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Green Energy in India and Its Socio-Economic Impact

Dr. Harish Sharma

Associate Professor of Commerce, Govt. Girls College, Rewari
Affiliated to IGU, University, Meerpur, rewari
Email: *imvijay8909[at]gmail.com*

Abstract: ***This paper explores the recent developments in green energy in India and its socio-economic impact, considering both environmental sustainability and economic growth. India's commitment to clean energy transition is driven by its ambitious targets for renewable energy expansion, addressing climate change, and fostering socio-economic benefits for its vast population. This paper investigates how India's shift toward green energy impacts job creation, economic development, rural upliftment, and environmental sustainability. It synthesises current data on India's renewable energy production and analyses socio-economic outcomes stemming from this shift. Green energy is rapidly gaining prominence as India strives to meet its growing energy demands while reducing its carbon footprint. India has emerged as one of the global leaders in renewable energy deployment, with a focus on solar, wind, and biogas.***

Keywords: Green energy, Renewable energy, Socio-economic impact, Environmental sustainability, Economic development, Employment Generation

1. Introduction

India is one of the fastest-growing economies, with a substantial demand for energy to fuel its industrialization and urbanisation, with its fast-growing economy and large population, faces a significant challenge in balancing energy needs with sustainable development. Traditionally reliant on coal and other fossil fuels, India has been making significant strides in integrating renewable energy into its energy mix. By the end of 2023, India ranked fourth in the world for installed renewable energy capacity, driven by government policies and private sector investments. The nation has set ambitious targets for expanding green energy production, aligning with its commitment to the Paris Agreement and achieving net-zero carbon emissions by 2070. Renewable energy sources such as solar, wind, hydro, and biomass are not only crucial for environmental sustainability but also for achieving socio-economic goals like poverty reduction, rural electrification, and job creation.

2. Literature Review

1) Renewable Energy Growth in India

Studies have shown that India ranks third globally in renewable energy capacity, driven by its focus on solar and wind power. According to Statista, India's total installed renewable energy capacity in 2023 was around 176 gigawatts (GW). This was an increase from 2020, when it was about 134.8 GW.

Here are some other renewable energy highlights for 2023:

- **Solar energy**: The largest source of renewable capacity, accounting for 36.7% or 1,418 GW
- **Hydropower**: The second largest source of renewable capacity, accounting for 32.7% or 1,265 GW
- **Wind energy**: The third largest source of renewable capacity, accounting for 26.3% or 1,017 GW
- **Bioenergy**: Accounting for 3.9% or 149 GW
- **Variable renewables**: Wind and solar accounted for 63.0% of renewable capacity

The International Renewable Energy Agency (IRENA) works with countries to help them develop and implement renewable energy policies and strategies. IRENA also publishes renewable energy statistics, including data on installed capacity, from a variety of sources.

2) Socio-Economic Impacts of Green Energy

Research highlights that India's green energy initiatives lead to socio-economic transformations, especially in rural areas. Employment opportunities in renewable energy sectors, including manufacturing, installation, and maintenance, are increasing, fostering rural development.

3) Environmental and Health Benefits

The shift to renewable energy reduces air pollution and greenhouse gas emissions. The health benefits, particularly in metropolitan regions suffering from high pollution levels, are significant. According to data from the Ministry of Health, India witnesses over 1 million deaths annually due to air pollution, which can be mitigated with cleaner energy sources.

3. Methodology

The paper employs a qualitative analysis of secondary data collected from government reports, international energy agencies, and academic sources. Additionally, quantitative data on renewable energy capacity, job creation, and environmental metrics are analysed to understand the socio-economic impact.

3.1 Growth of Renewable Energy in India

India's renewable energy sector has seen exponential growth over the past decade. Current data from the Ministry of New and Renewable Energy (MNRE) in 2023 indicate as on 31st March 2024, India's add up to introduced power capacity came to 441.97 GW, an increment from 275.90 GW of 2014-15, reflecting a development of 60.19% over the past nine years. Add up to introduced capacity beneath the Renewable

Energy sector, counting huge Hydro was expanded from 81.22 GW of 2014-15 to 190.57 GW by 2023-24 with a development of 134.63% amid the period.

