

Evaluation of the Effectiveness of Carbon Tax as a Tool for Controlling Air Pollution in Indonesia: Challenges and Opportunities

Abdul wahab¹, Sariana Damis², Lina Mariana³ Hernianti Harun⁴ Nur Sandi Marsuni⁵

Politeknik LP3I Makassar^{1 and 3}

Muhammadiyah University of Pare-Pare^{2 and 4}

Muhammadiyah University of Makassar⁵

Email : wahabpolinas@gmail.com

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Abstract

The implementation of a carbon tax is increasingly recognized as an effective tool for controlling air pollution by providing economic incentives to reduce greenhouse gas emissions. This study evaluates the effectiveness of carbon tax as a pollution control tool in Indonesia, focusing on the challenges and opportunities presented by its adoption. Using a literature review approach, this research examines various secondary sources, including peer-reviewed journals, government reports, and publications from international organizations. The analysis includes thematic synthesis and comparative analysis to understand how carbon taxes have been applied globally and what lessons can be drawn for Indonesia. Results indicate that while the carbon tax presents significant potential for reducing air pollution, its success in Indonesia faces numerous challenges. Key obstacles include public resistance, regulatory complexities, economic considerations, and the readiness of industries to adapt to cleaner technologies. However, opportunities exist in aligning the carbon tax with international environmental standards, leveraging technological advancements, and increasing public awareness. Successful implementation would not only improve air quality but also support Indonesia's commitments to global climate goals. This study contributes to a deeper understanding of how Indonesia can utilize carbon tax policy effectively by addressing its unique socio-economic and regulatory landscape. Recommendations are provided for policymakers to mitigate challenges and maximize the benefits of a carbon tax as a sustainable tool for air pollution control. This analysis aims to inform strategic actions that strengthen Indonesia's environmental policies in alignment with international best practices.

1. Introduction

Air pollution has become one of the most pressing environmental problems worldwide, including in Indonesia. Increasing greenhouse gas emissions, especially carbon dioxide (CO₂), are generated from various economic activities such as industry, transportation, and fossil fuel-based energy. These increasing carbon emissions not only impact human health and the local environment but also contribute significantly to global warming and climate change. In Indonesia, rapid urbanization and industrialization have worsened the air pollution situation in both urban and rural areas, requiring effective measures to control it (Suryani, 2021).

As a country facing major challenges in controlling carbon emissions, Indonesia signed the Paris Agreement in 2015 and committed to reducing greenhouse gas emissions by 29% on

its own, or up to 41% with international support by 2030. However, achieving this target requires strong and effective strategies and policies. One policy that is expected to help achieve this target is the implementation of a carbon tax. Carbon tax is an economic instrument that aims to internalize the social costs of carbon emissions, so that economic actors have an incentive to switch to cleaner and more environmentally friendly energy (Ministry of Environment and Forestry, 2021).

Carbon tax in Indonesia is still a relatively new concept and has raised pros and cons among stakeholders. On the one hand, carbon tax is considered as one of the effective policy instruments in reducing carbon emissions because it directly affects the source of pollution. With this tax, industries that produce high emissions will be encouraged to innovate and use environmentally friendly technology or

renewable energy in order to reduce their tax burden. On the other hand, some have expressed concerns that the carbon tax could burden the industrial sector, especially those that are heavily dependent on fossil fuels, and could have a negative impact on the competitiveness of the Indonesian economy (Sayekti, 2022). In addition, there are challenges in terms of regulations and infrastructure that support the implementation of the carbon tax. Indonesia still needs clear regulations and effective mechanisms to measure and monitor carbon emissions accurately. Without strong and transparent regulations, the implementation of the carbon tax could be less effective and only become an additional burden for industry without having a significant impact on reducing emissions. Therefore, efforts to develop a strong and adequate regulatory framework are needed so that the implementation of the carbon tax can run effectively and achieve the expected goals (Suryani, 2021).

