(IJRSSH) 2025, Vol. No. 15, Special Issue No. V **e-ISSN: 2249-4642 p-ISSN: 2454-4671**

Innovative Practices for Environmental Sustainability: A Study of India's Renewable Energy Sector

Dr. C. Jyothsna
Associate Professor, Department of Zoology, Nagarjuna Government College (A) Nalgonda, Telangana.

DOI:10.37648/ijrssh.v15i05.021

[1] *Received: 01/11/2025; Accepted: 20/11/2025; Published: 25/11/2025*

Abstract

Sustainable energy and inexpensive, dependable, sustainable, and contemporary energy for citizens enable sustainable development. India leads one of the world's most appealing renewable energy sectors due to government assistance and an improving economy. The government has created regulations, initiatives, and a flexible environment to attract international investment and rapidly expand the renewable energy sector. Renewable energy is expected to provide many home employment in the next years. This article discusses India's renewable energy development's successes, prospects, predictions, power generation, obstacles, investment, and employment potential. This review identifies renewable industry challenges. Policymakers, innovators, project developers, investors, industries, stakeholders and departments, researchers, and scientists will benefit from the review suggestions. India is working to achieve green growth by achieving a balance between economic development and ecological conservation. To achieve this, the country is employing new techniques for environmental sustainability and green energy. Among the most important projects are the development of green hydrogen, the promotion of biofuels, and the expansion of solar and wind energy. Despite the fact that hurdles like as grid infrastructure and early investment costs continue to exist, these initiatives are backed by robust government policies, increased private investment, and technology breakthroughs. In order to achieve sustainable development, the objective is to lessen the impact of pollution and climate change while simultaneously improving energy security.

1. Introduction

India's dependence on coal for energy has resulted in pollution, carbon emissions, and environmental risks. The Indian government is advocating for renewable energy to improve energy efficiency and mitigate environmental concerns. India seeks to reduce pollution and greenhouse gas emissions by investing in solar, hydro, and wind energy, therefore fulfilling energy demands responsibly. The transition to renewable energy not only enhances environmental sustainability but also diminishes reliance on energy imports and decreases expenses. Renewable energy technologies such as solar, hydroelectric, and wind are essential for power generation, providing clean alternatives sourced from natural resources. The government's emphasis on delivering round-the-clock cheap power for everybody has catalyzed advancements in off-grid electricity generation, especially in locations abundant in sunlight. These innovations have garnered private sector investments, enhanced energy efficiency, and mitigated energy shortages. India aims to establish 337 GW of renewable energy capacity by 2027, with substantial input from foreign and private sectors, highlighting the nation's considerable renewable energy potential. Legislative measures such as the Electricity Act 2001 and rural electrification have improved energy conservation and distribution efficacy. The shift to electric cars and progress in renewable energy technology indicate a favorable future for India's energy industry, presenting prospects for innovation, job creation, and sustainable development. This article examines government attempts to

[1] **How to cite the article:** Jyothsna C., (November, 2025) Innovative Practices for Environmental Sustainability: A Study of India's Renewable Energy Sector; *International Journal of Research in Social Sciences and Humanities*; Vol 15, Special Issue 5; 120-123, DOI: http://doi.org/10.37648/ijrssh.v15i05.021

Presented in National Seminar on "Viksit Bharat @ 2047: Public Policy, Governance & Digital Transformation" on 24-25, November 2025, GDC, Khairatabad, Hyderabad, T.G.

advance renewable energy, the contributions of solar, hydro, and wind power to electricity generation, and the prospective advantages of this shift for the Indian economy and environment.

Focusing on the country's fast growth in the renewable energy sector—which encompasses solar, wind, and hydropower—this research examines India's creative techniques for environmental sustainability. Energy security and climate change are motivating factors in India's shift to renewable energy sources. The country is working to lessen its impact on the environment and its reliance on foreign power generation by implementing new policies, developing cutting-edge technologies, and investing in grid modernization, energy storage, and local manufacturing.

