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RESEARCH ARTICLE

An Analysis of the Role of Fiscal Policy in Controlling CO2 Emissions in the Industrial Sector in Indonesia

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Abstract
Climate change and the growing dependence on fossil fuels have intensified the challenge of aligning Indonesia's industrial development with its emission reduction commitments. This study analyzes the role of fiscal policy in controlling CO_2 emissions in Indonesia's industrial sector during the period 2010–2023, with a particular focus on three fiscal instruments: carbon taxation, fossil fuel subsidies, and government expenditure on the energy and environmental sectors. Using a descriptive-analytical approach based on secondary time-series data from national greenhouse gas inventories, state budget documents, government reports, and international energy publications, this study compares the dynamics of industrial CO_2 emissions with the development of fiscal policy instruments. The findings show that industrial CO_2 emissions generally increased throughout the observation period, with a temporary decline during the COVID-19 pandemic and a sharp rebound in 2022–2023. This increase was closely associated with the expansion of energy-intensive industries and the continued reliance on coal-based energy, particularly in manufacturing and mineral processing activities. Fiscal policy has not yet provided a coherent emission-control signal. Carbon tax implementation remained limited and has not directly affected the manufacturing sector, while fossil fuel subsidies continued to create price distortions that weakened incentives for energy efficiency and renewable energy adoption. At the same time, government spending on environmental and renewable energy programs remained relatively small compared with the scale of fossil fuel subsidies. This study concludes that Indonesia's fiscal policy still operates in two opposing directions: supporting emission reduction through carbon pricing and green expenditure, while simultaneously sustaining carbon-intensive industrial activity through energy subsidies. Strengthening fiscal coherence is therefore essential to align industrial growth with Indonesia's low-carbon transition agenda.

Keywords
Fiscal Policy; CO2 Emissions; Industrial Sector; Carbon Tax; Fossil Fuel Subsidies; Green Spending.

1 | INTRODUCTION

Global climate change has become one of the key challenges facing modern economic development. Rising concentrations of greenhouse gases have led to a significant increase in global average temperatures over the past few decades. According to data from the Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report, the average global surface temperature has risen by 1.1°C compared to the pre-industrial period, and the rate of increase is accelerating due to the accumulation of greenhouse gases in the atmosphere (IPCC, 2023). Among the various greenhouse gases, carbon dioxide (CO_2) is the largest contributor, with the industrial sector accounting for around 30 per cent of total global energy-related CO_2 emissions (IEA, 2023). This situation places global pressure on every country to control emissions without sacrificing economic growth.

As a developing country, Indonesia's CO_2 emissions are likely to rise in line with ongoing industrialisation and the expansion of the manufacturing sector. Indonesia has the largest economy in Southeast Asia, and its manufacturing sector has contributed an average of around 20 per cent to the national Gross Domestic Product (GDP) over the past decade (KEMENPERIN 2024). Its contribution to GDP indicates that this sector has a strong multiplier effect on various other sectors, such as trade, services and transport. Wibowo, (2023) explains that the development of the manufacturing industry is a key indicator for measuring the stability and progress of the national economy. However, the fact that industrial growth still relies on fossil fuels makes Indonesia one of the largest producers of CO_2 emissions in the region. Data from the Ministry of Environment and Forestry shows that emissions from the energy and industrial sectors continued to rise between 2010 and 2022, with total national emissions reaching 1,186 million tonnes of CO_2 equivalent in 2022 (KLHK, 2023). Structural dependence on coal and petroleum in industrial production processes is the biggest obstacle to decarbonisation efforts (Rokhmawati *et al.*, 2024).

Indonesia's international commitments further underscore the urgency of domestic policy reform. Through the ratification of the Paris Agreement and the submission of its updated Nationally Determined Contribution (NDC) in 2022, Indonesia has set a target to reduce emissions by 31.89 per cent on its own and by up to 43.20 per cent with international support by 2030 (KLHK, 2022). This target requires policy design that is not only environmentally effective but also aligned with national economic development needs. In this context, fiscal policy occupies a strategic position as it can influence economic behaviour through government revenue and expenditure mechanisms. Fiscal policy can be used to price activities that generate emissions, reduce energy price distortions, and finance public investment that supports the energy transition (Ratnawati, 2016).

