

REVISITING THE CHALLENGES AND OPPORTUNITIES FOR EMERGING GREEN FINANCE IN INDIA

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DOI

[10.29121/shodhkosh.v5.i6.2024.3868](https://doi.org/10.29121/shodhkosh.v5.i6.2024.3868)

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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ABSTRACT

India's energy sector is undergoing a significant transformation, with an increasing share of renewables aimed at achieving a target of 175 gigawatts by 2022. However, one of the main challenges is securing adequate financing, particularly given limited budgetary resources and difficulties in attracting private investment. This paper examines the financial hurdles faced in mobilizing capital for renewable energy in India, identifying key challenges such as short loan tenures, high capital costs, and insufficient debt financing, along with sector-specific issues. The article also highlights trends and opportunities in green finance, showcasing how innovative financing mechanisms can help overcome these barriers. Successful initiatives in several cities demonstrate that energy efficiency not only conserves resources but also enhances resilience to climate disruptions and reduces fossil fuel dependency. Collaboration among different government levels is essential; the national government can facilitate local efforts through targeted funding. The article emphasizes the importance of policy innovations, such as emission permits and improved monitoring systems, to foster sustainable urban development. It suggests that green taxes can incentivize environmentally friendly practices, while innovative procurement strategies can align fiscal responsibility with ecological goals. Additionally, the paper addresses the critical role of water management, as many cities face significant water stress. Ultimately, it offers actionable recommendations to navigate these pressing challenges in India's renewable energy landscape.

Keywords: Green Finance, Green Indices, Renewable Resources, Agriculture and Rural Activities, Green Investment, Green Practices and Green Instruments

1. INTRODUCTION

Green finance refers to financial activities, investments, and products that support sustainable environmental practices and the transition to a low-carbon economy. It focuses on funding initiatives that address environmental challenges like climate change, resource depletion, and pollution. These financial activities can include investments in renewable energy, energy efficiency, sustainable agriculture, clean technologies, and other projects that have positive environmental impacts. One example of green finance is green bonds, which are debt instruments issued to raise funds for projects that deliver environmental benefits. Sustainable investment funds focus on companies or projects with environmentally responsible practices. Carbon credit markets allow companies to buy and sell credits for reducing or offsetting carbon emissions. Green banking refers to financial institutions offering loans or financial products that support environmentally sustainable initiatives. Ultimately, green finance seeks to integrate environmental

considerations into the financial system to promote long-term, sustainable economic growth. Moreover, the climate change significantly impacts agriculture and rural development, with activities such as forestry, agriculture, and land use including dairy and renewable energy practices holding considerable potential for reducing greenhouse gas emissions. Recognizing the urgency of addressing natural resource management, NABARD organized a workshop titled "Opportunities in Green Finance," where various stakeholders discussed actionable strategies to enhance green finance initiatives.

The interplay between climate change and agriculture poses serious challenges to crop production and food security, with projections suggesting that by 2050, glaciers may disappear, leading to increased flooding and rising sea levels. Transitioning to a low-carbon, climate-resilient economy will require substantial investments over the next two decades, necessitating private capital on an unprecedented scale, especially given current government financial constraints. Government policies must support the commercialization of innovative technologies and address market failures through mechanisms such as carbon pricing. Public financing can also help mitigate risks for investors, including pension funds, in uncharted territories. Currently, while the central and state governments own a significant portion of conventional power generation capacity, the responsibility for developing renewable energy lies primarily with the private sector. This shift raises concerns about mobilizing sufficient, affordable financing to meet India's ambitious goal of achieving 175 GW of installed renewable energy capacity by 2022. Understanding where this financing will originate is crucial, particularly as private entities tend to be more cautious due to associated risks and uncertainties.

This paper critically analyzes the landscape of renewable energy financing in India, aiming to provide a detailed understanding of its structure and identify key barriers to mobilizing necessary funds. The following sections will outline the current energy mix and future projections for renewable energy in India, examine the financing structures and instruments available, discuss challenges and potential solutions, and conclude with insights on the path forward.

2. GREEN FINANCE INDICES

Green finance indices serve to identify and group companies with strong environmental performance in the green energy sector, based on various green criteria. These indices can provide benchmarks not only for the environmental performance of companies but also for the financial performance of low-carbon enterprises. They can be categorized into three main types.

2.1. RENEWABLE ENERGY PROCUREMENT MECHANISMS

Feed-in tariffs have emerged as the most effective policy mechanism for promoting renewable energy. By guaranteeing long-term contracts at fixed rates—typically spanning 10 to 20 years—these tariffs create a secure investment environment for clean energy producers. They have been instrumental in driving global solar photovoltaic and wind power deployment. In 2009, renewable energy accounted for just 2% of several countries' energy supply, falling short of the 15% target set for 2020. The transformation of the energy sector necessitated by initiatives like the New Green Deal requires collective action, with feed-in tariffs playing a critical role.

2.2. INNOVATIVE TECHNOLOGY

In the agricultural sector, innovations like improved jute ribboning machines enhance productivity. Harvesting jute at the right time is crucial, as over-matured stalks can hinder quality and yield. New ribboning machines have been designed to optimize this process, resulting in better quality jute at a slightly increased cost.

2.3. BARRIERS TO GREEN INVESTMENTS

Despite the availability of financing options, obstacles such as limited grid access can impede the growth of green energy. This paper focuses on financial, behavioral, and informational barriers rather than physical limitations. Key financial hurdles include current regulations, market practices, risk perceptions, and financial incentives. Although green investments are socially preferable, the real-world environment often favors traditional investments. Four primary factors influence the success of green investments:

- 1) Return on Green Investments:** Aim to increase these returns.

