



## BEYOND EMISSIONS: A COMPREHENSIVE ANALYSIS OF CARBON TAX AS A CATALYST FOR ENVIRONMENTAL AND ECONOMIC TRANSFORMATION IN INDONESIA

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### Abstract

Climate change and environmental degradation caused by carbon emissions have emerged as significant global challenges, prompting the search for effective fiscal policies for mitigation without impeding economic growth. This research critically analyzes the effectiveness and implications of carbon tax policies in Indonesia in reducing emissions and promoting environmental sustainability. Through a comprehensive systematic literature review approach, this study analyzes empirical evidence from various jurisdictions and models its potential impact in the Indonesian context. The results indicate that carbon tax implementation in Indonesia could reduce emissions by 3.2%-8.6% by 2030 compared to business-as-usual scenarios, with the greatest effects in the energy sector and carbon-intensive industries. Key findings suggest that optimal carbon tax design requires progressive rate structures, equitable revenue distribution mechanisms, and integration with complementary policy instruments. This research also identifies specific challenges for carbon tax implementation in Indonesia, including carbon leakage risks, distributional impacts, and institutional capacity limitations. The study contributes to the literature by offering a comprehensive framework for carbon tax policy reform that maximizes emission reductions while minimizing regressive economic impacts and optimizing environmental and health co-benefits.

**Keywords:** Carbon tax, Environmental fiscal policy, Environmental sustainability, Greenhouse gas emissions

### INTRODUCTION

Climate change and environmental degradation caused by carbon emissions have evolved into urgent global challenges, driving efforts to adopt effective fiscal policies for mitigation without hampering economic development (Alcaraz et al., 2022; IPCC, 2023). Environmental tax policies, particularly carbon taxes, have emerged as key instruments in global efforts to reduce greenhouse gas emissions and promote the transition to a low-carbon economy (Köppl & Schratzenstaller, 2022; World Bank, 2021). In this context, Indonesia's carbon emission intensity shows concerning trends, making carbon tax a potential tool to address environmental externalities (Timilsina et al., 2022).

Indonesia, as the fourth most populous country in the world with a rapidly growing economy, faces complex challenges in reducing carbon emissions. Data from the Indonesian Ministry of Environment and Forestry shows that Indonesia's greenhouse gas emissions reached 1,808 million tons of CO<sub>2</sub> in 2020, with the energy sector contributing about 36% of total emissions (Ministry of Environment and Forestry [KLHK], 2023). This figure demonstrates the urgency of taking more comprehensive action to address climate change.

Indonesia's commitment to climate change mitigation is reflected in the National Medium-Term Development Plan (RPJMN) 2020-2024 and in its Nationally Determined Contribution (NDC), which sets emission reduction targets of 29% independently and 41% with international support by 2030 compared to the business-as-usual scenario (Ministry of National Development Planning [Bappenas], 2020). To achieve these targets, Indonesia has begun implementing various policies, including the application of a carbon tax based on the Harmonization of Tax Regulations Law (UU HPP) No. 7 of 2021.



However, carbon tax implementation faces various challenges, including concerns about economic impacts, distributional justice issues, and potential carbon leakage (Nurdianto & Resosudarmo, 2021). A study by Adityo (2022) shows that although carbon taxes can significantly reduce emissions, it is important to design policies that minimize negative impacts on economic growth and social welfare. Additionally, research by Sambodo et al. (2022) identifies technological and governance barriers as major challenges in implementing low-carbon development in Indonesia.

Despite several studies on carbon taxes in Indonesia, there remains a gap in comprehensive understanding of the impact of carbon tax policies on carbon emissions and environmental sustainability that considers the specific characteristics of the Indonesian economy. These gaps include: (1) Limited empirical analysis of the effectiveness of carbon taxes in the context of developing economies such as Indonesia; (2) Lack of understanding about the interaction between carbon taxes and other environmental policy instruments; (3) Inadequate evaluation of the distributional implications of carbon tax policies in Indonesia; (4) Limited analysis of the optimal mechanisms for utilizing carbon tax revenue. Based on these gaps, this research aims to: (1) Critically analyze the effectiveness of carbon tax policies in reducing emissions in Indonesia; (2) Evaluate the economic, social, and environmental implications of carbon tax implementation. (3) Identify the optimal design of carbon tax policies that maximizes emission reductions while minimizing negative economic impacts; (4) Formulate policy recommendations for effective carbon tax implementation in Indonesia.

This research provides significant contributions to the literature by offering a comprehensive analysis of carbon tax policies in the Indonesian context. Specifically, this study: (1) Expands the theoretical understanding of carbon tax mechanisms in developing economies with structural characteristics such as Indonesia; (2) Provides empirical evidence on the potential effectiveness of carbon taxes in achieving Indonesia's emission reduction targets; (3) Develops an analytical framework to evaluate the trade-offs between emission reduction and distributional implications; (4) Offers evidence-based perspectives that can inform the development of carbon tax policies in Indonesia and other developing countries.

The findings from this research can provide valuable insights for policymakers in designing and implementing effective and fair carbon tax policies, as well as contributing to the broader academic discussion on the role of economic instruments in climate change mitigation.

## **LITERATURE REVIEW**

### **Concepts and Theories of Environmental Taxation**

The theoretical foundation for environmental taxes, including carbon taxes, is rooted in the concept of externalities first proposed by Pigou (1920). Pigouvian theory suggests that negative externalities, such as pollution, can be internalized through the imposition of taxes equal to the marginal social cost imposed by such activities (Baumol & Oates, 1988). In the context of carbon emissions, Pigouvian taxes aim to correct market failures by forcing producers and consumers to consider the full social costs of their emissions in their economic decisions (Metcalf & Weisbach, 2018).

Public goods theory is also relevant to environmental taxation, with clean air and climate stability serving as global public goods (Sandmo, 2011). Due to the non-excludable and non-rivalrous nature of these goods, market mechanisms typically fail to provide them at optimal levels without policy intervention. Carbon taxes can serve as a mechanism to finance the provision of these public goods and encourage behaviors that contribute to collective climate mitigation goals (Cramton et al., 2017).

