

Carbon Trading: A Key Mechanism for Climate Change Mitigation under the Kyoto Protocol and, Empowering Businesses and Encouraging Environmental Responsibility

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SUMMARY

Carbon trading, also known as emissions trading or cap-and-trade, is an economic approach to mitigating climate change by placing a price on carbon emissions. This abstract provides an overview of carbon trading, its mechanisms, and its role in addressing climate change. It explores the concept of carbon markets, where entities can buy and sell carbon credits representing emissions allowances. The abstract discusses the benefits of carbon trading, such as providing financial incentives for emission reductions, promoting cost-effective mitigation strategies, and fostering innovation. Additionally, it examines the challenges associated with carbon trading, including the establishment of robust monitoring and verification systems, ensuring environmental integrity, and addressing concerns of equity and distributional impacts. By highlighting the key aspects of carbon trading, this abstract contributes to a deeper understanding of its potential as a market-based mechanism to drive greenhouse gas emissions reductions and transition to a low-carbon economy.

INTRODUCTION

Carbon trading—also known as emissions trading or cap-and-trade—reduces greenhouse gas emissions through market forces. It involves purchasing and selling carbon dioxide or greenhouse gas emission permits or credits (Bryner *et al.*, 2003). Carbon trading encourages emission reduction, cost-effective mitigation, and global climate change mitigation. Carbon trading assumes that greenhouse gas emissions cause climate change and cost society. Carbon trading encourages companies to reduce emissions by pricing carbon. It lets entities with lower emission reduction costs sell their surplus allowances or credits to others with higher expenses. A carbon trading scheme caps greenhouse gas emissions in a jurisdiction or sector. Permits or allowances allow greenhouse gas emissions. Emitters must buy more permits or credits or face penalties. Emitters with excess permits or credits can sell them. In the 1990s, carbon trading became a policy instrument to reduce greenhouse gas emissions cost-effectively. The 1992 UNFCCC created carbon trading. The Clean Development Mechanism (CDM) and Joint Implementation (JI) provisions of the 1997 UNFCCC Kyoto Protocol formalized carbon trading. Developed countries could invest in emission reduction initiatives in poor countries and get CERs through the CDM. JI allowed developed countries to reduce emissions in other developed countries and gain ERU credits. These procedures established international carbon trading and compliance and voluntary markets. Since then, carbon trading has been adopted in many regions and countries, notably the 2005 EU Emissions Trading Scheme (EU ETS), the world's largest carbon market. California, China, and South Korea also have carbon trading schemes. Carbon trading mechanisms have improved and adapted throughout time. Carbon trading is being improved to reduce greenhouse gas emissions and accelerate the low-carbon economy.

Carbon Trading Mechanisms

Carbon trading mechanisms, also known as emissions trading mechanisms, are designed to facilitate the buying and selling of carbon credits or permits as part of a market-based approach to reducing greenhouse gas emissions (Hepburn *et al.*, 2007). Here are some key details on carbon trading mechanisms:

- **Cap-and-Trade:** The most common carbon trading mechanism is the cap-and-trade system. Under this mechanism, a regulatory authority sets a cap or limit on the total amount of greenhouse gas emissions allowed from covered sectors or entities. Permits or allowances are issued, each representing the right to emit a specific amount of greenhouse gases. These permits can be bought, sold, or traded among participants in the market.
- **Emissions Permits or Allowances:** Emissions permits or allowances are the tradable units in carbon trading mechanisms. These permits are typically allocated to entities based on their historical emissions, sector-specific benchmarks, or auctioning. Each permit represents a specific quantity of greenhouse gas emissions. Entities must hold enough permits to cover their emissions; otherwise, they face penalties or compliance obligations.
- **Compliance Markets:** Compliance markets are established to ensure that entities covered by the carbon trading mechanism meet their emissions obligations. Participants must surrender enough permits or allowances to

cover their actual emissions. Compliance markets create a demand for permits and provide a platform for entities to buy or sell permits to maintain compliance.