The nation of India has risen to the forefront of the global renewable energy market due to the growing number of environmental concerns and the increasing need for energy security. Because of the country's enormous natural resources and unwavering commitment to the development of sustainable energy sources, it is rapidly transitioning to greener energy sources. India's energy environment is undergoing a transformation as a result of the continual pursuit of solar, wind, hydropower, and biomass technologies. These technologies are also assisting the country in reducing its carbon footprint and increasing economic growth. The intersection of India's objectives for progress with the sustainability concerns of the global community is symbolized by the phrase "Renewable Energy for Sustainable Development in India." Renewable energy emerges as a crucial resource in light of worries about the environment and the depletion of fossil fuels. Traditional forms of energy have environmental costs, yet India's economic progress is inextricably linked to its demand for energy. The transition of India to renewable energy sources such as solar, wind, hydropower, biomass, and geothermal is imbued with importance when considered in the context of international obligations. This investigation seeks to explain how the growth of India is connected to the use of renewable energy. It examines the socioeconomics, policy, technology, and global relationships that are influencing this period of transformation. The significance of renewable energy in not only the expansion of India but also in the restructuring of sustainable routes on a global scale.

Renewable energy statistics for sustainable development give a full picture of India's energy revolution toward a more environmentally friendly power grid. The phenomenal growth in renewable energy projects like as solar, wind, hydropower, and biomass, as shown by the renewable power installed capacity in different states and union territories, reflects an increasing dedication to sustainable development. Capacity expansion like this demonstrates the government's resolve to reduce fossil fuel use, slow global warming, and usher in a low-carbon economic future. Renewable energy installations are affected by external influences, as seen by the capacity augmentation year after year. Supply chain disruptions, labor shortages, and project execution delays can be the cause of the drop in capacity increase in 2020–21. However, the subsequent substantial uptick in 2021 and 2022 shows that renewable energy projects are making a triumphant return, proving that we are resilient and committed to sustainable growth. Renewable energy is essentially India's strategy for long-term sustainability. In addition to enhancing energy security and environmental sustainability, the United States' dedication to renewable energy sources paves the way for economic development, job creation, social inclusion, and job stability. The rapid adoption of renewable energy sources in India is a key component of the country's strategy to reduce its impact on the environment and ensure a sustainable future for generations to come.

2. Major innovative practices in Energy Sector:

- Renewable energy expansion: A key area of concentration is the rapid expansion of solar electricity, which includes decentralized rooftop solar systems. The policy also heavily emphasizes wind energy, with an emphasis on expanding capacity.
- Green hydrogen development: The production of environmentally friendly hydrogen by electrolysis with the utilization of renewable energy is a new frontier in the energy transformation of the country.
- Biofuel and bio-based products: India is investigating novel biofuels and cultivating a bio-circular bioeconomy that utilizes resources such as biomass to produce fuels, packaging, and various goods.
- Technological integration: Real-time environmental monitoring, predictive analytics, and energy optimization in urban ecosystems and structures are all being achieved through the use of AI-driven digital siblings.

- Sustainable business practices: Small and medium-sized businesses (SMEs) are focused more on green innovation to make them more competitive and resilient. They may even charge more for their goods because they are "green."

3. Challenges and future outlook:

Key challenges include land availability for large-scale projects, grid integration of intermittent power sources, and improving the financial health of DISCOMs.

- Cost and infrastructure: There are considerable obstacles, including as the prohibitively high initial prices of technologies such as green hydrogen and the requirement for substantial investments in grid infrastructure.
- Policy consistency: For the purpose of expediting the transition to green energy, addressing policy inconsistencies is absolutely necessary.
- Integrated approach: These projects will only be successful in the future if they are implemented using an integrated strategy that guarantees both the preservation of the environment and the protection of livelihoods.

4. Major Innovative Practices in India:

❖ **Technology and infrastructure:**
  - ❖ **Solar energy:** As a result of efforts such as the National Solar Mission, India is making considerable progress in increasing its capacity for solar energy, which includes advancements in solar photovoltaic cells and the encouragement of rooftop solar installations.
  - ❖ **Wind energy:** Having made improvements in high-efficiency turbines and grid integration technologies to handle intermittency, the nation is a global leader in wind generation.
  - ❖ **Floating solar:** Solar farms that float on reservoirs and lakes are one inventive solution to the problem of limited land.

❖ **Grid and Storage Solutions:**
  - ❖ **Smart Grids:** Upgrading the electricity infrastructure is crucial for incorporating intermittent renewable energy sources such as solar and wind.
  - ❖ **Energy Storage:** In order to maintain the dependability of the electrical grid, it is essential to implement large-scale battery storage, pumped hydro storage, and hybrid projects.

❖ **Policy and Financing:**
  - ❖ **Government Schemes:** The Purpose of the PM-KUSUM program is to encourage the use of solar energy in the agricultural sector, while the Revamped Distribution Sector Scheme (RDSS) is intended to improve the financial stability of power distribution firms (DISCOMs) and the effectiveness of power evacuation and distribution.
  - ❖ **Innovative financing:** Green bonds, viability gap funding, and various financial instruments are employed to entice private investment.