Related to optimal tax theory, literature indicates that environmental taxes can achieve the dual goals of enhancing efficiency and environmental improvement when properly designed



(Bovenberg & Goulder, 2002). The concept of a "double dividend" suggests that revenues from environmental taxes can be used to reduce other distortionary taxes, thus yielding both environmental and economic efficiency benefits (Goulder, 2013). However, empirical research shows that the realization of this double dividend depends on the underlying economic structure and tax policy design (Metcalf, 2019).

### **Empirical Evidence on Carbon Taxes**

Empirical research on the effectiveness of carbon taxes has yielded diverse evidence. Studies conducted in countries that have implemented carbon taxes show significant impacts on emission reductions. For example, Sweden's carbon tax, introduced in 1991, has been associated with a 25% reduction in carbon emissions between 1991 and 2018, while GDP grew by 75% during the same period (Swedish Environmental Protection Agency, 2020). Similarly, evaluations of British Columbia's carbon tax found emission reductions of 5-15% relative to other regions in Canada (Murray & Rivers, 2015).

However, the effectiveness of carbon taxes varies depending on the specific implementation context. Factors such as tax rate levels, sectoral coverage, elasticity of demand for carbon-intensive goods, and availability of low-carbon alternatives all influence the effectiveness of carbon taxes (Aldy & Stavins, 2022). A meta-analysis conducted by Best et al. (2020) found that carbon taxes on average result in emission reductions of 2% for each \$1 per ton CO<sub>2</sub> increase, albeit with significant variation across jurisdictions.

In the context of developing economies, several studies have investigated the potential impacts of carbon taxes. Research by Dorband et al. (2019) analyzed the distributional impacts of carbon pricing across countries and found that while carbon taxes tend to be regressive in developed countries, they can be progressive in low and middle-income countries. This suggests that concerns about distributional impacts may be less relevant for countries like Indonesia (Wang et al., 2016).

For Indonesia specifically, modeling by Adityo (2022) indicates that carbon taxes could reduce CO<sub>2</sub> emissions by 3.2-8.6% by 2030 compared to the business-as-usual scenario. However, Nurdianto and Resosudarmo (2021) warn that without proper redistribution mechanisms, carbon taxes could increase income inequality and poverty in Indonesia. Research by Yang (2024) also found that certain sectors, such as power generation, may experience significant structural changes in response to carbon taxes.

### **Conceptual Framework of Consumption Taxes and Carbon Emissions**

Consumption taxes, including Value Added Tax (VAT) and Luxury Goods Sales Tax, can serve as instruments to reduce consumption that generates high carbon emissions (Cnossen, 2011). The conceptual framework linking consumption taxes to carbon emissions focuses on how these taxes can influence consumption decisions and, indirectly, related carbon emissions (Carbonnier, 2007).

Consumption taxes can affect carbon emissions through several pathways. First, by increasing the prices of carbon-intensive goods, taxes can reduce demand for these goods (Bovenberg & Goulder, 1996). Second, differential consumption taxes targeting goods with different carbon intensities can encourage shifts in consumption patterns toward lower-carbon alternatives (Stiglitz, 2019). Third, revenue from consumption taxes can be invested in low-carbon infrastructure and technology, further reducing the economy's carbon footprint (OECD, 2021).

However, consumption taxes must also consider distributional implications. Because consumption taxes can be regressive, it is important to design policies that do not disproportionately burden low-income households (Atkinson & Stiglitz, 1976). Some mechanisms to address this issue include exemptions for essential goods, tax credits for low-



income households, and the use of tax revenue for social programs targeting vulnerable populations (Metcalf, 2021).

In the Indonesian context, a consumption tax model that takes into account carbon intensity could be an effective instrument to reduce emissions while generating revenue to support the transition to a low-carbon economy. Integration of carbon taxes with existing consumption tax systems can minimize administrative costs and broaden the tax base (Anwar, 2022).

### **Carbon Tax Policies in Indonesia: Institutional and Regulatory Framework**

Indonesia has taken significant steps toward implementing a carbon tax through the Harmonization of Tax Regulations Law (UU HPP) No. 7 of 2021, which establishes the legal framework for imposing a carbon tax. This tax initially targets emissions from coal-fired power plants at a rate of IDR 30,000 per ton of CO<sub>2e</sub>, with plans for gradual expansion to other sectors (Ministry of Finance, 2021).

The institutional framework for carbon tax implementation in Indonesia involves several government agencies, including the Ministry of Finance, the Ministry of Environment and Forestry, and the Ministry of Energy and Mineral Resources. This inter-ministerial coordination is essential to ensure effective implementation and coherence with other policies (Kuswanto, 2022).

Indonesia has also developed an emissions trading framework, which has the potential to interact with the carbon tax to create a hybrid carbon pricing system. Presidential Regulation No. 98 of 2021 outlines the implementation of a cap-and-trade system, starting with a pilot program in the electricity sector (Timilsina et al., 2022).

Significant regulatory challenges remain, including the establishment of a robust Monitoring, Reporting, and Verification (MRV) system, developing technical capacity for carbon tax administration, and ensuring consistency with other sectoral policies (Sambodo et al., 2022). Addressing these challenges will be key to effective carbon tax implementation in Indonesia.

## **METHODS**

### **Approach and Research Design**

This research adopts a systematic literature review (SLR) approach to comprehensively analyze available evidence on carbon tax policies and their impact on emissions and environmental sustainability, with a specific focus on their relevance to the Indonesian context. The SLR approach was chosen because it allows for systematic synthesis of existing evidence, facilitates identification of emerging patterns and themes, and minimizes bias in the selection and interpretation of literature (Okoli & Schabram, 2010). The SLR process follows the protocol developed by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), which includes identification, screening, eligibility, and inclusion stages (Page et al., 2021).

This approach is complemented by a qualitative meta-analysis of relevant findings, allowing for the integration of results from multiple studies to develop a more comprehensive understanding of the phenomena under investigation (Dixon-Woods et al., 2005). This research design enables critical evaluation of existing evidence while considering the specific characteristics of the Indonesian context.

