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With this thought, we hereby present to you

LEGAL

<u>THE ROLE OF CARBON MARKETS IN GLOBAL</u> <u>CLIMATE ACTION: MECHANISMS,</u> <u>EFFECTIVENESS, AND FUTURE PROSPECTS</u>

AUTHORED BY - DR. RUJUTA SAMIR JOSHI

1. Introduction

The role of carbon markets in global climate action is increasingly vital as nations and industries face mounting pressure to curb greenhouse gas emissions and mitigate the adverse effects of climate change. ¹Carbon markets have emerged as a market-based solution to achieving emission reduction targets set by international frameworks like the Paris Agreement.² These systems allow entities—governments, businesses, and organizations—to buy and sell emission allowances or credits, thereby creating financial incentives to reduce emissions.³

Carbon markets are built on scientific and economic principles that seek to internalize the cost of greenhouse gas emissions. They function as mechanisms to incentivize emissions reductions by assigning a monetary value to carbon abatement.⁴ Assessment of their effectiveness involves examining their design, regulatory frameworks, market performance, and ability to deliver verified emissions reductions.

In addition to mitigating climate change, carbon markets generate significant co-benefits, including contributions to sustainable development and biodiversity conservation. Innovations such as digital monitoring, new methodologies for carbon sequestration, and cross-border credit trading are reshaping the landscape.

¹ United Nations Dev. Programme, *What Are Carbon Markets and Why Are They Important?*, **UNDP Climate Promise** (Oct. 5, 2022), <u>https://climatepromise.undp.org/news-and-stories/what-are-carbon-markets-and-why-are-they-important</u>.

² Accounting Insights, *Carbon Markets: Key Players, Credits, and Emission Reduction*, Accounting Insights (Oct. 26, 2023), <u>https://accountinginsights.org/carbon-markets-key-players-credits-and-emission-reduction/</u>.

³ ICF, *Carbon Markets: How India Can Meet Economy Goals by 2070*, ICF Climate Insights (Feb. 17, 2025), https://www.icf.com/insights/climate/india-carbon-markets-net-zero-2070.

⁴ Singapore's Carbon Markets Cooperation, *Benefits of Carbon Trading*, Singapore Government (Jan. 27, 2025), https://www.carbonmarkets-cooperation.gov.sg/our-article-6-cooperation/benefits-of-carbon-trading/.

Defining the role of carbon markets within the broader climate transition requires a critical understanding of operational mechanisms, persistent challenges such as additionality and market integrity, and emerging strategic opportunities for enhancing global climate action.

2. Foundational Principles of Carbon Markets

At the heart of carbon markets lies the principle of pricing carbon, which seeks to internalize the environmental costs associated with carbon emissions. By assigning a cost to carbon, these markets create financial incentives for companies and governments to reduce their greenhouse gas emissions. There are two primary mechanisms by which carbon markets operate: cap-andtrade systems and carbon offset programs.

In a cap-and-trade system, a regulatory body sets a cap on the total allowable emissions for a sector or jurisdiction. The cap is usually gradually reduced over time to ensure a steady decline in emissions. Companies or entities within the cap are allocated allowances or permits that permit them to emit a specified amount of carbon. If a company emits less than its allowance, it can sell its excess permits to others who need them. Conversely, if it exceeds its allowance, it must buy additional permits or face penalties. This creates a financial incentive for companies to reduce their emissions in order to save on purchasing additional allowances.⁵

Carbon offset programs, on the other hand, allow businesses and individuals to offset their emissions by investing in projects that reduce or capture carbon elsewhere. These projects may include initiatives like reforestation, renewable energy development, or methane capture. The carbon reductions from these projects are quantified and verified, and the credits generated can be traded on the market.⁶

Both mechanisms aim to reduce emissions by placing a price on carbon, thus promoting the adoption of cleaner technologies and practices. In theory, by creating a market for carbon, carbon markets harness the power of supply and demand to incentivize businesses to adopt more sustainable practices.

⁵ Investopedia, Cap and Trade, Investopedia (n.d.), https://www.investopedia.com/terms/c/cap-and-trade.asp.

⁶ Gala Anania, *What Are Carbon Offsets and How Do They Work?*, Earth.Org (Apr. 7, 2022), <u>https://earth.org/what-are-carbon-offsets/</u>.

3. Scientific and Economic Rationale for Carbon Pricing

The scientific basis for carbon pricing stems from the need to address the market failure caused by the externality of carbon emissions.⁷ Carbon emissions contribute to global warming, yet the costs associated with these emissions—such as rising temperatures, extreme weather events, and sea-level rise—are not borne by the emitter. Instead, they are imposed on society as a whole. By putting a price on carbon, carbon markets internalize this externality, making emitters pay for the environmental damage they cause. This pricing mechanism encourages emitters to consider the full cost of their activities, leading to more sustainable practices.