Installed capacity beneath Solar, Wind, Bio Power and Small Hydro Power was 143.64 GW as on 31st March 2024 which was upgraded from 39.95 GW of 2014-15, having a momentous development of 259.55%.

Table 1.1: Cumulative Installed Capacity since 2014-15 (in GW)

Year	Mode- Wise Breakup (GW)					Grand Total	Growth (%)	Share of RE (%)
	Non- RE		Renewable (RE)					
	Thermal	Nuclear	Hydro	RES*	Total RE			
2014- 15	188.90	5.78	41.27	39.95	81.22	275.90	10.62	29.44
2015- 16	210.68	5.78	42.78	47.09	89.87	306.33	11.03	29.34
2016- 17	218.33	6.78	44.48	58.56	103.04	328.15	7.12	31.40
2017- 18	222.91	6.78	45.29	70.65	115.94	345.63	5.33	33.54
2018- 19	226.28	6.78	45.40	79.41	124.81	357.87	3.54	34.88
2019- 20	230.60	6.78	45.70	88.26	133.96	371.34	3.76	36.07
2020- 21	234.73	6.78	46.21	95.80	142.01	383.52	3.28	37.03
2021- 22	236.11	6.78	46.72	109.89	156.61	399.5	4.17	39.20
2022- 23	237.27	6.78	46.85	125.16	172.01	416.06	4.15	41.34
2023- 24	243.22	8.18	46.93	143.64	190.57	441.97	6.23	43.12
Gr (2014-15 to 2023- 24)	28.76%	41.52%	13.71%	259.55%	134.63%	60.19%		
CAGR (2014-15 to 2023- 24)	2.85%	3.93%	1.44%	15.28%	9.94%	5.38%		

Source: Ministry of New and Renewable Energy (MNRE) www.mnre.gov.in and Central Electricity Authority(CEA) https://cea.nic.in/?lang=en

RES*- Comprising of Solar, Wind, Bio- Power and Small Hydro Power
Gr= Growth (%)
CAGR= Compound Annual Growth Rate

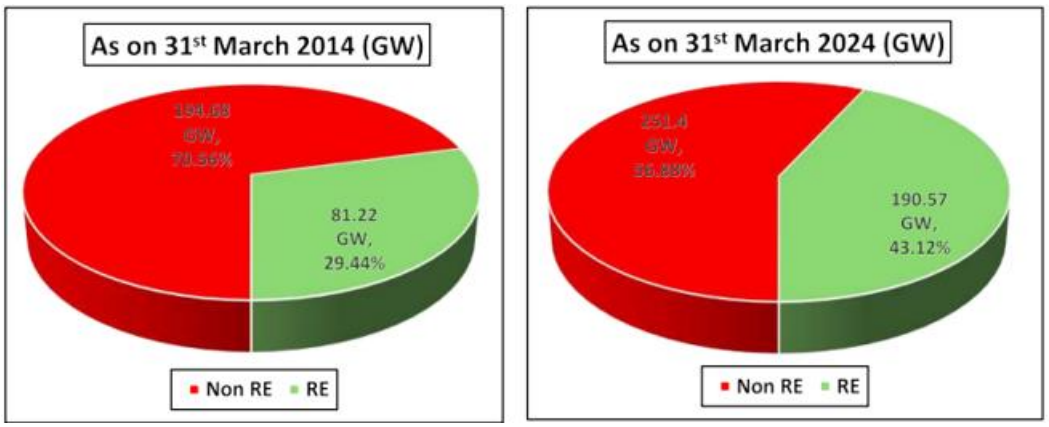


Figure 1.1: Share of Renewable Energy

Source: Ministry of New and Renewable Energy (MNRE) www.mnre.gov.in and Central Electricity Authority(CEA) https://cea.nic.in/?lang=en

During the last 9 years, the Renewable Energy sector has made a remarkable contribution in the total installed capacity with a significant share of 43.12% in 2023-24 from 29.44% of 2014-15. Fig 1.2 Trend in Cumulative Capacity installation.

