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CLIMATE CHANGE, ENERGY SECURITY, AND THE RENEWABLE ENERGY TRANSITION IN INDIA: CHALLENGES AND POLICY PERSPECTIVES AT THE REGIONAL LEVEL

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RESEARCH ARTICLE

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Abstract

Energy security and climate change have become major global issues, especially for developing nations like India where environmental concerns and growing energy demand coexist. This study looks at how renewable energy can help with these issues, concentrating on obstacles to its growth at the regional level. India has made great strides in increasing its capacity for renewable energy, but it still faces several challenges, such as financial limitations, inconsistent policies and regulations, infrastructure constraints, technical capacity gaps, and socio-political opposition. The study uses a qualitative methodology and secondary data gathered from academic sources, government reports, and policy documents. It emphasises how, despite national policies' strong support for clean energy, regional implementation of these policies is still uneven. According to the findings, accelerating the transition to renewable energy requires strengthening institutional coordination, developing infrastructure, raising public awareness, and encouraging public-private partnerships. The study concludes that to achieve sustainable energy development in India, a balanced strategy that incorporates energy security and climate goals through efficient policy implementation and regional involvement is needed.

Keywords: *Climate Change; Renewable Energy; Regional Governance; Policy Barriers; India*

Introduction

Climate is defined as the distribution of weather outcomes for a given area and climate change is defined as the environmental changes occurring in the distribution of weather outcomes. Climate change is progressing at an alarming rate and is rushing rapidly, with a narrow opportunity to escape its worst environmental and socio-economic outcomes (Cevik, 2024). In the contemporary world, climate change has emerged as one of the most pressing global challenges. Policymakers and international organisations increasingly recognise the urgency of addressing two closely interconnected issues: climate change and energy security (Elkhatat & Al-Muhtaseb, 2024). Climate change is largely driven by the rapid increase in pollution and greenhouse gas emissions resulting from industrialisation, urbanisation, and excessive dependence on fossil fuels. The bulk consumption of fossil fuels, containing petrol, diesel, coal and natural gas, to intersect the increasing energy demand has ensued in the accumulation of greenhouse gases in the air (Guresci & Ogochukwu, 2026). These factors have intensified extreme weather events and contributed to a steady rise in global temperatures. Studies indicate that between 1990 and 2018 the usual universal temperature increased by nearly 1.5 degrees Celsius. This rise in temperature has accelerated the melting of glaciers, caused a significant increase in sea levels, and disrupted ecological balance across the world. Consequently, addressing climate change and ensuring sustainable energy systems have become central priorities for achieving long-term environmental sustainability and global stability.

Global economic competition has significantly contributed to the intensification of climate change. In the pursuit of becoming global superpowers and achieving economic dominance, many countries have expanded their military capabilities and industrial activities. The large-scale production and testing of missiles and other military equipment across air, land, and sea have generated substantial greenhouse gas emissions, thereby contributing to environmental degradation. Such activities have also disrupted natural habitats and threatened the survival of numerous species. At the same time, rapid industrialisation has taken place in many countries without adequate consideration of environmental sustainability. To sustain economic growth and meet the demands of a rapidly increasing global population, nations require enormous amounts of energy. Nevertheless, in many cases governments have failed to implement strict regulations related to energy security, pollution control, and environmental protection. As a result, the overexploitation of natural resources and excessive reliance on non-renewable energy sources have

accelerated the process of climate change. Consequently, climate change has become one of the most critical challenges facing the contemporary world. Addressing the twin issues of climate change and energy security has therefore become an urgent priority for governments, policymakers, and international organisations across the globe (Patil, et al., 2025).