2) **Perceived Risk of Green Investments:** Work to reduce these risks.

3) **Return on Conventional Investments:** Seek to lower these returns.

4) **Perceived Risk of Conventional Investments:** Encourage market actors to recognize higher risks.

Poorly conceived investments, especially in fossil fuel projects, lead to an underestimation of price risks associated with dirty investments. This misalignment can result in excessive financial support for environmentally harmful projects.

Green Projects

Key green initiatives include:

- 1) Energy efficiency improvements and waste heat utilization.
- 2) Green housing projects focusing on rainwater harvesting, waste management, and eco-friendly materials.
- 3) Biomass energy projects utilizing resources like biogas and agricultural byproducts.
- 4) Development of biofertilizers and biopesticides.
- 5) Promotion of rural and eco-tourism.
- 6) Advances in jute retting technology.
- 7) Beekeeping initiatives.
- 8) Conservation-focused projects, such as prawn hatcheries and ornamental fisheries.

2.4. POLICY RECOMMENDATIONS FOR GREEN FINANCE

The effectiveness of policy frameworks often hinges on project scale—whether micro or macro. At the micro level, efforts should focus on talent development and organizational strengthening for green financial agencies. Innovative approaches to risk management and flexible operations are essential. Financial institutions must remain vigilant regarding policy changes that could impact green financing. On a macro level, countries like China exemplify effective green financing strategies. Ministries should foster collaboration to establish comprehensive operational guidelines and relevant regulations. To bridge the gap between green finance and credit, rational policies and incentives are crucial for promoting green finance development. Additionally, platforms should be created to minimize transaction costs and enhance environmental energy exchanges, often requiring intermediary services for successful project implementation.

2.5. ACCESSING GREEN INVESTMENTS

Institutional investors can engage with green investments through both traditional and alternative asset classes, including:

- **Equity:** Options include green equity indices, mutual funds, and ETFs.
- **Fixed-Income:** Green bonds, issued by governments, multinational banks, or corporations, provide capital for environmentally focused projects.

Green indices offer several advantages, such as:

- 1) **Diversification Potential:** Reducing risk by spreading investments.
- 2) **Quality Control:** Ensuring adherence to environmental standards.
- 3) **Screening Criteria:** Evaluating companies based on various green metrics.
- 4) **Aggregation:** Combining smaller green investments into larger opportunities.

2.6. GREEN BONDS

Establishing standardized criteria for project eligibility is crucial for green bonds. This includes defining minimum financial characteristics, such as size and rating, and applying rigorous governance and due diligence to facilitate the inclusion of green bonds in fixed-income indices.

3. REVIEW OF LITERATURE

Green finance is a rapidly evolving field within the financial sector that focuses on fostering investments aimed at addressing environmental issues, promoting sustainability, and contributing to the transition towards a low-carbon economy. As concerns over climate change, resource depletion, and biodiversity loss grow, financial instruments specifically designed to address these challenges are becoming more prominent. This review explores key green finance instruments, highlighting their roles in supporting sustainable projects, assessing their impact, and identifying challenges and opportunities in their implementation. The main green finance instruments discussed include green bonds, green investment funds, carbon markets, and sustainable banking.

In a recent study by Chen et al. (2022), the authors explored the impact of sustainable financing on financial institutions within Gulf Cooperation Council (GCC) member states. Their research, spanning from 2011 to 2021 and involving a large cohort of banks, revealed that banks could mitigate default risk by factoring in environmental considerations when extending loans. Particularly noteworthy was the finding that small banks stand to gain substantially from embracing responsible lending practices, as it not only opens up new revenue streams but also reduces risk exposure. The study underscores the potential of green finance in facilitating a sustainable recovery, with banks positioned as pivotal players in achieving sustainable development objectives. Moreover, it emphasizes the broader benefits accruable to the regulatory community, central banks, and the banking sector at large, as green finance holds promise for fostering financially robust and efficient economies.

Khairunnessa et al. (2021) examined the genesis of "Green Banking" in Bangladesh, shedding light on the pivotal role played by financial regulators in promoting environmental responsibility within the banking sector. Through an analysis of secondary data drawn from various sources including annual reports and websites of commercial banks, the study elucidated the proactive stance of the Bangladesh central bank in greening the country's financial landscape through the adoption of green policies and regulatory initiatives. Also, Ibe-Enwo et al. (2019) conducted a study on the effects of green banking practices on bank loyalty among retail banking customers in North Cyprus. Employing structural equation modeling techniques, the researchers found a direct correlation between banks' green reputations and their efforts towards promoting environmental sustainability. However, they observed no significant correlation between bank trust and loyalty, underscoring the distinct influence of green initiatives on customer behavior.

Park & Kim, (2020) provided an overarching perspective on the burgeoning green banking industry, highlighting its strategic advantages for private sector banks while also underscoring the increased responsibilities of central banks and regulators in ensuring financial system stability amidst this transition. Their study employed a theory of change conceptual framework to identify barriers to green banking adoption and propose potential solutions across institutional and sectoral levels. Additionally, Aruna Shantha's (2019) research delved into the factors influencing customers' adoption of green banking services at People's Bank of Sri Lanka. Through a structured questionnaire administered to 371 customers at the Kandy branch, the study revealed significant positive effects of green product awareness, perceived benefits, and privacy/security considerations on customers' choices. Conversely, factors like trust in green products had a significant negative impact on adoption.

