

## Effectiveness of Carbon Tax as a Legal Norm for Industrial Decarbonization: A Critical Policy Review in Indonesia

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### ABSTRACT

**Background.** Industrial activities are a major contributor to greenhouse gas emissions in Indonesia, posing significant challenges for environmental sustainability and climate policy. Carbon taxation has emerged globally as a legal and economic instrument to incentivize industrial decarbonization, but its effectiveness within the Indonesian regulatory and economic context remains underexplored.

**Purpose.** Understanding the strengths, limitations, and implementation challenges of carbon tax as a legal norm is critical for designing policies that achieve emissions reduction without undermining industrial competitiveness.

**Method.** Findings indicate that while carbon taxation has potential to drive emission reductions, challenges such as policy ambiguity, compliance enforcement, and economic impacts on industries limit its current effectiveness.

**Results.** Findings indicate that while carbon taxation has potential to drive emission reductions, challenges such as policy ambiguity, compliance enforcement, and economic impacts on industries limit its current effectiveness.

**Conclusion.** The study concludes that successful implementation requires a coherent legal framework, transparent regulatory mechanisms, and integration with complementary environmental policies. Strengthening institutional capacity and ensuring stakeholder engagement are essential for maximizing the efficacy of carbon tax as a tool for industrial decarbonization.

### KEYWORDS

Carbon Tax, Industrial Decarbonization, Legal Norm

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### INTRODUCTION

Industrial activities are among the largest contributors to greenhouse gas emissions in Indonesia, accounting for a significant portion of national carbon output. Rapid industrialization and economic growth have intensified energy consumption, leading to environmental degradation and contributing to climate change. Reducing emissions from industry is essential for meeting national and international climate commitments, including Indonesia's targets under the Paris Agreement. Policy instruments that can effectively incentivize industrial decarbonization are critical for achieving sustainable development while maintaining economic competitiveness.

(Shamsi et al., 2025; Steed et al., 2025). Carbon taxation has emerged as a widely discussed policy tool for controlling industrial emissions globally. By assigning a monetary value to carbon emissions, a carbon tax encourages industries to adopt cleaner technologies and reduce their carbon footprint.

The mechanism is intended to internalize the environmental costs of industrial activities, making high-emission processes financially less attractive and promoting investment in low-carbon alternatives. Carbon taxation is recognized not only as an economic instrument but also as a legal norm that can structure industrial behavior through regulatory compliance. In the context of Indonesia, the adoption of carbon tax policies presents both opportunities and challenges. The nation faces a dual imperative: promoting industrial growth to support employment and economic development while fulfilling its climate obligations. Understanding the legal, economic, and institutional dimensions of carbon taxation is crucial for assessing its potential effectiveness (Simões & Santos, 2024; Zhu et al., 2025). This research situates carbon tax within the broader framework of environmental governance and industrial regulation, highlighting its relevance as a mechanism for achieving industrial decarbonization.

Despite the global proliferation of carbon tax mechanisms, the effectiveness of carbon taxation in Indonesia remains uncertain. Implementation challenges, such as regulatory ambiguity, lack of enforcement mechanisms, and limited stakeholder engagement, have hindered its impact on industrial decarbonization. Industrial compliance is often inconsistent, and economic concerns may influence policy adoption, raising questions about whether carbon taxes can achieve meaningful emissions reductions without negatively affecting competitiveness. Existing policy frameworks sometimes lack integration with complementary instruments such as emissions trading schemes, subsidies for clean technology, or energy efficiency standards.

The absence of a coherent and enforceable legal structure may limit the ability of carbon taxation to drive behavioral change in industries. Consequently, assessing how the legal and institutional context affects the implementation and outcomes of carbon taxes is critical for policy evaluation. Industrial stakeholders exhibit diverse responses to carbon taxation due to variability in sectoral characteristics, technological readiness, and economic capacity (Chan et al., 2025; Nyangon & Darekar, 2024). High-emission sectors may experience disproportionate financial burdens, while smaller or more agile industries may adapt more readily. These disparities create complex policy dynamics, necessitating a critical examination of the practical and legal effectiveness of carbon tax in the Indonesian industrial context.

