Turning Emissions into Opportunities Through Carbon Credits and Offsets

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ABSTRACT

Carbon credits play a vital role in combating climate change by enabling both regulatory and voluntary efforts to reduce greenhouse gas emissions. As emissions from fossil fuels and deforestation rise, carbon credits offer a market-driven solution to support clean energy, reforestation, and sustainable practices. This report outlines how carbon credits function, their role in compliance and voluntary markets, and the impact of emerging technologies like blockchain, AI, and satellite monitoring in enhancing transparency and efficiency. It also addresses key challenges and highlights the growing importance of diversified, tech-enabled carbon markets in achieving global net-zero goals.

INTRODUCTION

A carbon credit represents the reduction or removal of one metric ton of CO_2 or its equivalent from the atmosphere. These credits are generated by verified projects such as reforestation, renewable energy and methane capture that either absorb CO_2 or prevent its emission. According to the Intergovernmental Panel on Climate Change, global temperatures have already risen by approximately 1.1°C above pre-industrial levels, leading to more frequent heatwaves, floods, and rising sea levels (IPCC,

2023). In response, carbon credits have been developed as a market-based tool to support and incentivize emission reduction efforts. Recognizing that not all emissions can be eliminated immediately, carbon credits enable meaningful progress through investment in clean energy, reforestation, and other sustainable practices. They offer flexibility in meeting climate targets while promoting environmental and economic benefits. Countries like New Zealand, Japan, Australia, and the U.S. have established mature carbon markets, while emerging economies such as China, India, South Korea, Mexico, Thailand, and Vietnam are developing robust systems, presenting new opportunities for climate-conscious investors and global sustainability efforts.

Types of carbon market

Compliance market (Carbon credit): Operated by governments or international agreements, where companies must buy credits if they exceed emissions limits, e.g., the European Union Emission Trading System (EU ETS), the cap-and-trade program (California), and the Regional Greenhouse Gas Initiative (RGGI).

Voluntary market (Carbon offset): Where individuals or businesses buy credits to offset their carbon footprint even if they are not legally required to do so, e.g. The Verified Carbon Standard (VCS), The Gold Standard, The Climate Action Reserve (CAR). By creating a financial incentive to reduce emissions, carbon credits help make environmental protection a viable business strategy.

How do carbon credits work?
A company that emits significant CO_2 through its operations can purchase carbon credits to meet emission reduction goals or regulatory requirements. A tradable permit representing one metric ton of CO_2 equivalent is allowed to be emitted. Credits often come from regulated / compliance markets or large-scale emission-reduction systems (Mehta, 2023). Some of the common categories include cap and trade allowances (EU ETS, California ETS), Industrial emission caps for power plants and factories, Carbon credit trading under national/regional regulatory schemes and credits allocated to companies that emit below their regulated limit. The various steps involved in carbon credit are as follows.

Implement emission reduction projects: The company invests in initiatives such as upgrading to energy-efficient technologies or switching to renewable energy sources to lower its emissions.

Generate carbon credits: These efforts result in carbon credits, each representing one metric ton of CO_2 emissions avoided or reduced.

Verification and certification: Independent auditors assess and confirm the actual emission reductions achieved by the project and ensure that it complies with recognized standards. Independent agencies like Carbon Check (India) Pvt. Ltd., KBS Certification Services Pvt. Ltd., TÜV SÜD South Asia Pvt. Ltd., Bureau Veritas, DNV (India Operations), and SGS India Pvt. Ltd. carryout the verification and certification process.

Issuance of carbon credits: After successful verification, the project is awarded carbon credits, typically one credit per ton of CO_2 equivalent emissions reduced.

Regulatory compliance: By buying carbon credits, the company offsets its excess emissions and demonstrates compliance with environmental regulations.

Support sustainable projects: Funds from carbon credit sales help finance ongoing projects focused on reducing emissions and promoting environmental sustainability.

Carbon offsets

A reduction or removal of one metric ton of CO_2 equivalent generated by a project, which is sold to compensate for emissions elsewhere. Offsets are usually from voluntary or project-based systems. The major carbon offset programs include reforestation and afforestation projects, renewable energy projects (solar, wind, hydro), methane capture (landfill gas, livestock manure digesters), soil carbon sequestration, REDD+ forest conservation, biochar application, waste management/composting, and energy efficiency upgrades.

