The Role of Renewable Energy in India's Sustainable Development

OPEN ACCESS

Manuscript ID:
ECO-2025-13038625

Volume: 13

Issue: 3

Month: June

Year: 2025

P-ISSN: 2319-961X

E-ISSN: 2582-0192

Received: 03.04.2025

Accepted: 20.05.2025

Published Online: 01.06.2025

Citation:
Roy, Kundan Kumar. "The Role of Renewable Energy in India's Sustainable Development." *Shanlax International Journal of Economics,* vol. 13, no. 3, 2025, pp. 26-33.

DOI:
https://doi.org/10.34293/economics.v13i3.8625

Kundan Kumar Roy
Research Scholar, Department of Economics
Patna University, Patna, Bihar, India
https://orcid.org/0009-0001-0353-9728

Abstract
India's rapid economic growth and rising energy demand have made renewable energy a crucial component of its sustainable development strategies. This study examined the role of renewable energy in enhancing energy security, driving economic growth, promoting environmental sustainability, and ensuring social equity. Using a descriptive and analytical research method, this study evaluates the current status, opportunities, and challenges of renewable energy deployment in India, based on secondary data and case studies. As of January 2025, India's installed renewable energy capacity reached approximately 212GW (including large hydropower), with solar and wind energy leading to expansion. Despite this progress, challenges, such as intermittency, financing constraints, and policy gaps remain. This study concludes with policy recommendations to accelerate India's transition to a low-carbon economy, emphasizing the need for advanced energy storage, innovative financing mechanisms, and a robust regulatory framework.

Keywords: Renewable Energy, Sustainable Development, Solar Energy, Wind Energy, Green Energy

Introduction

Renewable energy refers to energy derived from natural sources that is continuously replenished and cannot be depleted over time. Unlike fossil fuels, which take millions of years to form and are finite, renewable energy sources are sustainable and environmentally friendly. They help reduce greenhouse gas emissions, while contributing to energy security and economic development. India's growing energy demand and commitment to sustainability have made renewable energy a key driver of its economic and environmental progress. With ambitious targets under the National Action Plan on Climate Change (NAPCC) and Paris Agreement, India aims to achieve 500 GW of non-fossil fuel-based energy capacity by 2030. Empirical evidence suggests that renewable energy enhances environmental sustainability in India by improving energy efficiency and reducing carbon emissions (Alola et al.). This aligns with global efforts toward clean energy transitions to combat climate change. Additionally, the adoption of renewable energy sources is not only environmentally beneficial but also economically viable. Studies indicate that renewable energy can effectively substitute fossil fuels, while supporting economic growth and sustainable development (Solarin and Bello). This highlights India's potential to meet its energy needs through renewables, while advancing its economic and environmental goals. Moreover, the relationship between renewable energy and sustainable development extends beyond the environmental benefits. Research suggests that integrating Information and Communication Technologies (ICT) with renewable energy improves environmental quality in India (Pata and Destek). This underscores the interconnected role of technology and clean energy solutions in achieving Sustainable Development Goals (SDGs). Furthermore, renewable energy

technologies have shown significant potential for addressing infrastructure challenges, particularly in rural areas. Off-grid applications of renewable energy have played a key role in bridging the energy access gaps and promoting regional development (Ingole). This highlights the transformative impact of renewable energy on fostering inclusive growth, reducing energy poverty, and supporting India's sustainable development agenda.

Review of Literature

The role of renewable energy in India's sustainable development has been the subject of extensive research, with several key themes emerging from the literature. Energy Transition and Sustainability: India's energy profile is dominated by fossil fuels, raising concerns about resources and environmental sustainability (Solarin and Bello). The need for a transition to renewable energy sources is evident as it addresses both resource scarcity and environmental concerns. Studies have shown substantial substitution possibilities between fossil fuels and renewables for economic growth and sustainable development in India (Solarin and Bello). This transition is crucial for India to satisfy its energy needs while pursuing development goals.

Policy and Economic Implications: The success of renewable energy development depends heavily on well-thought-out and efficient policies (Mirza et al.). Research has identified five major themes in renewable energy development: institutional, environmental, financial, sociocultural, and technical (Mirza et al.). These themes are critical for making policy actions decisive, just and sustainable. Additionally, studies have explored the dynamic association between carbon dioxide emissions, economic growth, renewable energy consumption, and gross capital formation in India (Rej and Nag). The findings suggest an "N"-shaped Environmental Kuznets Curve (EKC) in the long run for India, indicating a complex relationship between economic growth and environmental sustainability.