On the other hand, carbon tax also presents opportunities for Indonesia, especially in encouraging the transition to a green and sustainable economy. Carbon tax can be an incentive for companies to develop clean technology and renewable energy. This is in line with Indonesia's need to increase competitiveness in the global market, where environmentally friendly products are increasingly receiving attention (Ministry of Environment and Forestry, 2021). The implementation of carbon tax also provides the potential for the government to obtain additional sources of revenue that can be allocated to environmental programs. Revenue from carbon tax can be used to fund environmental restoration projects, renewable energy development, and support other climate change mitigation policies. This can also increase Indonesia's credibility in the international community as a country committed to sustainable development goals and environmental protection (Suryani, 2021).

However, the success of a carbon tax is highly dependent on the understanding and

support of the public and industry players. The low level of public understanding of the importance of reducing carbon emissions and its impact on quality of life can be a major obstacle in implementing this policy. Therefore, socialization and education to the public and industry about the benefits and urgency of a carbon tax are very important. The government needs to conduct a comprehensive information campaign so that the carbon tax is understood not just as an additional financial burden, but as an important step in protecting the environment and public health (Sayekti, 2022).

Furthermore, the success of a carbon tax is also determined by the readiness of the industrial sector to adapt to this new policy. For industries that are heavily dependent on fossil fuels, such as the energy and manufacturing sectors, the transition to cleaner energy can require large investments and a long time. The government needs to consider an inclusive transition strategy, such as providing incentives for industries willing to invest in green technology and training for workers to adapt to this change. Thus, the negative impact on the economic sector can be minimized while still achieving the goal of controlling carbon emissions (Sayekti, 2022).

Finally, the implementation of carbon tax in Indonesia also provides opportunities for research and innovation in the field of green technology. With incentives to reduce emissions, companies and research institutions are expected to be increasingly encouraged to develop more environmentally friendly innovations, such as emission control technology, renewable energy, and green transportation systems. Support for this innovation will strengthen the green economy ecosystem and ultimately help Indonesia achieve sustainable development as a whole (Ministry of Environment and Forestry, 2021). With the various challenges and opportunities that exist, evaluating the effectiveness of carbon tax in Indonesia is very crucial. This study needs to consider various aspects, including regulations, industry readiness, and community response. A comprehensive and holistic

approach to implementing carbon tax is expected to drive Indonesia towards a cleaner, healthier, and more sustainable future (Suryani, 2021).

2. Literature Review

2.1 Introduction to Carbon Taxation

The carbon tax is a fiscal tool aimed at mitigating environmental issues, primarily by reducing greenhouse gas (GHG) emissions. As part of broader climate action policies, the carbon tax charges industries and businesses for their carbon emissions, creating financial incentives to adopt cleaner technologies and reduce their environmental footprint. Several countries have implemented carbon tax policies as part of their commitment to climate agreements, notably the Paris Agreement, which aims to limit global warming to below 2°C above pre-industrial levels (World Bank, 2020). This literature review focuses on the concept of carbon tax, its effectiveness, and the challenges and opportunities it presents in the context of Indonesia.

2.2 Carbon Tax Implementation in Indonesia

In Indonesia, the carbon tax is part of the government's strategy to control air pollution and greenhouse gas emissions, formalized under Law Number 7 of 2021 concerning the Harmonization of Tax Regulations (UUHPP). The tax is scheduled for phased implementation, with the initial focus on coal-fired power plants, a major contributor to emissions (ESDM, 2021). The "cap and tax" scheme sets a maximum allowable emission limit; companies emitting beyond this limit are taxed, thus encouraging reductions in emissions or a shift to cleaner energy sources (CNBC Indonesia, 2022). This approach aligns with other Southeast Asian countries that have introduced carbon pricing schemes as a regulatory approach to emission control (Asian Development Bank, 2021).

2.3 The Effectiveness of Carbon Tax in Reducing Emissions

Research on the effectiveness of carbon tax policies globally reveals mixed results. For instance, in European Union countries, carbon taxes have led to significant reductions in emissions, particularly in the energy and industrial sectors (Martin et al., 2014). However, the success of these policies depends on factors such as tax rate, the scope of coverage, and the presence of supporting incentives for green technology adoption. A study by Rosalie et al. (2024) suggests that the effectiveness of carbon taxes increases when paired with subsidies or incentives for companies investing in renewable energy and low-emission technologies. Without these supporting policies, carbon taxes alone may not drive substantial behavioral changes, especially among large polluters who can absorb the tax costs without altering production practices.