❖ **Circular Economy and Waste-to-Energy:**
  - ❖ **Biomass in a Circular Economy:** The government of India is now investigating methods for transforming its immense stockpiles of agricultural and urban trash into lucrative commodities, including biofuels and high-value chemicals.
    a. **Using organic waste:** Biomass energy systems use organic materials, such as agricultural or animal waste, as a feedstock to produce energy.
    b. **A circular feedstock:** Biomass is significant because it can replace petrochemicals and natural gas in many applications. This is especially true for products derived from biomass, like bio-based plastics and composites, which can substitute traditional materials and keep resources in circulation.
    c. **Sustainable energy source:** Biomass can be directly combusted for heat or used in WtE plants for electricity, providing a renewable energy source that can help offset fossil fuel emissions.
    d. **A sustainable bioeconomy:** Establishing a circular bioeconomy requires appreciating the role of biomass throughout its entire value chain—from design to end-of-life—and focusing on sustainable production methods.

- **Waste to Energy:** By recovering resources from ash and turning non-recyclable trash into energy, trash-to-Energy (WtE) is a tactic that can support the circular economy. WtE deals with the trash that is left over after recycling, reuse, and repair-all of which are part of the circular economy's goal to eradicate waste. By processing this trash, WtE avoids landfilling, generates energy (heat and electricity), and may extract minerals and metals from the ash for use in industry or building. Waste-to-Energy provides a comprehensive strategy for the recovery of resources from non-hazardous waste that cannot be recycled. It prevents this waste from being sent to landfills, recovers metals and minerals, and generates renewable energy from the biodegradable portion of the waste. As a result, it is an essential component of the circular economy and is able to create value for society.

5. Conclusion:

India's renewable energy sector has provided a compelling example of how economic development and environmental sustainability may be combined by utilizing cutting-edge methods and a strong legislative framework. The transition is in accordance with both the national priorities and the Sustainable Development Goals (SDGs) that have been established on a global scale. The research indicates that in order to fully actualize a sustainable and resilient energy future, it is necessary to employ a comprehensive approach that prioritizes financial innovation, grid modernization, and integrated land-use planning in order to overcome chronic difficulties and promote fair growth. Renewable energy has significant challenges. Some are inherent in every renewable technology; others are caused by a lopsided regulatory system and market. Lack of comprehensive policies and regulations hinders renewable technology implementation. The renewable energy sector needs clear regulations and laws to attract investment. Lack of defined policies delays private sector project approval. Private investors should be sought by the nation. R&D should address technical and infrastructural gaps for renewable technologies. This sector's research and innovation should receive additional government funding. Institutions should prepare the workforce since there are not enough qualified people to teach, demonstrate, maintain, and operate renewable energy infrastructure. Imported equipment is more expensive than locally built, making renewable energy generation unfeasible. To lower the cost of renewable products, the government should manufacture them. Unreliable grid connectivity hinders renewable energy technology development. Due of this, many investors lose trust in renewable energy technology and are wary of investing in them. India should arrange transmission and evacuation.

References:

Aggarwal, P. (2017). 2 °C target, India’s climate action plan and urban transport sector. *Travel Behaviour and Society, 6*, 110–116. DOI not found

Charles Rajesh Kumar, J., Mary Arunsi, B., Jenova, R., & Majid, M. A. (2019). Sustainable waste management through waste to energy technologies in India—opportunities and environmental impacts. *International Journal of Renewable Energy Research, 9*(1), 309–342. DOI not found

Charles Rajesh Kumar, J., Vinod Kumar, D., & Majid, M. A. (2019). Wind energy programme in India: Emerging energy alternatives for sustainable growth. *Energy & Environment, 30*(7), 1135–1189. https://doi.org/10.1177/0958305X19841297

Jeslin Drusila Nesamalar, J., Venkatesh, P., & Charles Raja, S. (2017). The drive of renewable energy in Tamilnadu: Status, barriers and future prospect. *Renewable and Sustainable Energy Reviews, 73*, 115–124. DOI not found

Kumar, S. (2016). CO2 emission reduction potential assessment using renewable energy in India. *Energy, 97*, 273–282. DOI not found

Pappas, D. (2017). Energy and Industrial Growth in India: The Next Emissions Superpower? *Energy Procedia, 105*, 3656–3662. DOI not found