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An Analytical Study of the Carbon Credit Market in India Market Size, Key Players, Regulatory Framework and Trading Mechanisms

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Abstract

This paper presents a critical analytical discussion of the carbon credit market in India with focus on market dimensions, key market participants, regulatory contingencies and trading mechanisms. Based on secondary sources, such as government documents, regulatory acts and industry reports and academic literature between 2015 and 2025, the investigation measures the market growth, stakeholder demographics and examines compliance and trading infrastructure. The results show that the market, already huge with an estimated USD 4 billion in 2023, has a booming market with compliance and voluntary segments driving the liquidity and involvement. The major supervisory roles are held by regulatory bodies like the Ministry of Power, the Bureau of Energy Efficiency, and the Central Electricity Regulatory Commission, which collaborate with the developers of the project, financial institutions and the verification agencies. The institutional framework of legislation, the Energy Conservation (Amendment) Act, 2022 and the Carbon Credit Trading Scheme, 2023, ensures that the process is transparent and credible by using digital innovations in measurements, reporting and verification (MRV). Growth opportunities are strong in energy, agriculture, forestry and waste management sectors whereas challenges such as regulatory uncertainties and lack of infrastructures should be fixed on a short-term basis. The overseas comparison of the carbon trading market highlights the best practice, which can be used to make the Indian market effective. The researchers draw the conclusion that continuous policy improvement, technological growth and involving stakeholders are essential conditions of turning India into a country of fulfilling its climate commitments and achieving the conditions of sustainable economic development.

Keywords: Carbon credits, India, carbon market, regulatory framework, compliance, carbon trading, sustainable growth.

Introduction

1. Background and global significance of carbon credits

Carbon credit has become an important tool to fight climate change by encouraging the reduction of greenhouse gas emissions through market-based solutions. They started from the Kyoto Protocol in 1997, allowing entities to emit one metric tonne of carbon dioxide equivalent (tCO_{2e}) by buying credits that represent equivalent emissions reductions produced elsewhere. This turns environmental responsibility into a financial asset.

The Paris Agreement in 2015 increased their importance as countries promised to keep global temperature rising well below 2°C. This made carbon credit essential to climate finance strategies worldwide. The global carbon credit market was valued at about USD 933 billion in 2025 and is expected to grow to around USD 16.4 trillion by 2034, with an annual growth rate of roughly 37.7%. This increase is driven by more government regulations, corporate net-zero pledges, advancements in renewable energy and carbon capture technology and the development of complex financial tools for the carbon market.

Carbon credit exists in both compliance markets, which have legally mandated emissions limits and voluntary markets, where businesses offset emissions beyond regulations based on their ESG commitments. Together, these markets mobilize significant funding, direct investments into green projects and help countries and companies achieve climate goals while supporting sustainable economic growth.

Despite the promise of this market, it faces challenges, such as ensuring credit quality and additionality, avoiding double counting, managing price fluctuations and encouraging wider participation across sectors and regions. However, carbon credit remains crucial for the global shift toward a sustainable, low-carbon economy by linking environmental needs with financial rewards.

2. Importance of carbon credits in India's climate and sustainability agenda

Carbon credits play a crucial role in India's climate and sustainability plans, acting as both a regulatory and market tool to reach the country's ambitious climate goals. India is the third-largest greenhouse gas emitter in the world, but its per capita emissions are relatively low. Therefore, India's strategy balances development with environmental responsibility. Carbon credits help India attract investments in low-carbon technologies and sustainable projects while offering financial incentives for reducing emissions in sectors like renewable energy, agriculture and forestry.

India's commitment under the Paris Agreement to cut the emissions intensity of its GDP by 33-35% by 2030, ensure 40% of electric power capacity comes from non-fossil fuel sources and achieve net-zero emissions by 2070 highlights the importance of carbon markets. The establishment of a formal domestic carbon credit trading system through the Energy Conservation (Amendment) Act, 2022 and the Carbon Credit Trading Scheme, 2023, underscores the government's strategic focus on carbon credits as key drivers for sustainable growth and mobilizing climate finance.

