

# Renewable Energy Resources in India- A Review

Saket Kumar, Anand Prakash, Pritesh Kumar Singh, Sudhanshu Kumar  
Department of Electrical Engineering, Greater Noida Institute of Technology, Greater Noida

Dr. Dheeraj Gupta  
Director of Greater Noida  
Institute of Technology, Greater Noida, India

Nikhil Gupta  
HOD, Dept. of Electrical Engineering  
Greater Noida Institute of Technology

Aneep Kumar  
Asst. Prof. Dept. of Electrical Engineering  
Greater Noida Institute of Technology

**Abstract:-** The demand of electrical energy is increasing which are causing increase in population due to extensive use of fossil fuel. This review paper presents energy potential in India and estimated renewable potential in India. It also presents its impacts, awareness and government achievements.

The particulars of India's contribution in renewable energy and challenges faced by government. It includes government policies, action and program for encouraging Renewable Energy. All analysis done in this paper will be valuable for researchers and invested in coming future. The primary objective for installing renewable energy in India to reduce climate changes and pollution and to advance economic development. The main purpose of this review is to show the present scenario of renewable energy in India and how India is contributing to fulfil the demand of energy consumption in India. This paper reviewed challenges faced in the development of renewable energy and their solutions.

## I. INTRODUCTION

About one third of greenhouse effect are due to electricity production from coal, fossil fuel and natural gases. For increasing standard of living of the people, it is necessary to provide cleaner and more reliable electricity. A 10-year detailed plan has framed by power (UP) under National Electricity Plan (NEP) to provide electricity across the country at reasonable price.

Climate change is one of the reasons which changes the ecological balance in the world. Hence there is Paris agreement which has helped to achieve the goal of limiting the rise of global temperature below 2 Degree Celsius.

That continuous economic growth of India caused huge demand of Energy resources. Since most of the energy resources are non-renewable resources, so once in future it will be exhausted. So, we need renewable energy resources for fulfilling the future demand of India.

## II. ENERGY SCENARIO OF INDIA

In India is one of the largest producer and consumer of electricity. Most of the energy needs of India is fulfilled by the fossil fuel. Mainly the Fossil fuel, which is mostly used for energy generation in India is coal. In current scenario, thermal power plant and hydro power plants are used for electricity generation in India.

## III. RENEWABLE ENERGY POTENTIAL IN INDIA

In 2022, renewable energy source has installed capacity of 150+ GW in India. Following is the installed capacity of renewable energy in India in the year 2022.

Renewable Energy Source	Installed Capacity (GW)
Solar Power	59.34
Biomass	10.2
Small Hydro Power	4.88
Large Hydro Power	46.85
Waste to Energy	0.47
wind Power	41.2

Table 1:- Renewable Energy potential in India

As per the Central Electricity Authority (CEA), the share of the renewable energy in power generation will increase from 18% to 44% by the year 2029-2030 and the dependency on non-renewable energy for electricity generation is going to be decreased from 80% to 52% in the coming years.

### ➤ Solar energy

India is provided with massive solar energy potential and every year 5000 trillion kWh solar energy fall on the India's land area. The capacity of electricity generation with the help of solar power plant is 0.20KWh /m square in India. There is a big problem for irrigation of crop because the electricity charge is high. To overcome this problem, government has provided about 111697 water pumping system to the farmers and this water pumping system solve the problem of clean drinking water in villages or rural areas of India.

Earlier, India was a 10th position in the list of countries producing electricity through solar power plant. But due to the policies and programs which is introduced by the current Government of India. The current government is going to achieve topmost position in the list of countries producing electricity through solar power plant. Current Government of India is focusing on the large projects of manufacturing solar cells, solar array in the country. The government is focusing on domestic manufacturing so that the total cost of installing the solar power plant reduces and installing the solar power plant becomes cheap. And we can easily available solar panels. Made in India is a new initiative taken by Government of India to make India independent in energy sector. Due to this initiative, number of companies investing in India to produce solar panel increases.