Economically, carbon pricing provides a flexible and efficient way to reduce emissions. By allowing market forces to determine the most cost-effective emission reduction strategies, carbon markets encourage businesses to find innovative solutions to reduce emissions at the lowest possible cost. This efficiency makes carbon markets an attractive policy tool, as they can achieve emission reductions at a lower cost than traditional regulatory approaches, which often require direct government intervention in specific industries or sectors.

Furthermore, carbon pricing signals to businesses that emissions are a financial liability, motivating them to invest in cleaner technologies and low-carbon alternatives.⁸ It also drives the development of new industries and innovations that can benefit from a low-carbon economy, such as renewable energy, energy storage, and carbon capture technologies.

4. Evaluating the Effectiveness of Carbon Markets

Evaluating the effectiveness of carbon markets requires a multidimensional analysis, incorporating both quantitative emission reductions and qualitative impacts such as institutional capacity, public perception, and policy coherence. Numerous studies and reports suggest that carbon markets when properly designed and implemented, can lead to significant reductions in emissions.⁹

⁷ Economatik Editors, *Carbon Conundrum: The Biggest Market Failure in the Face of Climate Change*, Economatik (Apr. 15, 2024), <u>https://economatik.com/news/1219130/carbon-conundrum-market-failure-and-climate-change</u>.

 ⁸ Robert G. Eccles & John Mulliken, Carbon Might Be Your Company's Biggest Financial Liability, HARV. BUS. REV. (Oct. 7, 2021), <u>https://hbr.org/2021/10/carbon-might-be-your-companys-biggest-financial-liability</u>.
⁹ Flues, F. and K. van Dender (2020), "Carbon pricing design: Effectiveness, efficiency and feasibility: An

⁹ Flues, F. and K. van Dender (2020), "Carbon pricing design: Effectiveness, efficiency and feasibility: An investment perspective", *OECD Taxation Working Papers*, No. 48, OECD Publishing, Paris, <u>https://doi.org/10.1787/91ad6a1e-en</u>.

For example, the European Union Emissions Trading System (EU ETS) has been credited with reducing emissions in the sectors covered like power generation and energy-intensive industries by over 50% since 2005.¹⁰ Its success is largely attributed to a declining cap, improvements in data transparency, and increasingly stringent allowance allocations. Similarly, California's Cap-and-Trade Program, aiming to achieve carbon neutrality by 2045 has shown measurable emissions reductions while supporting economic growth, illustrating the potential compatibility of climate policy and economic development.¹¹

India's government is in the process of implementing the Carbon Credit Trading Scheme (CCTS), which is designed to function as both a compliance and voluntary carbon market. The Bureau of Energy Efficiency (BEE) has been instrumental in drafting regulations for this scheme, with the final regulations expected to be adopted by mid-2026. These regulations will establish the operational framework for the market, including the issuance of Carbon Credit Certificates (CCCs) for verified emission reductions.¹²

However, carbon markets are not without challenges. Market oversupply, often due to overallocation of allowances or lack of demand, can lead to low carbon prices that fail to incentivize meaningful reductions. ¹³The initial phases of the EU ETS, for instance, suffered from low prices and volatility, undermining confidence in the system. The introduction of the Market Stability Reserve has been a corrective measure aimed at addressing this issue.¹⁴

Moreover, the integrity of offset credits, particularly in voluntary markets, has come under scrutiny. Questions around additionality, permanence, and the risk of carbon leakage have raised concerns about the actual environmental benefit of certain projects. Despite the existence of verification standards, the lack of uniform global governance over voluntary markets

¹⁰ **Press Release, Eur. Comm'n,** *EU Emissions Trading System Has Reduced Emissions in the Sectors Covered by 50% Since 2005* (Apr. 4, 2025), <u>https://climate.ec.europa.eu/news-your-voice/news/eu-emissions-trading-system-has-reduced-emissions-sectors-covered-50-2005-2025-04-04 en.</u>

¹¹ **California Air Resources Board,** *Cap-and-Trade Program* (Feb. 2025), <u>https://climatechangepolicies.legislature.ca.gov/system/files/2025-02/jlcccp_carb_2_26_25.pdf</u>.

