

Renewable Energy For Sustainable Development In India: Current Status, Future Prospects, Challenges, Employment, And Investment Opportunities

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Abstract

The adoption of renewable energy in India is being done with the primary objectives of achieving energy security and access, economic development, and climate change mitigation. To accomplish sustainable development, it is necessary to make widespread use of renewable sources of energy and to provide people with access to modern forms of energy that are affordable, reliable, and environmentally friendly. As a result of robust support from the government as well as an increasingly favourable economic environment, India has emerged as one of the most attractive markets for renewable energy in the world. The country's renewable energy industry is expanding at a quick rate as a direct consequence of the policies, actions, and an overall environment that is permissive taken by the government. In the next years, it is anticipated that the use of renewable energy sources would result in a large number of new home job opportunities. The availability of renewable resources in India is extensive, and the country also runs one of the most extensive programmes in the world for the deployment of renewable energy goods and systems. India is the only country in the world to have a ministry that is dedicated solely to the development of renewable energy sources. This ministry, known as the Ministry of New and Renewable Energy (MNRE), is responsible for launching one of the most extensive and comprehensive renewable energy programmes in the world.

Keywords: Renewable energy, sustainable development, energy products and systems

1. Introduction

Energy is often recognized as the single most important component in human advancement, and it is also an essential component that plays a significant role in the long-term growth of any country. The traditional sources cast a frightening shadow over our current and future global safety, environmental values, health, and society in general. As a result, there is an immediate need to priorities the promotion of renewable energy in the Indian electricity industry. The term "renewable energy" refers to the energy that is gathered from resources that can be naturally renewed on a human timeline. Some examples of renewable

resources are sunshine, wind, rain, tides, waves, and geothermal heat. It is the source of energy that produces the fewest amounts of carbon emissions and contributes the least to pollution. This contributes to lessening the dependency on coal and other forms of fossil fuels. India is able to improve air quality, decrease emissions that contribute to global warming, generate new businesses and employment, and contribute to the global movement toward a cleaner, safer, and more economical energy source thanks to the rise of renewable energy.

1.1 Different renewable energy sources:

1. **Solar Power:** Solar energy is considered a clean kind of energy since it does not result in the production of any hazardous wastes (solid, liquid, or gas) and it does not contribute to the formation of pollution. PV cells, which are constructed of semiconductors, and energy collectors, which may be categorized as parabolic trough, parabolic, tower, and parabolic disc systems, amongst others, are both necessary components in the generation of solar electricity. India gets around 5,000 trillion KWh per year thanks to its 300 days of unobstructed sunshine, which is much more than the country's current total energy usage. The power provided by the sun to the earth's surface is estimated to be 10^{16} W, but the overall power need of all aspects of human civilization is estimated to be 10^{13} W. As a result, the sun provides us with a thousand times more electricity than what we really need.
2. **Wind Power:** Wind power seems to be one of the most potentially advantageous forms of alternative energy technologies in the years to come. As a result of recent improvements in the turbine technology, there has been a considerable rise over the course of time in the quantity of energy that has been generated by wind-driven turbines. Although India is a relative newcomer to the wind industry in comparison to Denmark or the United States, due to India's domestic policy support for wind power, India has become the country with the fourth largest installed wind power capacity in the world. This is a significant accomplishment for India.
3. **Bio Energy:** Biomass is a source of renewable energy that is obtained from the carbonaceous waste of a variety of human and natural activities. Biomass may be found in plants, animals, and other living things. The term "bioenergy" refers to a broad category of energy production that includes things like "biomass power," "bagasse cogeneration," "waste to energy," "biomass gasifier," "bioethanol," and "biodiesel," among others. As it grows, biomass removes carbon from the atmosphere; when it is burnt, however, this carbon is released back into the atmosphere. India is situated in a tropical region and receives a plenty of sunlight and rain, making it a perfect setting for the production of biomass. It is projected that India has a potential for biomass energy of 16,000 MW from biomass energy and an additional 3,500 MW

from bagasse cogeneration. Both of these sources of energy would come from bagasse.

4. **Small Hydro Power (SHP):** The amount of hydroelectric electricity that India generates ranks it as the seventh most in the world. Small hydropower projects in India, with a capacity of less than 25 megawatts (MW), are referred to as "renewable energy" and are categorized as "Small Hydro Power." Up till this point, there have been SHP units erected that have a combined capacity of 4,380 MW.

2. Literature review

One third of the world's total emissions of greenhouse gases are attributable to the fuels used in the generation of electricity. These fuels include coal, oil, and natural gas. It is imperative that a higher level of life be achieved via the provision of power that is both cleaner and more dependable [1].

To carry out the economic growth plans that are now being put into action in India need an ever-increasing amount of energy. A essential pre-requisite for the expansion of a nation's economy is the generation of ever-increasing quantities of available energy [2].

The National Electricity Plan (NEP) [3], which was framed by the Ministry of Power (MoP), has developed a 10-year detailed action plan with the objective of providing electricity throughout the country. Additionally, the NEP has prepared a plan to ensure that power is supplied to the citizens of the country in an efficient manner and at a cost that is reasonable. Both of these plans can be found here.