- **Voluntary Carbon Markets:** In addition to compliance markets, voluntary carbon markets exist where organizations or individuals voluntarily purchase carbon credits to offset their emissions. These credits represent emission reductions or removals achieved from projects that are not covered by regulatory requirements. Voluntary carbon markets offer flexibility for entities to go beyond their compliance obligations and support additional emission reduction activities.
- **Trading Platforms:** Carbon trading relies on trading platforms or exchanges where buyers and sellers can interact and trade carbon credits or permits. These platforms provide a centralized marketplace for participants to conduct transactions and ensure transparency and liquidity in the market. Trading platforms can be operated by governments, industry associations, or private entities.
- **Offset Projects:** Carbon trading mechanisms support offset projects that generate carbon credits. These projects involve activities that reduce or remove greenhouse gas emissions, such as renewable energy projects, reforestation, methane capture, or energy efficiency initiatives. Each project is independently verified to ensure the credibility and integrity of the emission reductions achieved.
- **Market Mechanisms:** Carbon trading mechanisms can incorporate market mechanisms to ensure price stability and provide flexibility to market participants. These mechanisms can include price floors, price ceilings, reserve allowances, or other measures that influence the supply and demand dynamics in the market. Market mechanisms aim to avoid excessive price volatility and provide long-term certainty for participants.
- **International Carbon Trading:** International carbon trading mechanisms enable countries to meet their emission reduction commitments through international cooperation. Mechanisms like the Clean Development Mechanism (CDM) and Joint Implementation (JI) allow developed countries to invest in emission reduction projects in developing countries. This enables emission reductions to be achieved where it is most cost-effective and helps transfer sustainable technologies and practices to developing nations.
- **Carbon trading mechanisms provide economic incentives for emission reductions, promote cost-effective mitigation strategies, and foster innovation in clean technologies. They rely on accurate measurement, reporting, and verification systems to ensure the environmental integrity of emission reductions and the credibility of traded permits or credits.**

The Kyoto Protocol

The Kyoto Protocol is an international treaty adopted in 1997 under the United Nations Framework Convention on Climate Change (UNFCCC). It introduced the concept of carbon trading as a means to address global greenhouse gas emissions (Dumanski, 2004; Morgan, 2006). Here are some key details about the Kyoto Protocol and its relationship to carbon trading:

- **Objective:** The primary objective of the Kyoto Protocol is to reduce greenhouse gas emissions to combat climate change. It sets binding emission reduction targets for developed countries, known as Annex I countries, for the commitment period from 2008 to 2012.
- **Cap-and-Trade Mechanisms:** The Kyoto Protocol established two market-based mechanisms for achieving emission reductions: the Clean Development Mechanism (CDM) and Joint Implementation (JI).
- **Clean Development Mechanism (CDM):** The CDM allows developed countries to invest in emission reduction projects in developing countries. Projects that result in verifiable emission reductions can earn Certified Emission Reductions (CERs), which represent one tonne of carbon dioxide equivalent (CO₂e) reduction. CERs can be used by developed countries to meet their emission reduction targets or can be traded in carbon markets.
- **Joint Implementation (JI):** Joint Implementation enables developed countries to undertake emission reduction projects in other developed countries. Projects that result in emission reductions earn Emission Reduction Units (ERUs), which are similar to CERs. ERUs can be used by countries to meet their emission reduction targets or traded in carbon markets.
- **Emission Reduction Commitments:** The Kyoto Protocol sets specific emission reduction targets for Annex I countries, collectively aiming to reduce their emissions by at least 5% below 1990 levels during the commitment period.
- **Compliance and Trading:** The Kyoto Protocol introduced compliance markets, where Annex I countries must meet their emission reduction commitments. Carbon trading plays a crucial role in compliance markets, allowing countries to trade assigned amount units (AAUs) representing their emission allowances. AAUs can be bought or sold to facilitate compliance with emission reduction targets.

- **Market-Based Flexibility:** The carbon trading mechanisms established by the Kyoto Protocol provide flexibility for Annex I countries to achieve their emission reduction targets. By allowing emissions reductions to occur in other countries, where they may be more cost-effective, carbon trading promotes the efficient allocation of mitigation efforts.
- **Legacy and Evolution:** While the Kyoto Protocol's commitment period ended in 2012, the carbon trading mechanisms introduced under the protocol laid the groundwork for subsequent international carbon markets and trading systems. Lessons learned from the Kyoto Protocol have informed the development of newer initiatives, such as the Paris Agreement and its market mechanisms, including the Sustainable Development Mechanism (SDM).
- The Kyoto Protocol and its carbon trading mechanisms aimed to promote international cooperation in reducing greenhouse gas emissions, facilitate sustainable development, and encourage the transfer of environmentally sound technologies. Although the Kyoto Protocol has transitioned to newer global climate agreements, its legacy in advancing carbon trading and market-based approaches to address climate change remains significant.

