# CARBON TAX PRACTICE IN THE TRANSPORTATION SECTOR : OPPORTUNITIES AND CHALLENGES IN INDONESIA

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## ABSTRACT

This study examines the implementation of carbon taxation in Indonesia's transport sector by analyzing its opportunities and challenges through a qualitative method using literature review and secondary data analysis. The research highlights the urgency of emission reduction, as transportation contributes approximately 23% of Indonesia's total emissions, primarily from land-based vehicles. The methodology involves a comparative policy analysis and revenue projection using Holt's Linear Exponential Smoothing. The findings reveal that direct carbon taxes, as adopted in Sweden and Japan, provide greater revenue certainty but impose higher economic burdens. In contrast, emissions trading schemes (ETS), as implemented in South Korea and Singapore, are more flexible and market-driven but result in lower and less predictable revenues. Simulation results estimate that direct carbon taxation in the transport sector could generate approximately IDR 29.97 trillion between 2025 and 2030, while ETS may yield only around IDR 13.60 trillion. The study concludes that a phased, equitable, and well-targeted carbon tax policy—combined with strengthened institutional capacity, public education, and infrastructure development—can support Indonesia's climate goals while balancing social equity and economic growth.

Keywords : Carbon Tax; Emissions Trading System; Transportation Emissions

## *ABSTRAK*

*Penelitian ini bertujuan untuk menganalisis penerapan pajak karbon di sektor transportasi, termasuk potensi penerimaan negara dan tantangan implementasi di Indonesia. Sektor ini menyumbang emisi karbon yang besar secara nasional. Studi ini membandingkan kebijakan pajak karbon di empat negara—Swedia, Jepang, Korea Selatan, dan Singapura—yang mewakili berbagai strategi dan tingkat kematangan kebijakan. Pendekatan deskriptif kualitatif digunakan melalui tinjauan pustaka, analisis regulasi, dan data sekunder. Untuk memperkirakan potensi penerimaan, data emisi karbon sektor transportasi Indonesia tahun 2010–2023 dianalisis menggunakan metode Holt's Linear Exponential Smoothing. Hasilnya menunjukkan bahwa skema pajak karbon langsung berpotensi menghasilkan Rp29,97 triliun pada 2025–2030, lebih tinggi dibanding Rp13,14 triliun dari skema perdagangan emisi atau emission trading system (ETS). Namun, tantangan seperti rendahnya penggunaan kendaraan listrik, minimnya infrastruktur transportasi publik, lemahnya pengawasan, serta rendahnya dukungan publik menjadi hambatan utama. Penelitian ini menyimpulkan bahwa kebijakan pajak karbon yang dirancang dengan baik dapat menjadi solusi pengurangan emisi sekaligus sumber penerimaan negara yang stabil.*

*Kata Kunci : Pajak Karbon; Sistem Perdagangan Emisi; Sektor Transportasi*

## INTRODUCITON

Climate change is an urgent global challenge, and Indonesia, as one of the world's highest emitters, primarily contributes through its industrial and transportation sectors. The high risk of natural disasters in Indonesia serves as a strong impetus to reduce greenhouse gas emissions. Addressing this issue requires collective action from all stakeholders, including the government, to actively promote emission reduction efforts. In 2024, the National Disaster Management Agency (BNPB) reported that Indonesia experienced a total of 2,107 disaster events, with floods being the most frequent type, accounting for 1,088 cases (Litha, 2025). The high frequency of these disasters is closely linked to the impacts of climate change, driven by increasing greenhouse gas emissions. In Indonesia, approximately 23% of total emissions come from fuel combustion in the transportation sector, with 90% of that originating from land-based transportation modes (Padhilah et al., 2023). The combustion of fossil fuels generally contributes to rising global temperatures, sea level rise, increased flood risks, deteriorating public health, and a greater likelihood of natural disasters (Nchofoung & Ojong, 2023; Usman & Radulescu, 2022). Previous studies suggest that policies to maintain climate stability include transitioning to renewable energy and implementing environmental taxation, which places the financial burden on polluters through carbon taxes (Shahzad et al., 2020; Dogan et al., 2022). The introduction of a carbon tax can also incentivize the adoption of cleaner, renewable energy alternatives (Dradra, 2024).

The regulations regarding carbon tax in Indonesia are outlined in Presidential Regulation No. 98 of 2021, Article 47, which addresses carbon levies and the economic value of carbon. Further details on the carbon levy mechanism are stipulated in Law No. 7 of 2021 on Harmonization of Tax Regulations. Specifically, Chapter VI, Article 13, Paragraph (5) defines the carbon tax subjects as individuals or entities purchasing goods containing emissions. Article 13, Paragraph (11) states that the tax object will be determined within the state budget revenue draft. Additionally, Article 13, Paragraph (12) mandates that the revenue generated may be allocated for climate change mitigation efforts. These provisions establish that the carbon tax is implemented to address climate change caused by carbon-emitting activities and is levied on the responsible parties through fiscal policy serving both budgetary and regulatory functions of the state. Muzakki (2025) highlights that the initial focus of carbon tax implementation should be on the steam power plant subsector, with additional targets including the waste, forestry, industrial sectors, and product usage. The policy was originally scheduled to take effect on April 1, 2022; however, the launch of the emissions trading system has been postponed until 2025 due to business readiness and economic conditions. As supported by Suryawirawan (2022), it is emphasized that tax regulations should not be formulated in ways that are incompatible with those of other countries, as this may reduce investment interest. On the other hand, carbon taxation should also be applied to the use of fossil fuels such as aviation fuel, gasoline, gas, and others.