Energy is the enabler of growth, as history evident evolution of human society rests on accessibility of energy usage, ranging from initial use of fire and animal power to present usage of electricity and sustainable fuels (Energy Statistics India 2025). As a rapidly developing country with growing energy demands, India faces the dual challenge of safeguarding energy security while reducing environmental deprivation. Because primary India's consumed energy comes from the non-renewable sector like- coal, crude oil etc. which results huge contamination into the environment. Although the country has made progress in expanding renewable energy capacity, the transition toward clean energy remains slow due to several barriers at the regional level. Financial constraints, policy and regulatory gaps, weak infrastructure, limited technical capacity, and lack of public awareness often hinder the effective implementation of renewable energy initiatives. Therefore, it is important to examine the key challenges faced at the regional level and explore ways to strengthen renewable energy development in India.

Objectives of the Study

i. To analyse the role of renewable energy in tackling climate change and energy security.
ii. To examine the major challenges in promoting renewable energy at the regional level in India.

Research Questions

i. How can renewable energy contribute to addressing environmental change and strengthening energy security in India?
ii. What are the major barriers to renewable energy development at the regional level in India?

Methodology

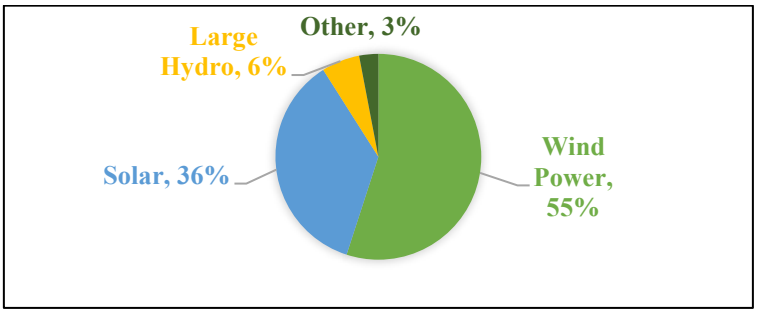
This study assumes a qualitative and analytical research design to examine the challenges of renewable energy development and its relationship with climate change and energy security in India. The research primarily relies on secondary sources of data. Relevant information has been collected from academic journals, books, government policy documents, and reports. The collected data has been analysed through a thematic and interpretative approach to identify the major barriers to renewable energy development at the regional level. The study critically evaluates existing policies and institutional frameworks to understand the obstacles faced by regional governments and to highlight possible strategies for strengthening renewable energy development and ensuring sustainable energy transition in India.

Policy Framework on Renewable Energy in India: at a glance

Energy issues have gained predominance in the political discourse like never before (Tagotra, 2017). Even though renewable energy is essential for growth and has not received noteworthy consideration in the policy formulation (Neupane, Chaudhary, Rijal, Ghimire, & Bhandari, 2022). Nevertheless, the Government of India has introduced several policy cunnings to endorse renewable energy and decrease dependence on fossil fuels to address climate change and strengthen energy security. Given that South Asia is a stifling region and its climate, both solar and wind could be alike potential sources of renewable energy next to hydropower (Neupane, Chaudhary, Rijal, Ghimire, & Bhandari, 2022). India currently stands as the 5th largest wind power producer in the world and was set the target to install 60 GW of wind power by 2022. The ministry of New & Renewable Energy and Power has acknowledged that the Government has recognised an objective of achieving 500 GW of installed capability from non-fossil energies by 2030 (Ministry of New and Renewable Energy, 2023). A major step in this direction is the National Action Plan on Climate Change, which provides an overall strategy for climate mitigation and adaptation through various national missions. One of its key components is the National Solar Mission, which aims to encourage large-scale solar energy generation and expand India's renewable energy capability.

India is progressively emphasising the expansion of renewable energy sources as share of its broader commitment to sustainable growth and climate action. As of March 31, 2024, the country's total projected renewable energy generation potential was approximately 2,109,655 MW. This possibility is derived from diverse renewable sources, including solar, wind, biomass, small hydropower, and bagasse-based cogeneration.

Figure 1: Source wise Projected Potential of Renewable Power in India.