There are three main fiscal policy instruments that are most relevant to controlling CO_2 emissions from the industrial sector in Indonesia. The first is a carbon tax, an instrument that places a price on the negative externalities of carbon emissions, thereby providing an economic incentive for industry to transition towards cleaner energy. Indonesia has laid the legal foundations for a carbon tax through Undang-Undang Nomor 7 Tahun 2021 on the Harmonisation of Tax Regulations, although its implementation remains limited and phased (Pamungkas & Haptari, 2022). Secondly, there are fossil fuel subsidies, which have long been the largest item of fiscal expenditure but are counterproductive to the goal of reducing emissions. Substantial subsidies for fossil fuel-based oil and electricity artificially depress energy prices, thereby weakening the industry's incentives to improve energy efficiency or switch to renewable energy sources (Anggraeni, 2021). Thirdly, there is government spending on the renewable energy and environmental sectors, which serves as a public investment instrument to accelerate the energy transition and strengthen emission reduction capacity at the sectoral level.

A number of previous studies have demonstrated the importance of fiscal instruments in controlling emissions. Lin & Li, (2011) found that the introduction of carbon taxes in several Northern European countries has contributed to a reduction in per capita CO_2 emissions. Andersson, (2019) also shows that Sweden's carbon tax has been able to significantly reduce emissions from the transport sector without hindering overall economic growth. In the context of Indonesia, Raihan *et al.*, (2022) indicates that the implementation of a carbon tax still faces technical and institutional challenges, whilst Sadewo *et al.*, (2025) highlights that the current carbon tax rate remains relatively low and is therefore not yet strong enough to bring about a substantial change in industrial energy consumption patterns. Siregar *et al.*, (2025) added that the effectiveness of a carbon tax depends heavily on the consistency of policy and enforcement mechanisms. Meanwhile, Dilasari *et al.*, (2023) emphasises the importance of learning from best practices in carbon tax policies across various countries to strengthen policy design in Indonesia.

Nevertheless, there is a significant gap in the existing literature. The majority of studies examining fiscal policy and CO_2 emissions in Indonesia tend to focus on a single instrument specifically carbon taxes without integrating it with other fiscal instruments, such as fossil fuel subsidies and government spending on the environmental sector, within a comprehensive analytical framework. In fact, these three instruments operate simultaneously and interact with one another in shaping Indonesia's climate policy landscape; consequently, analysing them in isolation risks yielding incomplete conclusions. Against this backdrop, this study focuses on analysing the role of fiscal policy in controlling CO2 emissions in Indonesia's industrial sector. The study does not merely treat the carbon tax as a standalone instrument, but also examines its relationship with fossil fuel subsidies and government spending on the energy and environmental

sectors. Thus, this study seeks to build a more comprehensive understanding of how Indonesia's fiscal design operates in two distinct directions: as an instrument for emissions control through carbon taxes and green spending, whilst simultaneously acting as a source of distortion through fossil fuel subsidies that perpetuate the industry's reliance on carbon-based energy.

2 | BACKGROUND THEORY

2.1 Karbon Dioxide

Carbon dioxide (CO_2) is one of the greenhouse gases that naturally plays a vital role in maintaining the Earth's temperature balance. At moderate levels, CO_2 helps maintain atmospheric conditions that support life. However, when its concentration rises excessively, this gas can intensify the greenhouse effect due to its ability to absorb infrared radiation, thereby contributing to global warming and climate change (IPCC, 2021). Generally, CO_2 emissions can originate from two sources: natural and anthropogenic. Natural sources stem from natural processes such as the respiration of living organisms, volcanic activity, and the decomposition of organic matter. Meanwhile, anthropogenic sources stem from human activities, particularly the burning of fossil fuels, industrial activities, transport, electricity generation, and waste management. Emissions from human activities tend to be a primary concern as their volume continues to rise alongside economic growth, industrialisation, and carbon-based energy consumption (Friedlingstein *et al.*, 2023). In the context of this study, CO_2 serves as a key indicator for illustrating the environmental pressure caused by the industrial sector. Industrial activities that remain reliant on fossil fuels have the potential to generate large quantities of CO_2 emissions, particularly through production processes, the use of coal-fired electricity, and the combustion of fuel in industrial machinery and equipment. Consequently, rising CO_2 emissions from the industrial sector not only reflect environmental concerns but also highlight the need to strengthen fiscal policies capable of steering industry towards more efficient and low-carbon energy use.