Environmental Sustainability and Emissions Reduction: Renewable energy utilization has been found to promote environmental sustainability in India by increasing the load capacity factor (Alola et al.). This is particularly important, given India's ambitious carbon emission reduction plans through increased renewables (Rej and Nag). However, research also highlights the need to balance economic growth with crisis response and resource management to achieve Sustainable Development Goal 7 (SDG 7) targets (Ramasubramanian and Ramakrishna).

Challenges and Opportunities: While renewable energy offers significant benefits, studies have identified challenges in its implementation. The interaction between financial development and natural resources has been found to worsen the ecosystem in Sub-Saharan African countries, which may have implications for India (Musah et al.). However, the interaction between natural resources and green innovations, as well as renewable energy, has shown potential for enhancing ecological quality (Musah et al.).

Holistic Approach to Sustainability: Recent research has emphasized the importance of a comprehensive approach to renewable energy and sustainability. Studies suggest that universities play a role in promoting sustainability by combining sustainable energy with knowledge transmission and research (Salvia and Brandli). Additionally, the concept of Positive Energy Districts (PED) has gained attention, highlighting the need for optimized design approaches from a sustainable development perspective (Marotta et al.).

Objectives

This study aims to:

- To examine the current status of renewable energy in India.
- Identifying key challenges and opportunities in the renewable energy sector.
- Recommend policies to accelerate India's transition to a low-carbon economy.

Research Methodology

This study adopts a descriptive and analytical approach, relying exclusively on secondary data, to examine the role of renewable energy in India's sustainable development. Data were collected from official reports published by the Ministry of New and Renewable Energy (MNRE),

Central Electricity Authority (CEA), NITI Aayog, International Renewable Energy Agency (IRENA), and International Energy Agency (IEA).Additional sources included World Bank reports, UNFCCC publications, and academic research papers. By leveraging comprehensive secondary data, this study aims to provide evidence-based insights into India's progress in renewable energy and offer policy recommendations to accelerate its transition to a low-carbon economy.

Current Status of Renewable Energy in India

Table 1 Summary of All India Total Renewable Energy Generation

Category	Installed Capacity (MW) (as on 31.01.2025)	Monitored Capacity (MW) (as on 31.01.2025) for which generation data is available	RE Generation (MW) Jan 2025	RE Generation (MU) Jan 2024	% of same Month Last Year	RE Generation (MU) Apr 2024- Jan 2025	RE Generation (MU) Apr 2023-Jan 2024	% of same period Last Year
Wind	48365.26	47890.42	5637.69	4075.12	138.34	73621.08	73899.71	99.62
Solar	100329.83	81505.6595 (*)	12285.74	9008.47	136.38	114425.28	93328.05	122.61
Biomass	10743.11	9807.01	356.41	306.36	116.34	3053.18	2840.97	107.47
Small Hydro	5100.55	4264.53	624.57	482.88	103.74	6702.77	7644.56	88.86
Large Hydro ($)	46968.17	46968.17	7388.05	6352.28	116.31	132809.56	121110.06	109.66
Others	663.46	858.53	239.24	223.14	107.21	2390.93	2264.35	106.59
Total Including	212170.38	191294.31	28572.76	22415.67	127.47	343483.81	309661.84	110.92
Total Excluding Large Hydro	165202.21	144326.14	21184.71	16063.39	131.88	210674.25	188551.78	111.73

(*) Solar Installed Capacity including 2.5 GW rooftop solar.

($) Large Hydro Generation data excluding import from Bhutan. However, the import from Bhutan during January 2025 is 15.38 MUs and April 2024 to January 2025 is 5298.15MUs.