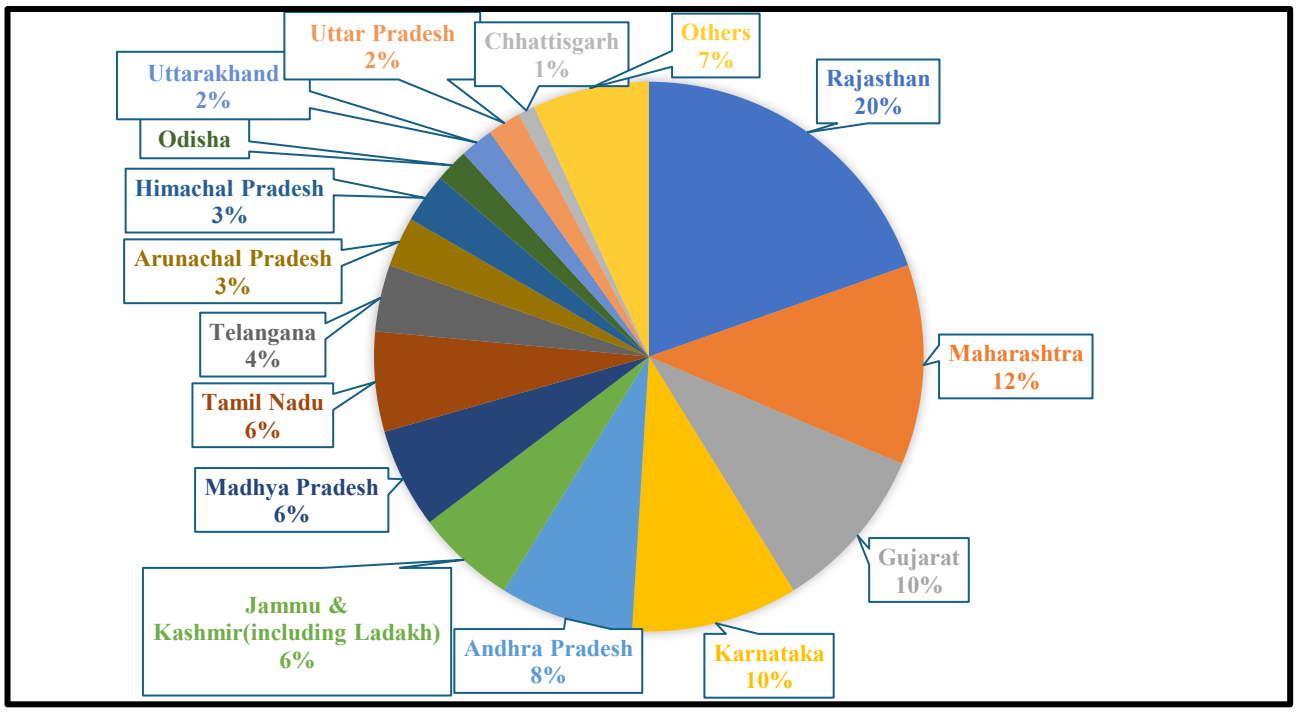
Source: https://mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2025/Energy%20Statistics%20India%202025_27032025.pdf accessed on 20th March 2026.

The above statistics published in Energy Statistics India (2025) indicate that approximately 55 percent of India's renewable energy capacity is derived from wind power, making it the dominant source. This is followed by solar energy, which accounts for around 36 percent of the total capacity. Large hydropower contributes about 6 percent, while the remaining 3 percent is generated from other sources, including small hydropower, biomass energy, and cogeneration bagasse, each contributing roughly 1 percent. At present, the government of India is giving higher consideration to solar power and has introduced the Solar Mission as one of the main edges for renewable energy. The government has launched the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) India Scheme to encourage the adoption of electric vehicles and reduce carbon emissions in the transport sector (Ministry of Heavy Industries, 2026). The PM-KUSUM Scheme promotes the use of solar energy in agriculture and rural areas, helping farmers reduce dependence on conventional energy sources. More recently, the National Green Hydrogen Mission (2023) has been introduced to develop green hydrogen as a sparkling energy spring and support India's long-term decarbonisation goals (Ministry of New and Renewable Energy, 2026). Together, these policies play a crucial role in advancing renewable energy expansion and supporting India's shift toward a bearable energy future.