### **Search Strategy and Inclusion/Exclusion Criteria**

The search strategy involved systematic searches in major academic databases, including Web of Science, Scopus, Science Direct, EconLit, JSTOR, and Google Scholar. This search was supplemented by exploration of grey literature from international organizations



(World Bank, IMF, OECD, ADB), local research institutions, and relevant government documents.

Key search terms included: "carbon tax" OR "environmental tax" OR "consumption tax" AND "emissions" OR "carbon emissions" OR "greenhouse gas" AND "environmental sustainability" OR "climate policy" AND "Indonesia" OR "developing countries" OR "emerging economies". Additional searches used terms such as "distributional impact", "revenue recycling", "double dividend", and "policy design".

Inclusion criteria encompassed:

1. Studies published between 2000-2023 to capture recent developments in carbon tax research.
2. Research focusing on carbon taxes, environmental taxes, or environment-related consumption taxes.
3. Studies analyzing impacts on carbon emissions, environmental indicators, or economic implications.
4. Research specifically focusing on Indonesia or relevant to developing economy contexts.

Exclusion criteria included:

1. Studies exclusively focusing on non-tax climate policy instruments without relevance to tax policies.
2. Opinion literature or commentaries without substantial empirical or theoretical analysis.
3. Studies not available in English or Indonesian.

### **Data Extraction and Analysis**

The data extraction process used a standardization framework to capture relevant information from each study, including:

1. Study characteristics: authors, year, geographical location, methodology, and theoretical framework.
2. Carbon tax policy design: rate levels, sectoral coverage, revenue mechanisms, and implementation features.
3. Results and findings: impacts on emissions, economic implications, distributional effects, and implementation challenges.
4. Relevance to the Indonesian context: applicability of findings and recommendations to Indonesian conditions.

Data analysis involved thematic synthesis to identify patterns, trends, and gaps in the literature. This approach allows for the identification and consolidation of key emerging themes and the development of a conceptual framework that integrates various perspectives and findings (Braun & Clarke, 2006). Triangulation of data from various sources and methodologies was used to enhance the robustness of findings and develop a more comprehensive understanding of the complexities of carbon tax policies.

### **Analytical Framework**

The analytical framework for this research integrates three main dimensions: environmental effectiveness, economic efficiency, and social justice implications. This framework allows for a comprehensive evaluation of carbon tax policies that accounts for various trade-offs and synergies that may occur.

For environmental effectiveness, the analysis focuses on potential emission reductions, impacts across various sectors, and contributions to national and international climate targets. For economic efficiency, the framework explores abatement costs, macroeconomic impacts, and interactions with other policies and taxes. For social justice implications, the analysis examines distributional effects across income groups, sectoral and regional impacts, and strategies for mitigating regressive impacts.



The framework also considers contextual factors that may influence the implementation and effectiveness of carbon taxes in Indonesia, including economic structure, institutional capacity, and political economy characteristics. By integrating these dimensions and factors, the analytical framework enables a balanced and contextual evaluation of carbon tax policies in the Indonesian context.

## **RESULTS AND DISCUSSION**

### **Effectiveness of Carbon Taxes in Reducing Emissions: Empirical Evidence from Indonesia and Internationally**

Analysis of empirical evidence indicates that carbon taxes can be effective instruments for reducing greenhouse gas emissions across various economic contexts. A meta-analysis of 40 studies across 15 jurisdictions by Green (2021) shows that carbon taxes consistently reduce emissions compared to business-as-usual scenarios, with the magnitude of effects depending on price levels, sectoral coverage, and other contextual factors.

In developed countries, evidence shows significant emission reductions following carbon tax implementation. Analysis of Sweden's carbon tax impact by Andersson (2019) found transport sector emission reductions of 11% between 1990 and 2005, with a 1% increase in carbon tax rates resulting in a 0.42% decrease in CO<sub>2</sub> emissions. Similarly, British Columbia's carbon tax was associated with emission reductions of 5-15% during the first ten years of implementation (Murray & Rivers, 2015).

For developing economies, evidence is more limited but shows significant potential. In South Africa, ex-ante modeling indicates that the carbon tax implemented since 2019 could reduce emissions by 13-14.5% by 2025 compared to business-as-usual scenarios (Alton et al., 2014). In Mexico, a relatively low carbon tax (about \$3 per ton CO<sub>2</sub>) has contributed to modest decreases in emission intensity in the industrial sector (Vera & Sauma, 2021).

In the Indonesian context, modeling by Adityo (2022) using a general equilibrium model shows that a carbon tax rate of IDR 30,000 per ton CO<sub>2e</sub> could reduce emissions by 3.2% by 2030 compared to the business-as-usual scenario. If the rate is progressively increased to IDR 200,000 per ton CO<sub>2e</sub> by 2030, emission reductions could reach 8.6%. Sectoral analysis indicates that the largest reductions are expected to occur in the energy sector (10.2-15.4%) and industry (4.5-9.8%).

A study by Yang (2024) provides insights into the mechanisms of carbon tax impacts on emissions. The analysis identifies three main pathways: (1) inter-fuel shifting from carbon-intensive energy sources to cleaner sources, (2) increased energy efficiency in response to higher energy prices, and (3) structural shifts in the economy away from carbon-intensive industries. In Indonesia, the sector projected to experience the largest inter-fuel shift is electricity generation, with shifts from coal to natural gas and renewable energy.

Although evidence indicates significant potential effectiveness, several context-specific factors in Indonesia may affect actual outcomes. First, limited availability of low-carbon alternatives and high costs in some sectors may reduce short-term price elasticities and limit responses to carbon price signals (Timilsina et al., 2022). Second, enforcement and compliance challenges, especially in the large informal economy, may reduce policy effectiveness (Sambodo et al., 2022). Third, the risk of carbon leakage to jurisdictions with looser regulations may reduce global effectiveness (Nurdianto & Resosudarmo, 2021).

To address these challenges, careful policy design is essential. A phased approach starting with low rates and progressively increasing can provide clear price signals while allowing time for adaptation (Kuswantoro, 2022). Integration with complementary policies that address structural constraints and support the transition to low-carbon alternatives is also important to maximize effectiveness (OECD, 2021).



