3 Carbon Credits: A Sustainable Commodity Powering the Carbon Market

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Abstract

In the global fight against climate change, carbon credits have emerged as a transformative financial instrument that turns abstract emission reductions into tangible, tradable commodities. This innovative market mechanism is built on a simple yet powerful principle: putting a price on carbon. By creating economic value for verified climate action, it establishes a direct financial incentive for businesses, nations, and even individuals to reduce their carbon footprint, while simultaneously channeling vital capital toward sustainable projects worldwide.

Keywords: Carbon Credits, Sustainable Commodity, Carbon Market, Climate Change, Carbon Footprint.

Introduction

As the world races to meet the ambitious targets of the Paris Agreement, voluntary and compliance carbon markets are becoming increasingly crucial in the transition to a low-carbon economy. They act as a flexible, cost-effective supplement to regulation, allowing entities that struggle with immediate, internal cuts to finance equivalent reductions elsewhere, ensuring global net emissions decline. The market transforms climate responsibility into a strategic economic activity, fostering innovation in green technology and providing sustainable development co-benefits—from biodiversity conservation to community health improvements in developing regions.

Carbon credits have emerged as a sustainable commodity at the core of modern carbon markets, designed to address the growing challenge of climate change. A carbon credit represents the verified reduction or removal of one metric tonne of carbon dioxide or its equivalent in other greenhouse gases. By assigning a measurable economic value to emission reductions, carbon credits transform environmental responsibility into a market-driven mechanism. Organizations that successfully lower their carbon footprint can generate or purchase credits, while those

exceeding emission limits can offset their impact through regulated or voluntary carbon markets.

As a tradable commodity, carbon credits encourage investment in clean energy, energy efficiency, afforestation, and low-carbon technologies. They play a crucial role in aligning economic incentives with global climate goals, supporting sustainable development while promoting accountability and transparency in emission management. In this way, carbon credits act as a bridge between environmental sustainability and economic growth, powering the evolution of the global carbon market.

However, this burgeoning market faces critical challenges of integrity, transparency, and standardization. Questions around additionality (would the project have happened anyway?), permanence (will stored carbon stay stored?), and leakage (does the project simply shift emissions elsewhere?) are driving ongoing evolution in certification standards and regulatory oversight. The future of carbon credits hinges on robust verification, digital monitoring (like satellite and blockchain technology), and seamless integration with national climate pledges under Article 6 of the Paris Agreement.

Ultimately, carbon credits are more than just a commodity; they are a bridge between today's carbon-intensive economy and tomorrow's net-zero future. By monetizing the value of a stable climate, they are fundamentally reshaping corporate strategies, investment flows, and global cooperation, positioning themselves as a cornerstone of 21st-century sustainable finance.

Carbon Credits

Collins English Dictionary defines carbon credit as a certificate verifying that a government or company has compensated for the removal of a specific amount of carbon dioxide from the atmosphere. Carbon credits were introduced for setting up limit for carbon emission on manufacturers. This limit was set up at international level by implementing Kyoto Protocol 5 Feb. 2005.

Carbon credits are generated by emitting less carbon in the environment. One carbon credit represents one metric ton of carbon dioxide (or its equivalent in other greenhouse gases) that has been either prevented from entering the atmosphere or removed from it. These credits are generated through two primary pathways: avoidance/reduction projects (like renewable energy farms or methane capture from landfills) and removal/sequestration projects (such as reforestation or direct air capture technology). This dual function makes the carbon market a dynamic tool for both curbing ongoing emissions and addressing historical atmospheric pollution.

Carbon Market

According to the Global Director for Climate Change at the World Bank, the past years has seen positive momentum. Key developments include a significant increase in revenue earmarked for community investment and the low-carbon transition. Furthermore, notable strides have been made in managing the cross-border complexities of carbon pricing, supported by new international carbon market regulations established at COP26 in Glasgow. These advancements provide enhanced policy clarity. To effectively leverage carbon pricing for inclusive decarbonization, it is now imperative to build on this foundation by expanding its coverage and raising price levels.

According to the World Bank's 2024 State and Trends of Carbon Pricing report, the global carbon pricing landscape has continued to mature, with 73 carbon pricing instruments now in operation covering around 23% of global greenhouse gas emissions. This includes 37 carbon tax regimes and 36 Emissions Trading Systems (ETS). In 2023, carbon pricing revenues reached a record approximately USD 104 billion, marking a significant increase from previous years and reflecting both expanded coverage and higher prices in key markets.

The European Union Emissions Trading System (EU ETS), the world's largest carbon market, saw prices exceed €90 per tonne in 2023, driving innovation and decarbonization. Notably, emerging economies are increasingly entering the market: China's national ETS—now the world's largest by covered emissions—continues its phased development, while systems in Mexico, Indonesia, and Vietnam are advancing.

