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Regulatory Framework of Carbon Markets and Their Impacts: A Cross-Country Study of Indonesia, the European Union, China, and the United States

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Abstract

Climate change represents a significant global challenge that demands coordinated policy responses to reduce greenhouse gas (GHG) emissions. Among the key instruments employed is the carbon market, comprising emission trading systems and carbon taxes, which aim to place a price on carbon emissions and incentivize efficient emission reductions. This study seeks to evaluate the regulatory frameworks and effectiveness of carbon markets in Indonesia compared to those in the European Union, China, and the United States. Indonesia initiated its carbon market regulation through Presidential Regulation No. 98 of 2021 on Carbon Economic Value (NEK) and launched the Indonesia Carbon Exchange (IDXCarbon) in 2023. However, its implementation faces several challenges, including limited private sector

participation, legal uncertainty, weak Monitoring, Reporting, and Verification (MRV) mechanisms, risks of double counting, and a lack of coordination among relevant institutions. Comparative analysis with the systems in the European Union, China, and the United States underscores the critical importance of strengthening MRV infrastructure, harmonizing domestic regulations with international frameworks such as the Carbon Border Adjustment Mechanism (CBAM), encouraging active private sector engagement, and adopting a phased and targeted policy approach. The findings of this study offer recommendations for improving the implementation of Indonesia's carbon market to effectively and sustainably achieve climate change mitigation targets, contributing to the broader goals of the Sustainable Development Goals (SDGs), particularly Goal 13 on Climate Action.

A. PENDAHULUAN

Climate change has emerged as one of the greatest global challenges facing the world today. The increasing concentration of greenhouse gases (GHGs) in the atmosphere, primarily resulting from human activities in sectors such as industry, transportation, and energy, has led to global warming. This phenomenon impacts multiple aspects of life, including rising global average temperatures, extreme weather events, and sea-level rise. In response, various countries have implemented carbon emission mitigation policies, one of which is through the carbon market mechanism.

The carbon market is an economic instrument that assigns a price to carbon emissions, aiming to promote the efficient and sustainable reduction of greenhouse gas emissions. Two primary approaches commonly applied in carbon markets are the Emissions Trading System (ETS) and the carbon tax. The European Union (EU) has pioneered the application of an ETS through the European Union Emissions Trading System (EU ETS), recognized as one of the

most developed carbon market schemes globally. Meanwhile, China has begun implementing its national ETS as part of its commitment to climate change mitigation. In the United States (US), carbon market regulations are more decentralized, with several states, such as California, operating their own emissions trading systems. As a developing country committed to achieving Net Zero Emissions (NZE) by 2060, Indonesia has introduced carbon market regulations through Presidential Regulation No. 98 of 2021 on Carbon Economic Value (NEK) and launched the Indonesia Carbon Exchange (IDXCarbon) in 2023.

Although many countries have adopted carbon market mechanisms, variations exist in terms of regulation, coverage, and effectiveness. Cross-country studies are essential to understand how carbon market policies in different jurisdictions influence emission reductions and their impacts on economic and industrial sectors. Therefore, this study aims to evaluate the regulatory frameworks and impacts of carbon markets in Indonesia, the European Union, China, and the United States, providing a comprehensive understanding of the effectiveness of these policies at the global level.

Climate change presents a significant global challenge that requires coordinated efforts to reduce GHG emissions. The carbon market has emerged as a market-based mechanism that incentivizes emission reductions by assigning a cost to carbon emissions. The effectiveness of these markets largely depends on the regulatory frameworks that govern their operation. This study explores the regulatory structures of carbon markets in Indonesia, the EU, China, and the US, and assesses how these frameworks influence the success of carbon markets.

Based on the background outlined above, several key research questions are formulated to provide deeper insights into the differences in carbon market policies across countries and their environmental and economic impacts. The research questions addressed in this study are: How are the regulatory framework and effectiveness of the carbon market implemented in Indonesia? What lessons can be learned from the comparative analysis of carbon market regulations to improve Indonesia's carbon market policies?

B. ANALYSIS AND DISCUSSION

1. Definition and Concept of Carbon Markets

The carbon market is a market-based mechanism aimed at reducing greenhouse gas (GHG) emissions by assigning a price to the carbon

released into the atmosphere (Stavins, 2019). This mechanism enables entities, including countries and corporations, to buy and sell emission allowances, particularly for carbon dioxide (CO_2) (Bagaskara, 2024). Each allowance or carbon credit represents the right to emit one metric ton of CO_2 or its equivalent in other greenhouse gases. The primary objective of carbon markets is to create economic incentives for the efficient and effective reduction of GHG emissions (Bagaskara, 2024).