Sahoo et al. (2016) emphasized the distinctiveness of green banking in contrast to conventional banking, emphasizing its focus on environmental betterment. Their study investigated the usage patterns of green banking products across different age groups, revealing a greater propensity among young individuals compared to middle-aged and older cohorts, highlighting the need for targeted awareness campaigns. Moreover, Tok, Y. W., & Heng, D. (2022) this study delves into the significance of Fintech in promoting financial inclusion. Utilizing data from the Global Findex and emerging fintech indicators, we observe a stronger positive relationship between Fintech and digital financial inclusion compared to conventional measures of financial inclusion. In the subsequent phase of our analysis, we explore the primary factors associated with the digital divide as delineated by the Fletcher School, including the gender, class (rich-poor), and rural divides.

Anifa, M., Ramakrishnan, S., Joghee, S., Kabiraj, S., & Bishnoi, M. M. (2022) focused on fintech innovations in payments and financing has witnessed significant growth and interest globally from 2014 to 2022. This systematic review aims to contribute to the understanding of the correlation between fintech innovations and regulatory frameworks in fostering a fair ecosystem within the financial services industry. Through an analysis of peer-reviewed journal articles explores the theoretical underpinnings of fintech innovations and their implications for the future of business. By synthesizing

existing research, shed light on the pivotal role that fintech plays in shaping the landscape of financial services and underscores the importance of regulatory frameworks in ensuring a balanced and equitable ecosystem for all stakeholders involved.

Fahmi, N. A., Yustika, B. R., & Shabur, U. (2024) conducted quantitative analysis to assess the impact of various financial variables on Fintech, incorporating factors such as Capital Adequacy Ratio (CAR), Gross Non-Performing Loans (NPL), Net Interest Margin (NIM), Return on Assets (ROA), Return on Equity (ROE), Operating Expense to Operating Income (BOPO), and Loans. Control factors, pertinent to the Fintech context, encompass the deposit ratio (LDR), gross domestic product (GDP), and inflation. The findings reveal that certain financial indicators—specifically CAR, NPL, gross, ROA, ROE, and NIM—do not exhibit a statistically significant influence on Fintech. Conversely, Fintech is notably influenced by other indicators such as BOPO and LDR, alongside control variables including GDP and inflation.

3.1. GREEN BONDS

Green bonds are one of the most prominent and widely used green finance instruments. These are debt securities issued by governments, corporations, or financial institutions with the specific aim of financing projects that have positive environmental benefits. Green bonds provide investors with a way to contribute to environmental goals while earning a return on their investment (Flammer, 2021). The defining characteristic of green bonds is their use of proceeds to fund projects that support climate change mitigation, renewable energy, energy efficiency, sustainable land use, and pollution reduction. One of the key advantages of green bonds is their ability to attract a broad range of investors, including those who prioritize environmental, social, and governance (ESG) criteria in their investment strategies (Barber, 2020). The market for green bonds has grown exponentially in recent years, with a significant increase in both the volume of bonds issued and the diversity of sectors involved (Mikheeva, 2021). Despite this growth, challenges such as lack of standardization in defining what constitutes a "green" project, concerns about "greenwashing," and the need for improved transparency and reporting mechanisms remain.

3.2. GREEN INVESTMENT FUNDS

Green investment funds are another key instrument in green finance. These funds pool capital from investors to invest in companies, projects, or initiatives that align with sustainability goals. Green investment funds focus on sectors like renewable energy, energy efficiency, and sustainable agriculture, and aim to generate both financial returns and positive environmental outcomes. A key distinction between green investment funds and traditional funds is the emphasis on ESG criteria, with managers selecting assets based not only on financial performance but also on their environmental impact (Kotsantonis, 2020). The growth of green investment funds has been driven by increasing investor demand for socially responsible investment opportunities. Studies have shown that green investment funds can provide competitive returns while also achieving substantial environmental benefits (Peiró-Palomino, 2021). However, the development of green investment funds also faces challenges such as the lack of a standardized classification system for green investments, which can lead to inconsistent reporting and difficulties in assessing the true environmental impact of fund portfolios (Gianfrate & Peri, 2020). Additionally, while demand for such funds is increasing, there is still a need for more robust data on the financial performance of green investments.

3.3. CARBON MARKETS

Carbon markets are designed to incentivize the reduction of greenhouse gas emissions by allowing companies or governments to buy and sell emission allowances or credits. These markets can be cap-and-trade systems or carbon offset mechanisms, where the goal is to create a financial incentive for emission reductions and investments in low-carbon technologies (Glenk & Rehdez, 2020). In cap-and-trade systems, a regulatory body sets a cap on total emissions and allocates allowances to entities, which can then trade these allowances in the market. Alternatively, in carbon offset mechanisms, companies or governments can purchase carbon credits to offset their emissions by investing in projects that reduce or capture carbon elsewhere, such as reforestation or renewable energy projects. Carbon markets have grown as a key tool in the global effort to meet climate targets, particularly under international agreements such as the Paris Agreement. However, the effectiveness of carbon markets has been questioned due to issues related to market volatility, lack of a global price on carbon, and concerns about the real environmental impact of some offset projects

(Michaelowa & Schenuit, 2021). Nevertheless, carbon markets offer potential for scaling up climate finance by creating financial incentives for emissions reductions and by channeling resources toward projects that promote sustainable development.