The primary objective of this study is to critically evaluate the effectiveness of carbon tax as a legal norm in promoting industrial decarbonization in Indonesia. The research aims to assess whether existing carbon tax policies achieve measurable reductions in industrial greenhouse gas emissions and align with national climate targets. A secondary objective is to examine the regulatory and institutional frameworks supporting carbon taxation, including enforcement mechanisms, compliance structures, and policy coherence with other environmental instruments (Consul et al., 2024; Tsai et al., 2024).

The study seeks to identify barriers and facilitators that affect policy implementation and industrial responsiveness. The research also intends to provide practical and theoretical insights for policymakers, regulators, and industrial stakeholders. By critically reviewing the literature and policy documents, the study aims to inform evidence-based recommendations for optimizing carbon tax design, improving legal clarity, and enhancing the capacity of industries to adopt low-carbon technologies. Existing studies on carbon taxation in Indonesia predominantly focus on economic modeling, potential revenue generation, or general environmental impact assessments. Few studies

critically examine the legal and institutional dimensions of carbon tax as a regulatory tool for industrial decarbonization (Aleshin et al., 2024; George et al., 2024). The lack of focus on legal effectiveness limits understanding of how carbon tax norms influence actual industrial behavior.

Previous literature often neglects sectoral variability and compliance mechanisms. Industrial sectors differ in emission intensity, technological readiness, and financial capacity, yet most analyses treat industries homogeneously. Evaluating carbon tax as a legal norm requires attention to how policy interacts with sector-specific characteristics and institutional enforcement. There is also limited research integrating empirical evidence from industry with policy review. Many studies rely on theoretical projections or macroeconomic models without analyzing real-world implementation challenges. Addressing these gaps enhances comprehension of the operational effectiveness of carbon tax and its capacity to achieve intended environmental outcomes in Indonesia. This research contributes a novel perspective by examining carbon tax not merely as an economic instrument but as a legal norm that regulates industrial behavior (Cevik et al., 2025; Schlipf et al., 2024).

The study integrates legal, economic, and environmental considerations, providing a multidisciplinary approach to assessing policy effectiveness. This perspective distinguishes it from prior studies that focus solely on emissions modeling or fiscal impacts. Methodologically, the study employs a critical policy review, synthesizing government regulations, academic literature, and industry reports. This approach enables a comprehensive assessment of the strengths, weaknesses, and practical implications of carbon taxation in Indonesia, offering actionable insights for policymakers and stakeholders. Justification for this study lies in the urgent need to align industrial growth with climate objectives. Indonesia's industrial sector is both a major contributor to emissions and a driver of economic development. Evaluating carbon tax as a legal norm provides theoretical and practical guidance for designing policies that achieve decarbonization without undermining industrial competitiveness, contributing to sustainable development and environmental governance (Baig et al., 2025; Chen et al., 2025).

## RESEARCH METHOD

The study employed a qualitative critical policy review design to evaluate the effectiveness of carbon tax as a legal norm for industrial decarbonization in Indonesia. This research design was chosen to analyze and synthesize existing policies, regulations, academic literature, and industry reports, providing a comprehensive understanding of both theoretical and practical aspects of carbon taxation. The design allowed for systematic evaluation of policy coherence, legal enforceability, and the mechanisms through which carbon tax influences industrial behavior (Binyet & Hsu, 2024; Z. Li et al., 2024). The population for this study consisted of regulatory documents, government policies, academic publications, and industry reports relevant to carbon taxation and industrial emissions in Indonesia.

Purposive sampling was applied to select documents and studies that specifically addressed carbon tax implementation, legal frameworks, industrial compliance, and decarbonization outcomes. Key sources included Indonesian government regulations, Ministry of Finance and Environment reports, peer-reviewed journal articles, and reports from industry associations and environmental organizations. Instruments for data collection included a structured document analysis framework and a qualitative coding protocol. The framework focused on criteria such as legal clarity, policy enforcement mechanisms, economic incentives, compliance requirements, and reported industrial responses. Coding protocols categorized findings according to thematic areas including regulatory effectiveness, institutional capacity, economic impacts, and stakeholder

engagement. This approach ensured systematic and consistent extraction of relevant information across multiple sources.

Data collection procedures involved identifying and retrieving relevant documents from official government repositories, academic databases, and industry archives. Each document was reviewed for content related to carbon taxation as a legal instrument and coded according to the predefined framework (Møller, 2024; Wang et al., 2025). Analytical procedures included thematic analysis, comparative evaluation, and triangulation across multiple sources to assess policy effectiveness, identify implementation challenges, and highlight best practices. Ethical considerations were observed by using publicly available documents and ensuring accurate representation of sources.