## Economic Implications of Carbon Taxes in Indonesia

Implementation of carbon taxes in Indonesia has diverse economic implications, depending on specific policy design, affected sectors, and broader macroeconomic conditions. Modeling by Nurdianto and Resosudarmo (2021) using a computable general equilibrium (CGE) model shows that a carbon tax of IDR 80,000 per ton CO<sub>2e</sub> without revenue redistribution could reduce Indonesia's GDP by 0.4-0.7% compared to the baseline.

However, these macroeconomic impacts can be significantly reduced through careful policy design. Burke et al. (2023) show that with effective revenue redistribution strategies, negative impacts on GDP can be reduced to 0.1-0.2%, while emission reductions remain significant. A study by Kuswantoro (2022) found that a phased approach starting with a low rate (IDR 30,000 per ton CO<sub>2e</sub>) and progressively increasing to IDR 200,000 per ton CO<sub>2e</sub> by 2030 can minimize economic shocks while providing clear long-term price signals.

Sectoral analysis shows significant variation in impacts across industries. Energy and carbon-intensive sectors, including coal-based electricity production, steel, cement, and petrochemicals, are projected to experience the greatest impacts (Timilsina et al., 2022). An Input-Output model developed by Hartono et al. (2020) identifies that the steel industry could experience output decreases of up to 4.2% with a carbon tax of IDR 100,000 per ton CO<sub>2e</sub>, while the cement industry could experience decreases of 3.7%.

On the other hand, low-carbon sectors and service industries are predicted to experience minimal or even positive impacts. Analysis by Anwar (2022) indicates that the renewable energy sector could experience additional growth of 2.5-3.8% per year in response to carbon taxes, creating potential for "green" growth in the economy. Similarly, energy efficiency and waste management industries are projected to enjoy positive effects from carbon tax implementation.

The labor market will also undergo transformation in response to carbon taxes. Research by Kurniawati and Wijaya (2021) estimates that while there may be short-term job reductions in carbon-intensive sectors (estimated between 0.5-1.2% of total employment in these sectors), the economy will also see employment growth in renewable energy and energy efficiency industries, with potential creation of 250,000-350,000 "green jobs" by 2030.

Inflation impact is also an important consideration. Analysis by Tjoanto and Tambunan (2022) indicates that a carbon tax of IDR 30,000 per ton CO<sub>2e</sub> could increase inflation by 0.3-0.5 percentage points in the short term, primarily through increased electricity and transportation costs. However, these inflationary effects are expected to diminish over time as the economy adapts and shifts to cleaner energy sources.

An important aspect of economic implications is regional distributional consequences. Indonesia has significant regional inequalities, and carbon tax implementation may affect different regions disproportionately. A study by Kharisma (2019) identifies that regions heavily dependent on carbon-intensive industries, such as East Kalimantan (coal mining) and Banten (coal-based power generation), may experience greater economic impacts. This indicates the need for just transition strategies that consider these regional differences in policy design.

It is also important to consider international competitiveness. As an economy with significant export orientation, Indonesia must balance emission reduction goals with maintaining industrial competitiveness. Xu and Masui (2021) show that without complementary policies such as carbon border adjustments or special treatment for trade-exposed industries, some Indonesian sectors may lose global market share. High-risk industries include textiles, electronics, and basic chemical products.

Despite potential short-term economic costs, evidence also indicates potential long-term economic dividends from the low-carbon transition. Analysis by Bappenas (2021) found that a low-carbon transition supported by carbon taxes could yield long-term net economic benefits



through improved resource efficiency, reduced fossil fuel imports, and health benefits from reduced air pollution. The report estimates that a low-carbon development pathway could increase Indonesia's GDP by 4-6% by 2045 compared to business-as-usual scenarios.

### **Distributive Impacts and Social Justice Implications of Carbon Taxes**

An important consideration in carbon tax implementation is its distributional implications across different income groups and its potential impact on social justice. Comprehensive research by Wang et al. (2016) across several developing countries shows that carbon taxes have different distributional impact patterns compared to those observed in developed countries.

Distributional analysis for Indonesia by Yusuf and Resosudarmo (2015) indicates that without revenue redistribution mechanisms, carbon taxes tend to be regressive in urban areas but tend to be proportional or even slightly progressive in rural areas. This is partly due to differences in energy consumption patterns, with low-income rural households using fewer fossil fuels as a proportion of their total expenditure. However, when accounting for indirect effects through price increases of goods produced with carbon-intensive inputs, the overall effect tends to be slightly regressive across the population.

Albab and Tjaraka (2024) identify that the groups most vulnerable to the regressive impacts of carbon taxes in Indonesia include low-income urban households, energy-dependent micro and small business operators, and workers in carbon-intensive industries. The study found that urban households in the lowest income decile could experience purchasing power decreases of 1.2-1.5% without proper mitigation measures.

Various revenue redistribution mechanisms have been proposed to address these potential regressive impacts. Dorband et al. (2019) analyze various revenue recycling options and find that lump-sum transfers to households (equal for all) are the most effective mechanism for making carbon tax policies progressive, as such transfers represent a larger proportion of income for low-income households. For Indonesia specifically, Long et al. (2019) conclude that redistributing 30-40% of carbon tax revenue as lump-sum transfers to the poorest 40% of households could make carbon tax policy progressive overall.

Alternatives to direct cash transfers include income tax reductions for low and middle-income groups, subsidies for essential goods, or investments in public services that disproportionately benefit low-income groups. Putri and Septyan (2023) argue that, in the Indonesian context, a combination of direct cash transfers and subsidies for electricity and public transportation could be the most effective redistribution strategy.

Broader justice perspectives are also important. Palupi et al. (2023) bring an ethical dimension to the discussion, examining carbon taxes through the lens of Islamic justice and arguing that principles of Islamic economic justice align with carefully designed carbon taxes with proper attention to distribution and protection of vulnerable groups. This study emphasizes that from an intergenerational justice perspective, climate change mitigation through instruments such as carbon taxes can align with commitments to protect future generations, a principle found in many ethical frameworks including Islamic justice.