2.2 Environmental Kuznets Curve (EKC)

The Environmental Kuznets Curve (EKC) is a theory that explains the relationship between economic growth and environmental degradation. This theory states that in the early stages of development, economic growth tends to increase pressure on the environment as production, industrialisation and energy consumption rise. At this stage, developing countries are generally still focused on increasing output and the utilisation of natural resources, meaning that environmental protection is not yet a top priority. Consequently, pollution and emissions tend to rise in tandem with increasing economic activity (Panayotou, 1993). However, as a country reaches a higher income level, this relationship may shift. Rising incomes, technological advancements, changes in economic structure, and growing awareness of environmental quality drive demand for better environmental policies and facilities. At this stage, the government begins to strengthen environmental regulations, increase budget allocations for environmental protection, and encourage a shift from pollution-intensive sectors towards more efficient, low-emission sectors. Thus, once a certain threshold is crossed, economic growth is no longer necessarily accompanied by increased environmental degradation, but may instead be accompanied by improvements in environmental quality. In the context of this study, the EKC theory is relevant for explaining Indonesia's position as a developing country that still faces a dilemma between industrial sector growth and CO2 emission control. Empirically, Sugiawan and Managi (2016), in their study using Indonesian panel data, found that the relationship between per capita income and CO2 emissions in Indonesia has not yet reached the EKC curve's turning point, meaning Indonesia remains in the ascending phase where economic growth is still accompanied by rising emissions. This finding implies that market mechanisms and economic growth alone are insufficient to drive emissions reductions, making fiscal policy intervention crucial. The industrial sector plays a vital role in driving economic growth, yet it remains reliant on fossil fuels that generate carbon emissions. Consequently, environmental improvement cannot rely solely on rising incomes or economic growth alone, but requires consistent fiscal policy support. Carbon taxes, fossil fuel subsidy reforms, and government spending on the energy and environmental sectors are key instruments for ensuring that industrialisation does not continue to drive up emissions, but instead moves towards low-carbon development.

2.3 Fiscal Policy

Fiscal policy is one of the economic policy instruments used by the government to influence the direction of the economy through the management of government revenue and expenditure. According to Nopirin (2000), fiscal policy aims to steer the economy towards a better state through changes in both government revenue and expenditure. In line with this, Mankiw (2013) explains that fiscal policy is an economic policy implemented by the government by regulating taxes and government expenditure to achieve the desired economic conditions. Generally, fiscal policy can be categorised into expansionary fiscal policy and contractionary fiscal policy. Expansionary fiscal policy involves increasing government expenditure or reducing taxes to stimulate economic activity. Conversely, contractionary fiscal policy involves reducing government expenditure or increasing government revenue to control specific economic pressures. In practice, fiscal

policy instruments are highly diverse, encompassing taxation, subsidies, government spending, financing, customs duties, government debt and fiscal decentralisation. In the context of this study, fiscal policy is understood not only as a tool for maintaining economic stability, but also as an instrument for controlling the environmental impact of industrial activities. The government can use fiscal policy to influence the behaviour of the industrial sector through the provision of economic incentives or disincentives. Thus, the fiscal policy instruments used in this study are.

