



Green Finance for a Carbon-Neutral India: Opportunities, Challenges and Accelerating the Transition

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Abstract

Green financing is crucial for India's transition to a low-carbon economy, given its significant carbon footprint due to a large economy and population of over 1.42 billion. With ambitious targets to reduce greenhouse gas emissions, India's Nationally Determined Contribution under the Paris Agreement aims to decrease its carbon intensity by 33-35 percent by 2030 compared to 2005 levels. Achieving carbon neutrality will require substantial changes in the energy, transportation, and industrial sectors, necessitating a surge in green finance and investment. This paper explore the role of green finance in India's low-carbon transition, focusing on three key aspects: understanding the relevance of green finance in reaching India's climate targets and transitioning to a low-carbon economy; assessing the efficacy of present green finance instruments and programs in India; and identifying the barriers and challenges preventing the widespread acceptance of green finance in the country. Through a conceptual analysis of green finance and its role in achieving carbon neutrality, this study examines the opportunities and challenges associated with this transition, utilizing secondary sources such as SEBI, Climate Bond Initiatives, and GRIHA over the past six years. The study also tabulates initiatives taken by government, public, and private stakeholders to promote the development of green finance in India.

Key Words: *Green Finance, Sustainable Development, low-carbon economy*

I. Introduction

a) India Climate goals and requirement for green finance

As a means of responding to the imperative for sustainable development, India has created bold climate targets consistent with the commitment made at Paris. This includes reducing greenhouse gas emissions intensity of its GDP by 33-35% below 2005 levels by 2030, and making 50% of its power from non-fossil fuel sources. For it to effectively meet these targets, integration of green finance is absolutely essential. This not only sets out to mobilize investments in renewable energy but also encourages innovation in green technology (John C Shideler et al., 2021). However, this transition to a carbon-neutral future would require a significant investment estimated at \$2.5 trillion between now and 2030 (John C Shideler et al., 2021). Without proper green financing mechanisms, India will not be able to achieve its climate commitments, and both public and private stakeholders must play their role in facilitating this financial flow to mitigate environmental degradation and foster sustainable economic growth.

b) Significance of carbon neutrality

The pursuit of carbon-neutrality marks a vital milestone in mitigating climate change-a factor threatening not only the environmental but also the human form of sustainability. Achieving this milestone, therefore is an ethical necessity-it is in fact an essential driver of economy and society, at least for the developing nations of the world. The imperative nature of the challenge can be illustrated in the pressing necessity for frameworks to facilitate financial transactions as a path towards sustainable development. As noted in recent literature, there is a need for governments and the private sector to collaborate in overcoming the challenges of carbon neutrality, such as insufficient technology and funding gaps (Zhang et al., 2023). In addition, integrating environmental, social, and governance considerations into financial practices can be used to unlock investment in sustainable aviation and infrastructure; hence, the potential of green finance to help transform the economy of India(Hooda et al., 2023). Finally, carbon-neutrality shall always be marked by the big challenge of ensuring that the future is sustainable.

II. Literature Review

Beyond environmental concerns, attaining carbon neutrality is inextricably tied to the robustness of economies and societies, especially in developing nations like India. The recent literature underlines the need for multi-stakeholder engagement between governments and the private sector to overcome challenges such as inadequate technology and funding gaps to achieve carbon neutrality (Zhang et al., 2023).

Green finance instruments and initiatives have played a pivotal role in India's journey towards carbon neutrality. The Solar Parks Scheme has facilitated the large-scale deployment of solar energy by reducing the investment cost and increasing access to energy. Green bonds have also gained popularity, which enable public and private entities to fund sustainable projects and attract international investment. These are in line with the recommendations from COP21 to have a stringent carbon governance structure that enforces compliance and provides a platform for the transition into green energy paradigms (Berezin et al., 2016).

But adopting green finance is riddled with challenges and regulatory constraints. One main challenge is lack of awareness about the stakeholders who cannot make sound decisions on which investments to hold in the books. High entrance costs of deploying green technologies bring about financial bottlenecks within businesses, more so in emergent sectors. The regulatory systems are often non-coherent with erratic policies that do not instil confidence, most times in emerging markets like India (Jose Arturo Garza-Reyes et al., 2022).

Multifaceted approaches are needed to accelerate green finance in India. For instance, government initiatives such as the National Action Plan on Climate Change have set a foundational framework for promoting investment in renewable energy and sustainable infrastructure. The private sector and financial institutions are the best means of developing innovative green finance instruments that effectively channel resources into environmental projects. Enhancing the regulatory environment to provide clarity and stability is vital for attracting domestic and foreign investments in green initiatives.