Challenges and Policy Perspectives: an analytical overview

India has the great potential to adapt the transition of its energy consumption from non-renewable to renewable energy springs. Renewable energy sources are categorically fall under natural resources. So, equal potential of the sources into different states is not reasonable, but distribution of the energy generated can be distributed equally or as necessity. However, present data shows a divergent picture of distribution of renewable energy in different Indian states.

Figure 2: State wise Predictable Potential of Renewable Power in India as on 31.03.2024



Source: https://mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2025/Energy%20Statistics%20India%202025_27032025.pdf accessed on 20th March 2026.

The chart shows that renewable energy capacity in India is unevenly distributed across states. Rajasthan leads with 20 percent, followed by Maharashtra 12 percent, and Gujarat and Karnataka 10percent each. Andhra Pradesh contributes 8percent, while several states like Madhya Pradesh, Tamil Nadu, and Jammu & Kashmir each account for 6percent. Smaller shares come from Telangana 4percent and others, with Chhattisgarh at the lowest 1percent. Overall, the data indicates that renewable energy capacity in India is highly focused in a few leading states, particularly Rajasthan, Maharashtra, Gujarat, and Karnataka. These states benefit from favorable geographical conditions, better infrastructure, and stronger policy implementation. In contrast, several states contribute relatively less, highlighting regional disparities in renewable energy development across the country.

The matter of Environment and Energy security fall under the *concurrent list* of the centre-state power distribution in India. Nevertheless, Policy response on climate change and renewable energy sector primarily devoted to the central government of India. The regional governments are liable to implement and obey the mandates set by the central government. In this regard, regional governments are facing a complex and multilayered set of challenges in promoting renewable energy. The governance structure involving multiple levels—central, state, district, and local authorities—often creates administrative and coordination difficulties in implementing renewable energy initiatives. One of the major obstacles is the high initial cost of renewable energy technologies, along with the lack of proper management, technical expertise, and public awareness regarding their effective use into the geographically vast and populated country like India. Regulatory gaps and bureaucratic delays further complicate the

process, making it difficult for regional authorities to align with national and state-level programs. Another significant challenge in promoting renewable energy is the limitation of financial resources. Policy inconsistencies, and insufficient infrastructure required for renewable energy projects are dependent only on the sanctions by the central government. Many regional and local governments struggle with inadequate funding due to ideological and motivational differences with central government. In addition, local resistance and lack of community acceptance often create barriers to the successful implementation of renewable initiatives which are mattered to governed by the state governments. As a result, despite ambitious national and state-level renewable energy targets, these structural and institutional challenges tend to slow down the transition toward sustainable energy systems.

Technological modernisation in renewable energy is not only important but essential in the present global geopolitical context. India remains highly dependent on imported energy resources, particularly crude oil, with nearly 80 percent of its demand met through imports from other countries (Ministry of Petroleum & Natural Gas, 2025). This dependence exposes the country to various external challenges such as international sanctions, geopolitical conflicts, and global market instability arising from events such as the Russia–Ukraine war and tensions in regions like the Middle East. Most recent issue of Israel- Iran war and crisis on crude oil. Such uncertainties highlight the pressing need for developing domestic renewable energy technologies and strengthening energy security. Nevertheless, the development and expansion of renewable energy technologies in India face significant financial and institutional constraints. The lack of adequate technological capacity and insufficient funding slows down the pace of renewable energy innovation and deployment. The high preliminary investment essential for renewable energy schemes—such as solar, wind, and biomass—poses a major challenge for regional and local authorities that operate with limited financial resources. Uncertain profitability, inadequate government management, and insufficient budget allocation further intensify these constraints. Moreover, competing priorities in public expenditure often limit the funds available for renewable energy development, thereby creating additional obstacles to the expansion of sustainable energy systems.