1) Carbon Tax
   A carbon tax is a type of pollution tax levied on the use of fossil fuels to address market failures arising from negative externalities such as climate change and air pollution (Ratnawati, 2016). Fossil fuels are fuels containing hydrocarbons that are by nature non-renewable, such as crude oil, coal and natural gas. As it is levied on fossil fuels, the imposition of a carbon tax automatically increases the price of these fuels. In accordance with microeconomics, this price increase will reduce demand for these carbon-based fuels and reduce the negative externalities they cause. The legal basis for the imposition of a carbon tax is broadly set out in Article 13 of Law No. 7 of 2021. The rationale behind the carbon tax is the negative externalities caused to the environment by industrial activities that produce carbon. Therefore, the carbon tax can be considered a form of Pigouvian Tax. Furthermore, the government is committed to achieving its NDC target of reducing greenhouse gas (GHG) emissions by 31.89 per cent independently and by up to 43.20 per cent with international support by 2030 (KLHK, 2022).
2) Fossil Fuel Subsidies
   Fossil fuel subsidies are a form of government fiscal intervention aimed at keeping the price of fossil fuel-based energy below its economic cost, thereby reducing the energy costs borne by consumers and industry players to a level lower than that which would otherwise result from market mechanisms (Coady, Parry, Le, and Shang, 2019). These subsidies can take the form of direct subsidies, such as fuel price subsidies and electricity tariffs, or indirect subsidies in the form of tax relief, royalty exemptions, or debt guarantees for fossil fuel companies. In Indonesia, fossil fuel subsidies have historically been dominated by fuel subsidies and electricity subsidies, where power generation still relies heavily on coal and oil. From a microeconomic perspective, fossil fuel subsidies operate in a manner contrary to carbon taxes. Whilst a carbon tax raises energy prices to reduce demand and its negative externalities, fossil fuel subsidies, on the other hand, drive prices below their social marginal cost, thereby encouraging excessive consumption of fossil fuels beyond the socially optimal level. This condition is known in economic literature as a price distortion that exacerbates market failure due to the negative externalities of CO_2 emissions, as industry players do not receive price signals that reflect the true environmental costs they incur (Anggraeni, 2021). Consequently, incentives to improve energy efficiency or switch to renewable energy sources remain very weak as long as fossil fuel subsidies remain substantial. The legal framework for the management of energy subsidies in Indonesia is broadly set out in Law No. 30 of 2007 on Energy and is further implemented through the annual State Budget mechanism, which determines the allocation of subsidies for fuel and electricity. These subsidies are managed by the Ministry of Finance and channelled through PT Pertamina for fuel and PT PLN for electricity. The size of the fossil fuel energy subsidy budget in the State Budget reflects just how dominant this instrument is in Indonesia's fiscal policy; indeed, in certain years the value of fossil fuel energy subsidies has exceeded spending on infrastructure and education combined (Dilasari, Ani, and Rizka, 2023). In relation to national climate targets, substantial fossil fuel energy subsidies create a fundamental policy contradiction. On the one hand, the government is committed to reducing GHG emissions in line with the NDC by 31.89 per cent independently and up to 43.20 per cent with international support by 2030 (KLHK, 2022). On the other hand, fossil fuel subsidies structurally perpetuate the industrial sector's dependence on fossil fuels, thereby slowing down the sector's decarbonisation process. Reform of fossil fuel subsidies is therefore not merely a fiscal issue, but an integral part of Indonesia's climate policy strategy, the relationship between which and CO_2 emission trends in the industrial sector needs to be examined more systematically.
3) Government spending on the energy and environment sectors
   Government spending on the energy and environment sectors is a fiscal instrument that operates through the expenditure side of the state budget to accelerate the energy transition and strengthen emission reduction capacity objectives that cannot be optimally achieved through market mechanisms. Unlike carbon taxes, which operate through price disincentives, and fossil fuel subsidies, which operate through price incentives, government spending functions as an expansionary instrument that directly funds the development of renewable energy infrastructure, industrial energy conservation programmes, research and development of low-carbon technologies, and the strengthening of institutional capacity for environmental management (Baumol dan Oates, 1988). In this context, public spending addresses market failures distinct from externalities, namely failures in the provision of public goods and information failures that result in private investment in clean technologies consistently falling short of the socially optimal level. In Indonesia, government spending related to the energy and environment sectors is spread across various ministries and agencies, notably the Ministry of Energy and Mineral Resources (ESDM), the Ministry of Environment and Forestry (KLHK), and the National Research and Innovation Agency (BRIN). This expenditure covers funding for renewable energy programmes, energy efficiency grants for the industrial sector, budgets for pollution monitoring and control, as well as funding for national GHG inventory and reporting. Within the structure

of the State Budget, allocations for environmental functions and renewable energy management have historically remained far smaller than the scale of fossil fuel subsidies, reflecting an imbalance in the orientation of Indonesia's fiscal policy towards emission reduction targets (Anggraeni, 2021). From a theoretical perspective, the effectiveness of government spending in reducing CO_2 emissions from the industrial sector is largely determined by the extent to which it is directed towards transformative investments that is, those that permanently shift the structure of industrial production towards low-carbon technologies rather than merely temporary or administrative programmes. Rokhmawati, Sarasi, and Tawila (2024), in their system dynamics modelling, found that a combination of carbon pricing instruments and adequate public investment in renewable energy yields a far greater reduction in emissions than relying on a single instrument alone. This finding confirms that government spending on the energy and environment sectors is not a supplementary instrument, but rather a key component determining the success of the overall climate fiscal policy mix. In relation to Indonesia's NDC commitments, public spending on the renewable energy and environmental sectors should play a strategic role as a catalyst to accelerate private investment in clean technologies. Sunanda *et al.* (2025), in their systematic review of carbon pricing frameworks in Indonesia, emphasise that in developing countries with limited fiscal and technological capacity, the scale and targeting of public investment in the clean energy sector are key determinants of whether a low-carbon transition can proceed at the required scale and pace. Consequently, the development of government expenditure in this sector between 2010 and 2023 constitutes a key variable whose relationship with trends in industrial CO_2 emissions requires descriptive analysis in this study.