Risk management and mitigation strategies would facilitate the expected successful transition to carbon-neutrality in India. The principles of adaptive management incorporated into industrial policies can serve as a fertile ground for joint support of environmental sustainability and economic vitality. Effective governance through accountable partnerships among government, business, and community actors strengthens resource allocation processes while enhancing the efficacy of green finance initiatives (Allison Davis et al., 2015).

III. Objectives

1. To understand the relevance of green finance in reaching India's climate targets and transitioning toward a low-carbon economy.
2. To assess the present green finance instruments and programs in India in terms of their efficacy.
3. To identify the barriers and challenges preventing the acceptance of green finance in India.

IV. Research Methodology

This study employs a conceptual analysis of green finance to examine its role in facilitating India's transition to a carbon-neutral nation. The analysis involves a comprehensive review of existing literature on green finance, carbon neutrality, and sustainable development, highlighting the theoretical frameworks and mechanisms that underpin green finance initiatives. By exploring the conceptual foundations of green finance, this study aims to identify the opportunities and challenges associated with its adoption in India, including the potential for green finance to mobilize investments in renewable energy, energy efficiency, and sustainable infrastructure. The analysis also draws on secondary data from reputable sources such as the Securities and Exchange Board of India (SEBI), Climate Bond Initiatives (CBI), International Energy Agency (IEA) and the Green Rating for Integrated Habitat Assessment (GRIHA) over the past six years, providing an empirical basis for understanding the growth and development of green finance in India. Furthermore, the study catalogues and examines the initiatives undertaken by government, public, and

private stakeholders to promote green finance in India, offering insights into the collaborative efforts required to achieve a low-carbon economy.

V. Green Finance Opportunities

a) Overview of green finance instruments and successful programs in India

Green Bonds: debt obligations that borrow funds for financing green-oriented projects of renewable energy, efficient energy, and other related green infrastructural elements (SEBI, 2017).

Green Loans: the sanction of loans is used for a specific purpose like energy efficiency, renewable energy, or sustainable agriculture (Reserve Bank of India, 2018).

Carbon Credits: Tradeable certificates issued to quantify reductions or avoidance of greenhouse gas emissions caused by a project or an activity (Ministry of Environment, Forest and Climate Change, 2019).

Sustainable Sukuk: The Islamic bond to finance eco-friendly projects keeping Shariah standards (SEBI, 2020).

RECs: Tradable certificates quantifying 1 MWh of renewable energy generated (Ministry of Power, 2010).

Green Equity: Equity investments in environmentally friendly projects, such as renewable energy or sustainable infrastructure (Indian Renewable Energy Development Agency, 2020).

Green Asset-Backed Securities: Securities backed by environmentally friendly assets, such as renewable energy projects (RBI, 2020).

Blended Finance: Combining both public and private funding to support climate-friendly projects (National Investment and Infrastructure Fund, 2020).

The successful application of green finance instruments in India has come to be one of the critical approaches for meeting the country's carbon neutrality targets. The amalgamation

of policy frameworks, innovative financial products, and partnerships has triggered many successful initiatives, particularly in renewable energy. For example, the Solar Parks Scheme has made it possible to deploy large-scale solar energy, thus considerably bringing down the cost of investment and enhancing access to energy. Additionally, the instruments of green bonds have picked up pace that allow both the public and private sectors to fund green projects in conjunction with encouraging international investment in these sectors. These trends also resonate with COP21 insights in terms of carbon governance frameworks' need for toughness in enforcing the compliance process to transition into paradigms of green energy (Berezin et al., 2016). However, as technologies and partnerships evolve, it will be important to continue to review and adapt financing mechanisms to ensure that momentum is maintained and benefits of green finance are maximized for the India economy and environment (Egenhofer et al., 2008).

b) Green finance success stories in India

The growth of renewable energy projects in India, particularly in solar and wind, demonstrates the country's progress towards a sustainable future, fueled by effective green finance initiatives. The government has established a goal of reaching 450 GW of renewable energy capacity by the year 2030, which necessitates substantial financial mobilization. Public-private partnerships have become a significant source of financing for these projects, with a number of international investors providing capital as well as technical expertise. Instruments such as green bonds have also been instrumental in channelling funds into sustainable activities. Highlighting the links between sustainability performance and investment, as mentioned in recent literature, underlines that stakeholder engagement is important for the integration of ESG factors into financial practices (Hooda et al., 2023). In the context of India's journey toward a carbon-neutral economy, these initiatives not only show the possible ways but also highlight the need for increased investment and cooperation in the field of green finance.