3.4. SUSTAINABLE BANKING AND LENDING

Sustainable banking and lending practices are essential green finance instruments that enable financial institutions to support environmentally friendly projects. This includes providing loans, financing, and other forms of credit to projects that meet environmental sustainability criteria. The role of banks in green finance is expanding, with many banks now offering green loans and sustainable investment products as part of their portfolios (Scholtens, 2021). These institutions are also increasingly incorporating ESG factors into their lending criteria, which encourages borrowers to adopt more sustainable practices. Green loans typically finance projects like energy-efficient buildings, renewable energy infrastructure, and sustainable agriculture practices. These loans often come with favorable terms to encourage borrowers to pursue environmentally responsible investments. One of the main challenges in sustainable banking is the lack of standardization in ESG reporting and the need for reliable environmental data to assess the impact of projects (Ehlers & Packer, 2017). Despite these challenges, sustainable banking is likely to continue growing as financial institutions recognize the importance of managing environmental risks and seizing new opportunities in the green economy.

3.5. CHALLENGES AND OPPORTUNITIES

While the potential of green finance instruments is immense, several challenges must be addressed to fully unlock their impact. One major challenge is the lack of standardized definitions and metrics for determining what constitutes a "green" project or investment. This lack of clarity can lead to inconsistencies in the application of green finance principles and allow for "greenwashing," where projects are marketed as environmentally friendly without delivering significant benefits (Gianfrate & Peri, 2020). Establishing standardized definitions, reporting guidelines, and third-party verification systems will be crucial for ensuring the credibility of green finance instruments. Another challenge is the need for better data and transparency regarding the environmental impact of green investments. Investors and regulators require more robust data on the outcomes of green finance initiatives to assess their true effectiveness. Transparent reporting and monitoring systems will be essential for improving the accountability and integrity of green finance markets (Barber, 2020). Despite these challenges, green finance presents significant opportunities. As the global push for sustainability intensifies, green finance instruments offer a way for investors to contribute to climate action while also achieving financial returns. The continued development of green finance markets could help accelerate the transition to a low-carbon economy, create new job opportunities, and drive innovation in sustainable technologies and practices.

Green finance instruments are essential tools for promoting environmental sustainability and addressing the challenges of climate change. Instruments such as green bonds, green investment funds, carbon markets, and sustainable banking provide opportunities for investors, financial institutions, and governments to align their financial activities with sustainability goals. While challenges remain, particularly in terms of standardization, data transparency, and market efficiency, the growth of green finance represents a promising pathway for financing the transition to a more sustainable global economy.

4. RESEARCH METHODOLOGY

The study of green finance instruments requires a well-defined and systematic research methodology that ensures the collection of reliable data, enables an understanding of the effectiveness of various green finance instruments, and allows the researcher to analyze how these instruments support environmental sustainability. This research methodology would typically follow a structured approach consisting of several key steps: identifying research objectives, selecting appropriate research design, choosing data collection methods, and determining data analysis techniques.

4.1. RESEARCH OBJECTIVES AND PROBLEM STATEMENT

The first step in studying green finance instruments is to clearly define the research objectives. These objectives should address specific aspects of green finance instruments, such as their effectiveness in funding sustainable projects, the challenges, and opportunities they present, and their impact on environmental and financial markets. Examples of research questions could include:

- How do green bonds and green investment funds contribute to environmental sustainability?
- What are the barriers to the widespread adoption of carbon markets as a tool for reducing emissions?
- How do financial institutions integrate environmental, social, and governance (ESG) criteria into lending practices?

By setting clear objectives, the researcher ensures the study remains focused and relevant to the field of green finance.

Research type: Descriptive Research: Descriptive research is a type of research method aimed at providing an accurate portrayal or snapshot of a situation, event, or phenomenon as it exists naturally, without influencing or manipulating the environment. The primary goal of descriptive research is to describe the characteristics of a subject or phenomenon, offering detailed insights into its aspects. Unlike experimental research, which focuses on cause-and-effect relationships, descriptive research merely seeks to observe, describe, and document what is occurring. In descriptive research, the researcher does not intervene or change variables but instead collects data to gain a deeper understanding of the subject.

4.2. RESEARCH DESIGN

Research design: After formulating the research problem, Researcher worked out on preparing the research design. It has prepared a design so that maximum information is collected. The Researcher has managed data collection with the optimum time, effort, and expenditure utilization. While preparing a research design suitable for a research problem, Researcher has considered. The research design outlines the approach and methods used to address the research questions. In the context of green finance, a mixed-methods design could be an appropriate choice. This would allow the researcher to combine quantitative data (such as financial performance indicators, investment volumes, etc.) and qualitative data (such as interviews, case studies, and expert opinions) to gain a comprehensive understanding of green finance instruments.

There are three primary types of research designs that could be applicable to studying green finance instruments:

- **Descriptive Research Design:** This design is used to describe and analyze the characteristics, trends, and developments of green finance instruments. It involves gathering and analyzing data to document how various instruments, such as green bonds or carbon markets, are implemented and their outcomes.
- **Exploratory Research Design:** This design helps to explore new or under-researched areas in green finance, particularly in understanding the potential of emerging green finance instruments and their adoption across various sectors.

Comparative Research Design: This design allows for the comparison of different green finance instruments, such as comparing green bonds with conventional bonds in terms of their effectiveness in financing environmental projects.

4.3. DATA COLLECTION METHODS

The choice of data collection methods is critical for obtaining relevant and reliable information about green finance instruments. Some effective methods for collecting data in this area include:

- **Surveys and Questionnaires:** Surveys can be distributed to investors, financial professionals, or stakeholders involved in green finance, asking them to assess the effectiveness, challenges, and opportunities of green finance instruments. These instruments can be designed to collect both quantitative data (such as the amount invested in green bonds or the return on investment) and qualitative data (such as opinions on the perceived success of carbon offset programs).