The regional dimension of justice is also relevant for Indonesia as a diverse archipelagic nation. Rahman and Vu (2021) show that provinces outside Java, particularly those with high dependence on resource-intensive industries, may bear a disproportionate burden from carbon taxes if implemented uniformly nationally. This research recommends a phased approach that considers regional economic characteristics and adaptive capacity in determining the timing and level of tax implementation.

Another important dimension of justice is the implications of the low-carbon transition for workers in carbon-intensive industries. Sambodo et al. (2022) highlight the need for a "just transition" that provides retraining, income support, and alternative economic opportunities for



workers negatively affected by carbon taxes. This study estimates that without such programs, up to 1.2 million workers in the mining, coal-based electricity production, and related energy-intensive industries could experience significant employment disruption.

Research by Alcaraz et al. (2022) illustrates that energy resilience and vulnerability to carbon taxes are unevenly distributed among different community groups, with rural and remote communities facing particular challenges in adapting to energy price changes. The study recommends specific programs to increase access to affordable clean energy alternatives in these areas as a complement to carbon tax implementation.

Overall, evidence indicates that while carbon taxes may have regressive impacts if implemented without complementary measures, careful policy design can address these distributional issues. With appropriate revenue redistribution mechanisms and attention to the needs of vulnerable groups and regions, carbon taxes can be implemented in ways that align with social justice goals while achieving necessary emission reductions.

### **Optimal Carbon Tax Policy Design for Indonesia**

Based on empirical evidence and previous analysis, this section synthesizes findings to propose key elements of optimal carbon tax policy design for Indonesia. The optimal design should balance environmental effectiveness, economic efficiency, and social justice implications while considering the specific characteristics of the Indonesian economy.

#### ***Rate Structure and Price Path***

International evidence indicates that for optimal effectiveness, carbon taxes require sufficiently high rate levels to drive significant behavioral changes. However, immediate implementation with high rates can cause unwanted economic shocks. For Indonesia, the phased approach recommended by Kuswanto (2022) offers the right balance: starting with moderate rates (IDR 30,000-50,000 per ton CO<sub>2e</sub>) and increasing progressively and predictably over time, reaching IDR 200,000-300,000 per ton CO<sub>2e</sub> by 2030.

This pre-announced price path provides several important advantages: (1) provides certainty for businesses for long-term investments in low-carbon technology, (2) avoids economic shocks by allowing time for adjustment, and (3) enables learning and policy adjustments. Metcalf (2019) found that jurisdictions with clear and predictable carbon price paths enjoy higher levels of low-carbon investment compared to more ad hoc approaches.

#### ***Sectoral Coverage and Point of Regulation***

For Indonesia, research by Tjoanto and Tambunan (2022) recommends a phased approach to sectoral coverage, starting with emission-intensive sectors with relatively low carbon leakage constraints. Consistent with Indonesia's initial approach, coal-fired power generation is a logical starting point, followed by gradual expansion to petroleum refineries, cement, steel, and other energy-intensive industries. This phased approach allows for refinement of administrative capacity and monitoring before expanding to more complex sectors.

Regarding the point of regulation, analysis by Metcalf and Weisbach (2018) indicates that for economies like Indonesia with large informal sectors, upstream carbon taxes (at the point of production or import) are likely more administratively efficient than downstream regulation. However, Putra and Rusgianto (2023) argue that for some sectors such as transportation, a mixed approach combining upstream and downstream regulation may be optimal to ensure adequate coverage while minimizing administrative costs.

#### ***Revenue Recycling Mechanisms***

Strong evidence indicates that revenue recycling mechanisms are a critical component of optimal carbon tax design. For Indonesia, analysis by Yusuf and Resosudarmo (2015) and Dorband et al. (2019) suggests that a combination of revenue recycling mechanisms will be most effective in balancing various policy objectives:



1. Carbon Dividends (30-40% of revenue): Direct lump-sum transfers to households, with a focus on the poorest 40% of households, to address potential regressive impacts and strengthen public support.
2. Industry Transition Support (25-30%): Targeted funding to support energy efficiency investments, low-carbon technology research and development, and transition assistance for affected industries.
3. Low-Carbon Infrastructure (20-25%): Investments in public infrastructure supporting the low-carbon transition, including public transportation, renewable energy networks, and climate resilience projects.
4. Labor Tax Reductions (10-15%): Moderate reductions in labor taxes to generate a "double dividend" by improving labor market outcomes.

Roach (2020) emphasizes that transparency in managing and using carbon tax revenue is crucial for building public trust and support for the policy. Clear and auditable mechanisms for revenue tracking and distribution should be an integral part of policy design.

#### ***Competitiveness Protection and Anti-Leakage***

To address concerns about competitiveness and carbon leakage, research by Timilsina et al. (2022) recommends a suite of tailored protection measures:

1. Output-Based Allocations: Providing partial tax exemptions or output-based credits for trade-exposed industries during the transition phase, with exemptions gradually reduced over time.
2. Carbon Border Adjustments: Developing a framework for carbon border adjustments for certain high-risk industries, aligned with evolving international practices.
3. International Harmonization: Actively engaging in regional and global efforts to align carbon pricing policies, reducing the risk of leakage and inequalities.
4. Targeted Innovation Support: Providing grants and support for high-risk industries to adopt low-carbon technologies that enhance competitiveness while reducing emissions.

#### ***Integration with Other Policy Instruments***

Carbon taxes function most effectively as part of a comprehensive policy mix. As emphasized by Sambodo et al. (2022), integration with complementary policy instruments is essential:

1. Cap-and-Trade System: Developing a hybrid system integrating carbon taxes with Indonesia's newly introduced ETS, with the tax serving as a carbon price floor.
2. Efficiency Regulations: Complementing carbon taxes with energy efficiency and performance standards for equipment, buildings, and vehicles to address non-price barriers.
3. Sector-Specific Policies: Developing policies tailored to specific challenges in key sectors such as forestry, agriculture, and transportation.
4. Renewable Energy Incentives: Aligning existing renewable energy support instruments with carbon taxes to ensure consistent promotion of low-carbon alternatives.

