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Analysis of the Impact of Fiscal Incentives on the Development of Electric Vehicles in Indonesia's Green Economy Transition (2020-2024)

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Climate change, Electric vehicles, Fiscal incentives, Green economy

Abstract
Accelerating the transition to a green economy is the main demand for developing countries such as Indonesia amid the increasing impact of climate change. This study analyzes the effectiveness of fiscal incentive policies regulated in Presidential Regulation No. 79 of 2023 on increasing the use of battery-based electric vehicles as part of the national clean energy strategy. The study was conducted using a quantitative descriptive approach with secondary data from the Central Statistics Agency, the Ministry of Energy and Mineral Resources, and the 2021–2030 *Rencana Usaha Penyediaan Tenaga Listrik (RUPTL)*. The (PCA) method is used to assess sectoral contributions to variations in carbon emissions, while the ANOVA test is applied to identify significant differences between years. The results of the analysis show that there is a surge in the adoption of electric vehicles after the policy is implemented, but CO_2 emissions still fluctuate highly, especially in the industrial and electricity sectors. The highest score of the first key component (PC1) in 2021 indicates a pivotal point in the changing sectoral dynamics towards green transformation, but the misalignment in the following years highlights the need for cross-policy integration. Thus, the effectiveness of fiscal incentives is not enough to rely solely on the demand for electric vehicles but also requires energy system reform and the readiness of economic structures to adopt low-emission technologies.

INTRODUCTION

Climate change has become the most serious global threat of the 21st century, evidenced by the continuous rise in global average temperatures (Kabir et al., 2023). According to the Intergovernmental Panel on Climate Change (IPCC, 2021), the global mean surface temperature has increased by approximately 1.1°C above pre-industrial levels, with projections indicating a potential rise of 1.5°C between 2030 and 2052 if current warming trends persist. This phenomenon is characterized by an increase in the earth's average temperature, an increasingly high frequency of extreme weather events, and significant risks to biodiversity sustainability. For Indonesia, as a vulnerable archipelagic country, the transition to a *green economy* is an urgent need. The *green economy* is understood as a pattern of sustainable development that emphasizes energy efficiency, low emissions, and environmental sustainability (MoEF, 2020).

The transportation sector is one of the main contributors to national greenhouse gas emissions. In 2019, its contribution was recorded at around 27% of total emissions, with the number of motor vehicles exceeding 130 million units in 2022, most of them still reliant on fossil fuels (BPS, 2022). Within the framework of achieving the 2060 net zero emission (NZE) target in accordance with the Paris Agreement commitments, electric vehicles are seen as strategic instruments. However, their penetration is still very limited, only 0.1% of the total national motor vehicles, due to the high cost of ownership and limited supporting infrastructure.

As an effort to accelerate the energy transition, the government passed Presidential Regulation Number 79 of 2023, which provides various fiscal incentives. This scheme includes exemption from Sales Tax on Luxury Goods (PPnBM), purchase subsidies, and import duty relief for battery-based electric vehicles. The policy aims to reduce consumer ownership costs, stimulate manufacturing investment, strengthen the battery industry's supply chain by utilizing domestic nickel potential, and reduce fossil fuel imports, which in 2022 reached IDR 500 trillion (MEMR, 2023). Case studies in Norway and China show that the consistency of such incentives is effective in driving the massive adoption of electric vehicles (Figenbaum, 2017; Zhang et al., 2018).

However, the effectiveness of fiscal incentives in Indonesia is still questionable. The biggest challenge lies precisely in the dominance of motorcycles, which reach around 80% of the total national motor vehicles (BPS, 2022). Although sales of electric vehicles continue to increase—23,900 units of electric cars were sold in January-April 2025—the market share is still below 5%. This fact shows that fiscal policy is not enough if it only focuses on electric cars but must also be directed at accelerating the electrification of motorcycles, which have the greatest contribution to transportation emissions.