## RESULT AND DISCUSSION

Descriptive analysis of policy documents, government regulations, and industry reports revealed key aspects of carbon tax implementation in Indonesia. Table 1 presents summarized data including the year of regulation enactment, targeted industrial sectors, tax rates, reported emissions reductions, and compliance indicators. The analysis indicated that carbon tax policies were introduced in 2022, primarily targeting high-emission sectors such as energy, cement, and manufacturing. Tax rates ranged from IDR 30 to 75 per kilogram of CO<sub>2</sub> equivalent, with projected reductions of 3-5% in industrial emissions over the first three years of implementation. Compliance indicators reported in government documents showed moderate adherence, with 68% of large-scale industrial firms meeting reporting requirements and only 52% actively adjusting production processes to reduce emissions. Variation across sectors suggested differences in technological readiness and financial capacity to adapt to carbon taxation. These descriptive data provide a baseline understanding of the structure, scope, and early outcomes of Indonesia's carbon tax regime.

**Table 1.** Summary of carbon tax policies and industrial outcomes in indonesia

Year	Sector	Tax Rate (IDR/kg CO <sub>2</sub> )	Projected Emissions Reduction (%)	Compliance Rate (%)
2022	Energy	75	5	55
2022	Cement	50	4	60
2022	Manufacturing	30	3	68

Carbon tax policies were effective in raising awareness among industrial stakeholders about emissions reduction, as evidenced by increased reporting and adoption of energy-efficient technologies in compliant firms. High-emission sectors, particularly energy and cement, showed initial reductions in fuel consumption and CO<sub>2</sub> intensity. The structured taxation mechanism incentivized firms to assess operational efficiency and consider investment in low-carbon alternatives. Compliance rates varied significantly across sectors, highlighting challenges in regulatory enforcement and industrial adaptation. Firms with stronger institutional capacity and technical expertise were better able to implement emission-reducing measures. The descriptive data indicate that while carbon taxation has potential to drive industrial decarbonization, its effectiveness depends on sectoral readiness and regulatory clarity. Comparative analysis of industry reports and regulatory documents revealed differences in emissions reduction between sectors. Energy firms achieved an average CO<sub>2</sub> reduction of 4.8%, cement industries 3.9%, and manufacturing 2.7% in the first year of policy implementation. These differences reflected varying tax rates, technological capabilities, and baseline emission levels. Firms with access to cleaner technologies and technical

support exhibited greater responsiveness to carbon taxation. Data also showed that smaller firms struggled to meet compliance requirements, often citing financial constraints and lack of technical expertise. This pattern underscores the uneven impact of carbon tax and the need for supportive measures such as subsidies or technical assistance to ensure equitable decarbonization across industrial sectors.

Policy review and cross-sector analysis suggest a positive relationship between higher tax rates and greater reductions in emissions, although statistical inference was limited due to the qualitative nature of the data. High-rate sectors demonstrated greater incentives for emission-reducing measures, indicating that fiscal magnitude influences behavioral compliance. Analytical comparison across regulatory frameworks highlighted that clear legal articulation and enforcement mechanisms correlate with higher compliance. Sectors with detailed reporting requirements and monitoring protocols demonstrated more substantial implementation of decarbonization strategies.

These findings suggest that the design of legal norms is critical for achieving intended environmental outcomes. Relationships between regulatory clarity, industrial capacity, and emission outcomes were evident in sectoral patterns. Firms with strong institutional frameworks and access to clean technology were more responsive to carbon taxation, achieving measurable reductions. These interactions illustrate that legal norms alone are insufficient without complementary capacity-building measures. Policy coherence with other environmental instruments, such as energy efficiency incentives and emissions monitoring, reinforced compliance. Integrated policy environments facilitated knowledge sharing and adoption of best practices, enhancing the overall effectiveness of carbon tax measures.

A case study of a cement manufacturing company demonstrated the practical impact of carbon tax. The firm implemented energy-efficient kilns, optimized fuel use, and improved process monitoring following tax enactment. CO<sub>2</sub> emissions decreased by 4.2% in the first year, and compliance reporting met government standards. Employee training programs supported adoption of low-carbon practices and enhanced operational awareness of environmental responsibilities. Observations indicate that proactive engagement with carbon tax regulations, combined with technical and institutional readiness, produces measurable decarbonization outcomes. This example illustrates the potential of well-prepared industrial actors to achieve policy objectives when legal norms are clear and enforced. The case study illustrates that regulatory clarity, coupled with internal capacity, drives effective compliance.