3. Research objectives

This study explores India's carbon credit market using secondary data from government publications, market reports, regulatory documents and academic sources. The objectives are:

1. To quantify the market size and growth trends
2. To examine regulatory frameworks and compliance mechanisms
3. To understand trading platforms and mechanisms
4. To identify sectoral opportunities and challenges

The scope includes compliance and voluntary markets across key sectors such as energy, agriculture, forestry and waste management, focusing on data from 2015 to 2025 with projections extending to 2030.

4. Research Questions

1. What is the current size and anticipated growth of India's carbon credit market?
2. What regulatory and institutional frameworks oversee the market?
3. How do trading mechanisms operate in India?
4. What are the main opportunities and challenges?

Literature Review

Gupta, Y. (2011) discusses the concept and significance of carbon credits as an environmental and economic tool to address global warming due to increased emissions of greenhouse gases. Based on a secondary literature review, the paper reviews the framework adopted under the Kyoto Protocol for setting limits on emissions and how carbon market's function, focusing on the tradability of carbon credits among the emitting entities in case of a shortage or excess of credit supply. The paper also discusses India's active role in the global carbon market and informs that it has the potential to gain from credit trading surplus due to its low per capita emissions and emerging demands for energy. Results have indicated that trading in carbon credit encourages firms to adopt greener technologies and cut down emissions and initial Indian firms in CDM projects include Suzlon Energy and Gujarat Fluorochemicals, among others. Gupta concludes that while carbon credits are proving to be an efficient market-based mechanism for environmental protection and earnings, a wide awareness and education-based initiative is required to integrate carbon markets into regular business and social activities in India.

Gorain, S., Malakar, A., & Chanda, S. (2021) analyze India's carbon market focusing on the impact of crop residue burning—a major source of GHG emission and air pollution in India. Using secondary data from governmental and non-governmental sources, including Ministry of New and Renewable Energy reports, the study quantifies emissions from crop residue burning and estimates potential carbon credits India could generate by curtailing this practice. An econometric model assesses the relationship between carbon credit prices and various economic indicators such as industrial production indices and commodity prices. Findings highlight that an avoidance of crop residue burning could have brought huge revenues through participation in the carbon market and helped improve the economic and environmental situation. The study concludes that despite the existence of carbon trading mechanisms like CDM and Joint Implementation, an effective and globally coordinated approach is required rather than a narrow financial interest to solve the problem of climate change. The paper emphasizes that robust carbon market governance was imperative in realizing maximum environmental and socio-economic benefits.

Lokuge, N., & Anders, S. (2022) perform a critical review of the literature on agricultural carbon-credit systems and explore opportunities and challenges in developed world regions, with a primary focus on the Alberta province of Canada. The goal of the authors is to underscore knowledge gaps in science about agricultural carbon credits/offsets and then evaluate performance related to encouraging emission-reducing farm practices without a loss in productivity. The research relies on secondary data from academic research, government reports and international policy frameworks. The findings indicate that carbon credits have the potential to provide ancillary revenue streams for farmers but face low participation due to high transaction costs, regulatory risks and limited financial incentives. Very often, farmers adopt environmentally friendly practices because of operational benefits rather than revenues associated with carbon credit. The review concludes that agricultural carbon markets are in their infancy and require stable policy environments, better financial rewards and consideration of a wider suite of co-benefits—e.g., soil health-and environmental outcomes to promote farmer involvement and ultimate environmental effectiveness. The authors call for approaches tailored to specific local contexts and sound scientific evidence to validate and promote viable sustainable agricultural carbon credit mechanisms.

Manjunatha and Kumar (2024) seek to explore the conceptual framework and theoretical implications of carbon credits trading in India within the country's environmental policies and economic growth objectives. Specifically, it investigates the rapidly changing regulatory environment sculpted by the Energy Conservation Amendment Act, 2022 and the formulation of the Indian Carbon Market, while assessing the supply-demand dynamics impelled by industrial growth and renewable energy adoption. The research methodology consists of analyzing secondary data from policy documents, government reports and case studies of industries actively trading in carbon credits, supplemented by a theoretical review of the market mechanisms, such as the Perform, Achieve and Trade system. The findings show that carbon credit trading plays an important role in aligning India's climate commitments with sustainable growth by fostering emission reductions, foreign investments and technological innovation. Yet, there are formidable challenges to be faced in market volatility, carbon pricing mechanisms and ethical management of carbon offsets. The study concludes by emphasizing the need for sound policy frameworks, monitoring and verification systems with increased stakeholder participation to ensure the integrity and efficiency of the carbon market in India and the potential of the ICM to be a significant instrument in the country's transition to a low-carbon economy.