Carbon trading exchanges

Carbon trading exchanges are platforms where buyers and sellers can trade carbon credits or permits. These exchanges provide a centralized marketplace for participants to conduct transactions, ensuring transparency and liquidity in the carbon market. Here are some notable carbon trading exchanges:

- **European Energy Exchange (EEX):** The EEX is one of the largest carbon trading exchanges in the world. It operates the European Union Emissions Trading System (EU ETS) spot and derivatives markets, facilitating the trading of European Union Allowances (EUAs) and Certified Emission Reductions (CERs).
- **Intercontinental Exchange (ICE):** ICE operates several carbon trading exchanges, including ICE Futures Europe, where EUAs and Certified Emission Reductions (CERs) are traded. ICE also operates ICE Futures US, which facilitates trading of California Carbon Allowances (CCAs) under California's cap-and-trade program.
- **Chicago Climate Exchange (CCX):** The CCX was the first voluntary carbon trading exchange in North America. It operated from 2003 to 2010 and facilitated the trading of emission allowances and offsets. Although it is no longer active, it played a significant role in early carbon trading efforts.
- **California Carbon Market:** California has its own carbon market, established under the state's cap-and-trade program. The California Air Resources Board (CARB) operates the Western Climate Initiative (WCI) market, where participants trade California Carbon Allowances (CCAs).
- **Shanghai Environment and Energy Exchange (SEEE):** SEEE is a Chinese carbon trading exchange that operates China's national carbon market, the largest carbon market in the world. It facilitates the trading of carbon allowances and offsets, including China Certified Emission Reductions (CCERs).
- **Emission Trading Registry:** The Emission Trading Registry is an online platform established by the United Nations Framework Convention on Climate Change (UNFCCC). It serves as a registry for carbon credits and allows participants to transfer and track emissions units issued under the Kyoto Protocol's market mechanisms, including Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs).
- **Over-the-Counter (OTC) Markets:** In addition to dedicated carbon trading exchanges, some transactions occur through over-the-counter markets, where buyers and sellers directly negotiate and trade carbon credits or permits outside of formal exchange platforms. OTC markets provide flexibility and can complement exchange-based trading.
- These exchanges and platforms play a crucial role in facilitating the trading of carbon credits, providing liquidity, price discovery, and transparency in carbon markets. They enable participants, including governments, companies, and individuals, to buy and sell carbon credits to comply with regulatory requirements, offset emissions, or voluntarily support emission reduction efforts.

Types of carbon credits

There are several types of carbon credits, also known as carbon offsets or emission reduction credits, which represent a reduction or removal of greenhouse gas emissions (Wang *et al.*, 2022). These credits can be used to offset emissions, comply with regulatory requirements, or support sustainable projects. Here are some types of carbon credits:

- **Verified Emission Reductions (VERs):** Verified Emission Reductions are carbon credits generated from projects that have undergone independent verification and certification processes. These projects can be in

various sectors, such as renewable energy, energy efficiency, forestry, or methane capture. VERs is commonly used in voluntary carbon markets.

- **Certified Emission Reductions (CERs):** Certified Emission Reductions are carbon credits generated from projects implemented under the Clean Development Mechanism (CDM) established by the Kyoto Protocol. CERs are issued for emission reductions achieved in developing countries and can be used by developed countries to meet their emission reduction targets.
- **Emission Reduction Units (ERUs):** Emission Reduction Units are carbon credits generated from projects implemented under the Joint Implementation (JI) mechanism of the Kyoto Protocol. ERUs are issued for emission reductions achieved in developed countries. They can be used by countries to meet their emission reduction targets or traded in carbon markets.
- **Offset Project Credits:** Offset Project Credits refer to carbon credits generated from specific projects that reduce or remove greenhouse gas emissions. These projects can include renewable energy installations, energy efficiency initiatives, methane capture projects, afforestation, or reforestation efforts. Offset Project Credits are typically verified and certified by recognized standards and can be used for compliance or voluntary purposes.
- **Renewable Energy Certificates (RECs):** Renewable Energy Certificates represent the environmental attributes of electricity generated from renewable energy sources. RECs are used to incentivize the development and use of renewable energy. They are commonly traded in separate markets but can also be considered a form of carbon credit, as they represent the avoidance of greenhouse gas emissions from fossil fuel-based electricity generation.
- **Voluntary Carbon Units (VCUs):** Voluntary Carbon Units are carbon credits generated from projects that reduce or remove greenhouse gas emissions outside of regulatory compliance obligations. VCUs are commonly used in voluntary carbon markets and can be generated from a wide range of projects, including renewable energy, energy efficiency, reforestation, or waste management initiatives.
- **Carbon Removal Credits:** Carbon Removal Credits represent the removal of carbon dioxide from the atmosphere through natural or technological processes. These credits can be generated from projects such as afforestation, reforestation, direct air capture, or carbon capture and storage (CCS) technologies.