Several previous studies have examined various aspects of electric vehicle adoption and fiscal policy effectiveness in different contexts. Figenbaum (2017) demonstrated that Norway's comprehensive fiscal incentive scheme, including tax exemptions and toll-free access, successfully increased electric vehicle market share to over 50%. Similarly, Zhang et al. (2018) found that China's subsidy program significantly accelerated electric vehicle adoption, though sustainability concerns emerged when subsidies were reduced. In the Southeast Asian context, Lutsey and Nicholas (2019) identified infrastructure readiness and total cost of ownership as critical barriers to electric vehicle penetration. However, existing literature has primarily focused on four-wheeled vehicles in developed economies, with limited attention to the unique dynamics of motorcycle-dominated markets in developing countries. Furthermore, few studies have comprehensively examined the interaction between fiscal incentives and energy infrastructure readiness in contexts where electricity generation remains heavily dependent on fossil fuels. This research gap is particularly significant for Indonesia, where motorcycles constitute the majority of motorized vehicles and the energy transition is still in its early stages.

The urgency of this research is underscored by three critical factors. First, the transportation sector's contribution to national emissions continues to escalate, threatening Indonesia's commitment to the Paris Agreement and the 2060 NZE target. Second, Presidential Regulation No. 79 of 2023 represents a significant policy intervention whose effectiveness must be empirically evaluated to inform future policy refinements. Third, the apparent contradiction between increasing electric vehicle adoption and persistently high sectoral emissions necessitates a systematic investigation of the structural factors that may limit policy impact. Without such evidence-based assessment, Indonesia risks implementing costly incentive programs that fail to deliver meaningful environmental benefits.

The novelty of this study lies in its integrated analytical approach that combines statistical assessment of adoption trends with sectoral emission dynamics specifically in a motorcycle-dominated market. Unlike previous research that treats electric vehicle adoption in isolation, this study examines the critical linkage between transportation electrification and the national energy mix, utilizing the 2021–2030 Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik - RUPTL*) framework. Furthermore, this research contributes methodologically by applying Principal Component Analysis (PCA) to identify the relative contribution of different economic sectors to emission variations, thereby revealing the structural constraints that may undermine fiscal incentive effectiveness. This multidimensional perspective provides crucial insights into the complex interplay between policy instruments,

market dynamics, and infrastructure readiness in the context of developing economies transitioning toward *green transportation*.

Based on this background, this study aims to evaluate the effectiveness of Presidential Regulation No. 79 of 2023 in accelerating the adoption of electric vehicles in Indonesia, with an emphasis on electric motorcycles as the main strategy for the clean energy transition. The research questions focus on two main aspects: (1) the extent to which fiscal incentives are able to increase the adoption of electric vehicles, especially motorcycles, and (2) how these policies interact with the readiness of energy infrastructure and domestic market dynamics. To answer this, this study uses a multidisciplinary approach that combines statistical analysis, legal studies of regulations, and international comparisons with similar policy practices. The analysis was strengthened through the context of the 2021–2030 Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik - RUPTL*) to review the linkage between transportation electrification and the energy mix of national power plants.

RESEARCH METHOD

The data for this study used secondary data obtained from official institutions, namely the Central Statistics Agency (BPS), the Ministry of Transportation, the Ministry of Energy and Mineral Resources (MEMR), as well as the 2021–2030 Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik - RUPTL*) document. The data included the number of electric motor vehicles per year, sectoral emissions, and the national energy mix relevant to energy transition policies.

This research applied a quantitative method based on the philosophy of positivism. This approach aimed at studying a specific population or sample using sampling techniques that were generally random. The data collection process was carried out using research instruments, while data analysis was conducted quantitatively or statistically to test the hypotheses that had been formulated (Sugiyono, 2013). This approach was chosen because it aligned with the research objectives to evaluate the effectiveness of fiscal incentive policies as stipulated in Presidential Regulation No. 79 of 2023 in encouraging the adoption of electric vehicles in Indonesia as part of the transition strategy to a green economy.

