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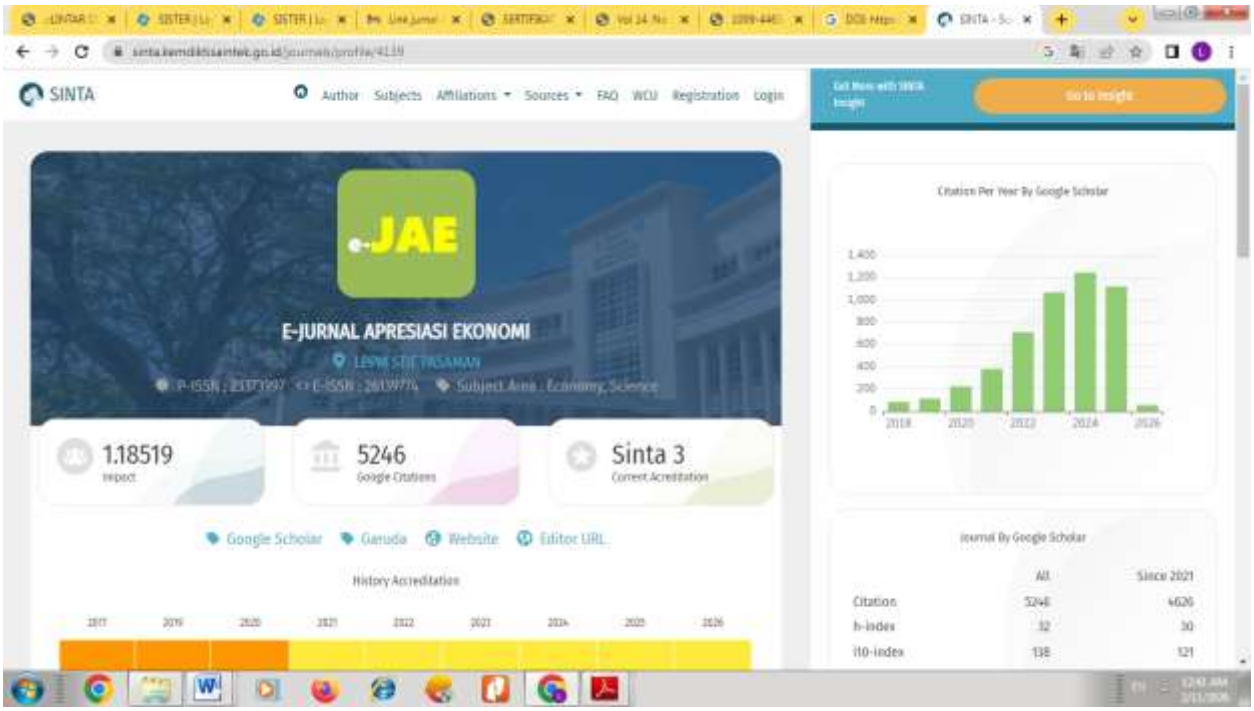

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OPTIMIZATION STRATEGY FOR CARBON TAX IN SUPPORTING THE 2060 NET ZERO EMISSION TARGET

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ABSTRACT

This study analyzes the role of the carbon tax as an environmental fiscal policy instrument in supporting Indonesia's Net Zero Emission (NZE) 2060 target. The carbon tax functions not only as a source of state revenue but also as an emission control tool encouraging industries to adopt cleaner energy. Using a qualitative descriptive and evaluative approach, the study reviews literature, government regulations, and corporate sustainability reports. The findings reveal that implementation challenges persist, including industrial readiness, emission monitoring systems, and policy coordination. However, with progressive tax rates, revenue allocation for renewable energy, and just transition mechanisms, the carbon tax can effectively support sustainable development. The study concludes that a well-designed and equitable carbon tax policy can strengthen Indonesia's transition toward a low-carbon economy and the NZE 2060 goal.

Keywords: Carbon Tax; Net Zero Emission; Environmental Fiscal Policy; Energy Transition.

INTRODUCTION

One of the major global challenges of the 21st century is the issue of climate change, which demands serious attention and urgent action. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), the rise in global temperature is caused by the accumulation of greenhouse gases (GHG), resulting in significant environmental impacts such as increased frequency of natural disasters, severe droughts, floods, and rising sea levels. Based on the IPCC Sixth Assessment Report, the global average temperature has increased by 1.1°C compared to the pre-industrial era, and without serious mitigation efforts, this increase could exceed 1.5°C before 2040. This condition poses potential threats to ecological systems, food security, and global economic stability.

