

Analysis of Electric Car Growth in Support of Sustainable Energy Transition and Transportation Solutions in Indonesia

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ABSTRACT

Purpose: This study aims to analyze the role of electric vehicle growth in supporting sustainable energy transition efforts and transportation sustainability in Indonesia by examining energy efficiency, infrastructure readiness, and electricity system challenges.

Research Method: This study employed a descriptive qualitative approach using a Systematic Literature Review (SLR). Secondary data were collected from peer-reviewed journal articles, government reports, and energy policy publications indexed in Scopus, ScienceDirect, SpringerLink, Wiley Online Library, and Google Scholar from 2020 to 2025. The analysis used thematic synthesis involving screening, categorization, and interpretative analysis.

Results and Discussion: The findings indicate that electric vehicles provide higher energy efficiency, lower operational costs, and reduced dependence on fossil fuels. However, EV sustainability remains dependent on the readiness of the charging infrastructure, the electricity grid's capacity, the integration of renewable energy, and the development of battery technology.

Implications: The findings emphasize the importance of integrated policies involving renewable energy expansion, charging infrastructure development, and electricity system strengthening.

Originality: This study offers an integrative perspective that links EV adoption, energy transition readiness, electricity systems, and sustainability challenges in the Indonesian context.

Keywords: electric vehicles; energy transition; energy efficiency; sustainable transportation; renewable energy.

1. Introduction

The transportation sector remains one of the largest contributors to fossil fuel consumption and greenhouse gas emissions in Indonesia, creating substantial environmental and energy security challenges. High dependence on fuel oil (BBM) not only accelerates the depletion of non-renewable energy resources but also increases vulnerability to national energy security (Ministry of Energy and Mineral Resources, 2023). The continued dependence on fuel-based transportation systems increases carbon emissions, accelerates environmental degradation, and heightens vulnerability to fluctuations in global energy markets. In response to these concerns, the transition toward sustainable transportation has become an increasingly important policy agenda in Indonesia. Electric vehicles (EVs), particularly electric cars, are widely viewed as a strategic technological innovation capable of improving energy efficiency and reducing direct tailpipe emissions within the transportation sector. Unlike conventional



vehicles, electric cars utilize electrical energy stored in batteries as their primary power source and produce no direct tailpipe emissions during operation. However, the sustainability implications of electric vehicle adoption remain closely associated with electricity generation systems, battery efficiency, and the broader transition of Indonesia's energy sector toward cleaner energy sources (International Renewable Energy Agency, 2022).

The Indonesian government has demonstrated its commitment to promoting electric vehicle development through various strategic policies, including Presidential Regulation No. 55 of 2019, fiscal incentives, and the development of Public Electric Vehicle Charging Station (SPKLU) infrastructure (Ministry of Energy and Mineral Resources, 2023). These policies aim not only to accelerate electric vehicle adoption but also to support energy diversification and reduce dependence on fossil fuels through a cleaner transportation ecosystem. Recent studies demonstrate that electric vehicle development in Indonesia has experienced significant growth across industrial, social, and policy dimensions. Ardiyanti *et al.*, (2023) documented a substantial increase in electric vehicle sales between 2020 and 2023, with the Hyundai Ioniq 5 emerging as the best-selling model in 2022 and the Wuling Air EV gaining market popularity after August 2022 due to its relatively affordable price. Similarly, Alhari *et al.*, (2022) analyzed 1,502 Twitter posts and found that approximately 79% of public sentiment toward electric vehicles was positive, indicating increasing public acceptance of EV technology in Indonesia. Wicaksono & Aprianingsih (2021) further explained that environmental values significantly influence consumer purchase intentions toward electric cars, suggesting that sustainability awareness has become an important factor shaping consumer behavior.

Despite these positive developments, several studies emphasize that major structural barriers continue to hinder the acceleration of electric vehicle adoption in Indonesia. Regina & Ulmi (2023) identified three dominant challenges: high production capital requirements, relatively high vehicle prices compared to conventional automobiles, and limited availability of charging infrastructure. In addition, Setiawan *et al.*, (2022) argued that reducing EV-related taxes and improving battery technology would have a greater impact on adoption rates than current fiscal incentive mechanisms. Meanwhile, Yusgiantoro *et al.*, (2021) highlighted Indonesia's abundant nickel reserves as a strategic advantage for supporting the domestic electric battery industry and strengthening the long-term sustainability of the national EV ecosystem. These findings indicate that EV development in Indonesia is influenced not only by technological innovation and environmental awareness but also by industrial readiness, resource availability, and infrastructure capacity.