Source: Monthly Renewable Energy Generation Report January 2025, CEA, Ministry of Power

India's renewable energy sector has seen substantial growth, with a total installed capacity of 212,170.38 MW, including large hydropower, as of January 31, 2025. Excluding large hydropower plants, the installed capacity is 165,202.21 MW. Solar energy is the dominant source, contributing 100,329.83 MW, followed by wind energy at 48,365.26 MW and large hydro at 46,968.17 MW. In January 2025, total renewable energy generation, including large hydro, reached 28,572.76 MU, while the figure excluding large hydro stood at 21,184.71 MU. Among individual sources, solar energy accounted for 12,285.74 MU, wind energy 5,637.69 MU, and large hydro 7,388.05 MU. Compared to the same month in the previous year, the total renewable energy generation increased by 27.47%, while the generation excluding large hydropower grew by 31.88%. Solar energy increased by 136.38 %, whereas wind energy increased by 38.34% over the previous year. From April 2024 to January 2025, total renewable energy generation, including large hydropower, reached 343,483.81 MU, while excluding large hydropower, it stood at 210,674.25 MU. Solar energy contributed 114,425.28 MU, a 22.61% increase from the previous year. Large hydropower generation totalled 132,809.56 MU, an increase of 9.66%. Wind energy generation was 73,621.08 MU, maintaining a level similar to that of the previous year at 99.62%. These figures highlight the continued expansion of renewable energy in India, with solar energy making the largest contribution to overall capacity and generation.

Table 2 State-wise Installed Capacity of Renewable Power as on 31.03.2024

State-wise installed capacity of Renewable Power as on 31.03.2024														
S.No.	States/UTs	Small Hydro Power	Wind Power	Bio-Power					Solar Power				Solar Power Total	Total Capacity
				BM Power/Bagasse Cogen.	BM Cogen. (Non-Bagasse)	Waste to Energy	Waste to Energy (Off-grid)	Bio Power Total	Ground Mounted Solar	Rooftop Solar	Hybrid Solar Comp.	Off-grid Solar/ KUSUM		
		(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)
1	Andhra Pradesh	163.31	4096.65	378.10	113.57	53.16	29.56	574.39	4298.52	198.12	0.00	88.34	4584.98	9419.33
2	Arunachal Pradesh	133.11						0.00	1.27	4.34	0.00	6.18	11.79	144.90
3	Assam	34.11			2.00			2.00	105.00	41.74	0.00	9.44	156.18	192.29
4	Bihar	70.70		112.50	26.40		1.32	140.22	146.06	71.89	0.00	21.28	239.23	450.15
5	Chhattisgarh	76.00		272.09	2.50		0.41	275.00	747.96	75.70	0.00	388.73	1212.39	1563.39
6	Goa	0.05				1.94		1.94	0.95	41.41	0.00	1.12	43.48	45.47
7	Gujarat	91.64	11722.72	65.30	12.00	7.50	27.68	112.48	9437.41	3455.90	590.96	60.61	13544.88	25471.72
8	Haryana	73.50		151.40	111.26	11.20	9.84	283.70	265.80	590.67	0.00	619.25	1475.72	1832.92
9	Himachal Pradesh	969.71			9.20		1.00	10.20	41.85	19.31	0.00	34.07	95.23	1075.14
10	Jammu & Kashmir	169.93						0.00	2.49	37.66	0.00	25.29	65.44	235.37
11	Jharkhand	4.05			19.10			19.10	21.00	91.87	0.00	49.53	162.40	185.55
12	Karnataka	1280.73	6019.61	1867.10	20.20	1.00	19.42	1907.72	7920.47	593.90	0.00	30.31	8544.68	17752.74
13	Kerala	276.52	63.50		2.27		0.23	2.50	322.79	675.25	0.00	24.75	1022.79	1365.31
14	Ladakh	42.99						0.00	6.00	1.80	0.00	0.00	7.80	50.79
15	Madhya Pradesh	123.71	2844.29	92.50	14.85	15.40	12.19	134.94	3550.33	346.07	0.00	99.03	3995.43	7098.37
16	Maharashtra	382.28	5207.98	2568.00	16.40	12.59	46.20	2643.19	3848.47	2071.55	0.00	329.65	6249.67	14483.12
17	Manipur	5.45						0.00	0.60	6.36	0.00	6.08	13.04	18.49
18	Meghalaya	55.03			13.80			13.80	0.00	0.21	0.00	4.03	4.24	73.07
19	Mizoram	45.47						0.00	22.00	1.96	0.00	6.35	30.31	75.78
20	Nagaland	32.67						0.00	0.00	1.00	0.00	2.17	3.17	35.84
21	Odisha	115.63		50.40	8.82			59.22	419.16	48.22	0.00	28.25	495.63	670.48
22	Punjab	176.10		299.50	231.79	10.75	25.21	567.25	886.27	356.65	0.00	81.35	1324.27	2067.62
23	Rajasthan	23.85	5195.82	119.25	2.00		4.39	125.64	17354.08	1134.25	1980.00	659.25	21347.58	26692.89
24	Sikkim	55.11						0.00	0.00	5.12	0.00	1.92	7.04	62.15
25	Tamil Nadu	123.05	10603.54	969.10	43.55	6.40	26.40	1045.45	7546.37	599.16	0.00	65.85	8211.38	19983.42
26	Telangana	90.87	128.10	158.10	3.30	45.80	14.47	221.67	4360.49	388.96	0.00	8.71	4758.16	5198.80
27	Tripura	16.01						0.00	5.00	4.78	0.00	8.68	18.46	34.47
28	Uttar Pradesh	49.10		1957.50	165.26		103.38	2226.14	2435.46	265.10	0.00	219.77	2920.33	5195.57
29	Uttarakhand	218.82		72.72	60.00		9.52	142.24	298.40	262.71	0.00	14.42	575.53	936.59
30	West Bengal	98.50		300.00	43.52		4.84	348.36	113.80	67.13	0.00	13.14	194.07	640.93
31	Andaman & Nicobar	5.25						0.00	25.05	4.59	0.00	0.27	29.91	35.16
32	Chandigarh							0.00	6.34	58.37	0.00	0.81	65.52	65.52
33	Dadar & Nagar Haveli/ Daman & Diu							0.00	12.64	33.82	0.00	0.00	46.47	46.47
34	Delhi					84.00		84.00	9.84	243.21	0.00	1.46	256.51	340.51
35	Lakshadweep							0.00	2.45	0.00	0.00	2.52	4.97	4.97
36	Pondicherry							0.00	0.88	48.85	0.00	0.18	49.91	49.91
37	Others		4.30					0.00	0.00	0.00	0.00	45.01	45.01	49.31
	Total (MW)	5003.25	45886.51	9433.56	921.79	249.74	336.06	10941.15	64415.20	11569.63	2570.96	2957.81	81813.60	143644.51
	MW = Megawatt													