2.4 Gross Domestic Product

Gross Domestic Product (GDP) is the primary indicator used to describe the total value of final goods and services produced within an economy over a specific period. In economic development analysis, GDP not only indicates the scale of economic activity but also reflects the sectoral structure that shapes the growth process. According to Sadono (2010), GDP is used to assess the development of economic activity in a region, whilst McEachern (2000) explains that GDP encompasses the total value of final goods and services produced by factors of production within the territorial boundaries of a country over a specific period. Based on a sectoral approach, the economy can be divided into primary, secondary and tertiary sectors. The primary sector relates to the direct utilisation of natural resources, such as agriculture, fisheries, forestry, mining, and oil and gas. The secondary sector encompasses activities involving the processing of primary sector outputs into semi-finished or finished goods, including manufacturing, construction, and the supply of electricity, gas, and water. Meanwhile, the tertiary sector focuses on the provision of services such as trade, transport, finance, education, health, and communications (Central Statistics Agency, 2020). In this study, the industrial sector—as part of the secondary sector—is the primary focus due to its direct link to energy consumption and CO_2 emissions. Industrial activities generally require large amounts of energy, whether for production processes, machinery operation, heat generation, or electricity consumption. If the energy used still comes from fossil fuels, an increase in industrial output has the potential to increase CO_2 emissions. Consequently, the industrial sector occupies a dual position in Indonesia's economic development: as a driver of growth and simultaneously as a source of environmental pressure. It is this relationship that makes the industrial sector relevant for analysis within the context of fiscal policies aimed at controlling emissions. Based on this theoretical framework, this study positions fiscal policy as a strategic instrument for controlling CO_2 emissions from the industrial sector in Indonesia. This study does not merely view a carbon tax as a standalone policy, but also links it to fossil fuel subsidies and government spending on the energy and environmental sectors. This framework is important because fiscal policy can operate in two distinct ways. On the one hand, carbon taxes and green spending can support emissions reductions and the industry's transition towards clean energy. On the other hand, fossil fuel subsidies can maintain the industry's dependence on carbon-based energy. Therefore, this study establishes a theoretical basis for a descriptive analysis of how the design of Indonesia's fiscal policy relates to the dynamics of CO_2 emissions in the industrial sector.

3 | METHOD

This study employs a descriptive-analytical approach based on secondary data. This approach was chosen because the focus of the study lies in identifying patterns and correlations between the government's fiscal policy instruments and the development of CO_2 emissions in the industrial sector in Indonesia, for which data is available in aggregate form in official publications and can be analysed without variable manipulation or statistical hypothesis testing (Sugiyono, 2019; Creswell, 2014). The research period covers time series data from 2010 to 2023, representing a significant climate policy cycle, ranging from the period prior to the Paris Agreement commitment (2015) to the initial implementation of a carbon tax in the electricity sub-sector under Law No. 7 of 2021 on the National Energy Policy. The data is sourced from three main groups, namely: (1) industrial sector CO_2 emissions data from the Ministry of Environment and Forestry's National Greenhouse Gas Inventory Report, the Biennial Update Report (BUR) Indonesia's submissions to the UNFCCC, as well as publications by the International Energy Agency

(IEA) and the IESR; (2) fiscal policy data covering the implementation of fossil fuel subsidies, carbon tax revenue, and expenditure on the energy and environment sectors from the Budget Memorandum and the Ministry of Finance's State Budget Implementation Report; and (3) contextual data from the Central Statistics Agency (BPS) regarding the sectoral structure of GDP and macroeconomic indicators. The analysis was conducted using a descriptive-comparative approach through three sequential stages: an analysis of CO_2 emission trends in the industrial sector, an identification of developments in key fiscal instruments, and an examination of the descriptive relationship between the two groups of variables in chronological order. The results of the analysis were then presented in the form of tables and descriptive-interpretative narratives in accordance with the availability of data for each research variable.

4 | RESULTS AND DISCUSSION

4.1 Results

4.1.1 Trends in CO_2 Emissions from Indonesia's Industrial Sector, 2010–2023

Based on GHG inventory data published by the Ministry of Environment and Forestry (KLHK, 2023) and the GHG emissions inventory report for the energy sector from the Ministry of Energy and Mineral Resources (2020), CO_2 emissions from Indonesia's manufacturing and construction sectors showed a persistent upward trend throughout the 2010–2023 period. In this study, industrial sector emissions comprise two components: emissions from fuel combustion in the manufacturing and construction subsectors (IPCC category 1.A.2) and emissions from industrial processes and product use (IPPU). In 2019, this sector's contribution stood at 21.46 per cent of the total national energy emissions of 638,452 $GgCO_2e$, equivalent to approximately 137 million tonnes of CO_2e (ESDM, 2020). Overall, the IEA (2022) noted that Indonesia's total energy emissions in 2021 reached around 600 million tonnes of CO_2, placing Indonesia as the world's ninth-largest emitter of energy emissions.