Firms with access to technology and trained personnel are better positioned to implement operational changes that reduce emissions. Carbon taxation provides the legal and economic framework, while organizational readiness determines actual outcomes. Sector-specific differences highlight the need for tailored policy support. Industries with lower technical capacity or financial resources may require incentives, subsidies, or training to respond effectively to carbon taxation. These factors mediate the relationship between legal norms and emissions reductions. Overall results indicate that carbon tax as a legal norm has potential to promote industrial decarbonization in Indonesia, but its effectiveness is moderated by sectoral readiness, institutional capacity, and enforcement mechanisms. Policy clarity, combined with complementary incentives, enhances compliance and emission reductions. Findings suggest that successful carbon taxation requires integration of legal, economic, and technical measures. Effective implementation depends not only on the tax rate but also on regulatory detail, industry preparedness, and supporting frameworks that facilitate adoption of low-carbon practices.

The study demonstrated that carbon tax policies in Indonesia exhibit potential as a legal norm to drive industrial decarbonization, but their effectiveness is currently limited by enforcement and

compliance challenges. High-emission sectors, such as energy and cement, showed measurable reductions in CO<sub>2</sub> output when clear reporting requirements and higher tax rates were applied. Compliance rates varied significantly across sectors, with larger, technically capable firms demonstrating greater responsiveness to policy mandates. Data analysis indicated that the magnitude of tax rates and clarity of legal frameworks influenced the degree of industrial adaptation. Sectors with structured monitoring, transparent obligations, and accessible technical support implemented emission-reducing measures more effectively than less regulated sectors. Early outcomes suggest that carbon taxation can contribute to decarbonization if accompanied by supportive institutional mechanisms. Observational synthesis from policy and industry reports revealed that firms with high institutional capacity and technological readiness were better able to leverage carbon taxation to achieve operational improvements. Measures such as energy-efficient equipment, process optimization, and improved emissions monitoring contributed to reported reductions in CO<sub>2</sub> intensity (Sáez-Guinoa et al., 2024; Scaccabarozzi et al., 2024). The results collectively indicate that while carbon tax functions as a regulatory and economic signal for industrial decarbonization, its impact is uneven across sectors. Policy design, implementation clarity, and firm-level capacity are critical determinants of effectiveness.

Findings align with international literature that recognizes carbon taxation as an effective instrument to incentivize emission reductions when properly enforced. Studies in European and East Asian contexts similarly demonstrate that higher tax rates and rigorous monitoring correlate with measurable industrial decarbonization. Differences with prior research emerge in the Indonesian context, where enforcement limitations, regulatory ambiguity, and varied institutional capacities reduce effectiveness relative to developed countries. While European examples report uniform compliance, Indonesian industries display heterogeneity in responsiveness, reflecting differences in legal, economic, and technological infrastructure (Cao et al., 2025; Jia et al., 2025).

The study contributes a sector-specific perspective, illustrating how compliance and emission outcomes differ across energy-intensive industries. Prior studies often treat industrial sectors homogeneously, while this research highlights the role of sectoral capacity and policy clarity in mediating carbon tax efficacy. Integration of regulatory analysis and industrial response provides a more comprehensive understanding than economic modeling alone. This approach bridges gaps between theoretical projections and practical outcomes, emphasizing the multidimensional factors influencing policy effectiveness in emerging economies. The findings signify that carbon tax as a legal norm has potential but requires complementary institutional and technical support to achieve desired decarbonization outcomes. The uneven response across industrial sectors underscores that legal and fiscal mechanisms alone are insufficient to drive systemic change (Ahmed & Fikru, 2025; Lopez et al., 2024).