The quantitative approach in this study included two main methods: descriptive analysis and Principal Component Analysis (PCA). Descriptive analysis was used to describe the development of the number of electric motor vehicles year by year (Field, 2017). Meanwhile, PCA was applied to identify economic sectors that affected the dynamics of electric vehicle adoption. This method was also used to reduce the dimensionality of sectoral data related to fossil energy emissions and dependence, as well as to reveal the contribution of annual variations to structural changes in policies and the implementation of environmentally friendly technologies (Shlens, 2014).

RESULTS AND DISCUSSION

Indonesia's Commitment to the Paris Agreement and Its Implications for Fiscal Policy

The Paris Agreement is an international agreement signed by 195 countries at the United Nations Climate Change Conference (COP21) in Paris, France, on December 21, 2015 (UNFCCC, 2020). This agreement targets controlling the average global temperature rise below 2°C and seeks to contain it to 1.5°C through a strategy to reduce carbon and greenhouse gas emissions (Ayuningsih et al., 2023).

Indonesia's commitment to the Paris Agreement is realized through various national policies, one of which is Presidential Regulation Number 79 of 2023 concerning the acceleration of the use of battery-based electric vehicles. As argued by Santika et al. (2020), achieving Indonesia's Nationally Determined Contribution (NDC) requires comprehensive

sectoral transformation, particularly in transportation and energy systems. This regulation contains fiscal instruments in the form of purchase subsidies and special incentives for electric two-wheeled vehicles as stipulated in Article 19 paragraph (2) (BPK, n.d.). This reflects the government's serious steps in accelerating the transition to low-emission transportation while supporting the achievement of national emission reduction targets.

In addition to fiscal policy support, Indonesia's commitment is also reflected in the development of supporting infrastructure initiated by PT PLN (Persero). This effort includes the provision of Public Electric Vehicle Charging Stations (SPKLU), Public Electric Vehicle Battery Exchange Stations (SPBKLU), as well as Home Charging Station. As of 2022, as many as 129 SPKLU units have been operational, although the distribution is still uneven throughout the region (Ministry of Energy and Mineral Resources, 2022). This infrastructure gap represents a significant barrier to electric vehicle adoption, as demonstrated by Hardman et al. (2018), who found that charging infrastructure availability is a critical determinant of consumer willingness to purchase electric vehicles. This fact shows that transportation electrification is positioned as one of the main instruments in realizing Indonesia's commitment to the Paris Agreement.

However, challenges still arise due to limited infrastructure that has not been widespread and the dominance of fossil fuel two-wheeled vehicles. Therefore, the effectiveness of fiscal policy needs to be strengthened through cross-sectoral synergy. Thus, Indonesia's success in fulfilling the Paris Agreement commitments does not only rely on fiscal incentives, but also on the readiness of energy infrastructure, equitable access to technology, and consistency in policy implementation at the national and regional levels.

Electric Motor Sales Trends and Market Response

Increasing global attention to environmental issues and reducing carbon emissions has prompted Indonesia to commit to the development of Battery-Based Electric Motor Vehicles (KBLBB). This commitment is reflected in the growth in the number of electric motorcycles that continues to increase from year to year. These developments can be seen in the following graph, which presents data for the 2020–2024 period.