Despite this progress, a significant gap remains in many developing countries, where formal carbon markets are still nascent or absent. However, the landscape is shifting rapidly under the Paris Agreement's Article 6, which establishes frameworks for international carbon credit trading. The European Union has shifted its position, now focusing on stringent criteria for international offsets rather than broad acceptance of CERs, emphasizing the need for real, additional, and permanent emissions reductions that avoid double counting. This evolution highlights the growing emphasis on integrity and transparency as carbon markets become a central pillar of global climate finance.

Carbon markets exist because carbon credits are traded as a commodity. These markets are platforms for buying and selling carbon credits. Sellers are typically entities that have emitted less than their allocated quota, generating certified credits upon verification by a competent authority. Buyers are entities that have exceeded their emission limits but need to continue production, thus purchasing additional allowances at international prices. The carbon market was formally

established through International Emissions Trading, one of the three flexibility mechanisms under the Kyoto Protocol.

Carbon Market in India

India is a signatory and ratified the Kyoto Protocol under the UNFCCC in 1993. As a developing nation, it is not bound by mandatory greenhouse gas (GHG) mitigation targets, allowing for the promotion of industrial activity to accelerate growth. India has been a leading participant in the Clean Development Mechanism (CDM), ranking second globally after China in registered projects.

India has emerged as a significant player in the global carbon market, with its voluntary carbon credit generation estimated at around 100 million credits annually, placing it among the top five countries globally. Under the Clean Development Mechanism (CDM) of the Kyoto Protocol, India registered over 1,700 projects—the second-highest in the world after China—which have cumulatively generated more than 300 million Certified Emission Reductions (CERs). In the compliance market, India's domestic carbon market, operationalized under the Carbon Credit Trading Scheme (CCTS) 2023, initially covers 1,500 energy-intensive units across sectors like aluminium, cement, and fertilizers, with an estimated annual reduction potential of 70–100 million tonnes of CO_2 equivalent.

The carbon market was a novel concept in India at the time. The country's first recorded trade took place on March 30, 2011, through two initial exchanges: Power Exchange India Ltd (PXIL) in Mumbai and the Indian Energy Exchange (IEX) in Delhi, which dealt in Renewable Energy Certificates (RECs). In this landmark transaction, 424 out of 523 issued RECs were sold. Subsequently, the Ministry of Power, Government of India, launched the Perform, Achieve, and Trade (PAT) scheme, with the Bureau of Energy Efficiency (BEE) appointed as the implementing, regulatory, and grievance redressal body. Its first cycle commenced in 2011.

In the voluntary carbon market, India remains a top supplier. As of recent estimates, India accounts for roughly 10-15% of global voluntary carbon credit supply, issuing an estimated 100 million credits annually. Credits from Indian projects, especially renewable energy, have traditionally traded at lower price points (often $2–$5 per credit) due to high volume and early methodologies.

Domestically, the regulatory landscape is transforming with the Carbon Credit Trading Scheme (CCTS), launched in 2023. This compliance market builds upon the existing Perform, Achieve and Trade (PAT) scheme, which has completed multiple cycles. The PAT scheme, covering over 1,100 designated consumers across 13 energy-intensive sectors, has reportedly achieved cumulative energy savings equivalent to over 100 million tonnes of CO_2 in its initial cycles. The new CCTS framework will initially govern these same sectors, creating a formal cap-and-trade system where Energy Saving Certificates (ESCerts) will transition into tradable carbon

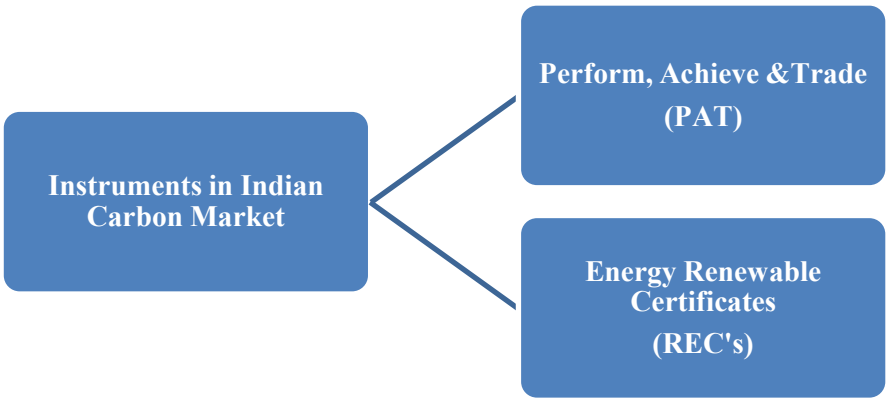
credit certificates. While the exact market size is nascent, the compliance obligation covers entities responsible for nearly 50% of India's total industrial energy demand, indicating a substantial future domestic trading volume. Prices in India's voluntary market vary widely, from $2–$15 per credit for standard renewable credits to $15–$30+ for high-integrity nature-based solutions with strong community co-benefits, reflecting both the scale and evolving quality of India's carbon credit landscape.