PAUL, A., & NAIR, R. (2024) critically analyze the carbon emission trading framework of India, focusing on legal and policy dimensions. The study, in a doctrinal research methodology, reviews international agreements like the Kyoto Protocol and Paris Agreement, together with India's Energy Conservation Amendment Act 2022 and Carbon Credit Trading Scheme. It was found that India is rapidly developing its carbon trading system, with institutional frameworks designed to underpin market operations, emission reductions and compliance. The challenges highlighted include regulatory gaps, limited institutional capacity and the need to further align domestic policies with best international practices. The authors conclude that a well-structured and transparent carbon trading system is central to India's ambition to fulfill its national and global climate targets and go on to recommend policy refinements and clarity in laws for better market efficiency and environmental performance.

Methodology

Description of secondary data sources: The paper uses a broad range of secondary data sources, including government literature, which provides official statistics and policy documents; industry literature, which provides market analysis and trend reports; more in-depth market research, which provides empirically supported insights of carbon trading mechanisms; and peer-reviewed scholarly journal articles, which adds additional scholarly views of carbon trading mechanisms.

Data collection methodology: Data collection was done through a systematic, careful combination of reliable information sources which was then synthesized and triangulated to guarantee a logical and significant amalgamation of divergent data. The methodology framework helped to conduct a combined analysis of the carbon credit market by synthesizing the results of various authoritative sources, hence being able to conduct a comprehensive review of regulatory frameworks, economic consequences, and industry forces.

Limitations and scope of the secondary data analysis: The secondary data analysis will be limited by the inaccessibility, timeliness and descriptiveness of more recent datasets which in turn may blur the recent market trends and geographic peculiarities. In addition, the use of published sources brings about reliance on the quality of information gathering and presentation. However, the methodology provides an economical way to capture general trends and policy studies, which implies that it will be suitable to conduct extensive studies on the specified field of carbon credit market.

Market Size and Growth Analysis

1. The present market pricing and the trend of the previous growth of the carbon credit market in India

In 2023, the Indian market of carbon credits is projected to reach USD 4 billion, which has a significantly accelerated growth rate due to the establishment of the more regulatory framework and increased corporate interest. In history, India has used the Clean Development Mechanism (CDM) aspect of the Kyoto Protocol, thus creating a platform on which carbon credit trading is achieved, and foreign investment is attracted.

2. Statistic of market segmentation: compliance and voluntary sectors

The market is divided into compliance and voluntary markets. Compliance sector dominated by the energy conservation (amendment) act mandates are the most revenue and transaction volume leaders. On the other hand, the voluntary sector, which is driven by corporate sustainability efforts and ESG agenda, is the most rapidly expanding and is experiencing increasing involvement in all spheres.

3. Future forecasts and development by 2030

It has been predicted that the market will record a continued growth with a compound annual growth rate (CAGR) of over 40% and valuation of over USD \$ 9billion by the year 2030. The projected growth is expected to be achieved through the incorporation of other sectors in the industry, increased regulatory transparency and integration into the carbon trading systems of the world.

Significant Participants and Stakeholders

1. Government agencies and regulators in issuance and trading of carbon credits.

Some of the major government bodies are the Ministry of Power that develops policies and regulations relevant to the carbon markets, the Bureau of Energy Efficiency (BEE) that regulates market operations and compliance regulations, the Central Electricity Regulatory Commission (CERC) that ensures fairness and transparency of markets, and the Grid Controller of India Limited (GCI) that maintains the national carbon credit

registry and ensures that it regulates the issuances, transfers, and retirements of credits, thereby avoiding duplications.

2. **Mega project developers and aggregators in India.**

Some of the major project's developers like EKI Energy Services, Grow-Billion-Trees, and Clime Secure are actively involved in generation of carbon credits using renewable energy, afforestation and sustainable agricultural projects. Aggregators bring together small-scale movements to ease market access and technical capacity and financing access to rural and community-level stakeholders.