2.4 Challenges in Implementing Carbon Tax in Indonesia

Indonesia faces unique challenges in implementing an effective carbon tax policy. One of the major obstacles is the readiness of industries reliant on fossil fuels, such as coal, to transition to cleaner energy sources. The relatively low initial tax rate of IDR 30 per kilogram of CO₂e has also raised concerns among environmental experts who argue that this rate may not provide sufficient incentives for industries to reduce emissions significantly (ESDM, 2021; Kementerian Keuangan, 2021). Moreover, financial constraints and technological limitations make it challenging for industries to adopt cleaner technologies. Public perception and understanding of the carbon tax policy also remain low, which could hinder public support and compliance (World Bank, 2020).

2.5 Opportunities for Carbon Tax Policy in Indonesia

Despite these challenges, the carbon tax policy in Indonesia presents opportunities for fostering a green economy. By promoting the adoption of renewable energy technologies, such as solar and wind power, the carbon tax

could enhance Indonesia's energy security, reduce dependency on fossil fuels, and create new jobs in the green energy sector. Carbon tax revenue can be allocated to fund environmental projects, including reforestation, land restoration, and investment in eco-friendly infrastructure (Zaini, 2021). Additionally, the policy could improve Indonesia's standing in the international community as a country committed to sustainable development and climate action.

2.6 Carbon Trading as a Complementary Mechanism

Alongside carbon taxation, the Indonesian government is exploring carbon trading as a supplementary policy. The cap-and-trade system allows companies that exceed their emission limits to buy additional emission allowances from companies that have reduced emissions below their limits (ESDM, 2021). This system provides flexibility for companies struggling to reduce emissions while encouraging overall reductions across industries. Carbon trading has been successfully implemented in countries such as Japan and South Korea, where it has enhanced the effectiveness of carbon reduction efforts (Asian Development Bank, 2021).

3. Research Methodology

3.1 Research Design

This study employs a literature review approach, aiming to evaluate the effectiveness of a carbon tax as a tool for controlling air pollution in Indonesia and to identify the associated challenges and opportunities. This approach involves collecting, analyzing, and synthesizing relevant literature sources, including scholarly journals, government reports, books, and publications from international organizations.

3.2 Data Sources

The data sources in this study are secondary data obtained from:

- Peer-reviewed journal articles in the fields of environmental economics, public policy, and climate change.

- Official reports from national agencies such as the Indonesian Ministry of Finance, Ministry of Environment and Forestry (KLHK), and Ministry of Energy and Mineral Resources (ESDM).
- Reports from international organizations such as the World Bank, Asian Development Bank, and research institutions related to carbon and environmental policy.
- Books and conference papers that discuss theories and practices of carbon tax implementation.

To ensure data quality and relevance, selected literature is from publications within the last 10 years, except for foundational and theoretical references deemed relevant.

3.3 Inclusion and Exclusion Criteria

- **Inclusion Criteria:** Selected literature must be relevant to carbon tax policies, air pollution control, climate change, or environmental policies in Indonesia and other countries for comparison.
- **Exclusion Criteria:** Literature not directly related to the research topic or containing outdated data (over 10 years old) is excluded, except for fundamental theoretical literature, as well as non-peer-reviewed articles.

3.4 Data Collection Procedure

Data collection is conducted through a structured search in several academic databases, such as Google Scholar, JSTOR, ScienceDirect, and ProQuest. Keywords used in the search include "carbon tax," "air pollution control," "environmental policy in Indonesia," "carbon pricing," and "carbon tax challenges and opportunities." Relevant literature is then organized and categorized based on the main themes of the study: carbon tax effectiveness, implementation challenges, and opportunities in Indonesia.

3.5 Data Analysis Technique

The obtained data is analyzed using a qualitative approach. The analysis steps include:

- **Thematic Synthesis:** Collected literature is grouped based on the main research themes to

identify patterns, trends, and research gaps related to the effectiveness of carbon tax in controlling air pollution.