Government policies and governing frameworks play a vital role in endorsing clean energy development at the regional level. Nevertheless, several policy and governing barriers hinder the effective expansion of renewable energy initiatives. One of the major challenges is the inconsistency of policies and the absence of clear and long-term targets for renewable energy development as well as follow-up action. Recurrent policy changes in addition a lack of harmonisation between different stages of government often create uncertainty for investors and project developers. The approval and licensing procedures for renewable energy ventures are often multifaceted and time-consuming. Limited grid connectivity and inadequate infrastructure further constrain the incorporation of renewable energy into prevailing power systems. Unclear land acquisition policies and the absence of standardized regulatory frameworks across regions also create administrative difficulties. Moreover, bureaucratic complexity and weak institutional coordination slow down project implementation. The lack of long-term policy planning and insufficient financial management mechanisms further reduce the effectiveness of renewable energy programs at the regional level. Consequently, these policies and regulatory challenges significantly impede the transition toward sustainable and clean energy systems.

Infrastructure constraints represent a major barrier to the development and integration of renewable energy, particularly in rural and remote regions. Weak and underdeveloped grid infrastructure makes it difficult to connect renewable energy projects to the main power system. Many villages still lack proper electricity connectivity, and the existing grid capacity is often insufficient to support large-scale renewable energy generation. In addition, the absence of an efficient transmission network further complicates the distribution of energy produced from renewable sources. Another important challenge is the lack of adequate physical infrastructure required for renewable energy projects. In many regions, there is insufficient land planning and inadequate facilities for installation of solar panels, wind turbines, and energy storing systems. Logistical difficulties in transporting equipment and maintaining projects in remote areas also create additional infrastructural obstacles at the regional level. To overcome these barriers, governments need to invest more in expanding grid connectivity and strengthening transmission networks, particularly in underserved regional areas. Modernizing energy infrastructure, promoting advanced technologies, developing efficient energy storage systems, and improving communication and transportation infrastructure in remote locations can significantly support the effective implementation of renewable energy projects.

Although national clean energy goals aim to promote renewable energy, particularly solar power—at the local level, regional governments often face several socio-political obstacles in implementing these initiatives. One major challenge is the lack of adequate public awareness regarding renewable energy policies, government subsidies, and the long-term benefits of sustainable energy systems. In many regions, local administrative bodies also suffer from limited institutional capacity, technical expertise, and financial resources needed to effectively manage renewable energy projects. Political opposition and local conflicts may further complicate project implementation. Disputes related to land acquisition, infrastructure development, and local governance sometimes create delays and resistance. In addition, misinformation or fear among local communities about the environmental or social impacts of renewable energy schemes such as solar farms can hinder public acceptance. Another important challenge is the difficulty of changing long-standing social practices and everyday energy consumption habits within communities. To overcome these barriers, it is essential to actively engage local communities in the development and decision-making processes. Governments and policymakers should promote public participation, conduct awareness drives highlighting the economic and environmental reimbursements of renewable energy, and provide clear information about government incentives and subsidy programs. Furthermore, developing local training programs and skill-development initiatives can strengthen community capacity and encourage greater acceptance and participation in renewable energy projects.

Technical and capacity-related challenges constitute a major bottleneck in promoting renewable energy generation, particularly in regional and remote areas. One of the key issues is the inadequate infrastructure for integrating renewable energy into existing power grids. Many regions lack the technical systems required to efficiently connect renewable energy sources with the national electricity network. In addition, there is often limited availability of skilled technical experts who possess adequate knowledge of renewable energy technologies such as solar, wind, and biomass systems. Another challenge is the limited local availability of renewable energy equipment and manufacturing facilities. Many regions depend on external suppliers for the procurement of solar panels, turbines, and other related technologies, which increases costs and delays project implementation. Furthermore, difficulties in predicting and managing renewable energy generation—due to the intermittent nature of sources such as solar and wind—create additional operational challenges. These issues can be addressed through a series of targeted measures. Governments should introduce training and skill development programs in rural and remote areas to build local technical capacity. Increased public investment and financial support are also necessary to promote technological development and infrastructure expansion. Awareness programs highlighting the benefits of modern renewable energy technologies can encourage communities to adopt such systems and improve their household economic conditions. In addition, governments should encourage local investors to establish manufacturing units for renewable energy equipment and promote collaboration between public and private sectors. Providing clear information about government subsidies and facilitating access to long-term loans can further support the development and expansion of renewable energy projects.