Furthermore, India is positioning itself within the Paris Agreement's Article 6 framework. The government has established a national registry and is developing procedures to authorize projects for international transfer, aiming to attract green investment and ensure that exported credits help meet its own Nationally Determined Contributions (NDCs).

India's carbon trading spans a legacy of large-scale international supply, a vibrant voluntary market, and the launch of a potentially large domestic compliance system—all underpinned by ambitious renewable energy targets of 500 GW capacity by 2030, which will continue to drive both credit generation and demand for trading mechanisms.

India continues to lead in CDM project registration, generating an annual stock of CERs. Once registered, a project generates carbon credits each year throughout its operational life, accumulating a bank of credits. Domestic instruments like the PAT scheme and RECs are closely aligned with the principles of the carbon market.

Instruments of Indian Carbon Market



Source: National Mission for Enhanced Energy Efficiency (NMEEE)

The Perform, Achieve, and Trade (PAT) scheme is a regulatory instrument initiated in 2009 by the Bureau of Energy Efficiency (BEE), operating under the National Mission for Enhanced Energy Efficiency (NMEEE). It targets 13 energy-intensive industrial sectors, such as iron and steel, cement, and fertilizers.

Within the framework of this market-based mechanism, registered entities—designated as Designated Consumers (DCs)—are assigned mandatory energy efficiency improvement targets. DCs that surpass their specific energy consumption reduction goals receive tradable Energy Saving Certificates (ESCerts). Conversely, those unable to meet their targets are obligated to purchase ESCerts on the open market to achieve compliance. Each certificate is equivalent to one tonne of oil equivalent (toe) of energy savings.

The Perform, Achieve and Trade (PAT) scheme, now in its seventh cycle, has reportedly achieved cumulative emission reductions of 100 million tCO_2e in its first two cycles alone, with over 1,104 DCs from 13 industrial and service sectors participating successfully. Renewable energy dominates project issuance, with India's solar capacity exceeding 82 GW as of early 2024, where each megawatt of installed solar avoids approximately 1,200–1,500 tCO_2 annually.

The Carbon Credit Lifecycle

The carbon credit lifecycle is a meticulously structured journey from project inception to final retirement, ensuring each tonne of CO_2 reduced or removed is real, additional, permanent, and uniquely accounted for. It begins with *project development,* where an activity is designed using an approved methodology and independently validated for its integrity and impact. Once operational, the project enters *verification and monitoring*, undergoing periodic audits by third parties to confirm actual emission reductions before credits are issued with unique serial numbers. These credits then enter *trading and transaction* on exchanges or over-the-counter markets, where their price reflects quality, demand, and policy signals. The cycle culminates in *retirement and claiming*, where a buyer permanently cancels a credit to make an offset claim, with the transaction recorded on a public ledger to ensure transparency and prevent double-counting. This end-to-end process forms the essential backbone of carbon market credibility.

Types of Carbon Credit Project

The landscape of carbon credit projects in India showcases a diverse and evolving portfolio, shifting from traditional renewable energy toward a greater emphasis on high-impact nature-based solutions and community-driven initiatives. Reforestation and forest management projects, such as the Khasi Hills REDD+ initiative and Himalayan afforestation efforts, generate significant credits while conserving biodiversity and supporting tribal rights. In renewable energy, India's world-leading solar parks and wind corridors continue to produce substantial volumes of avoidance credits as the country races toward its 500 GW clean energy target. Crucially, community-focused projects—including clean cookstoves, solar water ATMs, and energy efficiency programs—uniquely address energy poverty and public health while generating carbon revenue. Emerging technological and agricultural

innovations, from early carbon capture pilots to methane reduction in rice cultivation, represent the next frontier. This entire ecosystem is increasingly supported by rigorous measurement and verification protocols, with project selection requiring careful balance between cost, permanence, and the broader environmental and social impact that defines India's distinctive contribution to global carbon markets.

Innovation in Carbon Markets

Digital Measurement, Reporting and Verification (DMRV) is transforming carbon markets by leveraging satellite monitoring, AI, and IoT devices to dramatically improve accuracy and reduce verification costs. These technologies enable near-real-time tracking of carbon sequestration and emission reductions, addressing longstanding integrity concerns. Alongside, *blended finance models* are emerging, combining carbon credit revenue with public and private funding to enhance project viability and scale. Internationally, the implementation of Article 6 of the Paris Agreement is establishing new UN-backed rules to govern cross-border carbon trading between nations, aiming to prevent double-counting and ensure environmental integrity. Further enhancing transparency and accessibility, *tokenization* of carbon credits through blockchain technology is creating more liquid and fraud-resistant markets.