Source: Ministry of New and Renewable Energy, GOI

India's renewable energy sector has a total installed capacity of 1,44,364.51 MW as of March 31, 2024, with wind and solar power making the Slargest contribution. Wind power accounts for 45,886.61 MW, while solar power leads with 81,313.60 MW, including 64,415.20 MW from ground-mounted solar and 11,869.63 MW from rooftop installations. Bio-power, including bagasse cogeneration and waste-to-energy, contributes 10,941.15 MW, whereas small hydropower adds 5,003.25 MW to the total. Rajasthan has the highest renewable energy capacity of 26,667.93 MW, driven by 19,687.45 MW of solar power and 5,195.82 MW of wind power. Tamil Nadu follows with 19,983.27 MW, with 10,603.64 MW from wind and 7,546.37 MW from solar. Gujarat has 25,471.72 MW, largely from 11,722.72 MW of wind and 13,454.88 MW of solar power. Karnataka also contributes significantly, with 18,735.51 MW, primarily from solar (7,920.37 MW) and wind (6,019.61 MW). Bio-power plays a key role in states like Maharashtra (2,568.08 MW) and Karnataka (1,867.10 MW), while Himachal Pradesh (969.71 MW) and Kerala (276.52 MW) lead in small hydro power capacity. The off-grid solar and KUSUM schemes contribute 2,957.81 MW, with Rajasthan (815.35 MW) and Maharashtra (329.65 MW) having the largest shares. This distribution highlights the dominance of solar and wind energy in India's renewable energy mix, with certain states emerging as leaders in various segments of renewable power generation.