- **Comparative Analysis:** Comparing the effectiveness of carbon tax in various countries with the situation in Indonesia to understand the factors influencing the success or challenges of implementing this policy.
- **Literature Critique:** Evaluating the strengths and weaknesses of each selected literature to assess the validity and reliability of the information obtained.

3.6 Validity and Reliability

The validity and reliability of this study are ensured by selecting literature from credible sources, such as peer-reviewed scientific journals and official reports from government agencies or international organizations. Triangulation techniques are also employed, comparing data from various literature sources to ensure the consistency and accuracy of information.

3.7 Results Presentation Procedure

The analysis results are organized into several sub-sections discussing:

- An overview of carbon tax and its effectiveness as a tool for controlling air pollution.
- Key challenges in implementing a carbon tax in Indonesia, including regulatory, economic, and social aspects.
- Opportunities to enhance the effectiveness of a carbon tax in Indonesia by considering the national context and international best practices.

3 Results and Discussion

3.4 Implementation of Carbon Tax in Indonesia

The carbon tax in Indonesia is a strategic policy aimed at reducing greenhouse gas emissions and improving air quality. This policy is mandated in Law Number 7 of 2021 concerning Harmonization of Tax Regulations (UUHPP), as part of Indonesia's commitment to reducing the impact of climate change. The implementation of the carbon tax was originally scheduled to begin on April 1, 2022, but was postponed until 2025 to give the government

and industry players more time to prepare adequate mechanisms and infrastructure (ESDM, 2021; CNBC Indonesia, 2022). This delay indicates a major challenge in policy implementation, especially related to the readiness of the industrial sector and inter-agency coordination to ensure the effectiveness of the implementation of the carbon tax in the future.

The carbon tax will be implemented in stages, starting with the coal-fired power plant (PLTU) sector, which is one of the largest sources of carbon emissions in Indonesia. With the "cap and tax" scheme, the government sets an emission limit that each PLTU may exceed. If a PLTU's emissions exceed this limit, a carbon tax will be imposed on this excess emission. The tax rate set at IDR30 per kilogram of carbon dioxide equivalent (CO₂e) is the lowest in the world, which has raised pros and cons among academics, environmental practitioners, and industry (ESDM, 2021; CNBC Indonesia, 2022). Some consider this rate too low to have a significant impact on reducing emissions, while others see it as a realistic first step to begin the transition.

The implementation of this carbon tax aims to encourage behavioral changes in both industry players and the wider community to shift to green economic activities that are low in carbon emissions. This tax is expected to create economic incentives for companies to reduce their emissions by investing in cleaner technologies or switching to renewable energy sources. In this context, the government also supports the implementation of carbon trading, which allows companies that are able to reduce emissions more to sell their emission rights to other companies. This carbon trading serves as a complement to the carbon tax, encouraging efficiency in overall emission reductions.

However, the carbon tax policy in Indonesia faces various challenges, especially related to the readiness of the industry to adapt and invest in green technology. Many companies that still rely on fossil fuels face financial and technological constraints in this transition. In addition, low carbon tax rates can also reduce

incentives for companies to reduce emissions significantly. Regulatory readiness and public understanding are also important factors. The government needs to overcome these challenges by providing technical guidance, incentives, and more intensive education programs to encourage public understanding and acceptance of the importance of this policy.

On the other hand, the carbon tax policy also opens up great opportunities for Indonesia to develop a sustainable green economy. With the carbon tax, the market potential for renewable energy technologies, such as solar and wind, is growing. Investment in this sector can improve national energy security, create green jobs, and strengthen Indonesia's competitiveness in the global market. In the future, this policy has the potential to help Indonesia achieve its greenhouse gas emission reduction targets set out in the Paris Agreement and enhance the country's reputation as one of the countries committed to environmental sustainability.

3.5 Carbon Tax Implementation Mechanism

The carbon tax implementation mechanism in Indonesia is designed to be implemented in stages to maximize the readiness of the industrial sector and supporting infrastructure. Since 2021, the government has taken the initial steps by developing a carbon trading mechanism, which includes technical preparation and regulatory arrangements so that this policy can run optimally in reducing carbon emissions in various sectors (ESDM, 2021). This carbon trading mechanism is expected not only to be an effective economic instrument to reduce emissions, but also as a supporting step in accelerating the national energy transition towards more environmentally friendly energy.

