Solar Mission targeting 20,000 MW grid solar power, 2,000 MW of off-grid capacity including 20 million solar lighting systems and 20 million square meters solar thermal collector area by 2022 is under implementation.

India is also the home to the world's first and only 100% solar powered airport, located at Cochin, Kerala. India also has a wholly 100% solar powered railway station in Guwahati, Assam. India's first and the largest floating solar power plant was constructed at Banasura Sagar reservoir in Wayanad, Kerala.

## 6. Biomass & Biogas energy

India is an ideal environment for biomass production given its tropical location and abundant sunshine and rains. The country's vast agricultural potential provides huge agro-residues which can be used to meet energy needs, both in heat and power applications. Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. It is derived from numerous sources, including the by-products from the timber industry, firewood, agricultural residues such as bagasse, crop straw, animal dung and wastes generated from agro-based industries.

Biomass takes carbon out of the atmosphere while it is growing, and returns it as it is burned. If it is managed on a sustainable basis, biomass is harvested as part of a constantly replenished crop. Municipal solid wastes, animal and poultry wastes are also referred to as biomass as they are

biodegradable in nature. The main biomass sources are as listed below.

- i. Wood and wood waste: forest wood, wood from energy plantations, saw dust, tree branches and leaves etc.
- ii. Agricultural residues: rice husk, bagasse, groundnut shells, coffee husk, straws, coconut shells, coconut husk, arhar stalks, jute stick etc.
- iii. Aquatic and marine biomass: algae, water hyacinth, aquatic weeds and plants, sea grass beds, kelp, coral reef etc.
- iv. Wastes: municipal solid waste, municipal sewage sludge, animal waste, paper waste, industrial waste etc.
- v. In India, a total of 4,449 MW has been installed under bio energy, both in grid connected and off-grid capacities.

## 7. Biofuel

- a) **Ethanol:** Ethanol market penetration reached its highest figure of a 3.3% blend rate in India in 2016. It is produced from sugarcane molasses and partly from grains and can be blended with gasoline. Sugarcane or sugarcane juice may not be used for the production of ethanol in India.
- b) **Biodiesel:** The market for biodiesel remains at an early stage in India with the country achieving a minimal blend rate with diesel of 0.001% in 2016. Initially development was focused on the jatropha (*Jatropha curcas*) plant as the most suitable inedible oilseed for biodiesel production. Development of biodiesel from jatropha has met a number of agronomic and economic restraints and attention is now moving towards other feedstock technologies which utilize used cooking oils, other unusable oil fractions, animal fat and inedible oils.

## 8. Renewable Energy Targets

The 2022 electrical power targets include achieving 227GW (earlier 175 GW) of energy from renewable sources - nearly 113 GW through solar power, 66 GW from wind power, 10 GW from biomass power, 5GW from small hydro and 31GW from floating solar and offshore wind power.

**Table 1: Grid connected installed capacity from all sources as of 31 May 2018.**

Source	Installed Capacity (MW)	Share
Coal	196,957.50	57.27%
Large hydro	45,403.42	13.20%
Other renewables	69,022.39	20.07%
Gas	24,897.46	7.23%
Diesel	837.63	0.24%
Nuclear	6,780.00	1.97%
<b>Total</b>	<b>343,898.39</b>	<b>100.00%</b>

This Table is targeted to reach 175 GW by 2022. Coal power currently represents the largest share of installed capacity at just under 197 GW. Total installed capacity as of 31 May 2016, for grid connected power in India stood at a little under 344 GW.

**Table 3: Year wise renewable energy generation (GWh)**

Source	2014-15	2015-16	2016-17	2017-18
Large Hydro	129,244	121,377	122,313	126,134
Small Hydro	8,060	8,355	7,673	5,056
Solar	4,600	7,450	12,086	25,871
Wind	28,214	28,604	46,011	52,666
Bio mass	14,944	16,681	14,159	15,252
Other	414	269	213	358
<b>Total</b>	<b>191,025</b>	<b>187,158</b>	<b>204,182</b>	<b>227,973</b>
Total utility power	1,105,446	1,168,359	1,236,392	1,302,904
% Renewable power	17.28%	16.02%	16.52%	17.50%

## 10. Conclusion

In recent years, India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development. Rapid urbanization and improving standards of living for millions of Indian households, the demand is likely to grow significantly. The main concern arises on how to protect the fossil fuel for our coming generation with simultaneously utilizing the different resources of energy for high and sustained economic growth. Pressure to increase its

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## Off-grid renewable energy:

Source	Total Installed Capacity (MW)
Biomass (non-bagasse) Cogeneration	661.4
SPV Systems	539.13
Biomass Gasifiers	163.37
Waste to Energy	175.45
Aero-Generators / Hybrid systems	3.29
<b>TOTAL</b>	<b>1,542.65</b>
<b>Other Renewable Energy Systems</b>	
Family Biogas Plants (in Lakhs)	49.56
Water mills / micro hydel (Nos.)	2690/72

## 9. Renewable Electricity Generation

Total renewable energy which includes large hydro with pumped storage generation is nearly 17.5% of total utility electricity generation in India during the year 2017-18. Solar, wind and run of the river hydro being must run power generation and environment friendly, base load coal fired power is transforming in to load following power generation.

energy supplies and the consequent negative environmental impact of fossil fuels has led India to a conscious policy toward renewable sources. There is an urgent need for transition from existing fossil fuel based energy systems to one based on renewable resources to decrease reliance on depleting reserves of fossil fuels with the objective to assess whether India can sustain its growth and its society with renewable resources.

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