



RENEWABLE ENERGY IN INDIA: COMPREHENSIVE ANALYSIS OF OPPORTUNITIES, BARRIERS AND POLICY RECOMMENDATIONS

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Abstract: Over 1.42 billion people call India home, with 70% residing in rural regions. Every day, the number of people on Earth grows, and as this population grows, so does the need for energy. The Indian government's goal of achieving 175 GW through renewable energy resources is being pursued by the MNRE in collaboration with the NITI, Aayog. Increasing the amount of energy derived from renewable sources rather than traditional ones is crucial in the modern world. The most economical and practical energy sources come from renewable sources. Sustainable development and renewable energy are, therefore, closely related. Sustainable and eco-friendly, renewable energy sources are unconventional. Contemporary technology can be directly replaced by renewable energy technology. Renewable energy can help us replace fossil fuels with cleaner energy sources, saving more energy and benefiting the environment. The review study goes into great elaboration about India's use of renewable energy. Additionally, as the difficulties faced by other countries are comparable to India's, the policies and recommendations of the Indian government are examined in detail to support the development of renewable energy generation both domestically and internationally. The goal of this study barriers face adopting the renewable energy. The findings of the study will be helpful for academics, researchers, and policymakers.

Keywords: Renewable energy, Renewable energy barriers, Opportunities, Policy recommendations, and India

1. INTRODUCTION

Every country's commercial energy spending has been rapidly increasing in recent years since energy is the most essential component that may aid a country's industrial growth. As the population grows, so does the demand for energy resources. Energy requirements vary between countries. Developed countries require more energy than emerging countries. People nowadays are particularly concerned with renewable energy sources since they are pollution-free, easily accessible, less expensive, and more abundant on the planet (Dey et al., 2022). Utilizing natural energy sources like radiation from the sun, wind power, tidal, biomass, thermal, and so forth is necessary for clean energy technologies. These energy sources are eco-friendly.

India's large population and rapidly expanding economy have significant energy requirements. In terms of both power generation and consumption, the nation is third in the world. The country's population has grown over time, but the amount of electricity produced has not stopped growing. Even though the majority of the country's electricity comes from coal, it is not expected to survive until at least 2040–2050. Half of the population lives in rural areas, despite the fact that 72% of them are there. India has one of the many emerging markets in the world. Nearly all spheres are undergoing reform. Energy, infrastructure, technology, etc., are merely a few of the industries that have reaped the benefits of the nation's steady progress. That nation needs to put an emphasis on energy conservation, efficiency, and renewable energy. Solar power is one of the best options for meeting India's growing energy needs and keeping the country's energy supply and demand in balance.

The Indian government is working on significant projects and plans to improve and sustain electrical infrastructure in India. Energy is recognized as the most critical building component in human growth and a vital factor influencing a country's long-term development. Energy consumption in India is rapidly growing. India's energy consumption will double by 2030, with electricity demand nearly tripling from now ("IRENA 'Renewable Energy Map 2030' Report Bodes Well for Renewables," 2014). Current technologies enable the more effective use of these renewable resources to create power (Kumar et al., 2010). Fortunately, India has an abundance of natural resources for producing commercial power using renewables.

2. LITERATURE REVIEW

Dubey et al., (2023): This report analysed the progress made in the renewable energy sector as well as the long road ahead to meet the government's aim of 500 GW by 2030. This goal is attainable with favorable legislation and foresight into the crucial obstacles in the renewable energy sector. Furthermore, the study emphasizes institutional entities as the single point of contact for giving answers to specific challenges and, therefore, a roadmap for a successful trip.

Falcone, (2023): the study found that developing countries have significant challenges in pursuing sustainable energy strategies. However, the enthusiasm and tenacity thus far offer hope for a more resilient, inclusive, and ecologically sustainable energy landscape. Developing countries that prioritize sustainable development goals, welcome collaboration, and learn from their mistakes will be at the forefront of the global shift towards low-carbon, sustainable energy.