Role of Renewable Energy Resources in Sustainable Development

Renewable energy plays a crucial role in sustainable development by reducing energy imports and promoting economic growth without increasing greenhouse gas (GHG) emissions. It provides a cleaner alternative to fossil fuels and ensures long-term environmental sustainability. Additionally, renewable energy benefits low-income communities by improving access to modern energy services and supporting efforts to achieve Sustainable Development Goals (SDGs). For example, solar panel installations enable underprivileged households to consistently access electricity. In India, many regions still lack reliable access to electricity, particularly in rural areas. Distributed solar and wind energy systems can help mitigate power disruptions as weather conditions vary across locations, ensuring a continuous energy supply. Furthermore, renewable energy plays a key role in climate change mitigation by producing low or zero GHG emissions, thereby making it an environmentally friendly alternative to fossil fuels. The development of renewable energy sources also creates employment opportunities and promotes structural economic change. Sectors, such as solar and wind power, have the potential to generate millions of jobs, contributing to economic growth. Moreover, renewable technologies help reduce pollution and improve public health, as they do not involve combustion, significantly lowering local and regional air pollution compared with fossil fuel-based power generation. Renewable energy also enhances energy security by reducing the dependency on finite fossil fuel resources. Unlike oil, gas, and coal, which are being depleted, solar and wind energy are sustainable and in exhaustible. Investing in renewables ensures a stable and long-term energy supply, strengthening a country's resilience against energy crises. Overall, renewable energy is a key driver of sustainable and inclusive development, which ensures economic progress, social well-being, and environmental protection. Its adoption is essential for achieving long-term energy sustainability and securing a healthier future for both people and the world.

India's Efforts towards Renewable Energy

India has taken significant steps to promote renewable energy and reduce its dependence on fossil fuels. The government has set ambitious targets and introduced policies to accelerate the adoption of clean energy sources. The National Solar Mission is one of the key initiatives aimed at expanding the solar energy capacity. Large solar parks, such as Bhadla Solar Park in Rajasthan and Pavagada Solar Parkin Karnataka, have contributed to increasing solar power generation. Similarly, wind energy has seen steady growth, with states such as Tamil Nadu, Gujarat, and Maharashtra leading to wind power generation. Offshore wind energy projects have also been explored. To encourage

investment and innovation in the sector, policies such as Renewable Energy Certificates (RECs), Production-Linked Incentive (PLI) schemes, and the Green Energy Corridor project have been introduced. The PM-KUSUM scheme supports the use of solar power in agriculture and in rural areas. India has also played a leadership role in globally promoting renewable energy. The country played a key role in the establishment of the International Solar Alliance (ISA), which promotes cooperation among countries for solar energy development. India has committed to achieving 500 GW of non-fossil fuel capacity by 2030, and aims to become a carbon-neutral economy by 2070.Through these efforts, India is working towards energy security, economic growth, and environmental sustainability while reducing pollution and greenhouse gas emissions.

Challenges and Opportunities in Renewable Energy

The transition to renewable energy faces several challenges that hinder its large-scale adoption and implementation. A major challenge is the high initial installation costs. Renewable energy technologies, such as solar and wind power, require significant upfront investments, making them financially riskier than fossil fuel plants. Although solar and wind energy have become more affordable over time, their installation costs remain higher. For instance, the installation cost of large-scale solar power systems is approximately $2,000 per kilowatt, whereas a new gas-fired plant costs only around $1,000 per kilowatt. Another significant challenge is a lack of infrastructure. The current energy infrastructure is primarily designed for fossil fuels and nuclear power plants, making it difficult for renewable energy to integrate seamlessly. Grid integration and energy storage are also major concerns because renewable energy sources generate power intermittently, which does not always align with peak demand hours. The absence of efficient and affordable energy storage solutions further complicates the situation, leading to supply-demand mismatches. India faces several challenges in expanding its renewable energy sector. One of the key issues is the limited understanding of the linkages between development, sustainability, and climate-change mitigation. A country's current development models often contribute to greenhouse gas emissions, making them unsustainable and in equitable. Although India has set an ambitious target to achieve Net Zero greenhouse gas emissions by 2070, the long-term implications of this transition on local and national development remain uncertain. Another significant challenge is geographical and resource constraints. The renewable energy potential is not evenly distributed across the country, with some regions having greater access to solar and wind resources than others. Land use and environmental concerns are also obstacles. Large-scale renewable energy projects, particularly solar parks, require extensive land, which can lead to competition with agriculture and other productive land uses, potentially affecting food security. Studies estimate that India may need around 50,000–75,000 square kilometers of land—almost half the size of Tamil Nadu—to meet its Net Zero targets. Operational and technical challenges further complicate the deployment of renewable energy. In regions such as Rajasthan, dust accumulation on solar panels increases operational costs owing to the need for frequent cleaning. The unavailability of soft water necessitates investment in water treatment technologies such as reverse osmosis (RO) systems. Moreover, a shortage of skilled workers in installation, maintenance, and repair limits the efficiency of renewable energy systems. The monopoly on fossil fuels in India also presents a major hurdle. The fossil fuel industry has been deeply embedded in the country's economy for decades, and has enjoyed significant government support. Despite the policy incentives and rebates for renewable energy, conventional energy sources continue to dominate because of their established infrastructure and financial backing. Another major challenge is the dependency on imported raw materials. India relies heavily on imports of solar cells and modules, particularly from China and Vietnam, to meet its renewable energy demands. Limited domestic manufacturing of critical components, such as silicon panels and battery storage systems, increases the costs and dependence on foreign markets. Additionally, the lack of public awareness and resistance to change slows the adoption of renewable energy technologies. Many people remain reluctant to switch to renewable energy