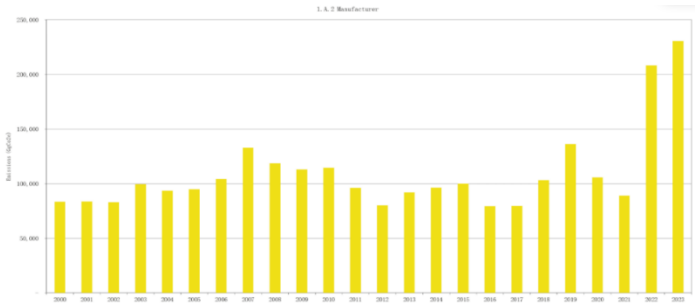

Figure 1. Carbon Emissions Levels in Indonesia, 2002–2023
Source: Ministry of Environment and Forestry (2023)

As shown in Figure 1, the first phase (2010–2012) was characterised by a decline in manufacturing emissions from around 115,000 $GgCO_2e$ to 78,000 $GgCO_2e$. This contraction does not reflect progress in decarbonisation, but is rather influenced by the slowdown in energy-intensive industrial activity following the 2008 global financial crisis and the moderation of growth in the manufacturing sector. This finding aligns with the argument by Sugiawan and Managi (2016) that short-term emission reductions in Indonesia are more heavily influenced by economic cycle factors than by structural changes in industrial energy intensity. The second phase (2013–2019) showed a gradual yet consistent rise in emissions. Manufacturing emissions rose from around 90,000 $GgCO_2e$ in 2013 to 137,072 $GgCO_2e$ in 2019, whilst the IPPU component also increased from 37,873 $GgCO_2e$ to 58,173 $GgCO_2e$ over the same period. This increase correlates with the acceleration of the manufacturing industry, driven by the influx of foreign investment in the nickel and steel processing sectors, whose production processes still rely heavily on coal-based energy. This situation is consistent with the findings of Rokhmawati, Sarasi, and Tawila (2024) that industrial expansion not accompanied by energy source transformation will structurally increase sectoral emission intensity. The third phase (2020–2023) was the most dramatic. Manufacturing emissions fell temporarily to around 105,000 $GgCO_2e$ in 2020 due to the contraction caused by the COVID-19 pandemic, before rebounding to 88,000 $GgCO_2e$ in 2021, and then surging sharply to around 209,000 $GgCO_2e$ in 2022 and 230,000 $GgCO_2e$ in 2023. This near-doubling over the two-year period is the most significant finding of this study and is closely linked to the wave of expansion of nickel smelters powered by captive coal-fired power plants, with Indonesia's domestic coal combustion surging by 33 per cent in 2022 compared to 2021 (Climate Analytics, 2024). Overall, this three-phase pattern expansion (2010–2019), temporary contraction (2020), and accelerated recovery (2021–2023) is consistent with findings that Indonesia remains in the ascending phase of the EKC curve, where economic growth is still accompanied by rising emissions (Sugiawan and Managi, 2016). This phenomenon underscores that without adequate fiscal policy intervention,

the expansion of export-oriented industries could drive emissions far beyond the downward trajectory required to meet the 2030 NDC commitments.

4.1.2 Implementation of Fiscal Policy relating to CO_2 Emissions Control in the Industrial Sector

Carbon tax instruments in Indonesia have only recently gained an explicit legal basis through Law No. 7 of 2021 on the Harmonisation of Tax Regulations, with the initial implementation being carried out on a limited basis in the coal-fired power plant sub-sector in 2023 at a rate of Rp30,000 per tonne of CO_2 or the equivalent of USD 2.1 per tonne. This rate is far below the effective carbon price range considered consistent with the Paris Agreement targets namely USD 50–100 per tonne meaning the price signal sent to industry players is not yet strong enough to drive substantial changes in energy consumption behaviour (Sadewo *et al.*, 2025). Furthermore, the scope of implementation, which targets only coal-fired power plants, means that the manufacturing sector has not been directly affected by this instrument throughout the study period. This situation is not merely a limitation of the data, but reflects the actual condition that Indonesia's carbon tax, up to 2023, has not been operational in the manufacturing sector—the primary source of emissions and the focus of this study. The absence of carbon pricing instruments between 2010 and 2021 meant there were no price signals to encourage industrial energy efficiency, which is consistent with the continued rise in emissions during that period. Siregar, Fatah, and Imansyah (2025) emphasise that the effectiveness of a carbon tax depends heavily on policy consistency and the strength of enforcement mechanisms, two elements that are not yet fully realised in the current design of Indonesia's carbon tax. Rais and Yusuf (2025) further demonstrate that the delay of over a decade in implementing this instrument reflects structural institutional weaknesses, rather than merely a policy choice that can be swiftly corrected.

Fossil fuel subsidies were the most dominant and most volatile fiscal instrument throughout the study period. Based on the State Budget realisation published by the Ministry of Finance, a reconstruction of Indonesia's energy subsidy data is presented in Table 1.