Recent evidence has also expanded the discussion by examining the broader economic and energy implications of electric vehicle adoption. Damanik *et al.*, (2025), in a systematic literature review of 65 peer-reviewed studies published between 2016 and 2024, found that EV growth contributes to increased investment opportunities, foreign direct investment (FDI), job creation, and economic growth. Kurniawan (2024) further reported that electric vehicles produce approximately 46–49% lower carbon emissions than conventional fossil-fuel vehicles, even though Indonesia's electricity generation system remains approximately 86.8% dependent on fossil fuels. Similarly, Amiruddin *et al.*, (2024) demonstrated that optimized EV charging management can reduce emissions by 12.8% and lower electricity system costs by 9%, while vehicle-to-grid (V2G) integration can reduce emissions by up to 23.7%. These studies suggest that the environmental effectiveness of EV adoption is strongly interconnected with electricity system management, charging optimization, and renewable energy integration rather than EV technology alone. However, several recent studies also emphasize that the environmental benefits of

electric vehicles are closely tied to the characteristics of the electricity generation mix in the national power system. Jolodoro *et al.* (2025) and Souma *et al.* (2025) argued that EVs cannot be fully categorized as environmentally sustainable transportation if electricity generation continues to rely heavily on fossil-fuel-based power plants. Moreover, Nugrah *et al.*, (2025) and Negara (2024) identified persistent barriers involving inadequate charging infrastructure, high ownership costs, electricity supply readiness, and slower adoption rates relative to government targets. Although previous studies have extensively discussed EV adoption from technological, economic, policy, and consumer perspectives, most discussions remain fragmented and largely descriptive. Existing studies rarely synthesize the interrelationships among EV growth, energy transition readiness, electricity infrastructure capacity, charging ecosystem development, and long-term sustainability challenges in the Indonesian context.

Furthermore, prior studies tend to emphasize EVs as environmentally friendly transportation technologies without critically examining the dependence of EV sustainability performance on Indonesia's electricity generation structure, which remains dominated by fossil energy sources. Comparatively few studies have integrated discussions of energy efficiency, grid readiness, the renewable energy transition, infrastructure constraints, and environmental sustainability into a single analytical framework. This limitation creates an important research gap because the long-term success of electric vehicle adoption depends not only on vehicle market expansion but also on the readiness of supporting energy systems and national electricity transformation pathways.

This study aims to analyze the development of electric vehicles in support of Indonesia's sustainable energy transition by critically examining energy-efficiency potential, charging-infrastructure readiness, electricity-system preparedness, and environmental-sustainability challenges. The novelty of this study lies in its integrative analytical approach, which positions electric vehicle development not merely as a transportation innovation but as part of a broader sustainable energy transition framework encompassing technological, infrastructural, economic, and electricity-system dimensions. This study also synthesizes recent evidence from policy analysis, economic assessment, infrastructure readiness, and energy system perspectives to provide a more comprehensive understanding of EV development challenges and opportunities in Indonesia. The remainder of this paper is organized into several sections: the literature review, research methodology, findings and discussion, and concluding remarks.

The remainder of this paper is organized as follows. Section 2 provides a literature review and hypothesis development. Section 3 presents the research method and design. Section 4 provides the results and discussion. Section 5 is Concluding Remarks and Recommendations.

2. Literature Review and Hypothesis Development

2.1 Concept and Energy Efficiency of Electric Vehicles

Electric vehicles (EVs) are transportation technologies that utilize electrical energy as the primary power source to improve energy efficiency and reduce dependence on fossil fuels. Generally, EVs consist of Battery Electric Vehicles (BEVs), which operate entirely using electricity stored in batteries, and Plug-in Hybrid Electric Vehicles (PHEVs), which combine electric propulsion systems with conventional internal combustion engines. The rapid development of EV technology has become an important component of sustainable transportation systems because EVs are considered more energy-efficient than conventional vehicles and can reduce direct tailpipe emissions (Haghani *et al.*, 2023). From a technical perspective, electric vehicles convert electrical energy into mechanical energy using electric motors,

which have lower energy losses than internal combustion engines. In conventional vehicles, a substantial portion of energy is dissipated as heat during combustion, whereas EV systems can use electrical energy more efficiently to drive the vehicle (Singh *et al.*, 2024). Consequently, EVs are increasingly positioned as a strategic solution for improving transportation energy efficiency while supporting long-term environmental sustainability objectives.