The research show that every year energy generation in India varies from 5,10,000 to 8,00,000 kWh per acre of land.

State	2019	2020	2021
Rajasthan	3226.79	5137.91	5732.58
Punjab	905.62	947.1	959.5
Uttar Pradesh	960.1	1095.1	1712.5
Uttarakhand	0	0	0
Haryana	224.52	252.14	407.83
Delhi	126.89	165.16	192.97
Jammu and Kashmir	14.83	19.3	20.73
Himachal Pradesh	22.68	32.93	42.73
Gujarat	2240.13	2948.37	4480.82
Maharashtra	1633.54	1801.8	2289.97
Chhattisgarh	231.35	231.35	252.48
Madhya Pradesh	1840.16	2258.46	2463.22
Telangana	3592.09	3620.75	3952.12
Andra Pradesh	3085.68	3610.02	4203
Kerala	138.59	142.23	257
Karnataka	6095.56	7277.93	7355.17
Bihar	142.45	151.57	159.51
Odisha	394.73	397.84	401.73
Jharkhand	34.95	38.4	52.06
West Bengal	75.95	114.46	149.84
Tripura	5.09	9.01	9.01
Arunachal Pradesh	5.39	5.61	5.61
Mizoram	0.5	1.52	1.53

Table 2:- State-wise solar energy potential in previous years.

#### ➤ Wind energy potential

Moving wind energy have great kinetic energy. This kinetic energy is used to rotate the windmill and windmill is connected to turbine. When the turbine rotates generated soft, the electricity produces.

The power generated through wind energy depends upon the speed of wind, density of air, cross section of air flow. The area or region in India which is highly suitable for

the production of electricity using wind energy is 12.20% and moderately suitable reason in India is 17.06%. and the area in India which is suitable for the production of electricity through wind energy is only 11.06%.

The most potential site in India for the generation of electricity by wind is Jodhpur district in Rajasthan. The location in Karnataka for the highly suitable region where the generation of electricity by wind is latitude 11°31' West to 74°12' East and longitude 18°45' N 78°40' E in Western central part of India. Solapurkar and Mahajan shows the data of Maharashtra state wind energy development in the last previous year by analysing wind project installation, total capacity, suitable wind sites and wind power density at different altitudes.

It was observed that investors can make money by investing in this region.

State	Installed capacity of wind power in 2019	Installed capacity of wind power in 2020	Installed capacity of wind power in 2021
Rajasthan	4299.72	4299.72	4326.82
Punjab	0	0	0
UP	0	0	0
Uttarakhand	0	0	0
Haryana	0	0	0
Delhi	0	0	0
Jammu and Kashmir	0	0	0
Himachal Pradesh	0	0	0
Gujarat	6073.07	7541.52	8561.82
Maharashtra	4797.13	5000.33	5000.33
Madhya Pradesh	2519.89	2519.89	2519.89
Telangana	128.1	128.1	128.1
Andhra Pradesh	4090.45	4092.45	4096.65
Kerala	52.5	62.5	62.5
Karnataka	4694.9	4790.6	4938.6
Bihar	0	0	0
Odisha	0	0	0
Jharkhand	0	0	0
West Bengal	0	0	0
Tripura	0	0	0
Arunachal Pradesh	0	0	0
Mizoram	0	0	0

Table 3:- Year wise wind power install capacity in India of different states.

As The data given by the MNRE, The Gujarat has highest wind energy potential and there are some states which have zero installed wind energy capacity.

#### ➤ Biomass Energy

Biomass is a renewable energy source of energy; it is a type of material which contain carbon in large amount and it

is originate from plants and animals. This includes the trace of discarded material from food processing plants, Waste from animals, agriculture and forestry. Biomass is a renewable source of energy because it is an organic material derived from terrestrial or marine vegetation and it can be derived again and again in a small interval of time. The amount of energy absorbed by growing plants is released the same amount of carbon after burning so it called a superior fuel.