because of insufficient knowledge of its benefits and cost-effectiveness. The environmental impacts of large-scale renewable projects also require further research, especially concerning biodiversity loss in sensitive ecosystems, such as deserts. The expansion of renewable energy infrastructure competes with other essential resources, particularly land and water resources. Large-scale solar projects require substantial amounts of water to clean panels, which can lead to water scarcity in drought-prone regions. Additionally, the conversion of agricultural land to solar parks could impact food security, as India would need approximately 400,000 hectares of land by 2030 to meet its renewable energy targets. Balancing the need for clean energy while protecting food production and natural ecosystems remains a significant challenge. Despite these barriers, India's commitment to renewable energy has remained strong. Overcoming these challenges will require strategic investments in infrastructure, R&D, policy stability, and greater emphasis on local manufacturing to reduce dependence on imports. By addressing these issues, India can successfully transition into a more sustainable and resilient energy future.

Result and Discussion

India has made significant strides in renewable energy, with the total installed capacity reaching 209.44 GW in 2024, comprising solar (97.86 GW), wind (48.16 GW), biomass (11.38 GW), and small hydro power, which grew from 4.99 GW in 2023 to 5.10 GW in 2024, reflecting a 2.20% increase. Leading states such as Rajasthan, Gujarat, Tamil Nadu, and Karnataka were at the forefront of this expansion. However, challenges persist, such as grid integration, financing constraints, and regional disparities. While government policies such as the National Solar Mission, Production-Linked Incentive (PLI) Scheme, and Renewable Purchase Obligations (RPOs) have accelerated growth, further efforts are needed to enhance energy storage solutions, decentralized renewable adoption, and public participation. To sustain momentum, India must focus on investments in battery storage, hybrid renewable systems, and policy stability while also promoting microgrids and bioenergy in rural areas. Recognizing the sector's potential, India has allowed 100% Foreign Direct Investment (FDI) under the automatic route for renewable energy generation and distribution projects in compliance with the Electricity Act of 2003. At the 26th session of the United Nations Framework Convention on Climate Change (COP 26) in November 2021, India pledged to achieve net zero emissions by 2070, highlighting the sector's crucial role in ensuring environmental sustainability and economic growth. Since 2014, India's wind energy capacity has more than doubled, reaching 47.95 GW, with plans to scale it up to 99.9 GW by 2029-30 in key wind-producing states such as Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Rajasthan, and Kerala. To further boost renewable energy adoption, the government has implemented various initiatives, including the Solar Parks Development Program, which sanctioned 50 solar parks across 12 states, each with a capacity of at least 500 MW. Additionally, the sustainable alternative Towards affordable transportation (SATAT) initiative aims to establish compressed biogas (CBG) production plants to supply CBG as an automotive fuel. The Smart Cities Mission also mandates rooftop solar installations for new buildings and ensures that at least 10% of urban energy consumption is sourced from renewable sources.