The efficiency performance of electric vehicles is strongly influenced by battery technology, charging systems, and electricity management mechanisms. Lithium-ion batteries remain the dominant technology in EV systems because they offer relatively high energy density, long operational life, and more efficient energy storage than conventional battery technologies (Jiang *et al.*, 2024). The effectiveness of EV energy systems is also influenced by battery charging efficiency and power management optimization, as charging speed, battery degradation, and electricity consumption significantly affect overall vehicle performance (Li, 2023). Recent technological developments have increasingly focused on improving battery durability, energy efficiency, and sustainable battery management systems to support large-scale EV adoption (Niri *et al.*, 2024). In addition, battery remanufacturing and recycling systems are becoming important components in reducing environmental impacts throughout the EV battery supply chain and enhancing resource sustainability within the electric transportation ecosystem (Neri *et al.*, 2024). These developments indicate that EV efficiency is determined not only by vehicle operation but also by the sustainability of battery production, charging systems, and end-of-life battery management.

Furthermore, electric vehicles play a strategic role within broader sustainable energy transition frameworks because EV systems can be integrated with renewable energy sources and smart electricity networks. The integration of EV charging infrastructure with renewable energy systems, such as solar power, enables cleaner, more sustainable transportation systems with lower carbon intensity (Tamba II *et al.*, 2025). Moreover, recent developments in vehicle-to-grid (V2G) technology demonstrate that EVs can serve not only as transportation devices but also as flexible electricity storage systems that support grid stability and energy management efficiency (Micari & Napoli, 2024). Despite significant technological progress, EV adoption still faces several challenges, including limited charging infrastructure, high battery production costs, electricity supply readiness, and sustainability issues related to battery raw-material extraction and supply chains (Neri *et al.*, 2024). Therefore, the concept of electric vehicles should not be viewed merely as an automotive innovation but rather as an integral component of the transformation of energy systems, combining transportation efficiency, renewable energy integration, and long-term environmental sustainability.

2.2. Electric Vehicles and Sustainable Energy Transition

Electric vehicles (EVs) have become an important component of the global sustainable energy transition because they are considered capable of reducing dependence on fossil fuels and supporting low-carbon transportation systems. The increasing integration of EV technology into transportation sectors reflects broader international efforts to achieve energy sustainability, carbon reduction, and environmental resilience. Unlike conventional vehicles powered by internal combustion engines, EVs utilize electricity as their primary energy source, enabling more efficient energy utilization and lower direct greenhouse gas emissions. However, the sustainability performance of EVs is closely dependent on the electricity generation systems that supply the charging infrastructure. Consequently, the transition toward electric mobility cannot be separated from the transformation of national electricity systems toward renewable

and low-carbon energy sources (Malik *et al.*, 2025). Recent studies also emphasize that EV deployment should be viewed not only as transportation modernization but also as part of an integrated energy transition framework involving renewable energy expansion, smart grids, and sustainable infrastructure development (Salkuti, 2024). Therefore, EV adoption increasingly represents the intersection between transportation electrification and broader sustainable energy transformation agendas.

The integration of electric vehicles with renewable energy systems offers substantial opportunities to improve energy efficiency and reduce overall carbon intensity in modern transportation systems. Amiruddin *et al.*, (2024) explained that integrating EV charging systems with renewable electricity generation can significantly reduce emissions and improve grid efficiency in Indonesia's electricity sector. Similarly, Senga *et al.*, (2026) argued that the synergy between renewable energy and EV systems plays an important role in accelerating low-carbon energy transitions, as EVs can serve as flexible electricity demand units that support the utilization of renewable energy. Furthermore, vehicle-to-grid (V2G) systems and sector coupling mechanisms enable EV batteries to serve as distributed energy storage, helping to balance fluctuations in electricity demand and improve grid reliability (Pranawengkapti *et al.*, 2025). Kabeyi & Olanrewaju (2022) further emphasized that integrating renewable energy into EV ecosystems can strengthen sustainable power transitions by reducing dependence on fossil fuels and improving long-term energy resilience. These findings demonstrate that EV systems are increasingly interconnected with renewable energy technologies, electricity system flexibility, and sustainable power management strategies.