According to the Ministry of Environment and Forestry (MoEF), Indonesia — as the world's largest archipelagic country — is highly vulnerable to the impacts of climate change. Data from MoEF show that Indonesia's total greenhouse gas emissions have reached more than 1,700 million tons of CO_2 equivalent per year, with the transportation, energy, and industrial sectors being the largest contributors. Therefore, the Indonesian government has committed to achieving Net Zero Emissions (NZE) by 2060 or earlier, as outlined in the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) 2050 and the Enhanced Nationally Determined Contribution (NDC). This commitment represents Indonesia's contribution to global efforts in limiting the rise of the Earth's temperature in line with the Paris Agreement of 2015.

Based on data from the Ministry of Environment and Forestry (MoEF, 2023), Indonesia's greenhouse gas emissions have continued to increase over the past two decades. National emissions rose from approximately 1,050 million tons of CO_2 equivalent in 2000 to more than 1,820 million tons in 2023, mainly contributed by the energy, transportation, and manufacturing sectors. This trend indicates that without effective policy interventions, Indonesia will face difficulties in achieving its emission reduction targets and Net Zero Emission (NZE) 2060 commitment. Therefore, the implementation of fiscal instruments such as a carbon tax has become an essential tool to curb the growth of national emissions.

One of the most effective policy instruments for reducing carbon emissions is the carbon tax, an economic mechanism that assigns a price to each ton of CO_2 emitted, encouraging economic actors to reduce emissions. According to the World Bank (2022), a carbon tax serves not only as a source of government revenue but also as a market signal for companies and individuals to shift toward cleaner energy. Data from the Organization for Economic Co-operation and Development (OECD, 2021) show that developed countries such as Sweden, Norway, and Canada have successfully reduced greenhouse gas emissions significantly without hindering economic growth.

Indonesia introduced its carbon tax policy under Law No. 7 of 2021 on the Harmonization of Tax Regulations (HPP). The tax was implemented

gradually starting in 2022, with an initial rate of Rp30 per kilogram of CO_2 equivalent, applied to coal-fired power plants. However, its implementation remains limited due to challenges such as the lack of verified emission data, administrative readiness, and industry resistance to potential production cost increases.

From an industrial perspective, the carbon tax carries significant economic implications. Energy-intensive industries must restructure their cost systems to remain competitive, particularly in manufacturing and energy sectors that depend heavily on fossil fuels. Many companies still lack the financial and technical capacity to transition to greener technologies. This challenge is observed in major firms such as PT PLN (Persero), PT Semen Indonesia (Persero), PT Astra International Tbk, PT Pertamina (Persero), and PT Vale Indonesia Tbk, which face issues in energy efficiency management, emission accounting, and internal policy alignment with the government's green economy direction.

According to MoEF (2023), the energy sector is the largest contributor to Indonesia's carbon emissions, accounting for 43% of total national emissions, followed by forestry and industry. This underscores the importance of emission control policies in the energy and manufacturing sectors, including carbon tax implementation to promote energy efficiency and clean technology adoption.

Another key challenge lies in how carbon tax revenues are used effectively to support a socially just clean energy transition. The International Energy Agency (IEA, 2023) emphasizes that a successful carbon tax policy must be accompanied by a "just transition" mechanism to ensure that low-income groups and labor-intensive industries are not negatively affected by the shift toward a low-carbon economy. Therefore, fiscal policies such as carbon taxation must be designed inclusively and adaptively to the national economic context.

According to the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) published by Bappenas (2021), Indonesia aims to gradually reduce GHG emissions to achieve NZE by 2060 or earlier. The comparison between the business-as-usual (BAU) scenario and the policy scenario—which includes carbon tax implementation, renewable energy expansion, and industrial efficiency—shows that without new policies, emissions could rise to 3,000 million tons of CO_2 equivalent by 2060, whereas with green fiscal policies and investments in low-emission technologies, emissions could be significantly reduced to achieve net zero.