Almost every village of India uses biomass as a fuel for cooking and other purposes. Waste of organic matter is used to produce electricity in India.

In India, there is abundance of biomass fuel. Every year approximately 750 MTs biofuel is produced. If we completely harness biomass fuel, then it can be the very important source of energy in India. The government understood the need of biomass energy for the people of India. After understanding the availability of biomass energy in India, the MNRE make number of programs and policies to harness the biomass potential in India.

Nookman and sipahutar introduced biomass energy resources as wood, leaves and grass. The assets of biomass fuel contain of calorific value, sulphur content, flame temperature and flue gas emissions.

Lohan et al. have shown that 70% of population of Jammu and Kashmir obtain their living from agricultural sector and use wood, compost of cake for cooking as fuel.

States	2018	2019	2020	2021
Rajasthan	121.3	121.3	121.3	121.3
Punjab	317.1	317.1	317.1	317.1
Uttar Pradesh	2115.1	2115.1	2115.1	2115.1
Uttarakhand	0	0	0	0
Haryana	205.66	205.66	205.66	205.66
Jammu & Kashmir	0	0	0	0
Himachal Pradesh	7.2	7.2	7.2	7.2
Gujarat	65.3	77.3	77.3	77.3
Maharashtra	2186.4	2516.1	2516.1	2516.1
Chhattisgarh	230.5	230.5	244.5	244.5
Madhya Pradesh	105.35	105.35	105.35	105.35
Telangana	159	159	159	159
Andhra Pradesh	477.18	477.18	477.18	477.18
Kerala	0.72	0.72	0.72	0.72
Karnataka	1768.8	1798.8	0	0
Bihar	121.2	121.2	121.2	121.2
Odisha	59.22	59.22	59.22	59.22
Jharkhand	4.3	4.3	4.3	4.3
West Bengal	319.92	319.92	319.92	319.92
Tripura	0	0	0	0
Arunachal Pradesh	0	0	0	0

Mizoram	0	0	0	0
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Table 4:- Year wise bio mass install capacity in India of different states.

#### ➤ Geothermal Energy potential

Geothermal utilizes the earth's internal heat. Hot springs are produced by water is heated by magma or hot rocks below the surface. At a geothermal power plant, there is wells drilled into the hot rocks. Hot water or steam may come up through that well. Alternatively, water may be poured into the well to be heated. The hot water or steam rotate the turbine to generate electricity.

From last several years, geothermal energy is used for cooking the food and it is also used to get the heat. Geothermal energy is a renewable source of energy because it is found in the interior of the earth in the form of hot water reservoir and it can be used as long as Earth exists.

This is a clean source of energy and reduce the greenhouse effect. We can say that geothermal energy does not produce carbon dioxide and other harmful greenhouse gases. There are hot rocks anywhere below the earth surface and we can get geothermal energy by drilling these rocks.

The area which has abundancy of geothermal energy in India are Himalayan region, Harley belt, Naga-lushi, Andaman and Nicobar Island, Surajkund and Hazaribagh in Jharkhand

The thermal springs of India is not a Luci area and the place where presently we can see volcanic activity in India is Andaman and Nicobar Island. Our researchers found if we come across to harness the geothermal energy in the east and north region, then we will have enough electricity to use.

#### IV. IMPACT OF RENEWABLE ENERGY RESOURCES

India has large storage of gold. It is fifth largest in the world after USA, China, Russia and Australia. According to Ministry of Aesthetics and program implementation, estimated resource reserve of coal as on 1 April 2021 were 352.13 billion tonnes, An addition of 8.11 billion tonnes than the previous year. It is the growth of 2.36 percentage in the total reserve goal during the year 2020-21 over 2019-20.

In India, the three states, Jharkhand, Odisha, Chhattisgarh possess approximately 70% of the total coal reserve in the country. The estimated reserves of crude oil in India as on 1<sup>st</sup> April 2021 were 587.33 million tonnes against 603.36 million tonnes in the 2020. Geographical distribution indicates that the crude oil is in the Western offshore (37 %) followed by Assam (26 %). The estimated reserve of natural gas as on 1<sup>st</sup> April 2021 was at 1372.62 billion.