- **Interviews and Expert Consultations:** In-depth interviews with key stakeholders—such as policymakers, green bond issuers, financial analysts, and environmental experts—can provide valuable insights into the practical challenges and opportunities associated with green finance instruments. Interviews allow the researcher to explore participants' views, experiences, and recommendations.
- **Case Studies:** Case studies of specific green finance initiatives or projects, such as a successful green bond issuance or a large-scale renewable energy project funded through green finance, can provide detailed, context-rich insights into how green finance instruments are used in practice and the outcomes they produce.
- **Secondary Data:** Gathering secondary data from existing reports, academic articles, and financial databases can help provide context for the study. This could include analyzing trends in green bond issuance, tracking the performance of green investment funds, or reviewing the development of carbon markets over time.

4.4. SAMPLING TECHNIQUES

For studies involving surveys or interviews, the choice of sampling method is essential to ensure that the sample is representative and can provide meaningful insights. Some common sampling methods include:

- **Random Sampling:** If the research aims to understand general trends or attitudes towards green finance, random sampling of a large population of investors or financial institutions might be appropriate. This method helps ensure that the sample is representative of the broader population.
- **Purposive Sampling:** If the research focuses on a specific subset of stakeholders, such as green bond issuers or sustainable banking institutions, purposive sampling would be used to select individuals or organizations with relevant expertise or experience in the field of green finance.
- **Stratified Sampling:** If the research involves comparing different categories of green finance instruments (e.g., comparing the effectiveness of green bonds in different industries), stratified sampling allow for the segmentation of the sample into relevant subgroups.

4.5. DATA ANALYSIS TECHNIQUES

Once data is collected, various data analysis techniques can be applied to interpret the findings. The choice of analysis method depends on the nature of the data and the research objectives.

- **Quantitative Data Analysis:** For numerical data, such as financial performance data from green bonds or carbon credit transactions, statistical analysis techniques such as regression analysis, correlation analysis, or descriptive statistics can be used. This will help quantify the relationships between green finance instruments and various outcomes, such as environmental impact or financial returns.
- **Qualitative Data Analysis:** For qualitative data gathered from interviews, case studies, or open-ended survey responses, thematic analysis or content analysis can be used to identify key themes, patterns, and insights. This helps in understanding the broader implications of green finance instruments and the perspectives of stakeholders involved in their implementation.

The research methodology for studying green finance instruments should be carefully structured to ensure that it addresses both the practical and theoretical aspects of these instruments. By employing a mixed-methods approach that combines quantitative and qualitative data, researchers can provide valuable insights into how green finance instruments contribute to sustainable development and the challenges that need to be overcome for their widespread adoption. Proper data collection, sampling, and analysis techniques will ensure the reliability and validity of the study, allowing researchers to make meaningful contributions to the field of green finance.

5. ANALYSIS AND FINDINGS

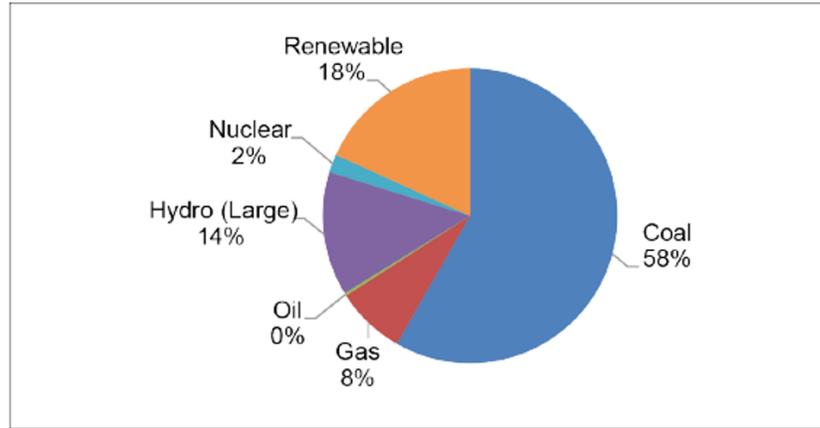
The development of renewable energy in India can be traced back to the global oil crisis of the late 1980s. Since then, the Indian government has made consistent efforts to advance the renewable energy sector through a range of strategic policies and regulatory frameworks. With energy recognized as a concurrent subject in the Constitution specifically, entry 38 in the concurrent list both the central and state governments periodically formulate initiatives aimed at

expanding this sector. A significant recent push towards a greener energy future is evident in the Government of India's ambitious goal of achieving 175 GW of renewable energy capacity by 2022. Solar power has been prioritized through initiatives like the Jawaharlal Nehru National Solar Mission (JNNSM), underscoring its importance in the renewable energy landscape. Other policy efforts, such as ensuring 24/7 electricity availability nationwide by 2019, reflect a strong commitment to renewable sources. This commitment is further emphasized by India's climate pledges made to the UN Framework Convention on Climate Change (UNFCCC), including the Intended Nationally Determined Contributions (INDCs). The goal of deriving 40% of the country's energy from renewable sources by 2040 highlights the government's priorities in energy policy.

5.1. ENERGY PORTFOLIO ANALYSIS

Additionally, the current energy mix in India illustrates this evolving focus, showing an increasing share of renewable energy in the overall energy portfolio. The installed capacity by source is depicted in Figure 1.