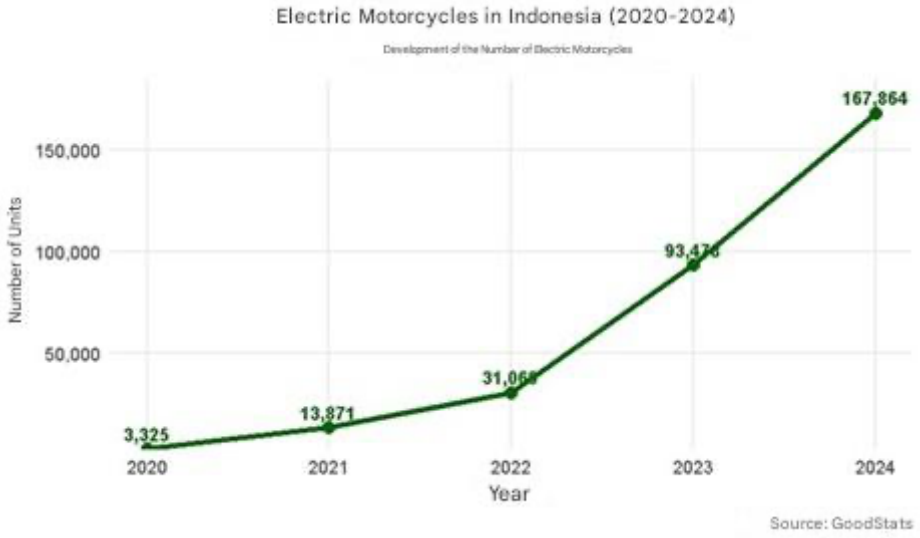

Figure 1 Development of the Number of Electric Motorcycles in Indonesia

GoodStats data shows that the adoption of electric motorcycles in Indonesia has experienced a very significant surge in the last five years. In 2020, the number of registered electric motorcycles was only 3,325 units. This figure increased to 13,871 units in 2021, then more than doubled to 31,060 units in 2022. Growth will accelerate in 2023 with 93,478 units,

reaching 167,864 units in 2024. This trend indicates that the use of electric motorcycles in Indonesia has grown rapidly with a strong acceleration rate.

This surge in sales cannot be separated from the fiscal incentive policy contained in Presidential Regulation (Perpres) Number 79 of 2023, which came into effect in December 2023. This policy has proven to provide a significant boost to the market through various facilities, such as tax breaks and financing support that make electric motorcycles more affordable. The effectiveness of such fiscal instruments is supported by economic theory suggesting that price elasticity of demand for electric vehicles is substantial, particularly in price-sensitive markets such as Indonesia (Langbroek et al., 2016). With an increasing growth trend, this policy is one of the main drivers in accelerating the transition to low-emission transportation in Indonesia.

Emission Challenges and the Role of Fiscal Policy

The analysis of Greenhouse Gas (GHG) emissions in this study uses secondary data from the Central Statistics Agency (BPS), especially the Physical Supply and Use table for Indonesia's GHG Emissions (Thousand Tons CO_2) which was last updated on June 30, 2025. The data includes estimated emissions from various sectors of the economy, including industry, electricity and gas, transportation, mining, and waste management. The 2018–2023 data range is processed through the cleaning, aggregation, and normalization stages before being analyzed spatially and temporally.

A summary of the annual fluctuations of each sector is shown in Table 1.

Table 1 Physical Supply and Use for Indonesia's GHG Emissions

Sector	2018	2019	2020	2021	2022	2023
Mining	36961	32427	25419	26540	26274	40619
Industry	229445	264601	237066	220682	343665	367738
Electricity and Gas	262548	275000	280452	303160	297168	284064
Waste Management	26170	29137	29561	30255	30708	31285
Transportation	83948	75219	60184	67306	80857	81565

Furthermore, Principal Component Analysis (PCA) is carried out to reduce the data dimension and identify dominant variations between sectors. The test of the difference in the score of the first major component (PC1) between years was carried out by one-way Analysis of Variance (ANOVA), with an independent variable in the form of years and a bound variable in the form of a PC1 score.

Table 2 ANOVA Test Results on Key Component Score (PC1) by Year

Variance Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Significance
Year	1	2.961	2.961	1.304	0.317
Residual	4	9.080	2.270		
Total	5	12.041			

Based on Table 2, the Significance value of 0.317 and the calculated F value of 1.304 were obtained. Because the significance value of 0.317 is greater than the significance level (α) used which is 0.05, it can be concluded that there is no significant difference in the Key Component Score (PC1) between the years tested. This indicates that the Year statistically has no significant influence on the variation in the Key Component (PC1) score.