Shukla et al., (2023): This research aims to explore why many countries continue to rely on fossil fuels, notably coal, as well as the challenges associated with deploying renewable energy technology, which limit their potential in many countries. This study discusses barriers to renewable energy adoption, such as excessive use of fossil fuels, geopolitical and bureaucratic obstacles, technological obstacles, market-related obstacles, cultural and social barriers, economic and financial barriers, and geographic and biological barriers.

Kumar & Majid (2020): The goal of this paper is to discuss major accomplishments, prospects, projections, and power generation, impediments, investment, and job opportunities resulting from India's renewable energy growth. In this assessment, we recognized the numerous challenges that the renewable sector confronts.

Pachar et al., (2021): This research study looks at renewable energy sources, drivers, difficulties, and policy. The study discovered that renewable energy can minimize environmental pollution, carbon emissions, and the shortage of nonrenewable energy resources. Renewable energy promotes economic growth, job creation, and wellbeing.

Ouedraogo, (2019): This study identifies several factors that have hampered the success of renewable energy in the region, including a poor Architecture and institutional framework, costly upfront capital expenditures, poor disseminating tactics, a labor shortage, inadequate baseline data, and inadequate maintenance services.

Majid et al., (2018): The study discovered that several problems exist, including inadequate market performance, insufficient information, unavailability of essential components for the potential utilization of renewable resources, and our everyday ecological impact. The report proposed several policy proposals and

actions that, if implemented, would aid in reducing emissions, mitigating climate change, and protecting a clean environment and energy for future generations to realize the aim of renewable energy.

Kumar & Pal, (2018): the study focuses on identifying and resolving challenges to renewable development, as well as making ideas for how to overcome them. The study discovered various hurdles to the growth of renewable energy in India.

Elavarasan et al., (2020): The study looked at the hurdles to growing renewable energy generation and policy. The study discovered several barriers to embracing renewable energy and developing strategies to grow the renewable energy sector. This study looked at a variety of renewable energy opportunities for the country in order to help academics, researchers, and policymakers understand the country's existing renewable energy landscape.

3. OBJECTIVES OF THE STUDY

- 1) To identify the opportunities of renewable energy for sustainable development.
- 2) To find barriers facing the development of renewable energy.
- 3) To make some recommendations for successful renewable energy planning in India.

4. RESEARCH METHODOLOGY

This research is descriptive. This study relies on secondary data sources such as online policy papers, publications, and research articles on renewable and green energy. This research paper examines the prospects and constraints to renewable energy in India's sustainable development, as well as potential recommendations for long-term renewable energy development. To achieve this goal, peer-reviewed publications were analysed and examined, and data was gathered from several authorized government sources. This analysis is based on an examination of secondary sources such as academic papers, government publications on renewable energy, green energy online policy documents, etc. The current article seeks to highlight hurdles and possibilities for expanding renewable energy in India.

5. DISCUSSION AND FINDINGS

According to the most recent Nationally Determined Contributions (NDC), India aims to achieve around 50 percent of total electric power installed capacity from non-fossil fuel-based energy resources by 2030. By the end of 2022, the nation had constructed 167.75 GW of renewable energy capacity. In addition, 78.75 GW of projects were in various stages of implementation, and 32.60 GW were out to bid. As per the REN21 Renewables 2022 Global Status Report, India has the fourth position globally concerning the installed capacity of renewable, wind, and solar power. A 2.20-fold growth in installed renewable energy capacity was seen from 76.37 GW in March 2014 to 167.75 GW in December 2022. From 2.63 GW in March 2014 to 63.30 GW in December 2022, the nation's total solar power capacity increased by 24.07.

5.1 OPPORTUNITIES OF RENEWABLE ENERGY FOR SUSTAINABLE DEVELOPMENT

There are several opportunities for India if the energy transition is accelerated. It can significantly lower national greenhouse gas emissions, boost energy security, and generate millions of new jobs. Currently employing 11.5 million people globally, the renewable energy sector is expected to grow by 24 million employments by 2030. By creating the world's most significant green workforce and producing a local supply of essential battery materials through recycling, India can lead by example in the fight against climate change on a national and worldwide scale.