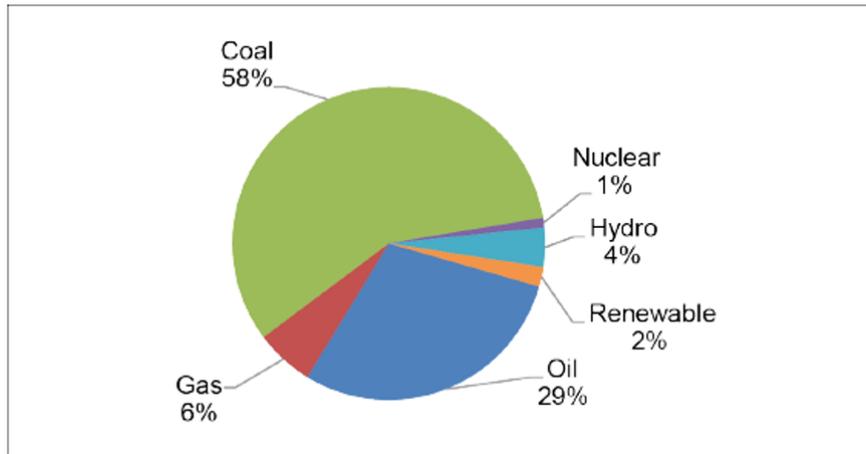
Figure1 Installed Source Capacity



(Source: CEA, 2023)

The data presented in the figure clearly indicates that India's renewable energy generation capacity has reached a significant milestone, accounting for approximately 18% of the total capacity, which translates to around 57,245 MW. A closer look at this installed capacity reveals that wind energy constitutes over 50% of the total, while solar energy represents about 20%. The remainder is made up of small hydro, biomass, and waste-to-energy sources. Notably, recent trends show that solar power is increasingly dominating the renewable energy sector.

Figure2 Primary Energy Consumption in India



(Source: CEA 2023)

However, an analysis of primary energy consumption reveals a different story, highlighting a continued dependence on biofuels and oil products (see Figure 2). This indicates that rural India still relies heavily on fossil fuels for its primary

energy needs. Consequently, it is evident that India has significant progress to make in achieving a comprehensive energy transformation.

5.2. POWER GENERATION CAPACITY

The most significant projections come from the International Energy Agency (IEA) in its New Policy Scenario (IEA 2015). According to this scenario, India's electricity generation capacity is expected to increase more than threefold by 2040, with a compound annual growth rate of approximately 7%. Detailed projections from the IEA under this scenario can be found in Table 1 below.

**Table 1: Power Generation Capacity by Type in India
in the New Policies Scenario
(GW)**

	2014	2020	2030	2040	Shares (%)		CAAGR*
					2014	2040	2014–2040
Fossil fuels	204	280	419	576	71	53	4.1
Coal	174	230	329	438	60	41	3.6
Gas	23	41	76	122	8	11	6.6
oil	7	9	13	15	3	1	2.9
Nuclear	6	10	24	39	2	4	7.6
Renewables	79	147	304	462	27	43	7
Hydro	45	58	83	108	15	10	3.5
Wind	23	50	102	142	8	13	7.2
Solar PV	3	28	100	182	1	17	16.4
Other	7	11	18	30	3	3	5.5
Total	289	436	746	1076	100	100	5.2

* Compound average annual growth rate.

Source: IEA (2015).

5.3. ANALYSIS OF CHALLENGES

Financing renewable energy in India faces numerous challenges closely tied to the industry's structure and investment dynamics. These challenges are largely influenced by the types of financial instruments available and investor sentiment. The capital-intensive nature of the renewable energy sector, combined with its reliance on private sector development, makes attracting the necessary investments a significant hurdle. Despite the introduction of various innovative financing tools over the years, securing sufficient funding at favorable rates remains difficult (CPI 2012). Labor and construction costs in India are notably lower, and there has been a recent substantial decline in renewable energy prices, particularly for solar and wind (Taghizadeh-Hesary et al., 2018). This section aims to outline key challenges and suggest potential solutions.

5.3.1. INSTITUTIONAL AND POLICY CHALLENGES

A major issue stems from the constitutional designation of energy as a concurrent subject, necessitating effective coordination between the central and state governments to mobilize financing. The political landscape complicates this coordination, resulting in inconsistent policy pronouncements from state electricity regulatory commissions (SERCs). The establishment of renewable purchase obligations (RPOs) can seem illogical, as energy investment responsibilities are shared between different governmental levels. This fragmentation creates a perception of India as multiple distinct markets rather than a unified one, deterring both domestic and foreign investors (GoI 2015a). Additionally, the uneven distribution of renewable resources across regions exacerbates market segmentation, leading to varied risks and barriers. To address some of these challenges, certain states, like Tamil Nadu and Andhra Pradesh, have implemented single-window clearance facilities to expedite project approvals. By designating solar energy zones and parks, these states aim to attract investors, a model that could be replicated elsewhere to streamline the investment process.

5.3.2. INTEGRATING RENEWABLE ENERGY INTO THE POWER SECTOR FRAMEWORK

The financing obstacles are partly due to renewable energy being perceived as just another component of the broader power sector. Traditional energy projects often overshadow renewables in attracting loans, with fossil fuel investments significantly outpacing those in green energy (GoI 2015a). Conventional projects are more appealing to investors due to their established track records, while the renewable sector struggles to build similar confidence.

Moreover, the banking sector's exposure to traditional energy sources is nearing the 15% lending cap imposed by the Reserve Bank of India (RBI 2015), complicating the provision of additional financing. The financial health of distribution companies and their varying balance sheets also contribute to the reluctance of banks to lend to renewable projects. Efforts are being made to rectify some of these risks, such as the Ujwal Discom Assurance Yojana (UDAY) initiative aimed at improving the financial stability of the sector. However, continuous reforms are essential to enhance the creditworthiness of distribution companies and recognize renewable energy as a distinct sector within the banking framework.