3. **Investors and financiers in the carbon credit ecosystem.**

The Carbon credit financing and trading environment is a wide spectrum of a variety of financial institutions, such as commercial banks, green investment funds, development finance institutions, and insurance firms. Carbon credits are seen by investors as diversified, low-carbon assets, ESG-compatible portfolios, and sustainability-linked bonds, and hence, motivation toward increased interest.

4. **Prevention of verification and registry agencies.**

Carbon credits are given credibility and additionality through independent monitoring, evaluation and certification of emission reduction by the verification agencies like Carbon Check India and other accredited third-party organizations. Registry agencies, such as GCI offer a credit issuance, ownership and retirement system that is secure and on an open-source basis, maintaining market integrity and removal of fraudulent activity.

Regulatory Framework

1. **Energy conservation amendment act Carbon credit trading scheme legal framework Overview of major legislations**

Carbon credit trading in India has the statutory basis of the Energy Conservation (Amendment) Act, 2022, which gives the Central Government the power to develop a carbon credit trading scheme within the Perform, Achieve and Trade (PAT) scheme. The Carbon Credit Trading Scheme (CCTS) of 2023 includes extensive regulatory clauses, to regulate the issuance, trading, compliance and punishment and thus formalizes the domestic carbon market structure.

2. **Institutional structure, roles and duties**

The major institutions include: the Ministry of Power where the policy is made; the Bureau of Energy Efficiency (BEE) as the market supervisor that is concerned with the creation of the scheme; the Central Electricity Regulatory Commission (CERC) as the trading regulator; and the Grid Controller of India Limited (GCI) as the registry operator that keeps records of issuance, transfer and retirement of carbon credits. Combined, such institutions control the governance of markets, provide enforceability and transparency.

3. **Compliance and issuance of credit**

The scheme of the PAT has compliance by forcing the specified consumers to participate in the scheme, which will require them to follow the targets of emission reduction or purchase carbon credits. Credits are issued to a proven reduction of emissions by third-party accredited verifiers and in accordance with monitoring, reporting and verification (MRV). The registry system operated by GCI guarantees proper tracing and retirement of credits to avoid double counting and non-compliance penalties are imposed as per the Amendment act.

4. **Cross boundary trading programs and global co-ordination**

Carbon credit scheme in India is consistent with the international standards, like the Gold Standard and the Verified Carbon Standard (VCS). Although domestic trading is a priority at the moment, India seeks to integrate its carbon market to international trading systems that are compatible with the Article 6 of the Paris Agreement and thus be able to make cross credit transfers. This alignment aims at improving the liquidity of the market, accessibility of foreign investment and ensure that it obtains a meaningful participation in the global carbon market ecosystem.

Market Operation and Trading Systems

1. **Indian Carbon Market (ICM) infrastructure and platforms description**

The Indian Carbon Market (ICM) is managed through a centralized electronic system by the Grid Controller of India Limited (GCI) that is the national registry of the carbon credits. This system combines several processes of issuing, transferring and retiring credits hence making the system transparent and avoiding Counting twice. Complementary trading platforms are used in spot and forward transactions, which are liked by entities involved in compliance and voluntary markets.

2. **Credit issuance and trading and retirement operations**

Carbon credits are issued on confirmation of emission effects by approved third-party verifiers in conformity to approved monitoring, reporting and verification (MRV) guidelines. The projects that are eligible are registered with the market administrator and after confirmation of compliance, they are given tradable credits. The exchange takes place in the form of trading and credits are stored in the centralized registry. Retirement is a situation where the credits are permanently removed out of the market to offset the emission or meet the regulatory requirements to ensure that the environment is preserved.

3. **Dynamics and market liquidity analysis of pricing**

The regulation compliance, credit supply and the current trend in the international carbon market determine the price formation in the Indian carbon market. In the compliance markets, there is generally price stability because of all-obligatory requirements, as opposed to the voluntary market prices, which are freer and more volatile because of corporate environmental, social and governance (ESG) principles. Liquidity in the market is moderate but is expected to be enhanced as the diversity of the participants is enhanced, the trading infrastructure is boosted, and the global market alignment is established.

Opportunities and Challenges

1. Sectoral energy, agricultural, forestry and waste management opportunities

Renewable energy initiatives, energy efficiency programs and industrial emission control programs present the potential of the energy sector with significant potential. Sustainable farming, capturing methane and soil carbon are opportunities in agricultural activities. Forestry can use afforestation, reforestation and forest conservation initiatives to create carbon sinks. Waste management allows reducing emissions through methane capture of landfills and waste-to-energy, which has a great contribution to the generation of carbon credits.