Carbon Offsets: Carbon offsets are a mechanism to compensate for greenhouse gas emissions by investing in projects that reduce or remove emissions elsewhere (Becken *et al.*, (2017)). They represent a reduction in greenhouse gas emissions or the removal of carbon dioxide from the atmosphere. Offset projects can include renewable energy installations, energy efficiency initiatives, reforestation efforts, or methane capture projects. Additionally ensures that the emission reductions achieved through offsets are additional and would not have happened without financial support. Verification and certification processes validate the emission reductions and provide transparency to the market.

Carbon Trading: Carbon trading is a market-based approach to reducing greenhouse gas emissions. It involves the buying and selling of permits or credits that represent the right to emit a certain amount of carbon dioxide or other greenhouse gases. Cap-and-trade systems set a limit on total emissions and allow entities to trade emission allowances. Trading provides economic incentives for entities to reduce emissions in a cost-effective manner. Compliance markets require entities to meet emission reduction obligations, while voluntary markets allow entities to offset emissions voluntarily. Carbon offsets are often integrated into carbon trading systems to achieve additional emission reductions and provide flexibility for entities.

Advantages of Carbon Trading:

- **Economic Efficiency:** Carbon trading promotes economic efficiency by creating a market for emissions reductions. It incentivizes entities to find the most cost-effective ways to reduce emissions, as those with lower costs can sell their surplus allowances to entities with higher costs. This encourages the deployment of innovative and cost-effective emission reduction technologies and practices.
- **Flexibility and Scalability:** Carbon trading provides flexibility for entities to choose the most suitable emission reduction strategies for their operations. It allows for a diverse range of projects and sectors to participate, including renewable energy, energy efficiency, forestry, and more. The scalability of the carbon market enables it to accommodate a large number of participants and a wide range of emission reduction goals.
- **Market-Based Approach:** Carbon trading is a market-based approach to reducing emissions, aligning with principles of supply and demand. It leverages market forces to drive emission reductions and provides

incentives for businesses to invest in cleaner technologies and practices. This approach fosters competition, innovation, and cost-effective solutions for emission reductions.

- **Emission Certainty:** Carbon trading systems set a cap on emissions, providing certainty and predictability for emission reductions. This helps governments, businesses, and investors plan and invest in low-carbon technologies and projects. The trading of emission allowances allows for flexibility in meeting emission targets while ensuring overall emission reductions are achieved.
- **International Cooperation:** Carbon trading can facilitate international cooperation and collaboration on climate change mitigation. It allows countries and entities to trade emissions allowances or offsets across borders, encouraging emission reductions where they are most cost-effective. It provides opportunities for developed countries to support emission reductions in developing countries through offset projects.
- **Revenue Generation and Investment:** Carbon trading can generate revenue for governments through the auctioning or sale of emission allowances. This revenue can be reinvested in climate-related initiatives or used to support vulnerable communities impacted by climate change. Additionally, carbon trading attracts investment in low-carbon projects and technologies, driving green economic growth and job creation.
- **Environmental Integrity:** Carbon trading systems incorporate verification and monitoring processes to ensure the integrity of emission reductions and carbon offsets. This helps maintain the credibility and transparency of the market, ensuring that emission reductions achieved are accurately measured and verified.
- **Carbon trading offers an effective and market-driven approach to reducing greenhouse gas emissions. It combines economic efficiency, flexibility, and international cooperation to drive emission reductions and promote the transition to a low-carbon economy.**

CONCLUSION

Carbon trading plays a crucial role in global efforts to combat climate change. The Kyoto Protocol and subsequent international agreements have provided a framework for its implementation, and carbon trading exchanges serve as important platforms for trading carbon credits. The advantages of carbon trading include financial incentives for emission reductions, cost-effective mitigation strategies, and opportunities for technological innovation. Nonetheless, addressing challenges related to monitoring, equity, and environmental integrity will be essential to ensure the continued success of carbon trading as a mechanism for reducing greenhouse gas emissions and transitioning to a low-carbon economy.

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