To date, Indonesia's emission control efforts have primarily focused on coal-fired power plants (CFPP), with carbon calculations based on the economic value of carbon as outlined in the Ministry of Energy and Mineral Resources Regulation No. 16 of 2022. However, other sectors, such as transportation, have yet to receive adequate attention. The transportation sector remains heavily dependent on aviation fuel and gasoline, which significantly contribute to total emissions. Indonesia ranks third in Asia for the highest number of vehicles, while vehicle tax compliance remains low at 51.99% as of September 2023 (Jauhari, 2023; Dananjaya & Kurniawan, 2023). This situation hampers efforts to control emissions and allocate sufficient budget for mitigating the impacts of transportation activities. Without effective policies to regulate emissions and encourage a shift toward cleaner energy sources, emission levels may increase drastically. Currently, companies in Indonesia are still being encouraged to improve the transparency of carbon emission reporting (Fadilah et al., 2025). Furthermore, under the legal framework of the Harmonization of Tax Regulations Law (UU HPP), individuals or entities purchasing goods that inherently contribute to carbon footprints are identified as subjects of carbon tax collection. This provision reflects the recognition that environmental degradation results from consumption activities.

Against this background, this study aims to analyze the implementation of the carbon tax with a particular focus on the transportation sector, including the potential state revenue and the challenges that may arise during policy execution in Indonesia. The analysis is intended to provide a comprehensive understanding of the benefits and obstacles associated with the adoption of this policy. The findings of this research are expected to offer valuable insights for the government in formulating effective carbon tax policies, especially within the transportation sector.

## LITERATURE REVIEW

### Carbon Tax

Carbon tax is an economic instrument imposed on carbon dioxide ($CO_2$) emissions and other greenhouse gases produced from the combustion of fossil fuels. These emissions contribute to rising sea levels and drastic changes in rainfall patterns, as well as the melting of the earth's surface, which can lead to geological shifts, potentially causing earthquakes (Irma & Gusmira, 2024). According to Stiglitz et al., (2017) and Meila et al., (2024), the purpose of a carbon tax is to internalize the environmental costs caused by emissions, thereby assigning responsibility for damage to the polluters and encouraging industries to reduce their carbon footprint while motivating consumers to choose more environmentally friendly goods and services.

### Pigouvian Theory

Based on Pigouvian theory, the higher the tax imposed, the greater the public dissatisfaction. This government action aims to correct resource allocation by taxing polluters, enabling consumers to consider the environmental impacts and benefits of the products they consume (Rohima, 2020). In essence, entities that generate lower pollution receive higher incentives compared to those with higher pollution levels.

The global agreement outlined in the Paris Agreement aims to limit the increase in global temperature to 1.5°C in order to minimize the effects of greenhouse gases. Indonesia has committed to climate change mitigation with a national target to reduce carbon emissions by 29% independently and up to 41% with international assistance by 2030 (Peraturan Menteri Energi dan Sumber Daya Mineral Republik Indonesia Nomor 36 Tahun 2016, 2016).

According to reports from various countries that have adopted carbon taxation, there are essentially two main mechanisms for According to reports from various countries that have adopted carbon taxation, there are essentially two main mechanisms for collecting carbon tax: a direct carbon tax and an Emission Trading System (ETS), both of which effectively place a financial burden on carbon emissions.

As illustrated in Figure 1, carbon levies are determined through two main schemes: a direct carbon tax on emission consumption and the Emission Trading System (ETS). The ETS, considered an indirect tax mechanism, functions as a cap-and-trade program that allocates emission allowances and provides incentives for industries to adopt more environmentally friendly renewable energy sources. Its primary objective is to reduce $CO_2$ emissions by balancing the cost of emission reductions with the environmental benefits achieved (Abeyratne, 2019). The implementation of a direct carbon tax is applied directly to the consumption of goods or activities that produce carbon emissions. This is represented in Equation 1: Carbon tax = CO2 Emissions x Carbon Tax Rate.

Look at Figure 2 The implementation of an indirect carbon tax, or Emission Trading System (ETS), is applied to emission-generating activities through a cap-and-trade mechanism, where emission allowances are traded before being taxed. This system functions as an incentive-based approach, encouraging emitters to reduce emissions by assigning a market value to carbon and allowing flexibility in meeting emission reduction targets.

In the emission trading process, each company is assigned an annual emission cap. If a company successfully reduces its emissions below the permitted threshold, it may sell the remaining emission allowances to other companies. Conversely, if a company exceeds its emission limit and fails to negotiate the purchase of additional allowances from other entities, the excess emissions will be subject to a carbon tax. This mechanism is illustrated in Equation 2: Carbon tax = (E actual – E cap – E purchased) x Tax Rate.

Look at Table 1 Based on the information presented in Table 1, it is evident that several countries have taken concrete steps to adopt emission-based economic policy instruments, either through direct carbon taxation or indirect mechanisms such as Emissions Trading Systems (ETS). Indonesia, as a developing country undergoing energy transition, has initiated a limited implementation of ETS, currently applied only to coal-fired power plants (CFPPs). This initiative forms part of the country's gradual effort to establish a green economic framework. In contrast, countries such as Singapore and South Korea have implemented ETS with broader sectoral coverage, although both have encountered various technical and market-related challenges. Meanwhile, Japan and Sweden were among the earliest adopters of direct carbon taxation, focusing on fuel-based carbon content pricing to influence energy consumption behavior and accelerate the shift toward low-carbon energy sources. These differing approaches across countries reflect variations in institutional readiness, fiscal capacity, and national strategies in addressing climate change at both domestic and global levels.