Figure 1.2: Trend in Cumulative Capacity Installation

Source: Ministry of New and Renewable Energy (MNRE) www.mnre.gov.in and Central Electricity Authority (CEA) https://cea.nic.in/?lang=en

The chart reveals that the trend of year wise capacity establishment of renewable energy division was reliably outpacing that of the non-renewable vitality segment, narrowing the gap between the two altogether. This reflects the expanding move towards the use of renewable energy sources, with a compound yearly development rate (CAGR) of 9.94 % from 2014-15 to 2023-24.

Fig 1.3 Year wise capacity addition (in %).

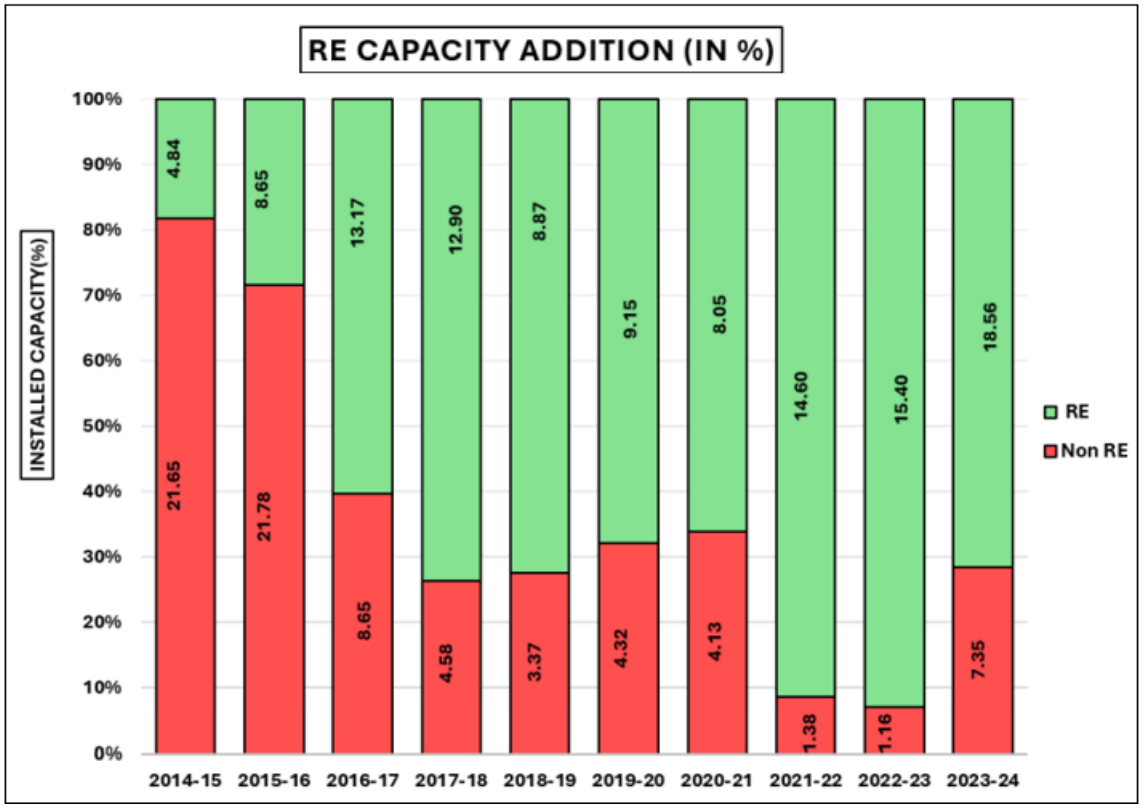


Figure 1.3: Year wise capacity addition (in %)

Data Shown inside the bar diagram represents the installed capacity in GW

Source: Ministry of New and Renewable Energy (MNRE) www.mnre.gov.in and Central Electricity Authority(CEA) https://cea.nic.in/?lang=en

Data shown inside the bar diagram represents the installed capacity in GW. In terms of year-on-year capacity addition, the RE sector has shown remarkable capacity expansion compared to non-RE sector. This reveals India's dedication towards its utilisation of Renewable Energy potential.