¹² International Carbon Action Partnership (ICAP), India Adopts Regulations for Planned Compliance Carbon Market, ICAP (July 2024), <u>https://icapcarbonaction.com/en/news/india-adopts-regulations-planned-compliance-carbon-market?</u>

¹³ SG Analytics, *Double the Emissions Reductions: Could Carbon Markets Avert the Climate Crisis?* (Aug. 2, 2021), <u>https://www.sganalytics.com/blog/double-the-emissions-reductions-could-carbon-markets-avert-the-climate-crisis/</u>.

¹⁴ European Commission, *Market Stability Reserve*, Climate Action, <u>https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/market-stability-reserve_en</u> (last visited Apr. 30, 2025).

Effectiveness also depends on the broader policy context. Carbon markets tend to perform better when integrated into comprehensive climate strategies that include regulations, subsidies for clean technologies, and public investments in green infrastructure. Coordination with international climate commitments, such as Nationally Determined Contributions (NDCs) under the Paris Agreement, is crucial for ensuring consistency and reinforcing ambition.¹⁶

Ultimately, while carbon markets have demonstrated potential, their effectiveness hinges on continual refinement of design, enforcement, and integration with wider sustainability goals.

5. Emerging Trends and Innovations in Carbon Markets

As carbon markets mature, a number of emerging trends and innovations are shaping their trajectory and enhancing their potential impact on global climate goals.

One of the most notable developments is the expansion of voluntary carbon markets (VCMs). Driven by corporate climate pledges and consumer demand for sustainability, VCMs allow companies and individuals to purchase carbon credits to offset their emissions voluntarily. These markets are rapidly growing, with increasing focus on high-quality, nature-based solutions such as reforestation, soil carbon sequestration, and blue carbon initiatives. ¹⁷Innovations in digital MRV (Monitoring, Reporting, and Verification) technologies, including satellite imaging and blockchain, are enhancing transparency and traceability in these markets.¹⁸

Another important trend is the linking of carbon markets across jurisdictions. By enabling the mutual recognition of credits and coordinated cap levels, market linking can reduce compliance

¹⁵ **SG Analytics**, *Double the Emissions Reductions: Could Carbon Markets Avert the Climate Crisis?* (Aug. 2, 2021), <u>https://www.sganalytics.com/blog/double-the-emissions-reductions-could-carbon-markets-avert-the-climate-crisis/</u>.

¹⁶ Anjal Prakash, Nishant Gupta & Ayush Chakraborty, Investing in the Future: The Promise of Carbon Credits for India's Sustainable Growth, Forbes India (Mar. 4, 2025), https://www.forbesindia.com/article/isbinsight/investing-in-the-future-the-promise-of-carbon-credits-for-indiassustainable-growth/95470/1.

¹⁷ **Anders Porsborg-Smith et al.**, *Why the Voluntary Carbon Market Is Thriving*, Boston Consulting Group (Jan. 19, 2023), <u>https://www.bcg.com/publications/2023/why-the-voluntary-carbon-market-is-thriving</u>.

¹⁸ **Serena Oggero,** *The Digital Disruption of Carbon Markets: How Technology Is Transforming Projects, MRV, and Sales in Driving Climate Action*, South Pole (Mar. 24, 2025), <u>https://www.southpole.com/blog/the-digital-disruption-of-carbon-markets</u>.

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costs, improve market liquidity, and facilitate cross-border climate cooperation. ¹⁹The linkage between California's program and Quebec's cap-and-trade system serves as a successful example.²⁰ Discussions around linking other regional systems, such as the EU ETS and emerging systems in Asia, are ongoing.²¹

Southeast Asia's carbon pricing mechanisms are currently fragmented, with countries like Singapore and Indonesia exploring their own systems. Unlike the EU ETS, which has a unified approach, Southeast Asia's diverse regulatory environments pose challenges to creating a cohesive regional market. However, there is growing interest in exploring synergies and potential linkages among these systems.²²

Article 6 of the Paris Agreement represents a major policy innovation that could reshape global carbon trading. It provides a framework for countries to engage in voluntary cooperative approaches, including international transfer of mitigation outcomes (ITMOs). If operationalized effectively, Article 6 could significantly enhance global mitigation ambition by allowing countries to achieve their targets more cost-effectively while promoting sustainable development.²³

Additionally, the integration of carbon markets with broader financial instruments and ESG (Environmental, Social, and Governance) metrics is gaining traction. Institutional investors are increasingly factoring carbon exposure into risk assessments, driving demand for credible carbon pricing mechanisms. Carbon markets are also beginning to intersect with green bonds, ²⁴climate risk disclosure frameworks, and sustainability-linked loans, creating a more interconnected climate finance ecosystem.