## RESEARCH METHOD

This study employs a descriptive qualitative method by utilizing a literature review and secondary data to achieve the intended objectives. Descriptive qualitative research involves the collection of data, which is then elaborated in depth based on actual facts and real-world occurrences (Raco, 2018). This qualitative approach is intended to provide contextual insights rather than to test rigid hypotheses. The stages of analysis in this research include:

1. Collecting relevant regulatory data using a practical approach methodology, focusing on the practical implementation of carbon tax policies in selected countries as references for evaluating concrete solutions applicable to the Indonesian context.
2. Analyzing the current carbon tax system in Indonesia, projecting its implications if extended to the transportation sector, and identifying potential challenges that may arise in the implementation of such a policy.
3. Estimating the potential revenue from carbon taxation in the transportation sector by gathering secondary data from the World Bank on carbon emissions in the transport sector from 2010 to 2023. The forecasting method applied is Holt's Linear Exponential Smoothing, which is appropriate for identifying trends in relatively stable historical data by incorporating a trend component (Hyndman & Athanasopoulos, 2021).
4. Comparing and synthesizing all collected data to provide a comprehensive overview and policy insights.

According to the State and Trends of Carbon Pricing 2023 (2023), six countries—Singapore, Japan, Sweden, South Korea, Australia, and Switzerland—have demonstrated a strong commitment to financing and supporting emission reduction projects in developing nations, as reported in the April 1, 2023 update. This indicates that these countries show a greater level of environmental concern compared to others. In this study, four out of the six identified countries—Singapore, Japan, South Korea, and Sweden—are selected as the focus of analysis. Singapore, Japan, and South Korea were chosen due to their geographical proximity within the Asian region, while Sweden was included for its pioneering success in implementing a carbon tax in the transportation sector. Australia was excluded because its carbon tax policy primarily targets the electricity sector rather than transportation, and Switzerland was omitted due to its small size and highly developed public transportation system, which differs significantly from Indonesia's infrastructure (Davis, 2024).

**Search Strategy and Database**

In this study, a structured literature search strategy was employed to identify relevant academic sources related to carbon pricing policies. The search process was guided by a set of predetermined keywords and terms, along with potential synonyms and alternative phrases associated with the research topic Salih et al., (2021). This approach was designed to improve precision and relevance during the screening phase, which included reviewing titles, abstracts, and, where necessary, full-text articles.

The databases and platforms used for sourcing literature included: Publish or Perish, Google Scholar, Web of Science, ScienceDirect, the International Journal of Education and Research, Oxford Academic, Sage Journals, ResearchGate, the Directory of Open Access Journals (DOAJ), and Taylor & Francis. The main search terms used were: "carbon tax," "emission trading system," "carbon tax (country)," "ETS (country), “Opportunities (Schema)”, and “Challenges (Schema)."

An initial total of 140 journal articles were identified from these databases. In the first screening stage, titles, abstracts, and major findings were reviewed to assess their relevance. Based on this review, 42 articles were selected for a full-text reading and in-depth evaluation. After a thorough analysis, 26 journal articles were determined to be the most relevant and were included in the final literature review for this study.

## DISCUSSION

Based on the $CO_2$ emission trend from the transportation sector, emissions have continuously increased from 1990 to 2023. Over these 33 years, transportation emissions have risen by 364%, with land transport being the dominant contributor.

Look at Figure 3 According to World Bank data, the increase in emissions from 1990 to 2023 also occurred in countries like Singapore (63%) and South Korea (143%). In contrast, countries such as Sweden and Japan succeeded in reducing their emissions by 33% and 15%, respectively. When compared to the years following the implementation of carbon pricing schemes, Singapore has not yet achieved emission reductions in the transport sector, as emissions in 2023 increased by 6% compared to 2019. Similarly, South Korea's emissions in

2023 rose by 8% compared to 2015. On the other hand, Sweden managed to reduce emissions by 33% and Japan by 19% in 2023 compared to 2012. Sweden and Japan have implemented direct carbon taxes, while South Korea and Singapore have adopted Emissions Trading Systems (ETS).

Look at Table 2 Based on the findings of this systematic literature review (SLR), carbon pricing mechanisms—whether through direct carbon taxes or Emissions Trading Schemes (ETS)—demonstrate varying levels of effectiveness depending on policy design, institutional readiness, and the national context. This analysis highlights three key dimensions: emission reduction effectiveness, initial implementation, and policy flexibility.

1. Effectiveness

   Sweden is often cited as a successful case in implementing an effective direct carbon tax. Introduced in the early 1990s, the policy has led to a 10.9% reduction in $CO_2$ emissions from the transport sector, equivalent to approximately 0.29 metric tons per capita per year. Additionally, gasoline demand became significantly more responsive to tax changes—around 3 to 4.5 times more elastic than standard price sensitivity—indicating a meaningful behavioral shift in energy consumption. A major factor contributing to this success was the steady and consistent increase in tax rates over time.

   In contrast, Japan's carbon tax has had limited effectiveness. Although implemented nationally in 2012, the flat rate of $2.65 (JPY 2.89) per ton of $CO_2e$ has not been revised or increased. As a result, the policy only contributed to a 0.5% to 2.2% reduction in emissions by 2020 compared to 1990 levels. This comparison suggests that the effectiveness of a carbon tax is closely linked to the rate structure—higher and progressively increasing rates tend to yield greater reductions.

   In the case of South Korea and Singapore, the impact of ETS on emission reductions is more difficult to quantify due to overlapping policies and external factors such as economic conditions and fossil fuel price volatility. Nevertheless, strong emissions caps provide an effective control mechanism over aggregate emissions. In South Korea, additional success factors include company-level characteristics, such as environmentally conscious management and investments in green technologies.

   Singapore adopts a systematic and relatively progressive approach. In 2024, the carbon tax was set at S$25 per ton of $CO_2e$, with an escalation planned to S$46 by 2026. The tax only applies to emissions exceeding the defined annual thresholds, incentivizing operational efficiency and offering firms the flexibility to plan mitigation strategies. Approximately 80% of the country's total emissions are covered by the carbon tax and fuel excise duties, including the transport sector, which contributes about 15% of total emissions (Singapore, 2025). However, similar to South Korea, the direct impact of the ETS on emission reductions is difficult to isolate due to the simultaneous implementation of other regulatory measures.