- **Falling energy cost:** Falling energy costs create a tremendous opportunity for renewable energy growth. Renewable energy sources are becoming increasingly affordable relative to fossil fuels (Raina & Sinha, 2019). This competitiveness makes renewable energy more appealing to investors, businesses, and consumers, encouraging increased investment and deployment.
- **Improved energy security:** Renewable energy possesses the capacity to significantly broaden your energy sources to increase energy security sources, reducing reliance on imports, promoting local energy production, increasing resilience to climate change, ensuring long-term cost stability, and encouraging technological innovation and economic growth (Rathore & Panwar, 2022)
- **Great economic gain:** Renewable energy provides several economic benefits, including job development, investment, revenue production, and export potential. Countries may encourage

sustainable development, resilience, and a bright low-carbon future by capitalizing on the economic benefits of renewable energy (Rathore & Panwar, 2022).

- **Social and economic growth:** Renewable energy promotes social and economic progress by increasing energy access, reducing poverty, enhancing public health, boosting education and capacity building, empowering communities, spurring rural development, and encouraging inclusive growth. Countries may accomplish sustainable development goals, increase resilience, and create a more equal and affluent society by leveraging the economic and social advantage of renewable energy (Majid et al. 2018).
- **Energy accessibility:** Energy accessibility is a significant opportunity for renewable energy deployment because it allows for the delivery of clean, affordable, and sustainable energy services to underserved populations, promotes inclusive growth and development, and contributes to climate change mitigation and adaptation efforts (Hammond, 2010). Countries can accelerate progress towards universal energy access and achieve SDG 7 by leveraging renewable energy technologies and implementing supportive policies and financing mechanisms.
- **Reduce environmental health consequences and Mitigate climate change:** Renewable energy offers a significant opportunity to mitigate climate change, reduce environmental health consequences, and promotes sustainable development by replacing fossil fuel-based energy sources, improving air and water quality, conserving natural resources, reducing waste generation, and increasing climate resilience (Dey, 2022). Countries that accelerate the transition to renewable energy may reap numerous environmental, social, and economic advantages while tackling the pressing issues of climate change and ecological degradation.

5.2 BARRIERS FACING DEVELOPMENT OF RENEWABLE ENERGY IN INDIA

India's power intervention strategy has recently expanded to include assistance for renewable technology, and the government has resolved to utilize hitherto untapped renewable energy resources. The country has various barriers/obstacles when it comes to adding or expanding renewable capacity. The MNRE has been actively working to create a renewable environment. Its initiatives have been successful in discovering and establishing renewable climates, as well as locating various impediments. This section describes in detail the challenges to the growth of renewable technology. Several papers (e.g; Nesamalar, 2017; Raina & Sinha, 2019; Rathore & Panwar, 2022; Dey et al. 2022; Elavarasan, 2020; Kumar & Pal, 2022; Shukla et al.,2023) discuss the barriers.

5.2.1 Policy and regulatory barriers

- There needs to be a comprehensive policy statement regarding renewable technology in the country.
- Policies are in place to encourage the development of renewable technology.
- Future ambitions for renewable technologies are different from present policies.
- States need a solid policy structure.
- Investment in renewable technology requires more policy and regulatory clarity.
- Renewable energy requires a solid regulatory framework.

5.2.2 Institutional barriers

- To implement policies in India's renewable sector, increased coordination and collaboration across ministries, institutes, and organizations are necessary. Such gaps undermine investors' confidence in renewable energy projects.
- In most states, relevant organizations are failing to prepare pre-feasibility reports (PFRs).
- Insufficient or few institutions exist to guide workforce for new renewable infrastructure projects.
- Current organizations are also not functioning effectively to build renewable infrastructures.
- There aren't enough customer service centers to advise green initiatives, yet existing ones aren't easily accessible.

5.2.3 Economic barriers

- The budget for renewables development in India is not given on schedule.
- It does not follow the JNNSM scheme guidelines.
- Financing is a crucial concern when authorizing renewable initiatives.

- Renewable energy sources offer cheap running costs and no need for fuel but they need significant investment. As a result, the high capital cost may constitute an impediment to funding.
- Subsidies are not available for non-availability or cost reductions in renewable energy.