Coordination issues also represent a significant challenge in the promotion of renewable energy at the regional level. Although people are increasingly aware that renewable energy sources are in high demand, the high cost of installation and the lack of adequate high-voltage transmission lines often hinder effective implementation. In many regions, energy generated from renewable sources such as wind or solar cannot be efficiently transmitted due to weak or insufficient transmission infrastructure. Another major problem is the overlap of responsibilities among multiple government departments involved in renewable energy development. This institutional fragmentation often leads to administrative delays and inefficiencies. Communication gaps between regional authorities and state or central governments further complicate policy implementation and project execution. In many cases, there is no single dedicated agency responsible for spreading awareness and guiding rural communities regarding renewable energy policies, subsidies, and environmental benefits. Additionally, local conflicts related to land use, infrastructure development, and solar connectivity sometimes create resistance and delay project implementation. To improve this situation, regional governments should establish dedicated renewable energy agencies or specialized administrative units to coordinate activities and ensure effective policy implementation. The introduction of centralized helpline systems or information centres can help rural communities access reliable information about renewable energy programs and government support schemes. Furthermore, governments should develop clear policies and regulatory frameworks while strengthening coordination between different administrative levels. Encouraging partnerships with the private sector and civil society organisations can also enhance awareness, improve technical support, and accelerate the transition toward sustainable energy systems.

Conclusion

If we reflect on life twenty years ago, many modern facilities such as developed roads, bridges, supermarkets, digital trading platforms, restaurants, fibre-optic communication systems, the internet, and mobile connectivity were far less widespread than they are today. Nevertheless, the natural environment was comparatively healthier, characterized by cleaner air, greener landscapes, richer biodiversity, and more stable climatic conditions. Over the past decades, rapid industrialisation, urban expansion, and excessive dependence on fossil fuels have significantly altered this balance**.** India has increasingly emphasized the promotion of sustainable and renewable energy. With approximately 226.9 GW of renewable energy capacity, India currently ranks among the leading renewable energy producers in the world. Nevertheless, given the country's rapidly growing population and expanding economic activities, the demand for energy continues to rise significantly. To address this challenge while reducing carbon emissions, India has set several ambitious targets, including the decarbonization of the transport sector by promoting electric mobility, with a goal of achieving around 30 percent electric vehicle adoption by 2030. The Government of India has also launched initiatives such as the PM Electric Drive Revolution in Innovative Vehicle Enhancement Scheme to accelerate the transition toward cleaner transportation technologies.

Furthermore, industries should be encouraged to adopt circular energy systems by reusing waste heat, recycling process gases, and establishing waste-to-energy units. Developing centralized management mechanisms to coordinate renewable energy programs, strengthening funding frameworks, promoting eco-friendly practices, and investing in smart grids, energy storage technologies, and climate-resilient infrastructure will be crucial for building a sustainable energy future. Through these combined efforts, it is possible to balance economic development with environmental protection and ensure long-term energy security for future generations.

Moving forward, India must continue to adopt advanced technologies, modernize energy infrastructure, and increase funds in renewable energy springs, including solar, wind, and emerging solutions such as green hydrogen. Strengthening public–private partnerships and implementing stricter regulations on fossil fuel consumption will also be essential. The concept of "Energy Atmanirbharta" (energy self-reliance) should guide national policy by promoting a clean, sustainable, and self-sufficient energy system for the future. Achieving these objectives will also contribute to the execution of the United Nations SDGs, mainly the goal of safeguarding access to reasonable, consistent, bearable, and contemporary energy for all by 2030.

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