2. Initial Implementation

   Sweden and Japan adopted a similar strategy in the early stages of their carbon pricing policies by introducing a direct carbon tax applied to fuel consumption. The tax was levied based on the average carbon content of each fuel type, making the administrative process relatively straightforward. This approach eliminated the need for complex emissions measurement systems, as emissions could be directly inferred from fuel usage volumes (Sweden, 2025; Gokhale, 2021)

   In contrast, South Korea became the first country in East Asia to implement an Emissions Trading Scheme (ETS) in 2015, following the enactment of the "Allocation and Trading of Greenhouse Gas Emissions Act" in 2012. Although supported by a clear legal framework, the initial phase of implementation faced several challenges, including high administrative costs and difficulties in establishing accurate and transparent Monitoring, Reporting, and Verification (MRV) mechanisms. Additionally, concerns around data security and the reliability of real-time trading systems posed significant operational hurdles. These institutional limitations contributed to liquidity issues during the early years of the program.

3. Price Capacity and Policy Flexibility

   Flexibility is a critical aspect in ensuring the long-term sustainability of carbon pricing mechanisms. In Sweden, a direct carbon tax is applied proportionally to the amount of emissions produced. To reduce the economic burden on society, the government regularly reviews the fairness and distributional impact of the tax system. Additionally, exemptions are granted for renewable energy vehicles, serving as an incentive to promote the adoption of low-emission technologies (Sweden, 2025).

In contrast, Singapore adopts a more flexible approach using a threshold-based system, where carbon tax is only levied on emissions that exceed a predefined annual cap. This allows companies to improve internal efficiency without facing immediate tax penalties. Moreover, the government does not impose a fixed rate for excess emissions, enabling firms to manage internal carbon costs according to their operational structure. In a competitive market environment, businesses are generally reluctant to fully pass carbon costs onto consumers due to concerns over losing competitiveness (Singapore, 2025).

These two approaches illustrate contrasting outcomes: direct carbon taxes, while effective, can impose higher economic burdens and thus require complementary measures to ensure equity. In contrast, ETS schemes with exempted emission thresholds and strong market competition mechanisms tend to reduce the consumer burden and promote cost-efficiency at the firm level.

A comparative review of international carbon pricing policies reveals that both major schemes—direct carbon taxation and emissions trading systems (ETS)—present distinct characteristics, levels of flexibility, and implementation challenges. These findings serve as a critical reference point for Indonesia in designing its future carbon pricing strategy.

Currently, Indonesia's implementation of an Emissions Trading System (ETS) is limited to the coal-fired power plant (PLTU) sector. To date, no quantitative data are available to assess the system's contribution to national emission reductions, as the implementation period remains relatively short and has not yet reached one full year. According to data from the Indonesia Carbon Exchange, the national ETS only began formal operation in July 2024 (Indonesia Carbon Exchange, 2025). This situation suggests that any consideration of expanding ETS coverage to the transport sector must be carefully assessed. Drawing upon the experiences of other countries will be essential to design a robust, equitable, and effective policy framework that avoids early-stage pitfalls and supports long-term emission reduction goals.

In addition to serving as a tool for controlling greenhouse gas emissions, carbon taxation also holds substantial potential as a source of government revenue. Within the transport sector, this fiscal potential can be estimated using a historical emissions-based approach. To assess this potential, the author projects transport sector carbon emissions for the period 2024 to 2030, based on historical emission trends recorded from 2010 to 2023. The projected emission figures are then multiplied by the minimum tax rate stipulated under Indonesia's Law on the Harmonization of Tax Regulations (UU HPP), Chapter IV, Article 13, Paragraph 9, which sets the rate at Rp 30 per kilogram of $CO_2e$, or Rp 30,000 per ton of $CO_2e$.

The resulting estimation outlines the potential state revenue from direct carbon taxation in the transport sector, covering both the retrospective and projected periods. These calculations are presented in Table 3.

As shown in Table 3, although the estimates for the years 2010–2024 reflect a retrospective scenario, they provide insight into the potential revenue that could have been generated had the carbon tax been implemented starting in 2010. The estimated revenue loss due to delayed policy implementation amounts to approximately IDR 60.25 trillion. However, based on emission trends for the period 2025–2030, immediate implementation could offer a new source of state revenue. The average projected carbon tax revenue is estimated at around IDR 4.99 trillion per year for the 2025–2030 period, with a total potential revenue of approximately IDR 29.97 trillion over six years. It is important to note that these revenue projections are the result of a simulation model.

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An alternative carbon tax implementation through the Emissions Trading System (ETS) also has the potential to generate revenue from excess emissions. If emission caps are set based on the 29% reduction target by 2030, using 2016 as the baseline year in accordance with Indonesia's emission reduction commitments, then additional state revenue can be expected. The estimated revenue potential from the indirect carbon tax scheme in the transportation sector, using the same tax rate, is presented in Table 4.

The projected state revenue from the implementation of the Emissions Trading System (ETS) is significantly lower compared to the direct carbon tax approach. This difference reflects the inherent flexibility of the ETS mechanism, where regulated entities may choose to reduce their emissions independently, purchase additional allowances through trading, or pay penalties for exceeding emission caps. Due to this flexibility, the revenue generated under ETS tends to be less predictable, in contrast to the more consistent and measurable income potential associated with direct carbon taxation.

Based on simulation results, the delayed implementation of ETS in Indonesia may have led to an estimated revenue loss of approximately IDR 13.74 trillion between 2016 and 2024. If applied beginning in 2025, the ETS is projected to generate an average of IDR 2.27 trillion per year, or approximately IDR 13.60 trillion over the six-year period from 2025 to 2030.

Moreover, the ETS imposes a lower financial burden on consumers when compared to a direct tax system. Although the revenue potential of ETS is relatively limited, the scheme offers an alternative source of income, particularly through the collection of final income taxes on emissions trading transactions conducted within the carbon market (Saputra et al., 2022).