Socio-Economic Benefits of Green Energy in India

1) Job Creation and Economic Development

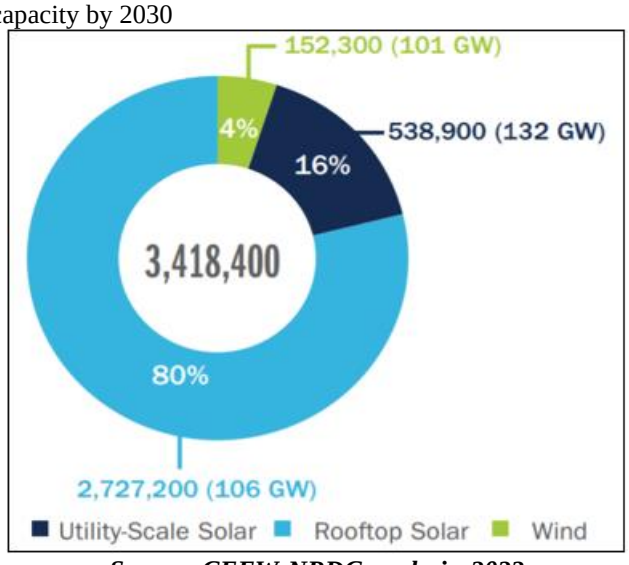
Employment Generation:

Renewable energy has emerged as a key employment sector. In 2023, around 1 million jobs were created in solar, wind, and bioenergy sectors (CEEW, 2023). India's green energy transition has expanded job opportunities in rural areas, where solar panel installation and wind turbine maintenance have become common. This employment growth is pivotal in poverty reduction and rural empowerment.

India's renewable energy division has ended up a critical driver of work, especially in rural ranges where solar and wind ranches have made various work openings. A study by Chatterjee and Kanitkar (2024) found that sun oriented water system pump sets in Uttar Pradesh not as it were moved forward rural efficiency but too created occupations over socio-economic classes, especially in upkeep and establishment administrations [Chatterjee & Kanitkar, 2024].

India can possibly make approximately 3.4 million occupations (brief and long term) by introducing 238 GW solar and 101 GW new wind capacity to accomplish the 500 GW non-fossil power era capacity by 2030 objective. These employments speak to those made in the wind and on-grid solar energy divisions. A workforce of approximately one million can be utilised to take up these green employment opportunities. Employments made are distinctive from the workforce required, as one labourer can perform more than one job.

Sector wise work creation potential by accomplishing 101 GW Wind and 238 GW solar targets of non fossil fuel capacity by 2030



Source: CEEW-NRDC analysis, 2022

Furthermore, the International Renewable Energy Agency (IRENA) estimates that the solar sector alone can create over 1.2 million jobs in India by 2030.

2) Rural Electrification and Energy Access

Rural India, home to a significant portion of the population, has historically struggled with access to reliable electricity. The deployment of decentralised renewable energy systems such as solar photovoltaic (PV) installations has provided rural communities with stable electricity, reducing their dependency on costly and unreliable diesel generators. The research by Mishra (2024) highlights the role of solar PV systems in enhancing energy access in rural dairy farms, thereby promoting sustainability and economic growth in India's agricultural sector [Mishra, 2024].

Rural Electrification and Economic Development:

Green energy projects have provided electricity to remote and underserved regions. The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya Scheme) aims to ensure last-mile electricity connectivity, significantly aided by renewable sources. Studies show that access to electricity facilitates education, healthcare, and small business growth, contributing to socio-economic upliftment.