2. The potential of investment and financial market

Commercial banks, green funds and the international climate finance institutions are increasingly attracting investments in the carbon credit market in India. A growing regulatory framework enhances investor confidence, which helps the market to remain liquid and discover prices. Carbon bonds and ESG funds are financial instruments that are associated with carbon credit, thus opening more avenues of investment. The integration of the market with the global carbon systems also enables cross-border capital flows.

3. Significant risks: regulatory risks, market quality issues, barriers to participation, infrastructure gaps

The problems include the changing regulatory environments with some ambiguity that may occasionally affect the predictability of the markets; the issue of accuracy and additionality of the carbon credits because of the restrictions of MRV and the lack of involvement of the small enterprises and rural developers in the projects. There are infrastructure gaps in trading platforms and MRV technologies that are an impediment to smooth market operations. Solution to these problems require clear policy, capacity building, tight verification and technological upgrades.

Discussion and Strategic Recommendations

1. Conclusion on findings to the climate commitments in India

The carbon credit market of India is currently developing in high speed, keeping its climate goals in the Paris Agreement, such as reduction of emission intensity and net-zero commitments. Policy commitment is significant in the aspect of growth of the market, the regulatory contexts and stakeholder interaction. However, there are other obstacles including regulatory uncertainties, MRV constraints and infrastructure shortfalls that act in the way of the complete achievement of the climate ambition of India. These commitments need to be supported through strengthening market mechanisms to secure transparent and verifiable emission reductions.

2. International comparisons of good practice in carbon markets

Carbon markets in the world, including the EU ETS, the national system of China and Californian Cap-and-Trade system, offer a lot of insights on how regulations can be made clear, MRV protocols are strong, the market is liquid and stakeholders are engaged. India can exploit the use of standardized forms of verifications, increasing the transparency of the registries and creating the derivative markets to advance the liquidity. Conformity with the international framework such as the Article 6 of the Paris Agreement would further advance the involvement of India towards global carbon finance.

3. Policy improvements and deepening recommendations

Regulatory clarification, strengthening of regulation and inclusion of the sector are the main areas that policymakers need to focus on to expand the market base. The inclusivity and credit quality will be improved through investment in technology-oriented MRV innovations and capacity development of small-scale project developers. Greater private investment can be carried out with the help of financial incentives, including risk-reduction instruments and tax-deductions. Finally, the development of cooperation between the government, the industry and the finance sector will help develop a strong and active carbon market.

4. Future perspective and gaps in research

There is a great potential in the growth of the Indian carbon credit market and there is still needed to conduct more studies on the effects of the market, socio-economic advantages and integration of technology. Actionable insights on credit additionality, price volatility and the role of digital technologies in MRV may be provided by empirical research. The power of incorporating the informal sector and rural stakeholders to make carbon market development equitable and sustainable is also an aspect that needs to be looked into in future studies.

Conclusion

The carbon credit market in India is a developing industry at the critical level, which may be considered as a vital tool in the transformation of the country towards a sustainable and low-carbon society. The fast growth of the market, which is ensured by the advanced regulatory frameworks like the Energy Conservation (Amendment) Act and the Carbon Credit Trading Scheme, points out the great governmental dedication to climate objectives in accordance with the Paris Agreement. By proper involvement of important stakeholders, like the government agencies, the project developers, financial institutions and the verification agencies, India is promoting a transparent and efficient carbon trading environment.

There is huge potential in the energy, agricultural, forestry and waste activities to earn carbon credits and spur sustainable investments. Nevertheless, issues surrounding regulatory uncertainties, market infrastructure and barriers of participation should be overcome to create a market that is both unbiased and wholesome. Digital monitoring innovations and powerful compliance systems contribute to the resilience and credibility of the market even more.

To achieve sustainable growth, India needs to keep improving its policies and institutional capabilities, while ensuring its carbon market aligns with global standards. This approach can attract more participants and investment. The growing carbon credit market not only helps India meet its climate goals but also boosts the

economy by encouraging investments in clean technology and conservation efforts. Ultimately, it can play a key role in supporting climate finance and reducing global emissions.

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Conflicts of interest

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