In conclusion, both carbon pricing instruments—ETS and direct carbon taxation—hold potential to contribute to national fiscal revenues while simultaneously supporting the achievement of emission reduction targets. The extent of revenue generation under each scheme will largely depend on the rate structure, compliance mechanisms, and policy enforcement effectiveness.

From a comprehensive perspective, based on the results and projected revenue potential in the transportation sector, a direct carbon tax scenario may be more relevant for countries seeking stable revenue sources to address emissions, lacking the administrative capacity to manage complex systems, prioritizing emission reduction effectiveness through significant carbon pricing, and being prepared to face greater economic risks. Conversely, the Emissions Trading System (ETS) scenario is more suitable for countries with strong and fair regulatory institutions, robust Monitoring, Reporting, and Verification (MRV) systems, and competitive market conditions, where the economic risks involved are relatively lower.

It is important to note that inadequate readiness in implementing the ETS framework may hinder the effectiveness of national emission reduction targets. In response to this challenge, South Korea is expected to complement its existing system with additional policy instruments to reinforce its decarbonization strategy. One such measure involves the planned introduction of a direct carbon tax in 2025, set at a rate of 20,000 KRW (approximately USD 13.90) per ton of $CO_2e$. This tax is designed to be adjustable based on the mileage and type of vehicle, aiming to incentivize progress toward the national goal of achieving 50% electric vehicle adoption by 2030 (Oh et al., 2023).

Despite the urgency to reduce carbon emissions and shift toward cleaner transportation systems, Indonesia faces several significant challenges in implementing a carbon tax. These challenges span across social, economic, and institutional dimensions:

1. Low Public Interest in Electric Vehicles

Electric vehicle (EV) adoption in Indonesia remains limited, with EVs constituting only about 0.13% of the total vehicle population as of 2024. The total number of electric vehicles on the road is around 207,000 units—far below the national target of 9 million electric motorcycles and 600,000 electric cars and buses by 2030 (Kementrian Perindustrian, 2025). Public interest in EVs is also low, with only 39.3% of survey respondents expressing a willingness to switch (Sugiarti, 2024). This indicates that the majority of the population is still heavily reliant on conventional fossil fuel vehicles. Therefore, targeted policies are needed to stimulate the demand for EVs.

2. Limited Public Transportation Infrastructure

Inadequate mass transportation infrastructure, particularly in remote and underdeveloped regions, presents a barrier to implementing a carbon tax due to the continued dependence on private vehicles (Andersson & Atkinson, 2020). Jakarta, Solo, and Semarang as examples of Indonesian cities with relatively well-developed public transportation systems, making them relevant benchmarks for sustainable transport policy development (Permana, 2022). Initial carbon tax implementation could focus on these cities while simultaneously providing incentives to expand public transportation infrastructure. However, this plan faces challenges related to the Ministry of Energy and Mineral Resources Regulation No. 36/2016, which mandates uniform fuel pricing across underdeveloped, frontier, and outermost regions (3T). This policy is scheduled to be phased out by 2027 and replaced with a targeted direct cash assistance (BLT) program (Indraini, 2025).

3. Weak Regulatory Oversight and Law Enforcement

Indonesia's limited institutional capacity for oversight and law enforcement poses a significant obstacle to implementing an effective carbon tax system. Weak transparency, integrity, and compliance monitoring mechanisms create an environment vulnerable to misuse of authority and corruption (Wijaya & Wijaya, 2025). The current administrative systems are insufficiently transparent and inadequately monitored, hindering the establishment of fair, accurate, and realistic emission caps.

4. Low Carbon Tax Rate

The current carbon tax rate is set at IDR 30 per kg $CO_2e$, which falls significantly short of the World Bank's recommended rate of IDR 75–100 per kg $CO_2e$. However, the effectiveness of a carbon tax must also consider a country's Gross Domestic Product (GDP). According to previous research, achieving a 25–30% emission reduction target by 2030 could still positively contribute to Indonesia's GDP, with an estimated increase of 0.16%, if a carbon price of approximately $42.75 per ton $CO_2e$ is adopted by 2030 (UGM, 2021). Indonesia may also look to Sweden's success in aligning carbon taxation with economic growth. Sweden's carbon tax was complemented by compensatory mechanisms, such as reductions in income tax and the removal of vehicle taxes for electric or renewable-fuel vehicles (Jagers et al., 2019).

5. Public Support and Acceptance

Public support for carbon tax implementation in Indonesia remains mixed and, in some cases, polarized. Resistance is often driven by a lack of environmental awareness and low trust in government institutions. On the other hand, support tends to come from individuals with higher environmental consciousness, which can be fostered through educational and informative content. (Lindvall et al., 2024), emphasize that both environmental awareness and trust in government are key determinants of public support for carbon pricing policies. Furthermore, Amado et al. (2023) highlight that allocating carbon tax revenues toward vulnerable groups can increase public support by enhancing perceptions of fairness. Concerns that the policy may disproportionately burden low-income households also significantly influence the level of public acceptance.

Both carbon pricing schemes—direct carbon tax and the Emissions Trading System (ETS)—can contribute significantly to emission reductions and, in turn, mitigate climate-related disaster risks. A well-calibrated tax rate can incentivize individuals and industries to adopt energy-saving practices and shift toward more environmentally friendly alternatives, such as electric vehicles. As a result, direct carbon taxation can alter consumer behavior and motivate producers to develop and adopt clean technologies more progressively and sustainably manner (Moore et al., 2021).

Sweden provides a clear example of the positive impact of carbon taxation, with an annual average of 38,853 additional clean technology innovations in the transport sector since the implementation of its carbon tax. This policy has created strong incentives for companies to innovate and reduce emissions without compromising competitiveness (Oppelt, 2024).