The concept of the carbon market is rooted in environmental economics, where market-based instruments are employed to address the externalities associated with pollution. Two major approaches in the carbon market are the Emissions Trading System (ETS) and carbon tax mechanisms (Ellerman et al., 2016). Both ETS and carbon taxes serve as primary tools for internalizing the social costs of carbon emissions, thereby encouraging emitters to reduce their carbon footprint. The design and implementation of these instruments are crucial, as they determine the market efficiency, environmental integrity, and economic impact of the system.

Previous studies have highlighted the effectiveness of both approaches in reducing emissions and their economic impacts across various countries (Aldy & Stavins, 2012). ETS, as part of carbon markets, operates under a cap-and-trade system, where the government sets a total cap on emissions and distributes allowances to entities (Efifah, 2024). Entities that successfully reduce their emissions below their allotted cap can sell surplus allowances to those who exceed their limits, thereby creating economic incentives for innovation and efficiency in emission reductions. Carbon markets serve as a tool to achieve emission reduction targets at lower costs compared to direct regulatory approaches (Cernansky, 2023). By putting a price on carbon emissions, the market drives investment into clean technologies and environmentally friendly practices. Moreover, carbon markets can contribute to sustainable development by channeling funds into emission reduction projects in developing countries.

2. Regulatory Framework and Effectiveness of the Carbon Market Implemented in Indonesia

Indonesia has only recently begun developing its carbon market regulatory framework with the issuance of Presidential Regulation No. 98

of 2021 on Carbon Economic Value (NEK) and the launch of the Indonesia Carbon Exchange (IDXCarbon) in 2023 (Ministry of Finance, Republic of Indonesia, 2023). This regulation was introduced to achieve the targets set out in Indonesia's Nationally Determined Contributions (NDC) and to control greenhouse gas (GHG) emissions within the framework of national development. Preliminary studies indicate that the regulation holds considerable potential but still faces significant challenges in cross-sectoral policy harmonization (Siregar & Santoso, 2023).

In addition to Presidential Regulation No. 98 of 2021, several other regulatory instruments form the basis of Indonesia's carbon market framework. These include Law No. 4 of 2023 on the Development and Strengthening of the Financial Sector (UU PPSK) and Financial Services Authority Regulation (POJK) No. 14 of 2023 on Carbon Trading through the Carbon Exchange. The PPSK Law establishes carbon units as financial securities tradable in the capital market, while POJK No. 14/2023 sets out the mechanisms for carbon trading in Indonesia, including requirements for carbon exchange operators and procedures for trading carbon units (Efifah, 2024).

Although the regulatory framework has been established, the effectiveness of carbon market implementation in Indonesia faces several notable challenges. First, limited participation. The official carbon exchange, IDXCarbon, was launched in September 2023 under the supervision of the Financial Services Authority (OJK). However, by early 2025, only 13 companies had participated in carbon trading through IDXCarbon, with relatively low trading volumes. This indicates that the carbon market has yet to attract widespread interest from the private sector. Second, lack of legal certainty. The classification of carbon units as securities has created legal uncertainty, particularly regarding their classification and legal treatment within Indonesia's legal system (Efifah, 2024). Third, the need for inter-agency coordination. Carbon trading involves multiple sectors and institutions; however, coordination among the OJK, the Ministry of Environment and Forestry (KLHK), and the Commodity Futures Trading Regulatory Agency (BAPPEBTI) needs to be strengthened to ensure effective implementation (Efifah, 2024). Fourth, the risk of double counting. There are concerns regarding potential double counting in carbon trading, particularly if carbon units are not

properly registered in the National Registry System for Climate Change Control (SRN-PPI) (Efifah, 2024).

Indonesia launched its first carbon market, IDXCarbon, in September 2023 as part of the NEK implementation based on Presidential Regulation No. 98/2021. However, trading volumes remain low, and the regulatory infrastructure is not yet fully developed (IESR, 2023). Key challenges include weak Monitoring, Reporting, and Verification (MRV) mechanisms, overlapping jurisdiction among agencies, and limited private sector participation (Rahmawati et al., 2024).

Indonesia has demonstrated its commitment to reducing GHG emissions through the development of carbon trading mechanisms under its NDC framework outlined in the Paris Agreement. The country's approach integrates multiple models, moving rapidly with new regulatory frameworks to support its climate goals. Notably, Indonesia has signed bilateral agreements, such as the Joint Crediting Mechanism (JCM) with Japan, to facilitate carbon trading while prioritizing its domestic climate objectives. Nevertheless, ensuring clarity regarding corresponding adjustments remains critical to building trust among international participants (OPIS, 2024).