Table:1 – Issuance of green bonds in India

Year	Green Bond Issuances (INR Crores)
2018	44,395
2019	56,720
2020 (est.)	74,300
2021 (est.)	47,744
2022	167,160
2023	188,830

Source: SEBI, CEEW, World Bank Blogs, ORF and Climate Bonds Initiative

India's green bond issuances have grown six-fold from INR 44,395 Crores in 2018 to INR 167,160 Crores in 2022, with a projected INR 188,830 Crores (Approx. including sovereign bond) in 2023. In the year of 2019 and 2020 were estimated but not achieved due to COVID 19 a pandemic situation faced by the entire world. After, overcoming the pandemic an upward trend indicates a rising focus on environmentally sustainable investments and projects, supporting India's climate goals. The growth also reflects increasing investor interest and government initiatives promoting green infrastructure.

Table: 2 – Green Fund Allocation in India

Year	Green Fund Allocations (INR crore)
2018	1147.34
2019	-
2020	-

Year	Green Fund Allocations (INR crore)
2021	1096
2022	3884
2023	114.38

Source: National Clean Energy and Environment Fund, Green climate Fund, Union budget of India, IEA

The green fund allocations in India from 2018 to 2023 show a fluctuating trend, with initial allocations of \$143.418 million in 2018, followed by a gap in 2019 and 2020. However, the trend resumed in 2021 with \$137 million and increased to \$285.5 million in 2022, indicating a renewed focus on climate action and green initiatives. The continued allocation of \$152.5 million in 2023 suggests sustained efforts towards achieving India's climate goals. Overall, the trend highlights India's commitment to transitioning to a low-carbon economy, but consistency and increased funding will be crucial to meet its Nationally Determined Contributions (NDCs) and support the growth of clean energy and sustainable infrastructure.

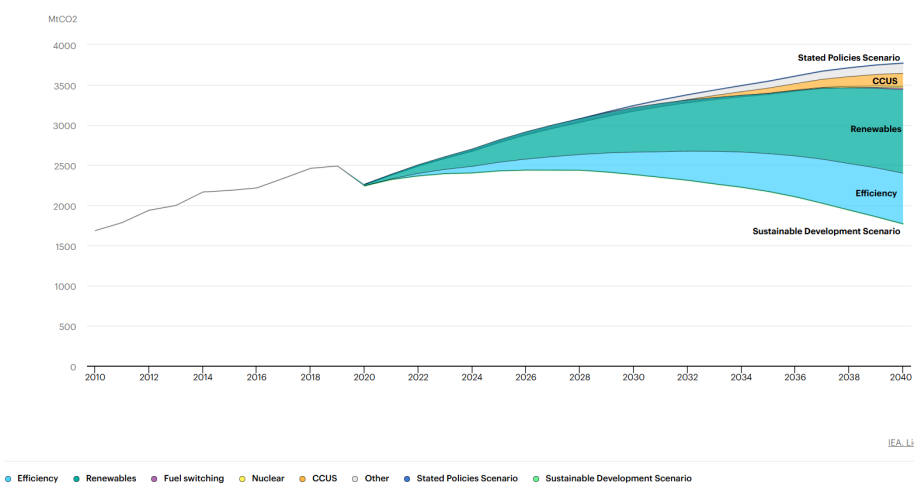
Table:3 – Carbon Emissions Reduction in India

Year	Carbon Emissions Reduction (Million tons)
2018	42
2019	63
2020	81
2021	104

Year	Carbon Emissions Reduction (Million tons)
2022	131
2023	160

Source: Ministry of Environment, Forest and Climate Change

Figure 1- Energy sector CO2 emissions and reduction levers in India in the Sustainable Development Scenario, 2010-2040



Source: International Energy Agency

Green Rating for Integrated Habitat Assessment (GRIHA) Certifications in India

GRIHA (Green Rating for Integrated Habitat Assessment) serves as India's premier national rating system, specifically designed to evaluate and certify green buildings and habitats. Jointly developed by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE), GRIHA assesses buildings based on their environmental sustainability and energy efficiency.

Table:4 - GRIHA Certifications in India

Year	GRIHA Certifications
2018	211
2019	301
2020	382
2021	481
2022	611
2023 (proj.)	750

Source: GRIHA Council

GRIHA certifications in India have consistently risen, growing 257% from 211 in 2018 to 611 in 2022, with a projected 750 certifications in 2023. This upward trend indicates increasing adoption of green building practices, sustainable architecture, and eco-friendly infrastructure development across the country.