On the other hand, indirect carbon pricing through an ETS primarily influences producer behavior. It encourages investment and innovation in clean technologies by assigning a cost to carbon emissions, prompting firms to reduce their carbon footprint to maintain profitability (Yan et al., 2023). Both carbon pricing mechanisms function as tools to regulate societal activities, aligning with Pigouvian tax theory, which suggests that polluters will internalize the external costs of their emissions. As a result, consumer demand for high-emission products tends to decline, while demand for renewable and low-emission alternatives increases.

Moreover, the implementation of carbon taxation policies holds potential for enhancing labor productivity. Reduced air pollution is closely linked to better public health outcomes, which can lower the incidence of pollution-related illnesses (Saputra et al., 2022). This improvement in public health enables governments to reallocate portions of healthcare spending toward investment in renewable energy development, thereby reinforcing the transition to a sustainable, low-carbon economy.

## CONCLUSION

This study demonstrates that carbon taxation in the transportation sector—both through a direct tax mechanism and via the Emissions Trading System (ETS)—has significant potential to increase government revenue while simultaneously serving as an effective emissions control instrument in Indonesia. Simulation results estimate that a direct carbon tax could generate approximately IDR 29.97 trillion over the six-year period beginning in 2025, which is considerably higher than the estimated IDR 13.60 trillion that could be generated through the ETS mechanism over the same timeframe. While direct taxation is administratively simpler and ensures a more stable revenue stream, it also carries the risk of placing a direct economic burden on consumers. In contrast, the ETS requires a robust regulatory framework and a strong Monitoring, Reporting, and Verification (MRV) system, but offers greater market adaptability and incentivizes innovation among industry actors.

Although carbon taxation holds significant potential benefits for Indonesia, its implementation continues to face substantial challenges. These include the low adoption rate of electric vehicles, limited access to reliable public transportation, weak institutional capacity, carbon tax rates that remain below international benchmarks, and insufficient public trust and support. Therefore, the success of this policy depends on a comprehensive and integrated strategy. Policy Implications for the Government are (1) Strengthening Institutional Capacity and MRV Systems. To ensure that the carbon tax mechanism is fair, transparent, and effective, the government must strengthen institutional capacity across fiscal, environmental, and transport sectors. A robust Monitoring, Reporting, and Verification (MRV) system must be developed to ensure accurate emission data and to prevent manipulation or data leakage; (2) Establishing Fair and Effective Tax Rates. The carbon tax rate must strike a balance between emission reduction effectiveness and the economic impact on the population. Indonesia should regularly evaluate its current rate of Rp 30/kg $CO_2e$ and progressively align it with international standards such as those applied in Sweden. Equitable compensation schemes—such as income tax reductions and vehicle tax exemptions for low-emission vehicles—should be part of the policy framework; (3) Enhancing Infrastructure and Clean Transport Incentives. The government must invest in expanding electric vehicle infrastructure, improving public transport systems, and accelerating the distribution of subsidies or fiscal incentives that support a transition toward low-emission transportation modes; (4) Public Education and Trust Building. Public support can be enhanced through comprehensive education campaigns focused on the environmental and economic benefits of carbon pricing, as well as transparent allocation of tax revenues. Earmarking funds to support vulnerable groups and energy transition programs will help strengthen public confidence; (5) Phased and Context-Specific Implementation. Implementation should begin in urban areas with adequate public transport infrastructure, followed by a phased roadmap for national coverage. A gradual rollout would reduce social resistance and improve technical preparedness.

With the right combination of fiscal, institutional, and social approaches, carbon taxation can serve as a strategic instrument for achieving Indonesia's emission reduction targets, strengthening national revenues, and advancing a sustainable green economy. However, without strong policy backing and political commitment, there remains a high risk of stagnation and inequality in the energy transition process. This study focuses specifically on the transportation sector and does not comprehensively quantify the broader economic risks and co-benefits associated with carbon taxation. Future research could expand on this work by incorporating a multi-sectoral analysis and evaluating the long-term economic implications, distributional impacts, and policy design trade-offs to ensure effective and equitable implementation of carbon pricing in Indonesia.

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## TABLE AND FIGURE

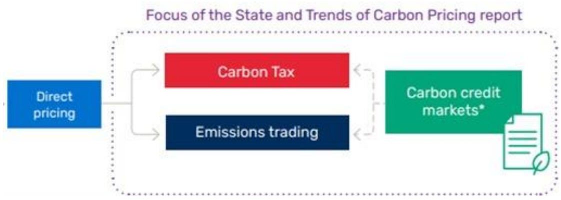


Figure 1. Direct Pricing

Source: State and Trends of Carbon Pricing 2024 (2024)

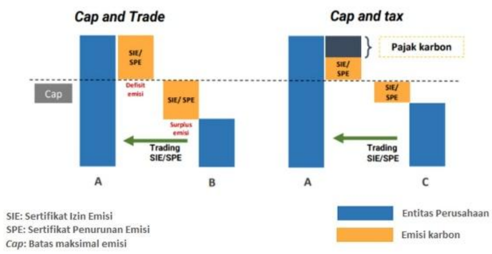


Figure 2. The Emission Trading System (ETS) Scheme in Carbon Taxation

Source: Marjaka (2023)