5.3.3. SHORT LOAN TERMS AND HIGH INTEREST RATES

India remains one of the costliest destinations for renewable energy investment, primarily due to high borrowing costs. Reports indicate a significant disparity in interest rates between India and other nations, stemming from high rates, short loan tenures, and limited availability of non-recourse financing (CPI 2012; Bridge to India 2013; CEEW 2016). For instance, solar projects often face exorbitant interest rates around 13% (Bridge to India, 2013). The preference for fixed interest rates over variable ones also complicates financing, as does the common practice of offering loans for only up to eight years, while renewable projects typically require 12 to 15 years to be financially viable (CPI 2012; Mytrah and PwC 2015). This mismatch is rooted in the short maturity of bank deposits and has led to cautious lending practices regarding renewable energy projects. Limited access to non-recourse financing is a significant barrier for new entrants into the renewable sector (Mytrah and PwC 2015). Additionally, the ability of banks to lend is often contingent on the source of equity financing, making them hesitant to provide loans when equity is sourced from third-party investors.

5.3.4. RISK FACTORS AND UNCERTAINTIES

Numerous risks affect renewable energy financing in India, including regulatory, technological, and market-related uncertainties. The interplay between renewable energy and the broader power sector introduces significant regulatory risks, such as the non-compliance of RPOs and uncertainties regarding renewable energy certificates (RECs). The lack of standardized processes for project development further complicates matters, as approaches vary across states, creating additional hurdles for investors. The nascent state of the renewable energy sector contributes to perceived risks, as investors lack historical performance data. This information asymmetry heightens the perceived risks associated with financing, leading to increased capital costs (Diacore 2016). Furthermore, new financing instruments like green bonds depend on investor confidence, which is often lacking in developing markets. Technological risks are prevalent due to the rapidly evolving nature of renewable energy technologies, such as solar and wind. Concerns about asset obsolescence and the quality of renewable energy equipment further limit investor comfort. Additionally, inadequate infrastructure for power generation and transmission can deter investments, particularly from foreign entities. Land acquisition challenges pose another significant risk. The new land acquisition law introduced in 2013 has made obtaining land for projects more complex, requiring consent from a significant majority of affected families. This complexity not only affects project development but also pre-development activities, such as setting up anemometry masts. Lastly, fluctuations in the foreign exchange market create additional risks, hindering international investment. While policies such as dollar tariff mechanisms with currency hedging have been introduced, they are still perceived as insufficient (Nelson and Shirmali 2014). To mitigate these risks, public financing support in high-risk areas is essential. Improved coordination between central and state governments can help reduce transaction costs for potential investors. Given the positive externalities generated by renewable energy, mobilizing public finance to address risks is crucial.

5.3.5. INEFFICIENT LONG-TERM FINANCING STRUCTURES

The organization of long-term financing remains inadequate for meeting the sector's needs. The domestic bond market is still underdeveloped, with a tendency for investors to gravitate toward low-risk, high-rated bonds, such as government securities. This preference limits the renewable energy sector's ability to establish its creditworthiness and attract necessary investment. Furthermore, the share of long-term financing from insurance and pension funds constitutes only a small portion of overall household savings (CEEW 2016). Non-banking financial institutions also face constraints in providing adequate financing. Corporate bond markets have yet to evolve, with long-term investors like insurance and pension funds often sidelined due to strict rating thresholds (Mytrah and PwC 2015). The renewable energy sector faces a multitude of risks, many of which can be mitigated through targeted government intervention. Stakeholder feedback from a survey conducted by NITI Aayog suggests that public sector engagement can be transformative. Potential government actions include offering loan guarantees, underwriting loan repayments, socializing transmission costs, enforcing existing regulations, and facilitating foreign investments by mitigating currency risks. By proactively addressing challenges in project development, such as land acquisition and necessary permissions, through initiatives like single-window facilities or Special Purpose Vehicles (SPVs), the government can streamline processes. Ongoing reforms in the power sector are crucial for reducing market-related risks associated with the financial health of distribution companies and improving overall investment conditions in the renewable energy sector.

6. CONCLUSION

This assessment highlights that financing renewable energy in India is mired in complex challenges. Key issues include short loan tenures, high capital costs, and insufficient debt financing, which are compounded by the sector's unique technological requirements and operational dynamics. Additionally, inconsistencies in policy and regulatory frameworks, along with inadequate support infrastructure like land, further hinder financing efforts. While innovative mechanisms such as green banks, green bonds, and crowdfunding have made some headway, much more needs to be accomplished to meet the ambitious goal of generating 175 GW of renewable energy by 2022. It is crucial for the government to adopt a facilitative role by implementing innovative policy measures that not only introduce financing instruments but also create a supportive environment that mitigates associated risks. Collaborative efforts among stakeholders, including government entities, financial institutions, investors, industry groups, and research organizations, can significantly reduce risks and enhance the effectiveness of financing initiatives. To lower transaction costs and improve transparency in approval systems, further regulatory reforms are necessary. Enhancing access to reliable technological data and fostering continuous regulatory and tariff reforms will create a more conducive ecosystem for financing renewable energy projects. Additionally, raising awareness about green finance among various stakeholders, including businesses and local governments, is essential for promoting the adoption of sustainable financial practices. Despite these challenges, opportunities for green finance in India are abundant. Government initiatives, such as the National Action Plan on Climate Change (NAPCC), provide incentives for renewable energy development. The growing interest from the private sector in financing green projects, particularly through instruments like green bonds, presents new avenues for capital raising. Moreover, India's advancements in renewable energy technology and energy efficiency can help lower costs and risks associated with green finance. International collaboration also holds promise for attracting necessary capital and expertise. Engagement with multilateral development banks, climate funds, and foreign investors can provide vital resources to tackle environmental challenges. In summary, while the path for green finance in India is fraught with challenges related to regulatory frameworks, costs, and capacity, the potential for substantial growth exists. By fostering collaboration among government, private sectors, and international partners, green finance can play a crucial role in advancing India's sustainable development goals and facilitating the transition to a more sustainable future.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None