In conclusion, the carbon tax has great potential to become one of the main pillars of Indonesia's strategy to achieve the Net Zero Emission 2060 target. However, its effectiveness depends on a well-designed implementation strategy, including rational tax rates, monitoring mechanisms, and optimal allocation of tax revenues for climate mitigation and adaptation programs. A comprehensive study on carbon tax optimization strategies is therefore crucial to ensure that this policy functions not only as a fiscal tool but also as a transformative instrument steering the national economy toward sustainable development.

This study aims to comprehensively analyze how carbon tax optimization strategies can support Indonesia's 2060 NZE target, both from a macro-policy perspective and at the industry level. Through a policy analysis approach and corporate case studies, this research is expected to provide strategic recommendations for the government, businesses, and society to realize a just transition toward a green economy.

LITERATURE REVIEW

Definition of Carbon Tax

According to the Ministry of Finance of the Republic of Indonesia (2022), a carbon tax is a levy imposed on carbon dioxide emissions or other greenhouse gases (GHGs) generated from economic activities that produce energy or industrial goods. The purpose of the carbon tax is to internalize environmental impacts into the prices of goods and services, ensuring that emitters bear the social costs resulting from their emissions.

Theory of Externalities and Internalization of Costs

According to Nicholson and Snyder (2017), externalities occur when the production or consumption activities of one party affect another party without compensation through market mechanisms. In the context of climate change, carbon emissions represent a negative externality, as they contribute to global temperature rise and environmental degradation.

Concept of Net Zero Emission (NZE)

According to Bappenas (2021) in the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) document, Net Zero Emission (NZE) refers to a balance between the amount of GHGs emitted and the amount removed from the atmosphere. The NZE 2060 (or sooner) target represents Indonesia's commitment to supporting the Paris Agreement, which aims to limit global temperature rise to below 1.5°C.

Public Policy Theory and Implementation of Carbon Tax

According to Dye (2017), public policy is a series of government actions designed to address specific public issues. The effectiveness of a policy depends on three key aspects:

1. Policy design
2. Policy implementation
3. Policy evaluation

According to Stiglits & Stern (2021), an effective carbon tax policy requires cross-sector coordination, transparent reporting, and incentives for industry players who succeed in significantly reducing emissions.

Strategies for Optimizing the Carbon Tax

The optimization strategy for a carbon tax aims to maximize the benefits of carbon tax policies in reducing emissions without hindering economic growth. According to the OECD (2021), optimization strategies involve:

1. Gradually adjusting carbon tax rates.
2. Allocating tax revenues for clean energy investments and low-emission technology research.
3. Providing education and outreach programs for industrial actors.
4. Enhancing digital-based emission reporting systems.

At the corporate level, optimization strategies can be implemented through:

1. Energy and emission audits to identify major carbon sources.
2. Substitution of fossil fuels with alternative energy sources such as Refuse Derived Fuel (RDF) — a fuel produced from combustible waste materials like paper, fabric, and plastic.
3. Energy efficiency improvements and the adoption of low-emission technologies.
4. Sustainability reporting in accordance with the Global Reporting Initiative (GRI) standards.

RESEARCH METHOD

The object of this research is companies engaged in the manufacturing industry that make significant contributions to carbon emissions in Indonesia. These types of companies generally operate on a national scale with main activities such as the production of building materials, metals, energy, or chemicals that require high levels of combustion and energy use.

Since the manufacturing industry represents a sector with large-scale energy intensity, it has become one of the government's primary focuses in implementing carbon tax policies and the NZE 2060 program. Therefore, this research observes the management mechanisms related to energy, efficiency strategies, and the maturity of companies in responding to fiscal policies within the environmental sector.

This research uses a qualitative descriptive approach with an evaluative method. This approach is applied to systematically describe the phenomena occurring in the field related to carbon tax implementation and the optimization strategies adopted by companies.
The main focus of this study is to evaluate the effectiveness of corporate strategies in responding to the achievement of the Net Zero Emission (NZE) 2060 target.

The data used in this study are secondary data—data that have been collected, processed, and published by other parties and then reused for new research or analysis. The secondary data in this study are obtained from credible and relevant sources, including:

1. Official Government Reports
   Official reports from the Ministry of Finance, the Ministry of Energy and Mineral Resources (MEMR), and the Ministry of Environment and Forestry (MoEF).
2. Sustainability Reports
   Sustainability reports from companies in relevant industrial sectors.
3. Scientific Journals
   Academic journals discussing environmental fiscal policy and carbon taxation.
4. Official Online Sources
   Official online sources such as the Carbon Exchange, the Central Statistics Agency (CSA), and publications from international organizations such as the OECD, World Bank, UNDP, and others.