3) Energy Security and Independence

Renewable energy plays a pivotal role in enhancing India's energy security by reducing its dependence on imported fossil fuels. As the world's third-largest oil importer, India's energy security is vulnerable to global oil price fluctuations. Expanding renewable energy sources reduces these risks while promoting energy independence. Studies such as those by Madheswaran et al. (2024) emphasise the potential of green hydrogen in India's decarbonization efforts and its contribution to energy independence [Madheswaran et al., 2024].

4) Environmental and Health Benefits

The shift from fossil fuels to renewables is crucial for reducing air pollution and greenhouse gas emissions. Cleaner energy sources reduce the health burdens associated with fossil fuel combustion, particularly in urban areas with high levels of pollution. This transition also has substantial cost-saving implications for public health systems. The adoption of clean cooking technologies, as discussed by Mishra and Patel (2024), has the potential to alleviate health issues caused by traditional biomass use, such as respiratory diseases prevalent in rural India [Mishra & Patel, 2024]. According to the World Health Organization, India's reduction in coal consumption aligns with an anticipated drop in air pollution-related health problems by 20% over the next decade, improving quality of life.

5) Economic Impact and Market Expansion

India's investment in renewable energy is attracting foreign investment. With initiatives like the Production-Linked Incentive (PLI) scheme, the government has encouraged manufacturing of solar cells and modules within the country. The influx of capital into India's renewable energy market fosters technological innovation, increasing production efficiency and reducing costs.

Despite its progress, India's renewable energy sector faces challenges:

a) Intermittency and Storage:
Solar and wind energy are dependent on weather conditions, leading to energy intermittency. Effective

storage solutions are costly, though recent investments aim to improve battery technology.

b) Land Acquisition and Environmental Impact:
Large-scale renewable projects require significant land, often leading to displacement and environmental concerns. Wind and solar farms may disturb local wildlife and ecosystems, raising questions about sustainable development practices.

c) Policy and Financial Constraints:
The lack of consistent policies and financial support hinders the growth of renewable energy. Infrastructure and investment requirements remain high, and attracting consistent funding is challenging due to competing development priorities.

Case Studies: Green Energy Projects in India

1) Solar Irrigation Pump-Sets in Uttar Pradesh

The introduction of solar-powered irrigation systems has had a transformative impact on agriculture in Uttar Pradesh. According to Chatterjee and Kanitkar (2024), solar irrigation not only provides a sustainable water supply for crops but also reduces operational costs for farmers, improving their socio-economic conditions [Chatterjee & Kanitkar, 2024].

2) Wind Energy in Gujarat

Gujarat: A Wind Energy Powerhouse

Gujarat's noticeable quality in India's wind energy segment is developing quickly. The state boasts the longest coastline in the nation, extending around 1,600 kilometres. This broad coastline encounters high-speed winds, making perfect conditions for wind energy generation. This common advantage has situated Gujarat at the cutting edge of India's wind power sector.

Gujarat boasts India's highest introduced wind capacity, with roughly 12.1 GW as of July 2024 i.e. 25.7% of generally India's add up to wind power capacity. This amazing figure underscores Gujarat's critical commitment to India's worldwide standing as the fourth-largest coastal wind energy market.(https://egov.eletsonline.com/2024/10/gujarats-onshore-offshore-energy-powering-indias-energy-transition

3) Biogas in Rural Rajasthan

Panwar and Samar (2024) evaluated the socio-economic benefits of the Deenbandhu Biogas Model in Rajasthan, highlighting its role in providing clean energy to rural households while improving health outcomes and reducing dependence on firewood for cooking [Panwar & Samar, 2024]. Biogas technologies have also been linked to improving agricultural productivity through the use of bio-slurry as fertiliser.

Policy Recommendations

To fully realise the socio-economic benefits of green energy, India must:

- Strengthen policy frameworks that promote public-private partnerships for renewable energy infrastructure development.
- Enhance support for the reskilling of workers from traditional energy sectors.
- Promote decentralised renewable energy projects in rural areas to improve energy access and reduce poverty.
- Encourage investment in green hydrogen and other emerging technologies to diversify India's renewable energy portfolio.
- Expand research and development initiatives focused on innovative green energy technologies.