¹⁹ **Thomas Kansy**, *Making the Links Between Carbon Markets in a Post-Paris World*, World Bank Blogs (Dec.

^{2, 2016), &}lt;u>https://blogs.worldbank.org/en/climatechange/making-links-between-carbon-markets-post-paris-world</u>. ²⁰ **California Air Resources Board et al.**, *Governments of the Three Jurisdictions Issue Joint Statement on Potential to Form Shared Carbon Market: California, Québec, and Washington Agree to Explore Linkage*, Gouvernement du Québec (Mar. 20, 2024), <u>https://www.quebec.ca/en/news/actualites/detail/governments-of-the-three-jurisdictions-issue-joint-statement-on-potential-to-form-shared-carbon-market-california-quebec-and-washington-agree-to-explore-linkage-54493.</u>

²¹ **Angela Sun**, *East Meets West: Linking the China and EU ETS's*, Kleinman Center for Energy Policy (June 3, 2022), <u>https://kleinmanenergy.upenn.edu/research/publications/east-meets-west-linking-the-china-and-eu-etss/</u>.

²² **Reccessary,** 2024 Carbon Forward Asia In-Depth Analysis, Reccessary (Mar. 2024), https://www.reccessary.com/en/research/2024-carbon-forward-asia-in-depth-analysis?

²³ Paris Agreement, Dec. 12, 2015, U.N. Doc. FCCC/CP/2015/L.9/Rev.1.

²⁴ Xiaohang Ren, Yiying Li, Cheng Yan, Fenghua Wen & Zudi Lu, *The Interrelationship Between the Carbon Market and the Green Bonds Market: Evidence from Wavelet Quantile-on-Quantile Method*, Technological Forecasting and Social Change, Volume 179, Article 121611 (June 2022)

Finally, there is growing interest in hybrid approaches that combine market-based and regulatory tools. For instance, carbon pricing can be paired with performance standards or sector-specific regulations to ensure baseline compliance while encouraging innovation.²⁵

These trends reflect an evolving landscape where carbon markets are not static instruments but dynamic tools that adapt to new scientific, economic, and political realities. Innovation will be key to expanding their role in a just and effective global climate transition.

6. Co-Benefits of Carbon Markets

Carbon markets not only help mitigate climate change but also provide several co-benefits, including enhanced biodiversity conservation, improved air quality, and the promotion of sustainable development. The development of carbon offset projects, especially those focused on reforestation and sustainable land management, can contribute to the restoration of ecosystems, provide habitat for endangered species, and reduce the risk of deforestation. Additionally, carbon markets can facilitate the transfer of technology and knowledge to developing countries, helping them leapfrog to more sustainable development paths.²⁶

7. Future Prospects and Strategic Recommendations

The future of carbon markets will be shaped by ongoing innovations, evolving political landscapes, and the growing urgency to meet global climate goals. To maximize their potential, several strategic recommendations must be considered to enhance their effectiveness and ensure their alignment with broader climate and development objectives.

i. Strengthening Governance and Transparency

The effectiveness of carbon markets depends heavily on strong governance frameworks that ensure transparency, accountability, and credibility. In the case of both compliance and voluntary markets, it is crucial to establish global standards for carbon credit issuance, verification, and monitoring. A unified global carbon market or a more closely integrated network of national and regional markets would enhance both market stability and the environmental integrity of carbon credits. Establishing independent

²⁵ Sweta Sen & Pravakar Sahoo, *Carbon Pricing for Sustainable Transition in India*, World Development Perspectives, Volume 34, Article 100586 (June 2024), DOI: 10.1016/j.wdp.2024.100586.

²⁶ Second Nature, *Co-Benefits of Carbon Offset Projects* (Rev. 5), Second Nature, <u>https://secondnature.org/wp-content/uploads/Co-Benefits-Document-Rev5.pdf</u>.

verification systems, backed by reliable data and robust auditing processes, will help address concerns about the credibility of offset projects, particularly in voluntary markets.²⁷

At the same time, the introduction of global rules for carbon pricing and the harmonization of carbon tax rates across jurisdictions would support global cooperation and mitigate the risk of carbon leakage. By creating a level playing field, businesses would face uniform pricing signals, enhancing fairness and reducing competitive disadvantages in international trade.²⁸

ii. Integrating Carbon Markets with Broader Climate Strategies

Carbon markets should not operate in isolation; they need to be integrated into broader climate and sustainability strategies. The linkage between carbon markets and other policy instruments—such as renewable energy incentives, energy efficiency programs, and technology subsidies—can strengthen market dynamics and boost overall emissions reductions. Moreover, ensuring that carbon pricing is aligned with national and regional climate goals, including Nationally Determined Contributions (NDCs), will provide clarity and direction for both market participants and policymakers.²⁹