India has significant strides on the environmental side; green bonds, funds, and building certifications show a steady increase. Carbon emission cuts are equally promising, leading to a long-term low-carbon economy benefit for the country.

c) Opportunity in Investing in Renewable Energy and Sustainable Infrastructure

The transformation toward a carbon-neutral economy strongly drives investment potential into renewable energy and sustainable infrastructure. The growing requirement for green technology is seen in a wide range of industries, such as in developing countries like India, which have significant renewable energy sources. An example is wind energy in towns like Udupi and Visakhapatnam; it is not only a result of the pressure of sustainable development but has also been considered critically in studies that use long-term data regarding wind potential, as discussed by (Sharma P et al., 2024). Moreover, the exploration of green hydrogen, especially in Bangladesh, illustrates the versatility of renewable resources and their implications for industrial and transportation sectors (Rahman MJ et al., 2024). As the investment landscape evolves, it becomes imperative for policymakers to create favorable conditions that encourage capital flow into green initiatives, ultimately facilitating a robust infrastructure that supports energy transition. The pathways to investment must emphasize innovation, collaboration, and regulatory support to harness these opportunities effectively.

VI. Challenges of Green Finance

a) Barriers to green finance adoption and regulatory challenges

The successful transition to green finance in India is fraught with various barriers and regulatory challenges that hinder put into practice and used extensively. A significant obstacle is the lack of awareness among stakeholders, which impedes informed decision-making regarding sustainable investments (Consalo et al., 2024). Green technologies also have the problem of a high initial cost for businesses, mainly in emerging industries where capital is scarce. Additionally, limited availability of reliable information on sustainable practices makes these problems even more acute in terms of reluctance to use green financing options (Consalo et al., 2024). According to a systematic review of sustainability in aviation, stakeholder engagement is very important; without it, efforts to integrate environmental, social, and governance ratings into finance are superficial (Hooda et al., 2023). The regulatory landscape often lacks coherence, and inconsistent policies can undermine confidence, especially in emerging economies such as India, thus exacerbating these barriers (Garza-Reyes JA et al., 2022). Addressing these challenges through cohesive

regulatory frameworks and enhanced stakeholder collaboration is essential for driving green finance forward.

b) Regulatory and policy challenges

The complex landscape of regulatory and policy framework in India poses significant hurdles to the advancement of green finance, fundamentally challenging the nation's journey toward carbon neutrality (Prof. (Dr.) Kaur A et al., 2023). This usually leaves a lack of coherent policies and inconsistent regulations that prevent investments in sustainable projects, thereby creating uncertainty in the financial institution and the investor. There has never been a more pressing need for standardized regulations to be brought into place, which should be aligned with international benchmarks, especially considering that stakeholders are now looking to address ESG criteria within their financing practices (Hooda et al., 2023). Moreover, ambiguous regulations on green classification may promote greenwashing and consequently dilute the credibility and impact of the sustainability initiatives. Hence, strengthening the regulatory structure is a necessity for ensuring transparency and involving both the public and private sectors in earnest participation, since a collaborative effort is the only one that can genuinely unleash the finance needed to realize a carbon-free India (Gelil A et al., 2012).

c) Risk management and mitigation strategies

Climate change, with the pace of rapid change, brings a requirement to effectively manage risk and mitigate while making the successful transition of carbon-neutral India feasible. The risk and substantial danger of climate change is acknowledged for threatening economic stability and sustainability (Mohanty M et al., 2024). As such, there is an important necessity for proactive stakeholders to strengthen the resilience while redressing the vulnerability of the economy. For example, the integration of adaptive management principles into industrial policies can promote both environmental sustainability and economic vitality in line with the broader frameworks of climate-resilient development found in emerging methodologies in green finance. This approach ensures that investments prioritize low-carbon technologies while encouraging diversification of industries, which mitigates risk associated with climate impacts. The further enhancement of accountable

partnership involving government, the private sector and community will facilitate stronger governance because it promotes improved resource utilization thus increasing effectiveness within green finance channels (Davis A et al., 2015). In conclusion, managing risks holistically will play the most central role in mitigating the problems created by transition while protecting the socio-cultural entity as India will attain carbon-neutrality (Zarsky L et al.,).