In the next stage, namely the period 2022 to 2024, the carbon tax policy will be applied specifically to the electricity generation sector, especially to coal-fired Steam Power Plants (PLTU). The "cap and tax" scheme implemented at this stage sets a carbon emission limit for each PLTU. If the PLTU

exceeds the specified limit, carbon tax will be imposed on the excess emissions. The selection of this sector as the initial focus is based on the high contribution of emissions produced by coal-fired PLTU in Indonesia. With these restrictions, the government hopes that the electricity generation sector will start switching to more efficient and environmentally friendly technology (ESDM, 2021; CNBC Indonesia, 2022).

After this initial period, in 2025, the government plans to continue implementing the carbon tax more widely and fully. This policy will be expanded to other sectors that are considered ready to implement the carbon tax scheme, taking into account the readiness of each sector to adapt. This gradual stage is expected to provide sufficient time for each sector to prepare for the transition, thereby reducing the risk of disruption to economic stability and industrial productivity. This gradual approach also allows for periodic evaluation and adjustment of policies to increase their effectiveness in the long term (ESDM, 2021).

In addition, the Indonesian government has also designed several carbon policy options as part of its energy transition efforts. The first option is the implementation of a direct carbon tax, where every emission produced will be taxed at a certain rate without considering the emission limit. The second option is a cap and trade scheme, where only emissions exceeding a certain limit will be taxed. This option aims to provide incentives for companies to reduce their emissions below a predetermined limit (ESDM, 2021).

In addition to these two options, there is a cap and trade option that allows companies that exceed emission limits to purchase additional emission permits from other companies that have successfully reduced their emissions. The last option is the Energy Transition Mechanism (ETM), which is being designed as a comprehensive mechanism to support carbon policies in accelerating the energy transition. Through these various policy options, the Indonesian government hopes to be

able to address the challenges of climate change more effectively, improve environmental quality, and significantly support the development of renewable energy (ESDM, 2021; CNBC Indonesia, 2022).

3.6 Effectiveness of Carbon Tax Implementation

The effectiveness of carbon tax implementation is highly dependent on proper policy design and implementation. Research by Thalia Rosalie et al. (2024) emphasizes that the success of carbon tax depends not only on the size of the tax rate, but also on the existence of additional incentives that can encourage companies to invest in clean technology. In this study, it was found that the implementation of carbon tax accompanied by incentives for green investment, such as low-emission technology and renewable energy, has greater potential to reduce emissions effectively. Therefore, carbon tax equipped with other supporting policies can provide more optimal results in efforts to reduce greenhouse gases (Thalia Rosalie et al., 2024).

Without adequate policy support, carbon tax may not be enough to encourage significant behavioral changes in large industries that contribute to emissions. This is due to the limited costs borne by large companies, where they tend to be able to absorb the burden of carbon tax without having to change their production patterns. In this context, providing incentives or encouragement to make a technological shift to renewable energy can strengthen the positive impact of carbon tax. These steps are key to encouraging companies to reduce emissions and achieve broader environmental goals.

In addition to the effectiveness in reducing emissions, it is also important to consider the socio-economic impacts of implementing a carbon tax. The Indonesian government plans to implement a carbon tax in stages, starting with the energy sector such as coal-fired power plants, which are one of the main contributors to carbon emissions in Indonesia. This plan allows for periodic

evaluations to assess the impact of the policy on the energy sector and the economy. Through this evaluation, the government can identify obstacles or barriers that may arise, and adjust policies to remain in line with national economic growth (Law of the Republic of Indonesia, 2021).

Continuous evaluation is important so that the implementation of carbon tax is not only effective in reducing carbon emissions, but also does not have a significant negative impact on the economy. Without adequate evaluation and adjustment, there is a risk that the carbon tax could burden certain sectors that are highly dependent on fossil fuels, thus having a negative impact on employment and investment. Therefore, this evaluation will ensure that the carbon tax policy can run effectively without sacrificing economic stability.