#### ***Governance and Transparency***

Strong governance mechanisms are essential for effective implementation. Studies by Jian et al. (2019) and Kharisma (2019) recommend key elements for an effective carbon tax governance system in Indonesia:

1. Oversight Body: Establishing an independent oversight body composed of experts and stakeholders to monitor implementation and impacts.
2. Regular Reviews: Establishing formal processes for periodic policy evaluation and adjustment, including annual reviews of tax levels and revenue allocation.
3. Robust MRV System: Developing a comprehensive monitoring, reporting, and verification (MRV) system to ensure carbon tax integrity.



4. Fossil Fuel Subsidy Removal: Aligning policies by phasing out existing fossil fuel subsidies, which may conflict with carbon tax objectives.
5. Transparency: Ensuring transparent public reporting on carbon tax revenue and its use to build trust and accountability.

By integrating these elements, Indonesia can develop a carbon tax framework that effectively reduces emissions and supports the transition to a low-carbon economy, while minimizing negative economic impacts and ensuring fair outcomes for all segments of society.

### **Implementation Challenges and Mitigation Strategies**

Despite strong evidence supporting the potential benefits of carbon taxes, successful implementation in Indonesia faces several significant challenges that require careful mitigation strategies.

#### ***Institutional and Capacity Challenges***

Effective carbon tax implementation requires a strong institutional framework and technical capacity. Sambodo et al. (2022) identify several key institutional challenges in Indonesia, including limited inter-ministerial coordination, uneven technical capacity for MRV systems, and an incomplete legal framework for carbon tax implementation.

Mitigation strategies to address these challenges include:

- Establishing a dedicated inter-ministerial coordination unit with clear mandate and decision-making authority
- Developing targeted capacity building programs for government officials in environmental tax administration and MRV
- Strengthening the legal framework with comprehensive implementing regulations and enforcement mechanisms
- Mobilizing international technical support through partnerships with institutions such as the World Bank and UNDP

Xuan Vinh Vo et al. (2021) note that countries with stronger institutional capacity have achieved higher levels of compliance and effectiveness in carbon tax implementation, highlighting the importance of early investment in capacity development.

#### ***Economic and Fiscal Challenges***

Carbon tax implementation also faces significant economic challenges, particularly in the context of post-pandemic recovery. Tjoanto and Tambunan (2022) identify concerns about short-term impacts on business competitiveness, cost of living, and price stability as potential barriers to implementation.

Effective mitigation strategies include:

- Introducing carbon taxes gradually with predictable escalation pathways
- Providing temporary exemptions or transitional facilities for highly impacted industries
- Establishing transparent revenue redistribution programs targeting groups most negatively affected
- Implementing companion programs to improve energy efficiency and reduce compliance costs
- Coordinating monetary and fiscal policies to manage potential inflationary pressures

Loujaina Abdelwahed (2020) notes that countries that have aligned carbon taxes with broader fiscal reforms have achieved smoother transitions and less economic disruption, highlighting the importance of an integrated approach.

#### ***Political Economy Challenges***

Perhaps the greatest challenge to effective carbon tax implementation lies in the political economy. Jian et al. (2019) analyze the dynamics of various stakeholder interests and identify several political barriers, including opposition from carbon-intensive industries, concerns about regressive impacts, and concerns about differential regional impacts.



Strategies to address these challenges include:

- Developing strong public communication and engagement strategies that articulate benefits and address concerns
- Building broad supportive coalitions involving businesses, civil society, and community leaders
- Creating just transition mechanisms for workers and communities dependent on carbon-intensive industries
- Implementing transparent impact monitoring systems that track and report policy outcomes
- Building multi-partisan support for the policy to ensure sustainability beyond political cycles

Borozaan (2019) shows that carbon taxes designed with particular attention to distributional concerns and companion policies that visibly benefit households enjoy stronger public support and political stability, indicating the importance of considering perception and communication in policy design.

### ***Technology and Infrastructure Challenges***

Indonesia also faces significant challenges related to the availability of low-carbon technology and supporting infrastructure. Putra and Rusgianto (2023) highlight that in some sectors, particularly heavy transportation and certain energy-intensive industries, commercially viable low-carbon alternatives remain limited, constraining short-term responses to carbon price signals.

Strategies to address these constraints include:

- Directing a portion of carbon tax revenue to research, development, and demonstration of low-carbon technologies
- Developing acceleration programs for key technologies identified in Indonesia's low-carbon plans
- Implementing public procurement policies that support market development for low-carbon solutions
- Strengthening intellectual property protection regimes to encourage technology transfer
- Investing in supporting infrastructure such as electric vehicle charging networks, smart grids, and energy storage facilities to support low-carbon technology adoption

Nugraha and Osman (2019) emphasize that to address the technology gap, Indonesia should adopt a dual-track approach that encourages adoption of commercially mature technologies while investing in long-term development of solutions tailored to the local context.

### ***Knowledge Gaps and Stakeholder Engagement***

An important issue in carbon tax implementation in Indonesia is the knowledge gap among various stakeholders about the mechanisms and implications of the policy. Albab and Tjaraka (2024) identify that many businesses, particularly small and medium enterprises, have limited understanding of how carbon taxes will affect their operations and what options are available to reduce taxes.

Strategies to address knowledge gaps include:

- Developing tailored education and awareness programs for various stakeholder groups
- Establishing technical assistance centers for businesses that provide information and support for low-carbon transitions
- Engaging industry associations, civil society groups, and academics in policy development and implementation
- Creating knowledge-sharing platforms and best practice repositories to facilitate peer learning



- Implementing pilot projects and demonstration programs to illustrate practical approaches to emission reduction

Addressing knowledge gaps and ensuring meaningful stakeholder engagement not only improves policy design but also builds broader ownership and support, as demonstrated by Kirikkaleli et al. (2021) in their analysis of successful environmental tax reforms in several countries.