Indian strategies towards expediting a Road to a carbon-neutral Economy

Investing in renewable energy is vital for driving India's sustainable growth and transition to a carbon-neutral economy. The country has vast natural resources available, which, if tapped with solar, wind, and biomass energy projects, will reduce dependence on fossil fuels. At the same time, tax breaks and other subsidies for green technology adoption by the government will provide an impetus to private investment (Mohanty M et al., 2024). Moreover, enabling the grid structure to support renewable energy sources will be reliable and stable, boosting the confidence of customers in these cleaner sources. Increasing public awareness through education is equally important since it can facilitate a culture that inspires people as well as businesses to embrace low-carbon lifestyles (Prof. (Dr.) Kaur A et al., 2023). International collaborations can help facilitate the transfer of technology and global green finance, and bridge India's gap to vault over traditional energy systems and capture groundbreaking solutions.

VII. Expediting Green Finance in India

Navigating the complex landscape in green finance in India would call for a whole-of-government and other stakeholders' approach in expediting the transition towards carbon neutrality. Initiatives of the government, like NAPCC, and other policies at the state level have given a basic structure to ensure a sustainable future, investing in renewable energy and green infrastructure is imperative. These structures form the base of mobilizing capital and setting the right environment for public-private partnerships. Moreover, the role of private sector players and financial institutions cannot be underemphasized because it is in these players that most innovative green finance instruments are developed to channel

resources into environmental projects effectively. As mentioned in other texts above, "insufficient core technology and innovation" remain a very critical barrier (Zhang et al., 2023), but innovative solutions such as green bonds and climate risk insurance have emerged to overcome such challenges. For that purpose, the Indian government will also need to further strengthen the regulatory environment that should bring transparency and stability and will help domestic as well as foreign investment for green initiatives with more acceleration for an economy, sustainable and carbon-neutral.

a) Government programs and the role of the private sector in facilitating green finance

Only effective strategies through comprehensive plans and ideas would work properly to promote green finance by both the governments' programs and the private sectors. Policymakers can initiate market transformation through regulatory policies that incentivize sustainable investment. For instance, policies announced in Government of India's carbon neutrality plan indicate that enabling sustainable development and unlocking private capital into a green sector is necessary. There is urgency in engaging the private sector. For instance, only through this segment can innovations in production technology and large-scale expansion of renewable energy infrastructure, along with sustainable fuels, be effectively managed as presented in the results from systematic literature reviews about stakeholder cooperation in finance ecosystem, in recent years (Hooda et al., 2023). Furthermore, frameworks established by key governmental projects, as detailed in research initiatives like the one at the University of Latvia, highlight the economic implications of sustainable practices, pushing businesses towards environmentally responsible operations (Bogdanova et al., 2023). By harmonizing efforts, both sectors Has the potential to drive a rapid transition to a low-carbon, sustainable future, balancing economic growth with environmental stewardship.

b) Role of private sector and financial institutions

The transition to a carbon-neutral economy in India necessitates an active and strategic involvement from private sector entities and financial institutions. These organizations are crucial in mobilizing capital for sustainable projects, particularly in financing renewable energy initiatives that align with India's climate goals. As public funding alone is

insufficient to meet the enormous investment requirements for green infrastructure, private finance can bridge the gap. For that, institutions will be advocating the importance of investment into sustainable directions in which financing can be applied into projects environmentally helpful. Such a financial device works only through effective frameworks where clearly defined frameworks bring about higher standards of transparency and accountability among investors. Additional to this innovative application of finances by innovative use of new financial devices will also amplify their efforts. Ultimately, it will be the solid partnership between the private sector and financial institutions that will be necessary to tap green finance at its full potential for India to guide the nation towards its ambitious climate objectives (Programme UNE), (González Martínez et al., 2021).

VIII. Conclusion

India needs a solid framework of green finance for transition to a carbon-neutral economy. The integration of green capital mobilization supports the facilitation of environmentally beneficial projects and reduces carbon footprints as well, emphasizing the global trend. This section has discussed how equitable resource access by women can improve sustainability and enhance environmental performance (Herklotz A et al., 2012). More importantly, the analytical evaluation of ESG ratings reflects that green finance is the main thrust area of aviation, but has much more universal applicability to other sectors (Hooda et al., 2023). These conclusions highlight the importance of overcoming the challenges and obstacles faced in green finance such as regulatory challenges and cost-related problems, both in terms of economic development and environmental protection. All of this, of course, calls for concerted action by governmental policies, private sector innovation, and stakeholder collaboration to not only foster but catalyze the movement aiming for a sustainable and carbon-neutral India.

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