Table 1. Indonesia's Fossil Fuel Subsidy Expenditure for the Period 2010–2023 (trillion IDR)

Year	Fuel/LPG subsidies (Rp T)	Electricity Subsidy (Rp T)	Total Energy Subsidies (Rp T)
2010	82,0	58,1	140,1
2011	165,0	60,0	225,0
2012	216,8	64,9	281,7
2013	190,0	78,6	268,6
2014	194,9	89,8	284,7
2015	81,8	76,6	158,4
2016	44,0	60,0	104,0
2017	32,3	50,0	82,3
2018	38,8	50,0	88,8
2019	50,0	50,0	100,0
2020	42,0	50,0	92,0
2021	18,5	55,0	73,5
2022	215,9	335,3	551,2
2023	95,6	68,7	164,3

Source: Ministry of Finance (2024); IISD (2026); State Budget Financial Statements for various years, compiled

The data shows that total energy subsidies rose sharply from around Rp140 trillion in 2010 to a peak of Rp284.7 trillion in 2014. This surge reflects the extent of energy price distortions, which structurally weaken the industry's incentives to pursue energy efficiency. From a microeconomic perspective, fossil fuel subsidies work in the opposite direction to a carbon tax: rather than raising prices to reduce demand and its negative externalities, subsidies instead push prices below their social marginal cost, thereby encouraging excessive consumption of fossil fuels (Coady, Parry, Le, and Shang, 2019). Consequently, incentives for energy efficiency and switching to renewable energy sources remain very weak as long as fossil fuel subsidies remain substantial.

The fuel subsidy reform implemented between late 2014 and early 2015 succeeded in significantly reducing the energy subsidy burden, from Rp284.7 trillion to Rp82.3 trillion by 2017. This reform was one of the most substantial fiscal changes of the past decade and, in theory, should have signalled prices that were closer to the true social cost. However, this reform was not permanent. In 2022, when global energy prices surged sharply due to geopolitical pressures, the total realisation of energy subsidies and compensation soared to Rp551.2 trillion, more than seven times the previous year's figure, before correcting back to Rp164.3 trillion in 2023. This pattern of extreme fluctuations demonstrates that Indonesia has not yet succeeded in breaking its structural dependence on fossil fuel subsidies, meaning that every external price shock is immediately transmitted as a significant fiscal burden whilst simultaneously weakening price signals for industry players. This finding reinforces Anggraeni's (2021) argument that structural dependence on fossil fuel subsidies constitutes a systemic barrier to the decarbonisation of Indonesia's industrial sector.

4.1.3 Government Expenditure on the Energy and Environment Sectors

In terms of expansionary fiscal measures, government expenditure on the environment sector showed a relatively stagnant trend throughout the study period. According to the Ministry of Environment and Forestry's (KLHK) Audited Financial Report, the ministry's total expenditure stood at Rp4.88 trillion in 2016, rising to Rp5.87 trillion in 2017 against a budget of Rp6.48 trillion, representing a realisation rate of 90.65 per cent (KLHK, 2017). Furthermore, of the total KLHK expenditure realised in 2017, the specific allocation for the Climate Change Control Programme was recorded at only Rp360.6 billion, or around 6.1 per cent of the ministry's total realised expenditure, reflecting that budgetary commitment to programmes directly related to emissions mitigation remains very limited, even within the KLHK budget itself.

Between 2020 and 2023, the Ministry of Environment and Forestry's budget allocation saw a gradual but not substantial increase, amounting to Rp7.64 trillion in 2020, Rp8.55 trillion in 2021, and approximately Rp7.3 trillion in 2022–2023 (Ministry of Environment and Forestry, 2021; 2022). When compared with the actual expenditure on fossil fuel subsidies and compensation, which reached Rp551.2 trillion in 2022, the total KLHK budget for the same year was only around Rp7.3 trillion less than 1.4 per cent of the value of fossil fuel subsidies. This stark disparity clearly illustrates Indonesia's fiscal orientation, which remains far more inclined towards maintaining fossil-fuel-based energy consumption than funding the transition to clean energy. From a theoretical perspective, this situation represents a failure in the provision of public goods: private investment in low-carbon technologies will always fall short of the socially optimal level unless supported by adequate government spending (Baumol dan Oates, 1988). Sunanda *et al.* (2025) emphasise that in developing countries with limited technological capacity, such as Indonesia, the scale and targeting of public investment in the clean energy sector are key determinants of whether a low-carbon transition can take place on the scale required. With public spending on the environment and renewable energy stagnating and failing to see a significant increase throughout the study period, there is no sufficiently strong fiscal catalyst to drive technological substitution at the industrial level. This finding aligns with Anggraeni's (2021) argument that the inadequate allocation of green spending in Indonesia's State Budget constitutes a structural barrier that slows down the overall decarbonisation process of the industrial sector.