The collected secondary data are processed through the following steps:

1. Data Classification, involving grouping information according to themes such as carbon tax policies, challenges, and impacts.
2. Data Reduction, involving the selection and summarization of data relevant to the research objectives.
3. Data Presentation, involving the organization of data in narrative, table, or graphical form to facilitate understanding.
4. Conclusion Drawing, involving interpretation of analytical results in line with theories and concepts supporting the study.

The data analysis method used is qualitative descriptive analysis, which combines descriptive and qualitative techniques to clearly explain a phenomenon, situation, or condition using non-numerical data such as interviews and observations.

This analysis is employed to examine and compare existing secondary data sources in order to:

1. Identify carbon tax policies currently implemented in Indonesia.
2. Analyze the effectiveness and challenges of their implementation.
3. Compare these policies with international best practices.
4. Formulate strategies to optimize carbon tax policies so that they align with the principles of sustainable development and a just energy transition.

This study is conducted as a desk study or literature review, without direct field involvement. The research location is not limited, as all processes are carried out through the collection and analysis of documents, both online and academic literature. The research period spans from July to November 2025, covering data collection, analysis, and final report preparation stages.

RESULT AND DISCUSSION

Overview of Carbon Tax Policy in Indonesia

The carbon tax in Indonesia serves as one of the economic instruments for structuring environmental fiscal policy, as stipulated in Law Number 7 of 2021 concerning the Harmonization of Tax Regulations (UU HPP). The purpose of this tax is to internalize external costs resulting from greenhouse gas (GHG) emissions, encourage industries to transition toward low-carbon technologies, and support the achievement of Net Zero Emission (NZE) by 2060.

The implementation of this policy began with a pilot phase in 2022, targeting coal-fired power plants (NEK), and was later expanded to other sectors, including cement, fertilizer, and heavy manufacturing industries. The carbon tax forms part of the carbon economic value system (NEK), as regulated under Presidential Regulation No. 98 of 2021, which includes components such as carbon trading, emission offsets, and result-based payment mechanisms.

Indonesia has adopted a low introductory rate model, setting the initial tariff at Rp30 per kilogram of CO_2e (approximately USD 2 per ton)—a relatively low rate compared to other countries. This strategy aims to allow the industrial sector to gradually adapt to carbon costs without causing significant economic disruption.

Carbon Emissions and Intensity Data (2023–2024)

According to reports from the Ministry of Environment and Forestry (MoEF) and publications from strategic industrial corporations, the development of carbon emissions in Indonesia indicates a downward trend, although the reduction has not yet been significant.

Table 1. National GHG Emission Reduction Trend

No.	Year	Total National GHG Emissions (million tons CO_2e)	Contribution of Energy & Industry Sector (%)	Key Notes
1	2020	1,970	63	Impact of the pandemic, leading to decreased economic activity.
2	2021	1,895	62	Economic recovery and an increase in fossil energy consumption.
3	2022	1,910	62	Beginning of the carbon tax pilot project.
4	2023	1,860	60	A 2.5% reduction through energy efficiency and fuel substitution.
5	2024	±1,820 (estimated)	59	Start of national carbon trading implementation.

Source: Ministry of Environment and Forestry, 2024

From the data above, it can be concluded that national emissions intensity has begun to decline since the implementation of the carbon instrument, but the rate of reduction remains below the medium-term policy target (a 31.89% reduction by 2030).

Evaluation of Carbon Tax Implementation

Table 2. Evaluation of Carbon Tax Implementation

No.	Evaluation Aspect	Current Condition	Analysis and Impact
1	Regulatory Framework	Available under the Harmonized Tax Law (UU HPP) and Presidential Regulation No. 98 of 2021.	The regulation is still general and not yet detailed for all industrial sectors.
2	MRV Infrastructure (Monitoring, Reporting, and Verification)	Still under development by the Ministry of Environment and Forestry (MoEF) and the Ministry of Energy and Mineral Resources (ESDM).	There is no fully integrated national emission monitoring system yet.
3	Industry Readiness	Varies depending on business scale and type.	Large industries (cement, energy) have begun to adapt, while MSMEs are not yet ready.
4	Economic Effects	Potential increase in production costs in the short term.	Green incentive support is needed to avoid excessive burdens.
5	Fiscal Institutional Framework	Coordination among institutions is not yet optimal.	Stronger roles of the Ministry of Finance and MoEF are required to harmonize taxation policies.