4. Conclusion

Green energy is transforming India's energy landscape, providing a sustainable solution to the country's growing energy demands. Its socio-economic impact is evident in job creation, rural development, improved energy access, and enhanced energy security. However, the transition presents challenges that require robust policies and investments to ensure inclusive and equitable growth. By fostering public-private partnerships, investing in infrastructure, and promoting regulatory reforms, India can harness the full potential of its renewable energy resources.

India's commitment to green energy represents a powerful driver for socio-economic transformation. Renewable energy development in India not only addresses climate goals but also enhances employment, promotes rural electrification, and mitigates health issues from pollution. However, addressing the current challenges of intermittency, land use, and financial sustainability is crucial to realising the full socio-economic potential of renewable energy.

References

[1] Chatterjee, J., & Kanitkar, T. (2024). A Shift to Solar Irrigation Pump-Sets: A Case Study from Uttar Pradesh, India. Review of Agrarian Studies. Link to PDF
[2] Vyas, A. (2023). Scope of PV Telecommunication Towers in India. IJWER.
[3] Madheswaran, D. K., Krishna, R., & Colak, I. (2024). Green Hydrogen: Paving the Way for India's Decarbonization Revolution. Environmental Science and Pollution Research.
[4] Mishra, A., & Patel, S. (2024). Future of Clean Energy for Cooking in India: A Comprehensive Analysis of Fuel Alternatives. Energy for Sustainable Development.
[5] Panwar, N. L., & Samar, K. K. (2024). Advancing Renewable Energy in Rural India: A Techno-Economic Evaluation of the Deenbandhu Biogas Model in Rajasthan. Annals of the Arid Zone.
[6] Ministry of New and Renewable Energy.
[7] International Renewable Energy Agency. (2022). "Renewable Energy Capacity Statistics 2022."
[8] Ministry of New and Renewable Energy (MNRE), Government of India. (2023). "Annual Report on Renewable Energy."
[9] Council on Energy, Environment, and Water (CEEW). (2022). "Employment Impacts of Renewable Energy in India."
[10] World Health Organization. (2023). "Air Pollution and Health Impact in India."
[11] International Renewable Energy Agency (IRENA). (2022). Renewable Energy Capacity Statistics 2022. Available at IRENA.
[12] Ministry of New and Renewable Energy, Government of India (MNRE). (2023). Annual Report on Renewable

Energy in India. Government of India, Ministry of New and Renewable Energy.
[13] Council on Energy, Environment, and Water (CEEW). (2022). Employment Impacts of Renewable Energy in India. Council on Energy, Environment, and Water. Available at CEEW.
[14] World Health Organization (WHO). (2023). Air Pollution and Health Impact in India. WHO Reports and Publications.
[15] Rej, S., & Nag, B. (2021). Land and clean energy trade-off: Estimating India's future land requirement to fulfil INDC commitment. International Journal of Energy Sector Management. Available at Emerald Insight.
[16] Ghosh, A. (2015). The big push for renewable energy in India: What will drive it?. Bulletin of the Atomic Scientists. Available at SAGE Journals.
[17] Sen, S., & Ganguly, S. (2016). Renewable energy scenario in India: Opportunities and challenges. Journal of African Earth Sciences. Available at ScienceDirect.
[18] Singh, K., Meena, R.S., Kumar, S., & Dhyani, S. (2023). India's renewable energy research and policies to phase down coal: Success after Paris agreement and possibilities post-Glasgow Climate Pact. Biomass and Bioenergy. Available at Elsevier.
[19] Kiesecker, J., Baruch-Mordo, S., Heiner, M., & Negandhi, D. (2019). Renewable energy and land use in India: A vision to facilitate sustainable development. Sustainability. Available at MDPI.
[20] Majid, M.A. (2020). Renewable energy for sustainable development in India: Current status, future prospects, challenges, employment, and investment opportunities. Energy, Sustainability and Society. Available at Springer.
[21] (https://egov.eletsonline.com/2024/10/gujarats-onshore-offshore-energy-powering-indias-energy-transition.