By developing comprehensive strategies to address these challenges, Indonesia can enhance the likelihood of successful carbon tax implementation that effectively reduces emissions while supporting sustainable economic growth and protecting vulnerable groups.

### **Environmental and Health Co-Benefits of Carbon Taxes**

Beyond the direct benefits of greenhouse gas emission reductions, carbon tax implementation in Indonesia can generate significant environmental and health co-benefits. Identifying and quantifying these co-benefits is important for comprehensive policy evaluation and can strengthen public support.

#### ***Air Pollution Reduction and Health Benefits***

One of the most significant co-benefits of carbon taxes is the concurrent reduction in air pollution with carbon emission reductions. Research by Yang (2024) demonstrates a strong relationship between carbon mitigation policies and reductions in conventional air pollutants, including fine particulates (PM<sub>2.5</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and ozone.

For Indonesia, which faces significant challenges related to urban air pollution, the health benefits from carbon tax-related air pollution reductions can be substantial. Based on Djula Borozan's (2019) study adapted to the Indonesian context, a carbon tax of IDR 80,000 per ton CO<sub>2e</sub> is projected to reduce PM<sub>2.5</sub> concentrations by 15-20% in major urban areas, yielding estimated annual health benefits valued at IDR 20-30 trillion. These benefits include:

- Reduction in pollution-related premature deaths (estimated 10,000-15,000 avoided deaths per year)
- Reduction in respiratory diseases, including asthma and chronic bronchitis
- Decrease in cardiovascular disease incidence
- Reduction in work and school absences related to pollution-related illnesses
- Increased labor productivity due to better health

Health benefit calculations by KLHK (2023) indicate that the monetized value of health benefits alone can offset much of the economic costs of carbon tax implementation, even before considering climate change mitigation benefits.

#### ***Water Quality and Aquatic Ecosystem Improvements***

Carbon taxes that drive reductions in fossil fuel use and modifications to industrial processes can also yield benefits for water quality and aquatic ecosystems. Kirikkaleli et al. (2021) identify several pathways through which carbon taxes can improve water quality:

- Reduction in acid deposition from SO<sub>2</sub> and NO<sub>x</sub> emissions that impact pH and aquatic ecosystem health
- Decrease in pollutant runoff from energy production and industrial facilities
- Reduction in oil spill risks and waste discharges from fossil fuel transportation and extraction
- Reduction in water heating from fossil fuel power plant cooling processes

For Indonesia, a country with extraordinary marine and aquatic biodiversity, these benefits are particularly important. Rahman and Vu (2021) estimate that carbon tax implementation could reduce pollutant loads to Indonesian waters by 8-12%, making a significant contribution to the protection of coral reefs, fisheries, and other marine resources critical to the economy and livelihoods.



### ***Biodiversity Conservation and Ecosystem Services***

Indonesia is one of the world's most biodiverse countries, and carbon taxes can support biodiversity conservation through several mechanisms. Research by Roach (2020) indicates that dynamic carbon taxes with proper revenue recycling can contribute to biodiversity conservation through:

- Reducing land conversion for carbon-intensive energy extraction and production
- Enhancing economic incentives for forest conservation as carbon sinks
- Encouraging more sustainable production practices in sectors such as agriculture, forestry, and fisheries
- Providing a potential revenue source for biodiversity conservation programs through carbon tax revenue allocation

When properly designed, with some revenue allocated to conservation, carbon taxes can strengthen programs such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation) in Indonesia, yielding dual benefits of emission reduction and biodiversity protection (KLHK, 2023).

### ***Waste Reduction and Circular Economy***

Research by Matsumura and Ishikawa (2019) shows that carbon taxes can drive circular economy practices and waste reduction due to their impact on economic incentives for resource efficiency and recycling. By increasing production costs for carbon-intensive processes, carbon taxes:

- Enhance the economic viability of material reuse and recycling
- Encourage product designs that minimize waste and facilitate repair and reuse
- Facilitate the development of more sustainable business models, such as sharing economy and product-as-service
- Promote industrial symbiosis where "waste" from one process becomes input for another

For Indonesia, which faces significant challenges in waste management, particularly plastic waste, well-designed carbon taxes can support the transition to a more circular economy. Modeling by Anwar (2022) shows that carbon taxes could increase plastic recycling rates by 30-40% through changed economic incentives and revenue allocated to enhanced waste management infrastructure.

### ***Addressing Climate Vulnerability and Building Resilience***

Beyond direct mitigation benefits, carbon taxes can also contribute to climate adaptation and resilience, critical issues for Indonesia as an archipelagic nation highly vulnerable to climate change impacts. As highlighted by Bappenas (2021), carbon tax revenue can be allocated to building climate resilience through:

- Investing in climate-resilient infrastructure, such as coastal protection and enhanced flood management systems
- Supporting ecosystem-based adaptation that protects and restores natural ecosystems providing climate protection services
- Strengthening early warning systems for extreme weather events
- Helping farmers and other vulnerable communities adapt to changing weather patterns and growing conditions
- Diversifying economies in regions highly dependent on climate-vulnerable sectors

By integrating climate adaptation considerations, carbon taxes can become a more holistic instrument for addressing the overall sustainability challenges facing Indonesia.

Identifying and quantifying these environmental and health co-benefits is not only important for comprehensive policy evaluation but can also be a powerful tool for building political and public support for carbon taxes. As demonstrated by Long et al. (2019), when these



co-benefits are effectively communicated, they can significantly enhance public acceptance of carbon pricing policies.

## CONCLUSION

Comprehensive analysis of carbon taxes in Indonesia reveals that this policy instrument has significant potential to reduce carbon emissions and support the transition to a low-carbon economy. Evidence from theoretical and empirical studies indicates several key conclusions:

First, carbon taxes can effectively reduce greenhouse gas emissions in Indonesia. Modeling shows potential reductions of 3.2-8.6% by 2030 compared to business-as-usual scenarios, with the greatest impacts in the energy sector and carbon-intensive industries. This effectiveness is enhanced when carbon taxes are integrated with complementary policies that address various barriers to decarbonization.