Conclusion and Policy Recommendation

India's renewable energy sector has made significant progress, reaching 212 GW of installed capacity (including large hydropower) by January 2025, with solar energy leading at 100 GW.The 27% year-on-year growth in renewable generation and solar staggering 136% surge showcase the sector's potential. However, sustaining this momentum requires a holistic strategy to address key challenges. Empowering communities and ensuring equity in renewable energy projects are crucial. Community-led renewable parks such as Pavagada's solar project demonstrate how wasteland leasing can benefit locals through fair compensation and job creation. Strengthening Environmental and Social Impact Assessments (ESIA) is necessary to safeguard against displacement and ecological harm. Modernizing infrastructure and fostering innovation are vital to the seamless integration of renewable energy. Grid upgrades and battery storage investments

are urgent priorities for managing solar and wind intermittency, and preventing blackouts. Innovations such as agrivoltaics, which combine solar power generation with farming, can enhance food security, while allowing farmers to become energy producers and consumers. Policy and investment reforms are essential for accelerating this transition. Faster project approvals and risk-sharing guarantees from multilateral banks attract more private capital. Financial incentives, such as subsidies, tax breaks, and R&D grants, can drive advancements in energy storage and green hydrogen technology. Additionally, key legislative measures, including the Electricity Amendment Bill and the domestic carbon market, must be prioritized to drive sectoral reforms. As renewable energy projects reshape employment patterns, targeted skilling programs are necessary to integrate unskilled and marginalized workers into the green economy. Ensuring an inclusive workforce transition strengthens the sector's long-term sustainability. India's renewable boom is not just about clean energy, but also about fostering energy democracy, economic growth, and climate resilience. By combining community participation, infrastructure investment, and policy reforms, India can achieve a sustainable & equitable energy future.

References

Alola, Andrew Adewale, et al. "Role of Non-Renewable Energy Efficiency and Renewable Energy in Driving Environmental Sustainability in India: Evidence from the Load Capacity Factor Hypothesis." *Energies*, vol. 16, no. 6, 2023.

Ingole, Chandrakant Kashiram. "Sustainability of Productive Use of Off-Grid Renewable Energy: A Case of a Women's Collective from Rural India." *International Journal of Management and Sustainability*, vol. 12, no. 3, 2023, pp. 337-54.

Marotta, Ilaria, et al. "Environmental Sustainability Approaches and Positive Energy Districts: A Literature Review." *Sustainability*, vol. 13, no. 23, 2021.

Mirza, Zuhaib Tayar, et al. "A Thematic Analysis of the Factors that Influence the Development of a Renewable Energy Policy." *Renewable Energy Focus*, vol. 49, 2024.

Musah, Mohammed, et al. "Assessing the Roles of Green Innovations and Renewables in Environmental Sustainability of Resource-Rich Sub-Saharan African States: A Financial Development Perspective." *Natural Resources Forum*, vol. 49, 2024, pp. 461-90.

Pata, Ugur Korkut, and Mehmet Akif Destek. "A Sustainable Development Assessment for the Load Capacity Factor and Carbon Footprint in India: The Role of Information and Communication Technologies, Renewable Energy, and Structural Changes." *The Journal of Environment & Development*, vol. 32, no. 4, 2023, pp. 392-412.

Ramasubramanian, Brindha, and Seeram Ramakrishna. "What's Next for the Sustainable Development Goals? Synergy and Trade-offs in Affordable and Clean Energy (SDG 7)." *Sustainable Earth Reviews*, vol. 6, no. 1, 2023.

Rej, Soumen, and Barnali Nag. "Investigating the Role of Capital Formation to Achieve Carbon Neutrality in India." *Environmental Science and Pollution Research*, vol. 29, 2022.

Salvia, A. L., and Luciana Brandli. "Energy Sustainability at Universities and Its Contribution to SDG 7." *Universities as Living Labs for Sustainable Development*, Springer, 2019, pp. 29-45.

Solarin, Sakiru Adebola, and Mufutau Opeyemi Bello. "Output and Substitution Elasticity Estimates between Renewable and Non-Renewable Energy: Implications for Economic Growth and Sustainability in India." *Environmental Science and Pollution Research*, vol. 28, 2021.

Authors Details

Kundan Kumar Roy, *Research Scholar, Department of Economics, Patna University, Patna, Bihar, India*
Email ID: *kundanrai123@gmail.com*