In the corporate sphere, leading companies are moving beyond simple offsetting to embed carbon credits into sophisticated climate strategies. This includes adopting *internal carbon pricing* as a shadow cost to guide low-carbon investment decisions, and pursuing *insetting*—reducing emissions within their own supply chains rather than relying solely on external credits. To make credible carbon neutral claims, firms are increasingly following the Science-Based Targets initiative (SBTi) guidance, ensuring their targets align with climate science. Finally, many are engaging in *portfolio diversification* by investing in a range of credit types—from nature-based solutions to engineered removals—to hedge risks and support multiple sustainable development goals alongside climate mitigation.

The Future of Carbon Markets

As the climate crisis escalates, carbon markets—systems that put a price on carbon emissions through trading permits or credits—are evolving from niche environmental tools into central pillars of the global financial and regulatory response. Their future is marked by greater scale, sophistication, and integration, driven by urgency and innovation.

The carbon market is undergoing a fundamental transformation, marked by four key trends. First, *regulatory convergence* is blurring the lines between voluntary and compliance markets, driven by demands for integrity, new global benchmarks like the Core Carbon Principles, and policies such as CBAM that make voluntary action a strategic necessity. Second, the market is expanding into a *broader nature-based*

asset marketplace, where biodiversity and water credits are emerging alongside carbon, allowing for portfolio diversification and integrated ecosystem financing. Third, *technological advancements* are dramatically reducing costs and enhancing credibility, with falling prices for direct air capture and AI-driven monitoring systems improving verification and transparency. Finally, carbon credits are seeing mainstream financial integration, evolving into a recognized asset class that attracts institutional investment, functions as a corporate hedge, and spurs the development of sophisticated market infrastructure.

Despite this rapid transformation, the future of carbon markets remains complex and faces several critical challenges. Success hinges on solving the integrity imperative—ensuring credits are truly additional, permanent, and socially responsible—as credibility is the foundation of all growth. Simultaneously, policy volatility creates uncertainty, where supportive regulations can catalyse markets, but political shifts can destabilize them. A further tension exists between market fragmentation and the need for global alignment, with Article 6 of the Paris Agreement striving to establish rules that prevent double-counting and enable international trading to achieve scale. Ultimately, demand must evolve from cheap offsetting to funding high-quality carbon removal as part of credible corporate net-zero strategies, ensuring markets finance what is scientifically essential rather than just convenient.

Conclusion

Carbon credits represent more than just permission to pollute—they are catalysts for sustainable development, directing private finance toward climate solutions that might otherwise remain unfunded. As standards tighten and transparency improves, this evolving commodity offers a pragmatic pathway to accelerate emission reductions while supporting communities and ecosystems worldwide. The challenge now lies in scaling high-integrity carbon markets that deliver measurable climate impact alongside sustainable development—transforming carbon from a waste product into a cornerstone of the green economy.

The success of this sustainable commodity will depend on continued innovation, rigorous standards, and unwavering commitment to genuine climate progress—ensuring every ton of carbon credited represents a real step toward a sustainable future.

India's carbon credit landscape represents a unique convergence of climate action and developmental priorities. From the solar parks of Rajasthan to the community forests of Nagaland, carbon projects are delivering measurable emission reductions alongside poverty alleviation, energy access, and ecosystem restoration. As India refines its domestic carbon market framework while engaging strategically in international markets, its diverse project portfolio offers a blueprint for how developing economies can harness carbon finance for sustainable growth.

The success of India's carbon market journey will depend on maintaining rigorous standards, ensuring equitable benefits, and continuously innovating across project types. With its scale, diversity, and commitment, India is poised not just to participate in the global carbon market, but to help redefine it for the 21st century—proving that economic development and climate action can advance together through the strategic use of carbon credits.

The future of carbon markets is evolving into an interconnected ecosystem where financial mechanisms, regulatory frameworks, and technological innovation converge to value climate and nature. This new paradigm will be defined by higher integrity through advanced verification and stricter standards, a broader scope that extends beyond carbon to include biodiversity and water, and deeper integration into global financial systems as a recognized asset class. Ultimately, success will be measured not by trading volume alone, but by the market's tangible and equitable contribution to stabilizing the climate and restoring ecosystems at the pace and scale demanded by science. This ongoing transformation is steadily moving carbon markets from the periphery to the core of the global economic response to the climate crisis.

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