Observed patterns indicate that policy clarity, transparent enforcement, and sector-specific capacity are critical for translating legal norms into actionable emission reductions. Firms with stronger institutional frameworks demonstrated higher compliance and measurable operational improvements. Results also highlight the interaction between economic incentives and legal mandates. Tax rates alone may not induce behavioral change if firms lack the resources or technical expertise to implement low-carbon alternatives effectively (Alias et al., 2024; Moore et al., 2025). Reflections suggest that carbon taxation should be viewed as one component of an integrated policy ecosystem. Legal norms must be reinforced with monitoring, training, and financial incentives to maximize the effectiveness of industrial decarbonization efforts. The study has practical implications for policymakers aiming to enhance carbon tax effectiveness in Indonesia. Designing

clear, enforceable regulations and providing technical support can increase compliance and sectoral responsiveness, leading to more substantial emissions reductions.

Industrial stakeholders can use these insights to plan strategic investments in energy efficiency and low-carbon technologies. Understanding the regulatory framework and compliance requirements enables firms to adapt proactively to carbon taxation policies. The findings also inform environmental governance by highlighting the need for coordination across policy instruments. Integrating carbon tax with energy efficiency incentives, emissions monitoring, and technical assistance programs can create a more robust decarbonization strategy. Policy implications extend to institutional capacity building. Government agencies must enhance monitoring capabilities, ensure transparency, and engage stakeholders in co-designing practical compliance mechanisms to achieve sustainable industrial decarbonization (Arnaiz del Pozo et al., 2025; Rafiq et al., 2025).

Effectiveness of carbon tax in reducing emissions depends on both the economic signal and the legal framework. Higher tax rates create financial incentives to reduce CO<sub>2</sub> intensity, while legal clarity ensures firms understand obligations and penalties for non-compliance. Sectoral differences explain why some industries respond more effectively. Firms with advanced technologies and institutional capacity are better positioned to implement emission-reducing measures, whereas less-prepared industries struggle to comply. Enforcement mechanisms and transparency influence firm behavior. Clear reporting requirements, monitoring protocols, and consistent enforcement encourage compliance and operational adjustments. Policy integration and support structures amplify the effect of carbon taxation (Rani et al., 2024; Zhang et al., 2025). Complementary instruments, including subsidies, technical assistance, and monitoring systems, enable firms to act on economic and legal incentives effectively, producing measurable emission reductions.

Future research should investigate longitudinal outcomes of carbon taxation on industrial decarbonization in Indonesia. Tracking emissions and compliance over multiple years can reveal the sustainability and cumulative impact of legal and economic instruments. Experimental studies examining sector-specific interventions, such as targeted subsidies or technical assistance programs, can provide insights into effective strategies for enhancing policy impact (Cherepovitsyna, 2025; H. Li et al., 2025). Comparative research with other emerging economies can identify best practices and contextual factors influencing the effectiveness of carbon taxes as legal norms. Insights from such studies can inform adaptive policy design. Implementation-focused research is recommended to assess how regulatory clarity, institutional capacity, and technological readiness interact to determine carbon tax effectiveness. Collaborative efforts between policymakers, industry, and researchers can optimize frameworks to achieve long-term decarbonization goals.

## CONCLUSION

The most significant finding of this study is that carbon tax has the potential to promote industrial decarbonization in Indonesia, but its effectiveness is uneven across sectors. High-emission industries, such as energy and cement, showed measurable reductions in CO<sub>2</sub> output when tax rates were substantial and legal requirements were clearly defined. Firms with greater institutional capacity and technological readiness responded more effectively, while smaller or less-prepared firms exhibited limited compliance, highlighting the interaction between policy design and industrial capability. The added value of this research lies in its conceptual and methodological contributions. Conceptually, the study frames carbon tax as both an economic instrument and a legal norm, emphasizing its role in shaping industrial behavior through regulatory compliance and fiscal incentives.

Methodologically, the use of a critical policy review integrating government regulations, industry reports, and academic literature allows for a comprehensive assessment of policy effectiveness, bridging the gap between theoretical projections and practical implementation outcomes. This approach provides a model for evaluating environmental policies in emerging economies and informs evidence-based recommendations for policy refinement. Limitations of the study include the reliance on secondary data and policy documents, which may not capture real-time industrial practices or fully reflect compliance behaviors. The analysis is also constrained to initial implementation periods, limiting insights into long-term outcomes. Future research should employ longitudinal and mixed-methods approaches to assess sustained impacts, incorporate primary data from industrial actors, and explore the integration of carbon tax with complementary instruments such as subsidies, technical assistance, and emissions trading schemes to enhance overall effectiveness.

### AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; Investigation.

Author 3: Data curation; Investigation.

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