A comprehensive policy mix would also help address any distributional challenges that carbon pricing might create. Carbon markets can sometimes exacerbate inequalities, particularly in developing countries, where carbon pricing can raise the costs of energy and other basic goods. Governments must prioritize the use of revenues generated by carbon markets for social programs, green energy development, and climate adaptation initiatives to ensure an equitable transition. The integration of social safeguards, such as equity assessments and inclusive policymaking, will be essential to making carbon markets a just tool for climate action.

iii. Strengthening Market Liquidity and Demand

One of the recurring challenges faced by carbon markets, particularly in their early

²⁷ **The Climate Warehouse**, *Carbon Markets Infrastructure Working Group*, The Climate Warehouse, <u>https://www.theclimatewarehouse.org/work/carbon-markets-infrastructure-working-group</u>.

²⁸ https://bcesg.org/business-continuity-esg-blog/global-leaders-adopt-key-rules-and-guidelines-forinternational-carbon-trading-in-november-2024-to-facilitate-the-development-of-rob-1736092918457

²⁹ Laura Lasso de la Vega, Leveraging Carbon Pricing Policies for NDC Achievement, UNFCCC RCC Latin America,

https://www.cepal.org/sites/default/files/presentations/carbon_pricing_for_ndc_laura_lasso_unfccc.pdf.

stages, is market liquidity. ³⁰Ensuring there is sufficient demand for carbon credits is critical for maintaining a functional market. This can be achieved through a combination of government mandates, increased corporate demand, and the growing consumer demand for sustainability. To strengthen market liquidity, it is essential to involve a wide range of market participants, including governments, businesses, financial institutions, and civil society organizations.

Moreover, initiatives to link existing carbon markets across jurisdictions could improve market liquidity by expanding the pool of buyers and sellers, leading to more stable and predictable pricing. Developing long-term contracts and futures markets for carbon credits could also provide greater market certainty, reducing price volatility and making carbon markets more attractive to investors.

iv. Advancing Technological Innovation

Technological innovation will play a crucial role in improving the efficiency and impact of carbon markets. The continued development of accurate monitoring, reporting, and verification (MRV) technologies will be key to ensuring the integrity of carbon credits and enabling accurate measurement of emissions reductions.³¹ Technologies like satellite imaging, blockchain, and AI-based analytics are revolutionizing the transparency and traceability of carbon projects, allowing for real-time monitoring and verification of emissions reductions at scale.

In parallel, innovations in carbon capture, utilization, and storage (CCUS) technologies offer significant potential for large-scale emissions reductions.³² These technologies could be integrated into carbon markets, providing additional opportunities for emission offsets while encouraging the development of cutting-edge solutions. Governments, research institutions, and the private sector must collaborate to accelerate the deployment of CCUS technologies and ensure they are integrated into carbon market frameworks.

³⁰ **Hemal Shah,** *Carbon Trading: A New Era in Commodity Markets*, EY India (Mar. 21, 2025), <u>https://www.ey.com/en in/insights/sustainability/carbon-trading-a-new-era-in-commodity-markets</u>.

³¹ GreenUp, Understanding MRV Technology for Carbon Credits, GreenUp (2024), https://greenup.asia/understanding-mrv-technology-for-carbon-credits/.

³² **International Energy Agency**, *Carbon Capture Utilisation and Storage*, IEA, <u>https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage</u>.

v. Supporting the Growth of Voluntary Carbon Markets

Voluntary carbon markets (VCMs) have experienced significant growth in recent years, driven by corporate climate pledges, consumer demand, and increasing awareness of environmental issues. To continue this momentum, it is critical to establish robust governance mechanisms, including clear standards for credit issuance and verification, to build consumer trust and ensure environmental integrity. Expanding the scope of VCMs to include more diverse types of carbon offset projects, including nature-based solutions, can contribute to sustainable development and enhance the appeal of voluntary carbon credits.³³³⁴

8. Conclusion

The potential of carbon markets to address global climate change is significant, but their success depends on the ongoing refinement of their design, governance, and integration with wider climate strategies. With a focus on innovation, policy alignment, and broad participation, carbon markets can play a central role in mitigating climate change, driving economic transformation, and fostering international cooperation toward a low-carbon future.



³⁴ **CFA Institute**, *Enhancing the Voluntary Carbon Market: Gaps and Solutions*, CFA Institute (2025), https://rpc.cfainstitute.org/research/reports/2025/enhancing-the-voluntary-carbon-market.