India is responsible for about 6.65% of total world carbon emissions, ranking it fourth after China (26.83%), the USA (14.36%), and the EU (9.66%), as stated in the World Resource Institute Report 2017 [4, 5]. The delicate ecological equilibrium of the globe might be thrown off by climate change. The United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement have both received what are known as Intended Nationally Determined Contributions (INDCs). The latter has maintained the expectation that it would be possible to realise the objective of keeping the increase in global temperature to well below 2 degrees Celsius [6, 7].

The projection that the peak in world power consumption will occur in the year 2030 comes from the World Energy Council [8]. The country of India is one of the greatest users of coal in the world and must bring in expensive fossil fuel [8]. Coal and oil together provide around 74% of the world's need for energy.

The Center for monitoring the Indian economy published a report stating that India imported 171 million tonnes of coal in the fiscal year 2013–2014, 215 million tonnes in the fiscal year 2014–2015, 207 million tonnes in the fiscal year 2015–2016, 195 million tonnes

in the fiscal year 2016–2017, and 213 million tonnes in the fiscal year 2017–2018 [9]. Therefore, it is of the utmost importance to locate different resources that may be used to produce power. In this manner, the nation will have a swift and worldwide transition to technologies that use renewable energy sources, which will allow for the achievement of sustainable development and the prevention of climate change catastrophes.

If we want to ensure a sustainable energy supply with less emissions, renewable energy sources are very essential [10]. It is common knowledge at this point that renewable energy technologies have the potential to greatly meet the demand for power while also lowering emissions. In recent years, the nation has established a more environmentally friendly method for the delivery of its energy. Citizens have been educated about the need of energy conservation in order to encourage a greater use of renewable energies such as solar, wind, biomass, trash, and hydropower. It should come as no surprise that renewable sources of energy are both safer and, in many cases, more cost-effective. By the year 2022, India plans to have 175 gigawatts (GW) of renewable energy capacity, of which 100 GW would come from solar energy, 10 GW would come from bio-power, 60 GW would come from wind power, and 5 GW would come from small hydropower projects [11].

Investors have pledged to deliver a total capacity that is more than 270 GW, which is far in excess of the lofty goals. The following are the commitments made: 58 GW contributed by international businesses, 191 GW contributed by private businesses, 18 GW contributed by private sectors, and 5 GW contributed by the Indian Railways [12]. It is vital that the government generates 330,000 new employment and livelihood possibilities in order to accomplish the lofty objectives of producing 175 GW of renewable energy by the year 2022 [15, 16].

3. Contribution of renewable energy sources: current and future aspects

The projected percentage of the total energy demand that can be met by renewable energy sources is shown in Table 1. In the draught of the national electricity plan for 2016, MoP and CEA predicted that there would be 327 billion units (BUs) of planned electricity output with 175 GW of installed capacity of renewable power by 2022. This would contribute to 1611 BU of required energy. This suggests that by the year 2022, renewable energy will satisfy 20.3% of the demand for energy, and by the year 2027, this figure will rise to 24.2% [17].

Table 1: Contribution of renewable energy sources [20]

Year	Installed capacity of renewable energy Sources (GW)	Expected Generation (Billion Unit)					Total energy requirement (Billion Unit)	% The Contribution of renewable energy source
		Solar	Wind	Biomass	Small hydropower	Total		
2021-22	175	162	122	38	15	327	1611	20.3
2026-27	275	243	188	64	21	516	2132	24.2

In 1995 [18], it was found that the estimated potential of wind power in the country was 20,000 MW (20 GW), the potential of solar energy was 5×10^{15} kWh/yr, the potential of bioenergy was 17,000 MW, the potential of bagasse cogeneration was 8,000 MW, and the potential of small hydropower was 10,000 MW. It was predicted that renewable energy had a potential of 85,000 MW in 2006, with wind providing 4,500 MW, solar providing 35 MW, biomass and biofuels providing 25,000 MW, and small hydropower providing 15,000 MW [19]. According to the annual report of the Ministry of New and Renewable Energy (MNRE) for 2017–2018, the estimated potential of wind power was 302.251 GW (at 100-m mast height), of small hydropower 19.749 GW, of biomass power 17.536 GW, bagasse cogeneration 5 GW, waste to energy (WTE) 2.554 GW, and solar 748.990 GW. Wind power was estimated to have the greatest potential.