Table 1. Literature Review on Carbon Tax Policy Practices in Selected Countries

| No | Author(s) & Year | Reason | Objective | Method | Key Findings |
|---|---|---|---|---|---|
| 1 | Rafiqi & Mentar (2024) | To Conduct a comparative analysis of carbon tax policies implemented across ASEAN countries, including Indonesia, to identify key similarities, differences, and contextual adaptations. | This study aims to analyze carbon trading policies across ASEAN countries, emphasizing Indonesia's policy as a point of comparison to evaluate regional alignment and policy effectiveness. | This research employs a normative legal method, utilizing both a juridical approach and a comparative approach. | Indonesia:<br>The Cap-and-Tax/Emissions Trading System (ETS) is currently limited to coal-fired power plants (PLTU), as stipulated in Law No. 7 of 2021.<br>The minimum carbon tax rate is set at Rp30 per kilogram of $CO_2e$ (±\$2/tCO2e).<br>Further provisions are regulated by the Ministry of Environment and Forestry.<br><br>Singapore:<br>The Emissions Trading System (ETS) has been in effect since 2019, based on the legal foundation of the "Carbon Pricing Act 2018"<br>The carbon tax began at a rate of S\$5/$tCO_2e$, with planned incremental increases to S\$25/$tCO_2e$ by 2024 and S\$46/$tCO_2e$ by 2026.<br>It is applicable to industrial facilities emitting more than 25,000 $tCO_2e$ per year. |
| 2 | Gokhale (2021) | This study aims to examine the structure of Japan's carbon tax policy | This policy study examines Japan's carbon tax framework, explores its limitations, and offers recommendations for | This study conducts a qualitative and comparative analysis of carbon policy frameworks in | Japan:<br>Japan has implemented a direct carbon tax policy since 2012.<br>The tax rate is approximately |

| No | Author(s) & Year | Reason | Objective | Method | Key Findings |
|---|---|---|---|---|---|
| | | | enhancement. | Japan, the United States, and Germany. | \$2.65 or JPY 2.89 per ton of $CO_2e$.<br>It is imposed on the use of fossil fuels, including gasoline, diesel, and other fuel types.<br>The carbon tax rate is still considered lower than the levels recommended by international standards and climate policy experts. |
| 3 | Jonsson et al., (2020) | This study aims to examine the impact of Sweden's carbon tax scheme on economic growth (GDP) and carbon emission reduction. | This study aims to assess the results of Sweden's three-decade carbon tax policy, analyzing its effects on economic growth and carbon emissions from 1990 to 2019, with particular attention to the transport sector. | This study employs an empirical approach utilizing national statistics, relevant literature, and official government documents. | **Sweden:**<br>• Sweden has implemented a direct carbon tax policy since 1991 as part of its national climate strategy.<br>• Sweden's carbon tax began at a rate of 250 SEK (around USD 25) per ton $CO_2e$ and has gradually risen to approximately USD 126 per ton $CO_2e$ as of 2020.<br>• Implementation targets fuel importers and major industrial consumers, with the tax burden subsequently transferred to final consumers.<br>• The policy includes direct carbon tax exemptions for vehicles powered by renewable energy, along with the elimination of conventional vehicle taxes as an incentive.<br>The carbon tax scheme achieved a 27% reduction in |

| No | Author(s) & Year | Reason | Objective | Method | Key Findings |
|---|---|---|---|---|---|
| | | | | | emissions relative to 1990, alongside a 50% increase in per capita GDP from 1990 to 2019. |
| 4 | Narassimhan et al., (2018) | This study aims to explore the institutional and market-related barriers to the effective implementation of the cap-and-trade system in South Korea. | Analyses the implementation of emissions trading systems (ETS) : Switzerland, the EU the Regional Greenhouse Gas Initiative (RGGI) and California, Québec in Canada, the Republic of Korea, New Zealand and pilot schemes in China | Comparative Policy and Literature Analysis | South Korea:<br>South Korea's Emissions Trading System (ETS) was launched in 2015 under the legal framework of the 'Allocation and Trading of Greenhouse Gas Emissions Act,' passed in 2012.<br>Non-compliance with the ETS obligations may result in penalties of up to USD 70 per ton of $CO_2$ equivalent.<br>In its initial year, the system encountered significant liquidity challenges, as trading volume remained at just 0.05%, largely attributed to the loosening of the borrowing cap on emission allowances from 10% to 20%. |

Source: processed by the author

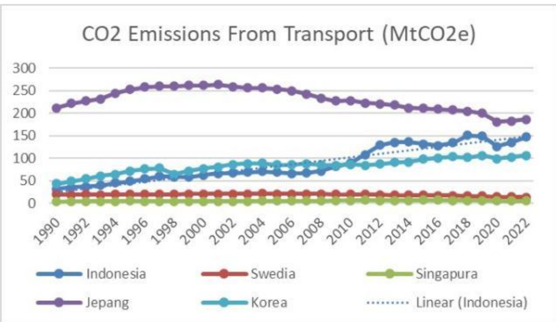


Figure 3. Transportation CO2 Trends
Source: Carbon Dioxide (CO2) Emissions from Transport (Mt CO2e) (2023)

Table 2. A Comparative Literature Review of Carbon Tax and Emissions Trading Schemes in Reducing $CO_2$ Emissions

| No | Author(s) & Year | Key Findings |
|---|---|---|
| 1 | Andersson (2019) | Sweden's carbon tax reduced $CO_2$ emissions in the transport sector by approximately 10.9% (around 0.29 metric tons per capita annually).<br>Gasoline demand under the carbon tax was 3–4.5 times more elastic than under normal price conditions, indicating significant behavioral change.<br>Long-term effectiveness was supported by gradual and consistent tax rate increases. |
| 2 | Gokhale (2021) | Japan's flat carbon tax rate of $2.65 (JPY 2.89) per ton $CO_2e$, without progressive increments, resulted in limited impact—only a 0.5% to 2.2% reduction in emissions by 2020 compared to 1990.<br>The tax is applied based on average $CO_2$ content per fuel type. |
| 3 | Park et al., (2024) | In South Korea, ETS success depends heavily on government support, particularly through strict regulations and accurate emissions data systems.<br>Firm-level factors, including green-oriented management and investment in clean technology, strongly influence emission reduction outcomes. |
| 4 | Haites (2018) | The impact of ETS is difficult to isolate due to overlapping policies and external influences like fuel prices and economic fluctuations.<br>However, a strong emissions cap helps maintain control over total emissions. |
| 5 | Peng et al., (2024) | ETS entails high administrative costs and faces challenges in accurate and transparent MRV (Monitoring, Reporting, and Verification).<br>Additional concerns include data security and the reliability of real-time trading systems. |
| 6 | Oh et al., (2023) | The Carbon Neutral (CN) scenario is projected to reduce emissions to near-zero levels by 2050, whereas the Business-As-Usual (BAU) scenario still results in substantial emissions despite a downward trend.<br>The carbon tax is planned to increase progressively from 20,000 KRW per ton of $CO_2eq$ in 2025 to 260,000 KRW per ton of $CO_2eq$ by 2050, serving both as an emission reduction incentive and a funding source for green infrastructure.<br>Existing literature emphasizes that achieving carbon neutrality in South Korea's road transport sector by 2050 heavily depends on a large-scale transition to electric and hydrogen vehicles, supported by a combination of ICEV bans, subsidies, and a progressively increasing carbon tax. |