3. Lessons from Carbon Market Regulatory Comparisons for Policy Improvement in Indonesia

Cross-country studies show that carbon market regulations impact several key areas, including emission reductions, economic growth, and green technology innovation. Emission reductions are evident in systems such as the EU ETS and RGGI, which have demonstrated significant declines in emissions within the industrial and energy sectors (Martin et al., 2014). Economic growth studies have found that emissions trading systems do not necessarily have a negative impact on economic growth, depending on the design of the policy and the existence of compensatory mechanisms (Newell et al., 2019). Green technology innovation has also been stimulated, as carbon pricing policies encourage investment in low-carbon technologies, such as renewable energy and energy efficiency improvements (Popp, 2016).

More specifically, this study compares the experiences of the European Union, China, and the United States. The European Union operates one of the world's largest emissions trading systems, the EU

Emissions Trading System (EU ETS), which has been in place since 2005, covering the energy, industrial, and aviation sectors. The system, based on a cap-and-trade model, has undergone several phases of reform to enhance its effectiveness (European Commission, 2021). Research shows that the EU ETS has successfully reduced industrial emissions and accelerated the transition to renewable energy (Borghesi & Montini, 2022). Carbon prices in the EU ETS surpassed €100 (US$108) per ton in February 2023 (Ember, 2023), creating strong incentives for decarbonization. The introduction of the Carbon Border Adjustment Mechanism (CBAM) in 2023 further added an international trade dimension, encouraging partner countries to strengthen their domestic carbon policies to remain competitive in export markets (Reynolds, 2021).

Meanwhile, China launched its national ETS in 2021 after conducting pilot projects across several provinces (Zhang et al., 2020). Studies indicate that while the system is still in its early stages and faces challenges related to transparency and emissions reporting (Qi & Wang, 2022), China has shown a commitment to expanding sectoral coverage and improving transparency. The price of China Certified Emission Reduction (CCER) credits has risen to 107.36 yuan (US$14.82) per ton (Saptakee, 2025). Furthermore, China's collaboration with the EU in ETS development highlights a gradual yet strategic approach.

In the United States, there is no national carbon market system; however, several states, such as California and Massachusetts, have implemented their own cap-and-trade programs (Burtraw et al., 2018). Empirical studies on the Regional Greenhouse Gas Initiative (RGGI) reveal that the policy effectively reduced carbon emissions without impeding economic growth (Schmalensee & Stavins, 2017). The decentralized approach reflects political challenges at the federal level but also demonstrates flexibility in adopting market-based climate policies.

From these comparative studies of the carbon market regulatory systems in the EU, China, and the US, several key lessons emerge for Indonesia in developing an effective carbon market: Strengthening the MRV Infrastructure: Learning from the EU ETS, Indonesia must develop a transparent and accountable Monitoring, Reporting, and Verification (MRV) system to ensure market integrity. This includes standardizing emissions reporting and instituting independent audits. Alignment with International Trade Mechanisms: With the advent of CBAM, Indonesia

must ensure that its export products comply with the EU's emissions standards. This requires harmonizing domestic regulations with international frameworks to avoid trade barriers (Matthews, 2024). Enhancing Private Sector Participation: Active private sector engagement is crucial to improve market liquidity and effectiveness. The government should provide incentives and regulatory frameworks that support investment in low-carbon projects. Adopting a Phased and Focused Approach: Following China's gradual model, Indonesia should identify strategic sectors for initial implementation and systematically expand coverage. This phased strategy can help manage challenges and enhance overall effectiveness.

C. CONCLUSION

This study finds that the carbon market serves as a strategic instrument for climate change mitigation by providing economic incentives for reducing greenhouse gas (GHG) emissions. Indonesia has established its carbon market regulatory framework through Presidential Regulation No. 98 of 2021 and the launch of IDXCarbon in 2023. However, the market's effectiveness remains limited due to low private sector participation, an underdeveloped regulatory infrastructure, legal uncertainties, and challenges in inter-agency coordination and Monitoring, Reporting, and Verification (MRV) mechanisms. A comparative analysis of carbon market regulations in the European Union, China, and the United States reveals several critical lessons for Indonesia. The EU has demonstrated success through the EU ETS, supported by a robust MRV infrastructure, high carbon prices that incentivize innovation, and the introduction of the Carbon Border Adjustment Mechanism (CBAM), which influences international trade practices. China has adopted a phased approach, strategically expanding sectoral coverage while steadily enhancing system transparency. Meanwhile, the US illustrates the success of decentralized and flexible carbon market policies at the state level.

Based on this study, the main recommendations for Indonesia are as follows: Strengthening the MRV infrastructure to ensure transparency and accountability, harmonizing domestic regulations with international mechanisms, particularly with CBAM requirements, enhancing private sector participation through clear incentives, Adopting a phased approach for the gradual expansion of carbon market coverage. By implementing these recommendations, Indonesia's carbon market is expected to more effectively

support the achievement of its climate mitigation targets while simultaneously fostering sustainable economic growth.

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