REFERENCES

- Anifa, M., Ramakrishnan, S., Joghee, S., Kabiraj, S., & Bishnoi, M. M. (2022). Fintech innovations in the financial service industry. *Journal of Risk and Financial Management*, 15(7), 287.
- Aruna Shantha, A. (2019). Customer's Intention to Use Green Banking Products: Evidence from Sri Lanka. *International Journal of Scientific and Research Publications (IJSRP)*, 9(6), p9029.
- Barber, R. (2020). Green bonds and the future of sustainable finance. *Journal of Sustainable Finance & Investment*, 10(4), 256-272.
- Ehlers, T., & Packer, F. (2017). Green bond finance and certification. *BIS Quarterly Review*, 1-16.
- Fahmi, N. A., Yustika, B. R., & Shabur, U. (2024). Impact of Financial Technology Firms on Banking Performance: Insights from Indonesia. *Journal of Economics, Bussiness and Management Issues*, 2(1), 86-93.
- Flammer, C. (2021). Green bonds: Effectiveness and implications for future research. *Journal of Applied Corporate Finance*, 33(1), 60-75.
- Gianfrate, G., & Peri, M. (2020). Green finance and investment: A critical review. *Sustainability*, 12(11), 4618.
- Glenk, K., & Rehdanz, K. (2020). Carbon pricing and green finance in practice: An overview of market mechanisms. *Environmental Economics and Policy Studies*, 22(1), 1-17.
- Ibe-Enwo, Igbudu, Garanti, & Popoola. (2019). Assessing the Relevance of Green Banking Practice on Bank Loyalty: The Mediating Effect of Green Image and Bank Trust. *Sustainability*, 11(17), 4651.
- Khairunnessa, F., Vazquez-Brust, D. A., & Yakovleva, N. (2021). A Review of the Recent Developments of Green Banking in Bangladesh. *Sustainability*, 13(4), 1904.
- Kotsantonis, S. (2020). The evolution of sustainable investment funds: A global perspective. *Journal of Sustainable Finance & Investment*, 13(2), 115-130.
- Kumar, J., & Rani, V. (2024). Investigating the dynamics of FinTech adoption: an empirical study from the perspective of mobile banking. *Journal of Economic and Administrative Sciences*.
- Lagna, A., & Ravishankar, M. N. (2022). Making the world a better place with fintech research. *Information Systems Journal*, 32(1), 61-102.
- Leong, K., & Sung, A. (2018). FinTech (Financial Technology): what is it and how to use technologies to create business value in fintech way?. *International Journal of Innovation, Management and Technology*, 9(2), 74-78.
- Madrado-Lemarroy, P., Márquez-Illescas, G., & Moya-Ponce, C. (2024). Cognitive wealth and fintech startup formation: an entrepreneurial absorptive capacity analysis in well-regulated environments. *Journal of International Entrepreneurship*, 1-44.
- Michaelowa, A., & Schenuit, F. (2021). Carbon markets and climate finance: Challenges and opportunities. *Climate Policy*, 21(6), 807-825.
- Mikheeva, A. (2021). Green bonds: A promising tool for sustainable finance. *International Journal of Green Economics*, 15(3), 207-220.
- Park, H., & Kim, J. D. (2020). Transition towards green banking: role of financial regulators and financial institutions. *Asian Journal of Sustainability and Social Responsibility*, 5(1), 5.
- Peiró-Palomino, J. (2021). Financial performance of green investment funds: Evidence from Europe. *Journal of Business Ethics*, 178(3), 609-629.
- Sahoo, B. P., Singh, A., & Jain, N. (2016). GREEN BANKING IN INDIA: PROBLEMS AND PROSPECTS. *International Journal of Research -GRANTHAALAYAH*, 4(8), 92-99.
- Scholtens, B. (2021). Sustainable banking and lending: The role of financial institutions in green finance. *Banking and Finance Review*, 19(1), 1-22.
- Schueffel, P. (2016). Taming the beast: A scientific definition of fintech. *Journal of Innovation Management*, 4(4), 32-54.
- Sreeshavittala, D. (2024). A Study on UPI Adoption among Marchant Outlets in Kalyana Karnataka. *SOUTH INDIA JOURNAL OF SOCIAL SCIENCES*, 22(1), 28-38.
- Tariq, A., & Hassan, A. (2023). Role of green finance, environmental regulations, and economic development in the transition towards a sustainable environment. *Journal of Cleaner Production*, 413, 137425.
- Tok, Y. W., & Heng, D. (2022). Fintech: Financial inclusion or exclusion?. *International Monetary Fund*.
- Udeagha, M. C., & Muchapondwa, E. (2023). Green finance, fintech, and environmental sustainability: fresh policy insights from the BRICS nations. *International Journal of Sustainable Development & World Ecology*, 30(6), 633-649.
- Vives, X. (2017). The impact of FinTech on banking. *European Economy*, (2), 97-105.

- Wang, L. (2024). Can Fintech Reduce the Cost of Corporate Debt Financing?--Evidence from Chinese Listed Companies. *Transactions on Economics, Business and Management Research*, 5, 172-179.
- Xiong, Y., & Dai, L. (2023). Does green finance investment impact on sustainable development: Role of technological innovation and renewable energy. *Renewable Energy*, 214, 342-349.