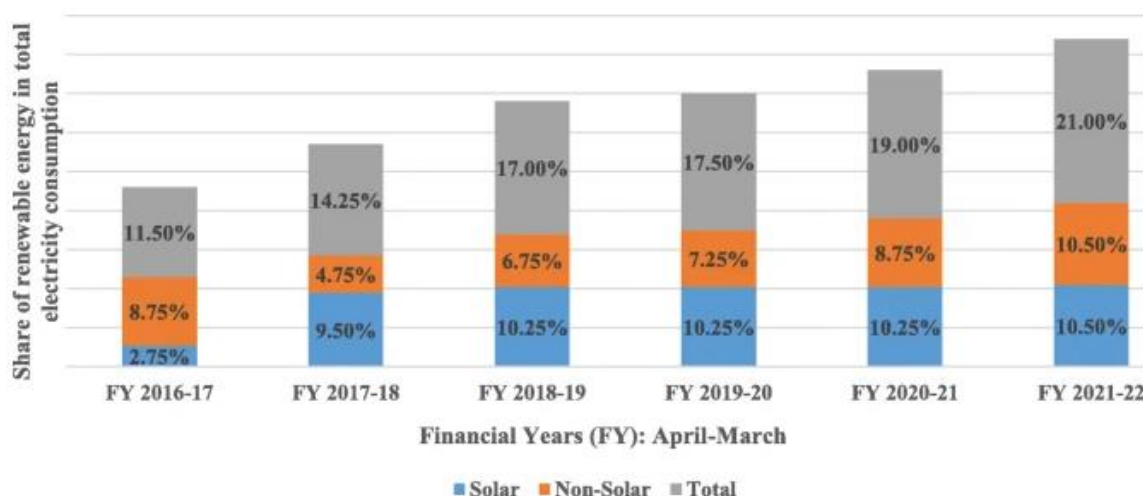


Fig: share of renewable energy in India's electricity consumption [20]

The Ministry of Power has established an ambitious new goal for the proportion of India's total power consumption that should come from renewable sources. The updated RPO calls for the nation to achieve a goal of a 21% share of renewable energy in its total power consumption by March 2022. This aim was established in accordance with the directive of revised RPO. The same target was set at 15% in 2014, and it was raised to 21% by the end of 2018. By the year 2030, India hopes to achieve its objective of obtaining 40% of its energy from renewable sources.

4. Future Prospects of Renewable Energy in India:

We may claim that India is in a good position to meet the ambitious renewable energy objectives if it makes the appropriate investments in environmentally friendly technology. The country's move toward a fully sustainable energy system will be significantly aided by efforts made toward the production of greener forms of energy. It is not a secret that India, with its total population of 1.3 billion people, is the world's fourth-largest carbon emitter,

with the electricity sector contributing the majority to the same. This is one truth that cannot be disguised. But in recent years, India has achieved great progress in the area of renewable energy, which is a positive development. Because of worries about global climate change, the government has been pressed to design a comprehensive strategy for providing clean and sustainable electricity to everyone.

According to the findings of a study conducted by the University of Technology (LUT) in Finland, India has a significant opportunity to transition towards an all renewable power grid by the year 2050 because of the country's rich supply of renewable resources. If we are able to apply advanced technology, then we can achieve this goal. The future of renewable energy in India seems to be bright as over 293 firms from around the world and inside the country have committed to generating 266 gigawatts (GW) of electricity in India from solar, wind, micro hydro, and biomass sources over the course of the next decade. Putting this into action would need an investment of between \$310 and \$350 billion (Euros 27 billion to Euros 30 billion). The International Finance Corporation, which is the investment arm of the World Bank Group, has plans to spend around 6 billion U.S. dollars (or 5 billion Euros) in a variety of sustainable and renewable energy projects in India by the year 2022. The fact that the Indian power industry has the potential to attract investments totaling 15 trillion Indian rupees (about 187 billion Euros) over the next four to five years implies that there are enormous prospects in the areas of power production, distribution, transmission, and equipment. In addition, the market for renewable energy storage in India is anticipated to experience robust growth over the next decade. This is anticipated to occur once the cost of storage decreases, which is anticipated to occur due to the sheer volume growth that will occur as a result of the route taken by electric vehicles.

5. Government initiatives

1. The following is a list of some of the steps that the Government of India has taken to enhance the renewable energy industry in India:
2. A brand new hydropower strategy covering the years 2018-2028 has been established in preparation for the expansion of hydro projects throughout the nation.
3. The government of India has revealed its intentions to carry out a National Mission on advanced ultra-supercritical technologies for cleaner coal use that would cost a total of 210 million Euros and 238 million United States Dollars.
4. The Ministry of New and Renewable Energy (MNRE) has made the decision to grant custom and excise tax advantages to the solar rooftop industry. This, in turn, would cut the cost of setting up as well as create electricity, which will ultimately encourage growth.

5. By the end of the 2016–17 fiscal year, the country had a total of about 4.96 million biogas plants of the household size that were erected as part of the National Biogas and Manure Management Programme (NBMMP).
6. In order to achieve its goal of reducing emissions by 33% by the year 2030, the Indian Railways is stepping up its efforts by continuing to implement measures that are more energy efficient and making the most of clean fuel.

Conclusion

The renewable energy industry faces significant barriers. Some of these challenges are intrinsic to each and every renewable technology, while others are the direct result of an imbalanced regulatory system and market. The implementation of renewable technology is hampered by the lack of adequate policy and regulatory frameworks. In order to attract more financial backers, the market for renewable energy must first establish clear guidelines and formalised legal processes. Due to the absence of well-defined rules, the process of authorising projects within the private sector moves at a glacial pace. The government of the nation needs to take steps to encourage private investment. Research and development should be used to overcome insufficient technology as well as the lack of infrastructure necessary to build renewable technologies. The government needs to make it possible for additional funding to be allocated to activities of research and innovation in this industry.

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