5.2.4 Market related barriers

- Renewable energy prices in India are inefficient.
- Renewable energy's high cost stems from the fact that it does not account for ecological expenses, despite the promotion of green energy.
- Current subsidy system essentially applies to conventional resources. As a result of an unjust subsidy arrangement in the electricity market, renewable energy costs more than conventional energy.
- Renewable energy development is hindered by challenges like as grid interconnection and limited infrastructure availability.
- The price of renewable equipment is precious. As a result, the cost of renewable energy is significantly higher.

5.2.5 Social barriers

- Conventional energy is more affordable than renewable energy, making renewable energy less accessible in society.
- Approximately 70% of India's population lives in villages. Villagers are unfamiliar with renewable energy methods.
- India is a populated country with a population density of 382 per square kilometer. As a result, meeting the need for abundant land for renewable energy is problematic.
- The Indian economy relies heavily on agriculture, with 60-70% of the people directly or indirectly involved. As a result, the majority of accessible land is used for this purpose, making land scarce.
- The general public in India is unaware of the environmental advantages of green energy technologies.

5.2.6 Environmental barriers:

- Renewable systems need a large amount of land and might cause soil erosion and drainage channel changes.
- Forest destruction is necessary to build a better renewable system, which demands a big land area. As a result, the renewable system has the potential to contribute to deforestation.
- Deforestation harms the environment. Trees absorb hazardous chemicals into the environment; therefore these pollutants are uninterested due to deforestation, resulting in increased global warming problems.
- Deforestation alters rainfall patterns, negatively impacting agriculture.

5.3 POLICY RECOMMENDATIONS TO OVERCOME THE BARRIERS

The following are policy recommendations to overcome the challenges.

- A strong policy framework is required for energy decision-making in various states, which may be accomplished by investing heavily in the most recent renewable energy technology.
- The government should prohibit or impose tight limits on reducing carbon footprints through lifestyle and behavior changes, which can help mitigate climate change.
- Developed countries should give technological assistance to emerging countries in expanding infrastructure to deliver green energy for industrial growth.
- The Indian government should prioritize investing in the grid and land infrastructure through legislation and initiatives.
- In India, geographic position can provide advantages for solar and wind energy, particularly in coastal areas with consistent wind flow.
- The energy department should focus on the cost of a GST reduction for renewable energy projects, which can lead to lower energy prices and make renewable energy more economical for utilities. Corporate funding has boosted consumer policy action.
- Rural regions in India should be provided with facilities for the production and application of biomass energy.

- Solar energy in states with more sunny days per year.
- The country's coastline territory offers significant potential for ocean energy development.

6. CONCLUSION

This article examines the prospects and constraints to the growth of renewable energy in India. The country's energy demand is increasing at an exponential pace as its population grows and its economy expands rapidly. Renewable capacity development faces unique challenges that must be overcome in order to meet future targets. The hurdles might be universal or exclusive to a few types of renewable energy. Better legislative and regulatory frameworks, accessible financial backing, and widespread knowledge are required to promote renewable energy. The need for sophisticated technology, as well as the cost of renewable goods, is potential barriers to renewable development. As a result, additional funds are necessary for research & development operations. The development of renewables decreases the pressure on fossil fuels and the natural system. Renewable energy penetration is expanding day by day, to the point where renewable energy will be adequate to meet future peak energy demands.

7. LIMITATIONS AND FUTURE SCOPE

The current study aims to address the obstacles that developing nations like India face while trying to produce renewable energy. Also, suggestions are made to address the challenges. Nonetheless, the barriers discussed and suggestions have yet to be fully implemented in other nations. Compared to India, industrialized nations use more renewable energy to generate power and possess advanced technological infrastructure. As such, renewable energy development faces few obstacles and is comparatively straightforward in these nations. In a similar vein, developing nations face more challenges to the advancement of renewable energy. Furthermore, the hurdles identified and recommendations made for the growth of renewable energy cannot be adopted by nations whose climate conditions differ from those of India.

The study's suggestions, challenges, and possibilities for the growth of renewable energy in India may apply to any comparable location in the world. Thus, this research may also be carried out to assist other nations in distributing renewable energy globally so that environmental issues, such as global warming, can be addressed. More obstacles still need to be removed before renewable energy may flourish in India. It is also possible to suggest some further measures to remove the barriers.

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