4.2 Discussion

Based on the findings of this study, it can be seen that the three fiscal policy instruments operated inconsistently in relation to CO_2 emission trends in the industrial sector throughout 2010–2023. During the period 2010–2014, when fossil fuel subsidies were at their highest levels ranging from Rp140 trillion to Rp284.7 trillion manufacturing emissions showed a consistent upward trend. Subsidy reforms in 2015 did indeed moderate the rate of emissions growth between 2015 and 2017, but did not result in an absolute reduction. This indicates that changes in energy prices have a tangible moderating effect, in line with Lin and Li (2011), yet this effect was not strong enough to reverse the overall trend as it was not accompanied by other emission control instruments operating simultaneously.

The most significant finding concerns the trend in 2022–2023. In 2022, Indonesia's GDP grew by 5.31 per cent (BPS, 2023), yet emissions from the manufacturing sector surged by around 137 per cent compared with 2021. At the same time, fossil fuel subsidies and compensation reached Rp551.2 trillion — the highest figure in Indonesia's fiscal history — whilst a carbon tax had only just been introduced at a rate of USD 2.1 per tonne with a scope that did not cover the manufacturing sector, and the Ministry of Environment and Forestry's budget stood at only around Rp7.3 trillion. Based on this data, it can be seen that these three fiscal conditions coexist and mutually reinforce emission pressures: there is no meaningful price disincentive from the carbon tax; energy subsidies are actually providing the largest-scale incentive for fossil fuel consumption in history; and green spending does not reach a scale capable of driving technological substitution at the industrial level. Ramadhani and Koo (2022), in their general equilibrium model simulation for Indonesia, demonstrate that a situation where carbon prices are too low and fossil fuel subsidies remain substantial simultaneously will drive the expansion of export-oriented industries, leading to a disproportionate increase in emissions relative to output growth; and the 2022–2023 data reveal precisely this dynamic.

Based on these overall findings, it can be seen that Indonesia's fiscal policy during 2010–2023 moved in two opposing directions simultaneously. On the one hand, carbon taxes and green spending functioned as instruments for controlling emissions, but on a scale and with an intensity that were far from adequate. On the other hand, fossil fuel subsidies structurally maintain the industrial sector's dependence on carbon-based energy and weaken the disincentive effects of other instruments. This situation reflects what is termed a 'policy contradiction' in the climate policy literature (Dilasari, Ani, and Rizka, 2023): Indonesia's normative commitment to reducing emissions by 31.89 per cent through its 2022 NDC is systematically undermined by a fiscal incentive design that remains biased towards fossil fuels. Sunanda *et al.* (2025) emphasise that this incoherence, if not corrected, has the potential to create a long-term lock-in effect: industrial investments that are decided

Based on distorted price signals, we will remain tied to fossil fuel technologies for the next two to three decades, well beyond the 2030 NDC target horizon. Achieving these targets cannot therefore rely on normative commitments alone, but requires comprehensive and simultaneous fiscal design reforms: strengthening carbon tax rates and expanding their scope to the manufacturing sector, reforming fossil fuel subsidies to make them resilient to external price shocks, and

significantly increasing the allocation of mitigation spending that directly targets the industrial sector.

5 | CONCLUSIONS AND FUTURE WORK

This study concludes that Indonesia's fiscal policy during the period 2010–2023 has not yet fully functioned as a coherent instrument for controlling CO_2 emissions from the industrial sector. Theoretically, this finding reinforces the relevance of the Environmental Kuznets Curve in the context of developing countries, namely that economic growth and industrialisation do not automatically reduce environmental pressure without consistent fiscal intervention. Carbon taxes and green spending have indeed provided a foundation for emissions control, but their effectiveness remains limited because their rates, scope, and budgetary scale are not yet commensurate with the magnitude of emissions pressure from the industrial sector. Conversely, fossil fuel subsidies remain the dominant fiscal instrument and have the potential to perpetuate the industry's dependence on carbon-based energy. Thus, the main contribution of this research lies in the understanding that emissions control cannot rely solely on a single fiscal instrument, but requires a combination of mutually reinforcing policies involving carbon taxes, subsidy reform, and increased spending on the energy transition. In practical terms, the findings of this study imply the need for more targeted fiscal reforms to support the industrial decarbonisation agenda in Indonesia. The government needs to gradually strengthen the design of the carbon tax, extend its scope to the manufacturing sector, reduce distortions caused by fossil fuel subsidies, and increase public spending on renewable energy, energy efficiency, and low-carbon industrial technologies. The limitations of this study lie in its descriptive approach, which has not yet measured the econometric causal relationship between fiscal instruments and CO_2 emissions. Therefore, future research could utilise quantitative models such as time series, panel data, or computable general equilibrium to obtain more precise impact estimates. Further studies could also focus on specific industrial subsectors, such as cement, steel, chemicals, and nickel smelters, so that the analysis of fiscal policy on emissions can be formulated in a more specific, practical, and appropriate manner for the emission characteristics of each industry.

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