Source: Processed by the Author, 2025

From the data above, it can be concluded that although the basic framework for carbon tax policy has been established, the effectiveness of its implementation is still influenced by technical readiness and institutional capacity.

International Comparative Analysis

Table 3. International Comparative Analysis

No.	Country	Year of Implementation	Initial Rate	Supporting Mechanism	Achieved Impact
1	European Union	2005	€25/ton CO_2e	EU-ETS (cap and trade)	Emissions decreased by 30% (2005–2020)
2	Japan	2012	¥289/ton CO_2e (~US$2.5)	Low-carbon technology subsidies	Energy efficiency increased by 10%
3	Singapore	2019	S$5/ton CO_2e	Green energy grant	Targeting NZE 2050
4	Indonesia	2022	Rp30/kg CO_2e (~US$2)	NEK and voluntary offset	Pilot stage

Source: Organization for Economic Co-operation and Development (OECD, 2023)

The table above indicates that Indonesia's carbon tariffs are still the lowest compared to other countries. The impact of emission reductions will be difficult to achieve without a balanced approach to progressive tariff increases and revenue recycling (utilizing tax revenue for the energy transition).

Economic and Social Impact Analysis

The scenario analysis was conducted using a qualitative approach based on policy reports and previous studies.

Table 4. Progressive Carbon Tax Policies and Rates

No.	Scenario	Tax Rate (Rp/kg CO_2e)	Revenue Potential (Trillion Rupiah)	Emission Reduction	Notes
1	Conservative	30	5	-2%	Not significant in influencing industrial behavior.
2	Moderate	75	12	5%	Requires support from clean energy incentives.
3	Ambitious	150	20	-10%	Encourages investment in renewable energy.

Source: Processed by the Author, 2025

A progressive tariff policy followed by the allocation of tax revenues to energy subsidies and social compensation is considered the most appropriate and optimal. This approach not only reduces emissions but also creates new green jobs in the renewable energy sector.

Linkage to the Sustainable Development Goals (SDGs)

Table 5. Objectives of the Sustainable Development Goals (SDGs)

No.	SDG	Goal	Contribution of Carbon Tax
1	SDG 7	Affordable and Clean Energy	Tax revenues are used to provide subsidies for renewable energy.
2	SDG 12	Responsible Consumption and Production	Encourages energy efficiency in the industrial sector.
3	SDG 13	Climate Action	Serves as a key fiscal instrument for emission mitigation.
4	SDG 17	Partnerships for the Goals	Promotes international cooperation through carbon trading.

Source: Organization for Economic Co-operation and Development, 2021

Thus, the carbon tax serves as a bridge between fiscal policy and sustainable development, not merely as a source of state revenue.

Analysis Based on Concepts and Theory

According to the theory of environmental economic instruments (Tietenberg & Lewis, 2018), the carbon tax ideally functions as a Pigouvian tax, i.e., a tax imposed on economic activities to internalize negative external impacts on the environment. However, in the Indonesian context, the effectiveness of the carbon tax is still limited by the following factors:

1. Information Asymmetry
   Not all companies have accurate emissions data, so tax rates do not reflect the true carbon burden.
2. Government Administrative Capacity
   Limitations in the MRV system make it difficult to determine a fair tax base.
3. Economic Resistance
   According to the theory of the Political Economy of Environmental Policy, industry resistance to environmental policies arises from concerns about reduced competitiveness and profitability.

Thus, environmental economics theory suggests that the success of a carbon tax in Indonesia depends on a gradual tariff adjustment mechanism, social compensation, and revenue recycling to incentivize clean energy.

Descriptive Analysis of the Impact of the Carbon Tax

Results from the literature review and secondary data indicate the potential for positive medium-term impacts, specifically by 2030, if the carbon tax is implemented consistently:

Table 6. Impact of Carbon Tax

No.	Indicator	Current Condition	Projected Impact by 2030
1	Emission intensity from industry (tons CO_2e/unit output)	High (average >0.8)	Decrease by 15–20% with a progressive tax rate
2	Share of renewable energy in the national energy mix	±13%	Increase to 23%
3	Carbon tax revenue	Not yet significant	Potentially >Rp10 trillion per year
4	Green jobs	Limited	Expected growth in renewable energy and energy efficiency sectors

Source: Ministry of Energy and Mineral Resources (KESDM), 2023

The analysis concludes that the carbon tax has the potential to provide economic and environmental benefits in line with the concept of sustainable development.