Even individuals are increasingly participating in carbon offset programs, purchasing offsets to support environmental protection and raise awareness about climate conservation. Buying carbon offsets is simple and can be done online through various certified carbon offset providers. However, it is important to remember that purchasing carbon offsets is not a substitute for reducing our own carbon footprint. Everyone has a role to play in environmental preservation, and small lifestyle changes can lead to a meaningful impact (Gupta, 2011). Other effective steps, including carpooling, adopting a vegetarian diet, and reducing landfill wastes, can contribute significantly to reducing carbon emissions.

Table 1. Comparison of carbon credit and carbon offset

Aspect	Carbon credit	Carbon offset
Purpose	Regulated permits to emit or trade carbon	Voluntary projects to balance emissions
Market	Regulated with strict rules	Voluntary and flexible
Verification	Strict government or official checks	Certified by third parties
Use	Used by companies to meet legal limits	Used by individuals and companies voluntarily
Projects	Large industrial and renewable projects	Small to medium projects like tree planting

Benefits of carbon credits

Carbon credits provide strong incentives to reduce greenhouse gas emissions and support climate change mitigation (Fig. 1). They also promote environmental conservation, sustainable development, and attract investments in clean technologies. By enabling flexible compliance and enhancing corporate responsibility, carbon credits also encourage global cooperation toward a low-carbon future (Prajapati *et al.*, 2023).

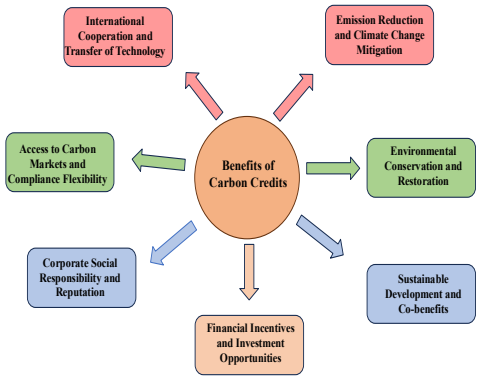

Figure 1. Multi-faceted benefits of implementing carbon credits

Emerging trends in carbon credit

The carbon credit market is becoming a key tool in fighting climate change by helping companies offset their emissions. New technologies are making the system more transparent, reliable, and easier to scale (Damayanti, 2024).

Blockchain for trust and transparency: Blockchain helps track carbon credits safely and clearly, reducing fraud. Smart contracts automate processes, saving time and money. Projects like Toucan Protocol by Brazil, Colombia, and Peru, and KlimaDAO by Japan, India and Bangladesh use this tech to trade carbon credits more efficiently.

AI and Machine Learning: AI tools use satellite and sensor data to better measure emissions and predict carbon credit prices. Satellites from NASA and other space agencies give real-time data on carbon and methane levels. This helps confirm how much carbon nature-based projects are actually removing, making the monitoring process more accurate and trading smarter.

New carbon removal methods: Technologies like Direct Air Capture (DAC) used by the USA, UK, Europe, China, Iceland, Switzerland, Canada, Norway, Kenya and natural methods like growing industrial hemp are being used to remove carbon in new, scalable ways.

Growth of voluntary markets: As more companies set climate goals, demand for carbon credits is growing. Technology is helping make the process faster, fairer, and more global.

Challenges and the future of carbon credits

Monitoring, reporting, and verification: To make sure carbon credit projects are trustworthy, we need reliable systems to measure and track emissions. Using clear rules and working together globally helps avoid counting the same emissions more than once and ensures accurate reporting.

Additionality and baseline setting: Carbon projects should only get credit if they reduce emissions that wouldn't have happened anyway. This means proving the project goes beyond normal business activities. Clear guidelines and checks from independent experts help make sure the impact is real.

Social and environmental safeguards: Projects should protect people, especially local communities and indigenous groups, as well as the environment. Listening to stakeholders, sharing benefits fairly, and making sure no harm is done are all important for long-term, positive results.

CONCLUSION

Carbon credits are a useful and practical way to help fight climate change by encouraging organizations and countries to reduce pollution and greenhouse gas emissions. Although there are some challenges, like the requirement of stronger verification systems and a positive carbon market, new technologies and international cooperation are making the system better and more trustworthy. As more countries and organizations commit to fighting climate change, the carbon credit market will continue to witness more nature-based solutions and interventions. By supporting new ideas, sustainable growth, and protecting the environment, carbon credits will continue to be an important part of climate action and business plans in the future.

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