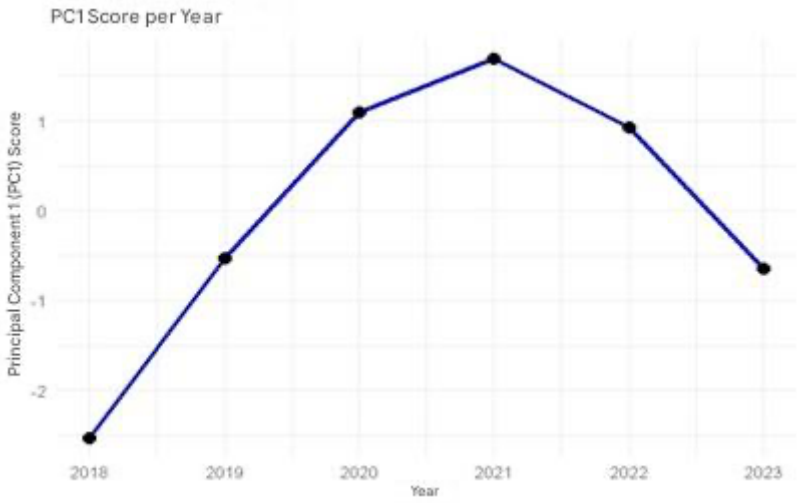

Figure 2 PC1 Score per Year

Based on Figure 2, the PC1 Score per Year graph shows an inverted parabolic trend pattern for Key Component 1 (PC1) throughout the 2018–2023 period. At the beginning of the observation, namely in 2018, the PC1 score was at a low point of around -2.5. This value then increased sharply and sustainably until it reached its peak in 2021 with a score of around +1.5. These conditions show that the dimensions represented by PC1 reached their highest strength of the year.

After 2021, the PC1 trend began to move downwards gradually. The value dropped to around +1.0 in 2022 and continued to decrease until it returned to a negative position of around -0.7 in 2023. This pattern indicates a significant phase of change: the dimension that previously experienced rapid growth reached a turning point in 2021, then entered a period of weakness in the following two years. This inflection point coincides with the post-pandemic economic recovery period, suggesting that structural changes in economic activity patterns may have influenced sectoral emission dynamics. As noted by Liu et al. (2020), the COVID-19 pandemic temporarily disrupted emission patterns across multiple sectors, but subsequent recovery often led to emission rebound effects.

Table 3 Emission Fluctuations by Sector 2018–2023

Sector	Emission Fluctuations (thousand tons CO_2)
Industry	63,022.254
Electricity and Gas	14,790.886
Transportation	9,339.041
Mining	6,366.050
Waste Management	1,813.155

Based on Table 3 regarding emission fluctuations per sector during the 2018–2023 period, the industrial sector was recorded as the largest contributor with total emissions reaching 63,022 thousand tons of CO_2. This reflects the sector's high sensitivity to production dynamics, energy consumption patterns, and inconsistency in efficiency policies implemented. The electricity and gas sector occupies the second position with emission fluctuations of 14,790 thousand tons of CO_2, which is closely related to changes in the national energy mix. Furthermore, the transportation sector showed a variation in emissions of 9,339 thousand tons of CO_2, which was mainly influenced by the high dependence on people's mobility patterns and

fuel policies. The mining sector (6,366 thousand tons of CO_2) and waste management (1,813 thousand tons of CO_2) were relatively more stable with a much lower fluctuation contribution.