The combustion of fossil fuels produces harmful gases like CO<sub>2</sub>, CO, NO<sub>x</sub>, Sox, etc. These harmful pollutants degrade environment, land, water, wildlife, hazards to human being and also cause various problems. SO<sub>2</sub> gas cause acid rain when it mixes with water. CO<sub>2</sub> gas is responsible for

global warming. The waste material of petroleum and nuclear power plant are very harmful for us and its disposal is also at risk.

## V. NATIONAL POLICY, GOVERNMENT OF INDIA'S ACTION, PROGRAM FOR ENCOURAGING RENEWABLE ENERGY.

### ➤ *Development and solar parts and Ultra Mega solar powered projects.*

Solar powered projects can be installed anywhere in country, however the dispersing of this project leads to higher cost per MW and have higher transmission losses. So, to get rid of, this can be resolved by making individual project of smaller capacity. We will have more challenges if we do this on large scale. Challenges like acquire land, get chance of land use and various permission etc.

To overcome these challenges, the scheme for "Development of Solar Parks and Ultra Mega Solar Power projects" was introduced in December 2014 with an objective to facilitate the solar project developers to set up in an easy way. They scheme for this report was rolled out by MNRE on 12 December 2014. Under this scheme, it was estimated to set up at least 25 solar parks and Ultra Mega Solar Power Projects targeting over 20,000 MW of solar power installed capacity within a time period of five years. All the States and union territories are eligible to avail benefit under this scheme.

### ➤ *Pradhan Mantri Kisan Urja Suraksha evam Uttham Mahabhilyaan ( PM KUSUM )*

The scheme objective is to set up solar and other renewable capacity of 25,750 megawatts by 2022 with overall central financial support of rupees 34,422. Including service charges to the concerned agencies.

The scheme consists of three components: -

Component A: 10,000 MW of Decentralized Ground Mounted Grid Connected Renewable Power Plants of individual plant size up to 2 MW.

Component B: Installation of 17.50 lakh Standalone Solar Powered Agriculture Pumps of individual pump capacity up to 7.50 HP

Component C: Solarisation of 10,00,000 Grid Connected Agricultural Pumps of individual pump capacity up to 7.5 HP.

### ➤ *Atal Jyoti Yojna ( AJAY ) : Phase 2*

This programme will cover installation of 3,04,500 Solar Street Lights (SSLs) in the following regions as per operational guidelines for implementation of the scheme.

- States of UP, Bihar, Jharkhand, Odisha & Assam, as there is much more demand in these states.
- Hilly states of Jammu and Kashmir, Himachal Pradesh & Uttarakhand.
- North-eastern states, including Sikkim.
- Island of Lakshadweep and Andaman and Nicobar.

Under this scheme, 2000 number of solar street lights (SSLs) will be provided in each of the hilly areas and islands as mentioned above.

### ➤ *Scheme on "Scale Up of Access to Clean Energy for Rural Productive Uses"*

This scheme, aimed to expand the use of reliable and easily available renewable energy for rural productive, uses in remote areas of states; Assam, Madhya Pradesh and Odisha for improving their lifestyle and to decrease the harnessing of Fossils fuels.

This project scheme focus is on available clean energy for rural livelihoods.

Especially considering rural livelihood such as Poultry, fishery, horticulture, diary, biomass based local business, cottage and other village industries etc.

Under this scheme, initially 19 districts have been identified in 3 target states for implementation which covers 1500 beneficiaries.

### ➤ *Seven Million Solar Study Lamp Scheme for School Going Children*

This scheme aims to 7 million solar study lamps to be distributed in identified block of the states of Bihar, Jharkhand, Odisha, Assam & Uttar Pradesh.

Lamps are being distributed to student Rs 100 per lamp and cost of lamp from MNRE.

This scheme is implemented in 5 states; Assam, Bihar, Jharkhand, Odisha and UP.