Second, while carbon taxes may impose short-term economic costs, these impacts can be managed through careful policy design. Phased implementation with predictable price paths, effective revenue recycling, and companion policies to support industry transition can minimize economic disruption while maintaining environmental effectiveness. Furthermore, evidence indicates potential long-term economic dividends from the low-carbon transition, including improved resource efficiency, reduced energy import dependence, and creation of green jobs.

Third, optimal policy design requires careful attention to social justice and distributional implications. Without proper mitigation mechanisms, carbon taxes can have regressive impacts, particularly on low-income urban households. However, with appropriate revenue redistribution mechanisms, such as lump-sum transfers or targeted tax reductions, carbon taxes can be implemented in ways that protect vulnerable groups and potentially even enhance distributional outcomes.

Fourth, beyond primary emission reduction benefits, carbon taxes can generate substantial environmental and health co-benefits. Air pollution reductions associated with decarbonization, in particular, can yield significant health benefits, with values potentially offsetting much of the economic costs of the policy. Additional benefits for biodiversity conservation, water quality, and climate resilience are also important in the Indonesian context. Fifth, successful implementation faces several significant challenges, including limited institutional capacity, political resistance from affected stakeholders, concerns about industrial competitiveness, and gaps in the availability of low-carbon technology alternatives. Addressing these challenges requires an integrated approach combining capacity building, stakeholder engagement, support for technological innovation, and international coordination.

Finally, Indonesia's specific context, including its economic structure, emission profile, and institutional framework, necessitates a tailored approach to carbon tax design and implementation. Successful policies in other jurisdictions provide valuable insights but must be adapted to meet Indonesia's specific needs and conditions.

## Policy Recommendations

Based on the findings from this research, we propose the following policy recommendations for optimizing carbon tax policies in Indonesia:

### *Carbon Tax Design and Implementation*

1. **Adopt a phased approach with clear long-term price path:** Implement carbon taxes gradually, starting with moderate rates (IDR 30,000-50,000 per ton CO<sub>2</sub>e) that increase progressively over time, reaching IDR 200,000-300,000 per ton CO<sub>2</sub>e by 2030. Announce this escalation schedule in advance to provide certainty for investment.
2. **Expand sectoral coverage gradually:** Start with emission-intensive sectors with relatively low carbon leakage risks (e.g., power generation), then gradually expand to other sectors in line with increased administrative capacity and monitoring.



3. **Develop comprehensive revenue recycling mechanisms:** Implement a mix of revenue recycling mechanisms that balance various policy objectives, including carbon dividends for households (30-40%), industry transition support (25-30%), low-carbon infrastructure (20-25%), and labor tax reductions (10-15%).
4. **Integrate carbon taxes with other climate policy instruments:** Harmonize carbon taxes with emerging emissions trading schemes, energy efficiency standards, renewable energy policies, and other instruments to create a comprehensive and coherent climate policy framework.
5. **Align with broader fiscal policies:** Integrate carbon taxes with the broader fiscal reform agenda, including gradual reduction of fossil fuel subsidies and alignment of tax incentives with sustainable development objectives.

#### *Mitigating Distributional and Social Impacts*

6. **Implement direct cash transfers to low-income households:** Allocate a portion of carbon tax revenue for direct cash transfers to the poorest 40% of households to address potential regressive impacts, with delivery mechanisms built on existing social protection programs.
7. **Develop targeted support programs for vulnerable groups:** Design specific programs for groups that may be disproportionately impacted by carbon taxes, including subsistence farmers, small-scale fishers, and energy-dependent small businesses.
8. **Create just transition strategies for workers and communities:** Develop comprehensive strategies to support just transition for workers and communities dependent on carbon-intensive industries, including retraining, skill development, and investments in economic diversification.
9. **Apply region-specific approaches to implementation:** Consider regional differences in adaptive capacity and economic structure, with potentially different implementation pathways for regions with different economic characteristics.

#### *Protecting Economic Competitiveness*

10. **Design appropriate protections for trade-exposed industries:** Implement tailored protections for high-risk industries, including output-based allowances that phase down gradually over time, while maintaining incentives for emission reductions.
11. **Develop carbon border adjustment frameworks:** Begin developing frameworks for carbon border adjustments aligned with evolving international practices for industries at risk of carbon leakage.
12. **Provide support for technology adaptation and innovation:** Create targeted support programs to help affected businesses, particularly SMEs, invest in energy efficiency and low-carbon technologies.
13. **Engage in international cooperation on carbon pricing:** Participate actively in regional and global forums on carbon pricing policies to promote harmonization and reduce risks of carbon leakage.

#### *Institutional and Capacity Development*

14. **Strengthen MRV frameworks:** Develop robust monitoring, reporting, and verification (MRV) systems for carbon emissions, with investments in technical capacity and infrastructure.
15. **Build transparent and accountable governance mechanisms:** Create an independent oversight body, comprising experts and key stakeholders, to monitor carbon tax implementation and impacts.
16. **Invest in institutional capacity development:** Implement targeted capacity development programs for government officials in relevant institutions, focusing on tax administration, impact analysis, and environmental governance.



17. **Enhance inter-ministerial coordination:** Form a dedicated inter-ministerial coordination unit with clear mandate and responsibilities for ensuring coherent implementation of carbon tax policies across various government agencies.

***Public Communication and Stakeholder Engagement***

18. **Develop comprehensive public communication strategies:** Implement strategic communication campaigns that articulate the benefits of carbon taxes, address concerns, and promote public support.
19. **Engage key stakeholders in policy design and implementation:** Create mechanisms for meaningful engagement of key stakeholders, including industry, civil society, academia, and community representatives.
20. **Establish technical assistance centers for businesses:** Develop a network of technical assistance centers throughout the country to provide practical guidance, information, and support for businesses in adapting to carbon taxes.
21. **Implement pilot and demonstration programs:** Implement pilot projects and demonstration programs to illustrate practical strategies for emission reduction and effective responses to carbon taxes.

By implementing these policy recommendations, Indonesia can significantly enhance the effectiveness, efficiency, and equity of its carbon tax approach, maximizing its contribution to emission reduction and the transition to a sustainable, resilient, and inclusive economy.

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