The complexity of these fluctuations between sectors underscores the need for proportionally designed fiscal policies. Fiscal incentives not only need to be focused on transportation electrification efforts, but also must be synergized with energy efficiency strategies in the industrial sector as well as energy mix transitions in the electricity sector. This integrated approach aligns with the findings of Michalek et al. (2011), who demonstrated that the environmental benefits of electric vehicles are contingent upon the carbon intensity of electricity generation. Thus, the effectiveness of fiscal policy in supporting the transition to a green economy will be largely determined by cross-sectoral alignment and consistency of policy implementation at the national level.

SWOT Analysis of Fiscal Incentive Policy in Presidential Regulation No. 79 of 2023

To accelerate the transition to Battery-Based Electric Motorized Vehicles (KBLBB), the government issued Presidential Regulation No. 79 of 2023 as a revision of Presidential Regulation No. 55 of 2019. This regulation provides fiscal incentives in the form of tax exemptions, subsidies, and ease of importing key components. This policy is an important instrument to encourage the decarbonization of the transportation sector and support Indonesia's commitment to the Paris Agreement. However, the effectiveness of its implementation is greatly influenced by infrastructure readiness, market response, and global energy dynamics. For this reason, SWOT analysis is used to evaluate the strengths, weaknesses, opportunities, and threats of this policy.

Table 4 SWOT Analysis of Fiscal Incentive Policy in Presidential Regulation No. 79 of 2023

Aspects		Explanation
Strengths	-	Provide significant fiscal relief, such as VAT and import duty reductions.
	-	Attracting foreign investors in the field of electric vehicles.
Weaknesses	-	The SPKLU infrastructure is not even and has not yet supported national needs.
	-	Dependence on electricity from coal-fired power plants reduces the environmental impact of KLBB. (Hasan & Hummer, 2024)
Opportunities	-	Increased demand for new labor in the green technology sector.
	-	The global commitment to decarbonization is driving green technologies.
Threats	-	An imbalance between vehicle electrification and energy transition.
	-	Dependence on imports of non-nickel raw materials and global geopolitical pressures.

Based on Table 4, the main strength of this policy is tax relief and subsidies that can attract investment and accelerate the adoption of electric vehicles. Opportunities arise as global demand for green technologies increases and new jobs are created in the clean energy sector. However, a prominent weakness is the dependence of electricity supply on coal-fired power plants, so the environmentally friendly benefits of electric vehicles have not been fully achieved. Another threat is the uncertainty of raw material supply that still depends on imports and the readiness of the national energy transition.

The problem of weakness is even clearer when looking at the dominance of coal-fired power plants as a national source of electricity. Although the government has responded through the preparation of Electricity Supply Business Plan (RUPTL) 2021–2030 and Presidential Regulation No. 112 of 2022 concerning the Acceleration of Renewable Energy Development, implementation in the field has not been fully aligned. This implementation gap reflects what Sovacool and Drupady (2016) identified as the "energy trilemma" in developing

economies, where governments must balance energy security, affordability, and environmental sustainability. PLN was mandated to replace coal-fired power plants with new and renewable energy plants (NRE), but the realization was slow.

Based on a report by the Center for Research on Energy and Clean Air (CREA) and Global Energy Monitor (GEM), coal-fired power plant capacity increased by 15% or equivalent to 7.5 GW in the period from July 2023 to July 2024. Of this amount, around 4.5 GW comes from captive-type coal-fired power plants, which are plants built for industrial energy needs independently (Hasan & Hummer, 2024).