This project also degrades the dependency on Kerosene oil. Project also consists the sharing of skills to repair and maintenance for solar lamp to be long lasting.

### ➤ *Off-grid and Decentralized Sola PV Applications Programme - Phase 3*

Objective of this programme is to installed an additional off-grid solar capacity of 118 MW power by 2021 through following targets.

- 3,00,000 solar street lights in the country with special emphasis on area where facility for street lightning through power grid is unavailable.
- 25,00,000 Solar steady lamps in north-western for a school going children and in backward and remote areas in north-eastern state and LWE (Left-Wing Extremism) affected district.
- 100 MW power off grid solar power plants.

## VI. CHALLENGES FACED BY RENEWABLE ENERGY IN INDIA

Renewable energy resources become better, cheaper and easier to access. These sources are only responsible for 20% of total energy consumption globally. There are few major challenges for the introduction of renewable energy resources in our daily life use. We imagine that there is a scarcity of energy on our planet. However, the Sun provides much more energy than we could ever need. Renewable energy sources include solar, wind, geothermal, hydropower, biomass, etc. We need to utilize these resources to fulfil our requirements.

➤ *Energy storage*

Among the seven challenges faced by renewable energy sources, the first one is energy storage. It is one of the major problems with the renewable energy generation is that supplies are much more variable other means of energy generation.

There are much more fluctuations in sunlight and wind. It means that supplies of energy sources are less consistent than those obtained from fossil fuels. Before, owners required batteries to store energy for later use. The advancement in battery technology have reduced the battery prices and thus energy storage is not such a big deal as batteries have improved and their prices have come down. However, the problem is mining the precious metals and the rare metals which batteries use.

➤ *Environmental and financial challenges.*

Economics is one of the biggest challenges faced by renewable energy sector. Majorly, the financial issues are introduced while bringing renewable energy. Or technology to the masses.

These days businessmen are investing in the sector at large scale. However, the transition or the shift from carbon and fossil fuel industry to renewable energy sources, comes with huge financial cost.

Over the last few years, investment in renewable energy sector has resulted in extending new technologies. However, economic pressure is still depressed. The innovation.

➤ *Infrastructure challenges*

In our country, use of renewable sources to meet the energy demand is necessary. However, the transition will be harder to fulfil such desire because of lack of reliable large scale energy grids even in several developed nations. Like various forms of infrastructure, energy infrastructure in many regions is poorly maintained and unstable to meet energy demand in future.

➤ *Land use*

This is also one of the other challenges for renewable energy sector. In a world where natural resources are continuously exhausted, Land is also become the point of controversy. Which land should we use for installation of solar panels and wind turbines? How can we fulfil this need along with the need for food, housing, etc.

Using agricultural land for wind power generation is not a good option. Yet the most precious land is often suitable for energy generation. In future, this renewal sector must find ways. This has become a major challenge within the industry.

➤ *Technical challenges.*

It has become one of the biggest challenges in keeping our atmosphere clean and healthy. This is actually the emission of CO<sub>2</sub> gas from the industry. We cannot defer 45% of CO<sub>2</sub> emissions from the feedstock used to produce energy.

Using alternative fuel like zero-carbon electricity will not be perfect as further processes require high temperatures.

And this zero-carbon electricity fuel is unable to produce such high temperature. For this there would need few changes with the furnace design.

## VII. CONCLUSION

Renewable energy like solar, wind, biomass and geothermal are very important source of energy. The conventional source of energy like coal, crude oil, etc. is going to deplete day by day. The way we are using non-renewable source of energy these days due to this in coming future, The non-renewable source of energy will be completely exhausted. That is why we should shift to the non-conventional source of energy in very small period of time. But there are many obstacles to achieve this target like availability of land, important machineries and infrastructure which is required to convert these energies into electricity energy.

The government policies may help to overcome these problems. The government should provide subsidy on installation of solar panel for the generation of electricity. The government should make various policies to promote the generation of electricity through renewable energy sources.

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