Table 3. Projected Carbon Tax Revenue from the Transportation Sector (Direct Taxation Method), 2010–2030.

| Year | $CO_2$ Emissions ($MtCO_2e$) | $CO_2$ Emissions (Ton $CO_2e$) | Carbon Tax Rate (IDR/ton $CO_2e$) | Estimated Revenue (Rp) |
|---|---|---|---|---|
| 2010 | 89,1 | 89.100.000 | 30.000 | 2.673.000.000.000 |
| 2011 | 108,5 | 108.500.000 | 30.000 | 3.255.000.000.000 |
| 2012 | 129,6 | 129.600.000 | 30.000 | 3.888.000.000.000 |
| 2013 | 136,1 | 136.100.000 | 30.000 | 4.083.000.000.000 |
| 2014 | 136,6 | 136.600.000 | 30.000 | 4.098.000.000.000 |
| 2015 | 132 | 132.000.000 | 30.000 | 3.960.000.000.000 |
| 2016 | 128,1 | 128.100.000 | 30.000 | 3.843.000.000.000 |
| 2017 | 135 | 135.000.000 | 30.000 | 4.050.000.000.000 |

| | | | | |
|---|---|---|---|---|
| 2018 | 151 | 151.000.000 | 30.000 | 4.530.000.000.000 |
| 2019 | 149,5 | 149.500.000 | 30.000 | 4.485.000.000.000 |
| 2020 | 126,8 | 126.800.000 | 30.000 | 3.804.000.000.000 |
| 2021 | 135,7 | 135.700.000 | 30.000 | 4.071.000.000.000 |
| 2022 | 147,6 | 147.600.000 | 30.000 | 4.428.000.000.000 |
| 2023 | 149,5 | 149.500.000 | 30.000 | 4.485.000.000.000 |
| 2024* | 153,3 | 153.283.546 | 30.000 | 4.598.506.377.561 |
| 2025* | 157,1 | 157.067.092 | 30.000 | 4.712.012.755.122 |
| 2026* | 160,9 | 160.850.638 | 30.000 | 4.825.519.132.683 |
| 2027* | 164,6 | 164.634.184 | 30.000 | 4.939.025.510.244 |
| 2028* | 168,4 | 168.417.730 | 30.000 | 5.052.531.887.804 |
| 2029* | 172,2 | 172.201.276 | 30.000 | 5.166.038.265.365 |
| 2030* | 176,0 | 175.984.821 | 30.000 | 5.279.544.642.926 |

Source: processed by the author

Table 4. Projected Revenue from the Indirect Carbon Tax / Emissions Trading System (ETS) in the Transportation Sector, 2016–2030

| Year | $CO_2$ Emissions ($MtCO_2e$) | Cap $CO_2$ Emissions (Ton CO2e) | Taxable Emissions | Carbon Tax Rate (IDR/ton $CO_2e$) | Estimated Revenue (Rp) |
|---|---|---|---|---|---|
| 2016 | 128.100.000 | 90.951.000 | 37.149.000 | 30.000 | 1.114.470.000.000 |
| 2017 | 135.000.000 | 90.951.000 | 44.049.000 | 30.000 | 1.321.470.000.000 |
| 2018 | 151.000.000 | 90.951.000 | 60.049.000 | 30.000 | 1.801.470.000.000 |
| 2019 | 149.500.000 | 90.951.000 | 58.549.000 | 30.000 | 1.756.470.000.000 |
| 2020 | 126.800.000 | 90.951.000 | 35.849.000 | 30.000 | 1.075.470.000.000 |
| 2021 | 135.700.000 | 90.951.000 | 44.749.000 | 30.000 | 1.342.470.000.000 |
| 2022 | 147.600.000 | 90.951.000 | 56.649.000 | 30.000 | 1.699.470.000.000 |
| 2023 | 149.500.000 | 90.951.000 | 58.549.000 | 30.000 | 1.756.470.000.000 |
| 2024* | 153.283.546 | 90.951.000 | 62.332.546 | 30.000 | 1.869.976.377.561 |
| 2025* | 157.067.092 | 90.951.000 | 66.116.092 | 30.000 | 1.983.482.755.122 |
| 2026* | 160.850.638 | 90.951.000 | 69.899.638 | 30.000 | 2.096.989.132.683 |
| 2027* | 164.634.184 | 90.951.000 | 73.683.184 | 30.000 | 2.210.495.510.244 |
| 2028* | 168.417.730 | 90.951.000 | 77.466.730 | 30.000 | 2.324.001.887.804 |
| 2029* | 172.201.276 | 90.951.000 | 81.250.276 | 30.000 | 2.437.508.265.365 |
| 2030* | 175.984.821 | 90.951.000 | 85.033.821 | 30.000 | 2.551.014.642.926 |

Source: processed by the author