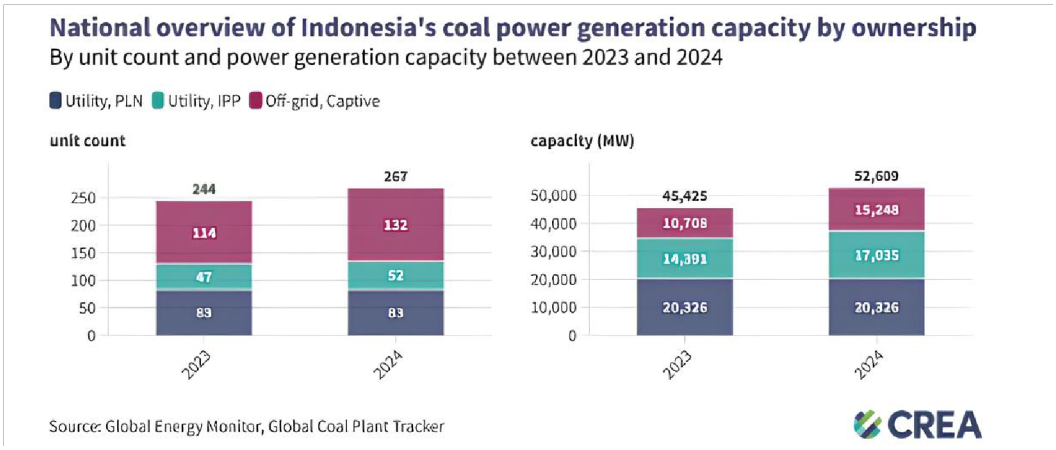

Figure 3. Indonesia's Captive Coal on The Uptick, (Hasan & Hummer, 2024)

The data in Figure 3 shows the development of coal-fired power plant capacity in Indonesia based on ownership in the period 2023 to 2024, reviewed from the number of units and capacity (MW). In terms of the number of units, there is an increase from 244 units in 2023 to 267 units in 2024. This increase was mainly triggered by the addition of units in the Off-grid, Captive (from 114 to 132 units) and Utility, IPP (from 47 to 52 units), while the number of Utility, PLN units remained at 83. In terms of capacity (MW), the total capacity has also increased from 45,425 MW in 2023 to 52,609 MW in 2024. The largest increase came from the Off-grid, Captive (from 10,708 MW to 15,248 MW) and Utility, IPP (from 14,391 MW to 17,035 MW) sectors, while the Utility, PLN capacity remained constant at 20,326 MW. Overall, this trend shows the growth of capacity and the number of coal generation units dominated by the non-PLN segment (IPP and Captive).

CONCLUSION

This study demonstrates that the fiscal incentive policy in Presidential Regulation No. 79 of 2023 has contributed positively to the increase in electric vehicle adoption in Indonesia, particularly electric motorcycles, which experienced remarkable growth from 3,325 units in 2020 to 167,864 units in 2024. However, the effectiveness of these incentives remains constrained by structural barriers, including the continued dominance of coal-fired power plants in electricity supply (which increased by 15% or 7.5 GW during 2023-2024), limited and unevenly distributed charging infrastructure (only 129 SPKLU units nationally as of 2022), and persistent socioeconomic challenges affecting consumer purchasing power. The Principal Component Analysis reveals that while electric vehicle adoption trends have accelerated, particularly following policy implementation, year-to-year differences are not statistically significant ($p=0.317$), suggesting that policy impact has been gradual rather than transformative. More critically, the industrial and electricity sectors have been identified as the largest contributors to emission fluctuations (63,022 and 14,790 thousand tons CO_2

respectively), indicating that transportation electrification alone cannot achieve meaningful emission reductions without concurrent reform of the national energy mix. The SWOT analysis confirms that while fiscal incentives possess substantial potential to catalyze green transition through tax relief and foreign investment attraction, their success is contingent upon addressing critical weaknesses—particularly energy infrastructure decarbonization—and mitigating external threats such as raw material import dependencies and geopolitical uncertainties. Therefore, achieving Indonesia's green economy transition objectives requires an integrated policy framework that synchronizes fiscal incentives with accelerated renewable energy deployment, cross-sectoral emission reduction strategies, and strengthened institutional capacity for policy coordination. Future research should investigate the long-term sustainability of electric vehicle adoption patterns once fiscal incentives are gradually reduced, examine consumer behavior and adoption barriers across different socioeconomic segments, and assess the lifecycle environmental impacts of electric vehicles under various national energy mix scenarios to provide more nuanced guidance for policy optimization.

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