Overall, the success of the carbon tax in Indonesia will depend heavily on the synergy between good fiscal policy and strong environmental policy support. With the right combination of tax rates, clean technology incentives, and periodic evaluation, it is hoped that the implementation of the carbon tax in Indonesia can be an effective step in reducing greenhouse gas emissions, while supporting sustainable economic growth.

3.7 Potential State Revenue

The potential for state revenue from a carbon tax is also an essential aspect of this policy. Research by PT PLN's Main Director, Zulkifli Zaini (2021), shows that carbon tax costs can be a significant financial burden for coal-fired power plant operators. However, total emissions from the energy sector in 2020 reached 580 million tons of CO₂e, with fossil fuel power plants dominating at 279.3 million tons of CO₂e. This indicates that potential revenue from a carbon tax could be substantial and directed towards funding environmental projects and enhancing eco-friendly infrastructure (Zulkifli Zaini, 2021).

Revenue from the carbon tax has the potential to support projects such as renewable energy development, land restoration, and

reforestation programs that can enhance environmental quality. Thus, the carbon tax not only functions as a tool for reducing emissions but can also play a role in funding measures that directly help Indonesia achieve its climate and environmental targets. If allocated properly, the revenue can positively impact various sectors, including transportation and renewable energy, thereby creating a multiplier effect for a greener economy.

However, the effectiveness of the carbon tax in reducing greenhouse gas emissions and improving air quality highly depends on the proper policy design. Setting the tax rate too low may not provide enough incentive for companies to cut emissions, while setting it too high could negatively impact industries and potentially deter investment. Therefore, determining the tax rate and other supporting policies, such as incentives for clean technology, are key factors in ensuring the success of the carbon tax policy in Indonesia.

Additionally, community involvement in supporting the implementation of the carbon tax is crucial. Raising public awareness of the impacts of climate change and the benefits of the carbon tax can help build support for this policy. Public engagement through education and campaigns can increase understanding of the importance of emission reduction, ultimately encouraging eco-friendly behavior at the individual and community levels. This public support will strengthen the policy's effectiveness in the long term.

Overall, the implementation of a carbon tax in Indonesia holds significant potential for controlling greenhouse gas emissions and improving air quality. However, achieving optimal results requires a well-thought-out policy design, community support, and continuous evaluation of its impacts. Thus, the carbon tax will not only contribute positively to the environment but also support the sustainability of the national economy.

5. Clusion

5.1 Conclusion

The implementation of a carbon tax in Indonesia holds significant potential as a tool for controlling air pollution and reducing greenhouse gas emissions. This study shows that a carbon tax can encourage behavioral changes among industrial players and the public toward environmentally friendly economic activities. However, the success of this policy faces several challenges, including public resistance, industry readiness, low tax rates, and the complexity of supporting regulations and infrastructure.

Nevertheless, there are substantial opportunities to leverage the carbon tax as a tool for transitioning to a green economy, improving global competitiveness, and strengthening Indonesia's commitment to sustainable development goals. The success of the carbon tax will heavily depend on proper policy design, synergy with other environmental policies, and continuous evaluation to ensure its effectiveness. With the right combination of tax rates, incentives for clean technologies, and public engagement, the carbon tax will not only reduce emissions but also support sustainable economic growth.

5.2 Suggestion

- a. Strengthening Regulations and Infrastructure:** The government should ensure that the regulations and infrastructure supporting the implementation of the carbon tax are comprehensively designed, transparent, and capable of addressing industrial challenges.
- b. Incentives for Clean Technologies:** Stronger incentives for industries to invest in green technologies and renewable energy are necessary for a more effective transition to a low-carbon economy.
- c. Education and Awareness Campaigns:** The government should intensify information campaigns to increase public and industrial understanding of the importance of the carbon tax in combating climate change.
- d. Adjustment of Tax Rates:** Setting a tax rate that provides a real incentive for emissions reduction without burdening the economy should be a priority.

- e. **Utilizing Tax Revenues:** Revenue from the carbon tax should be strategically allocated to environmental projects, such as renewable energy development, reforestation, and ecosystem restoration programs.
- f. **Regular Evaluation:** The government must conduct periodic evaluations to assess the impact of the carbon tax on emissions reduction and the economy, and adjust policies as necessary.

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