Based on the results of the analytical evaluation, it was concluded that the carbon tax policy in Indonesia is still in the transition phase toward an effective green fiscal system. Although there are still obstacles in terms of regulations, MRV infrastructure, and industrial readiness, the policy direction is already aligned with the principles of a low-carbon economy.

From the analysis, the following conclusions can be drawn:

1. The carbon tax meets the Pigouvian tax principle, but its effectiveness will only be

achieved when the policy is implemented with a robust monitoring system.
2. Implementation needs to be accompanied by clean energy incentives and subsidies to avoid industry resistance.
3. Cross-ministerial coordination is needed so that the carbon tax policy serves not only as a fiscal resource but also as a tool for the national energy transition.

Overall, a carbon tax has significant potential to contribute to achieving the 2060 Net Zero Emission target, provided it is implemented in a phased, transparent manner, and with attention to social justice (just transition) for affected community groups.

CONCLUSION

Conclusion

Based on the analysis and discussion, this study concludes that the carbon tax has strategic potential as an economic instrument to support the achievement of the 2060 NZE target in Indonesia, although its implementation still faces several challenges, namely:

1. From a policy and regulatory perspective: The legal framework for the carbon tax in Indonesia has been established through the HPP Law and Presidential Regulation No. 98 of 2021, but it has not yet been implemented with comprehensive technical regulations at the sectoral level. This means that implementation in the field is still in a testing phase and has not yet had a significant impact on national emission reductions.
2. From an institutional and infrastructure perspective, the monitoring, reporting, and verification (MRV) system is not yet fully integrated, so emissions measurement and tax rate determination still face data limitations. Weak coordination between institutions also hinders the effectiveness of the policy.
3. From an economic and social perspective: The implementation of a carbon tax at a low rate of IDR 30/kg CO_2e is not yet strong enough to drive changes in industrial behavior. However, this policy provides new opportunities to generate new green revenue to be allocated to clean energy subsidies and green jobs in the energy transition sector.
4. In terms of its linkage to sustainable development goals (SDGs): the carbon tax directly contributes to the achievement of SDG 7, namely clean energy, SDG 12, namely sustainable production, and SDG 13, namely climate. By being designed with the principle of just transition, the carbon tax can strengthen social justice and protect affected communities.

Overall, the carbon tax in Indonesia is still in the early stages of its transition to an effective green fiscal instrument. Its success depends heavily on increasing progressive tariffs, strengthening institutional capacity, and utilizing tax revenues for a just and inclusive energy transition.

Recommendations

In accordance with these conclusions, the following recommendations can be considered by the government, industry, and future researchers:

1. For the Government
   a. Strengthen regulatory aspects and coordination between institutions, namely the Ministry of Environment and Forestry and the Ministry of Energy and Mineral Resources, to create a transparent and consistent carbon tax governance system across sectors.
   b. Increasing the tax rate gradually (progressively) to better reflect the social cost of carbon, accompanied by fiscal compensation for energy-intensive industries and vulnerable groups.
   c. Optimizing the utilization of carbon tax revenue (revenue recycling) for investment in renewable energy, energy efficiency, and green workforce training.
   d. Building a digital and open national MRV system for more accurate and accountable emissions reporting.
2. For the Industrial Sector
   a. Increasing energy efficiency and investment in low-carbon technologies to adapt to green fiscal policies.
   b. Collaborating with the government and research institutions to develop innovation and emission offset schemes (carbon credits).
3. For Academics and Further Researchers
   a. It is recommended to conduct in-depth quantitative research or sectoral case studies using primary data to make the analysis more applicable.
   b. Further research is needed on the long-term impact of carbon taxes on industrial competitiveness, income distribution, and green economic growth.
   c. Cross-country comparative studies need to be expanded to identify the best implementation model appropriate to the Indonesian context.

Based on these recommendations, it can be concluded that the carbon tax is not only a fiscal tool but also a strategic mechanism for directing

the Indonesian economy towards long-term sustainability. Through inclusive, adaptive, and data-driven policies, the carbon tax can be a key driver of the transition to a green economy and the achievement of the NZE 2060.

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