Despite their significant potential, the implementation of EVs within sustainable energy transition systems continues to face several technological, infrastructural, and policy-related challenges. Ullah *et al.*, (2025) noted that integrating EVs into modern power systems requires substantial investments in charging infrastructure, grid coordination mechanisms, and electricity distribution management to maintain system stability and operational efficiency. Similarly, Muratori (2024) highlighted that large-scale EV adoption may place additional pressure on electricity grids if charging systems are not supported by adequate infrastructure planning and integration of renewable energy. In addition, disparities in renewable energy availability, electricity generation capacity, and policy readiness remain important barriers to achieving sustainable transportation transitions in many developing countries (Malik *et al.*, 2025). These challenges indicate that the success of EV adoption depends not only on technological advancement and vehicle production but also on the readiness of energy infrastructure, electricity systems, and renewable energy development pathways. Therefore, electric vehicles should be understood as part of a broader sustainable energy ecosystem that requires coordinated integration between transportation electrification, renewable energy expansion, and long-term energy policy transformation.

2.3 Challenges and Determinants of Electric Vehicle Adoption in Indonesia

The adoption of electric vehicles (EVs) in Indonesia is influenced by multiple technological, economic, infrastructural, environmental, and regulatory factors that collectively determine the pace of transportation electrification. As a developing country with growing transportation demand and strong dependence on fossil fuels, Indonesia faces complex challenges in accelerating EV adoption despite increasing government support and industrial interest. Several studies indicate that environmental awareness, technological innovation, and supportive public policies have become important drivers encouraging the transition toward electric mobility. (Ramadhan *et al.*, 2025) explained that

environmental knowledge and public awareness positively influence consumers' purchase intentions toward EVs, particularly when supported by affordable pricing and adequate charging infrastructure availability. Similarly, Kurniawan *et al.*, (2025) emphasized that consumer switching intentions from conventional vehicles to EVs are strongly affected by perceptions of economic benefits, environmental sustainability, and technological attractiveness. In addition, Ma *et al.*, (2024) argued that EV market development is closely associated with policy incentives, market dynamics, and interactions between consumers, infrastructure providers, and vehicle manufacturers. These findings demonstrate that EV adoption in Indonesia is shaped not only by environmental considerations but also by market readiness, technological confidence, and institutional support systems.

Despite growing interest in EV adoption, substantial barriers continue to impede the large-scale diffusion of electric vehicles in Indonesia. Lazuardy *et al.*, (2024) identified major obstacles involving technological limitations, insufficient charging infrastructure, high vehicle prices, regulatory uncertainty, and limited public understanding of EV systems. Similarly, Astuti & Susanto (2024) found that infrastructure readiness remains one of the most critical barriers, as the availability of Public Electric Vehicle Charging Stations (SPKLU) remains uneven across regions, reducing consumer confidence in EV usability for long-distance mobility. Economic constraints also remain a major challenge, particularly regarding high initial purchase costs and battery replacement expenses. Woodley *et al.*, (2024) highlighted that vehicle prices and consumer preferences significantly influence EV purchasing decisions, as affordability remains a dominant consideration in emerging EV markets. Furthermore, Fathoni *et al.*, (2025) explained that limited technological capabilities, supply chain readiness, and industrial adaptation capacity constrain the diffusion of eco-innovation within Indonesia's EV industry. These challenges indicate that EV adoption depends not only on technological advancement but also on infrastructure expansion, industrial development, and supportive economic policies.

Furthermore, the success of EV adoption in Indonesia is strongly dependent on the integration of policy frameworks, infrastructure investment, industrial transformation, and long-term sustainability strategies. Kamaruddin *et al.*, (2025), through a systematic literature review, emphasized that strong government incentives, reliable charging infrastructure, public awareness, and technological accessibility generally support successful EV diffusion globally. However, Indonesia still faces structural challenges, including electricity supply readiness, unequal infrastructure distribution, and the need for stronger coordination among transportation, industrial, and energy policies. The transition toward electric mobility also requires broader ecosystem development, including domestic battery industries, renewable energy integration, and sustainable electricity systems. In addition, consumer trust in EV technology remains influenced by concerns regarding battery durability, charging efficiency, and operational practicality. Therefore, the adoption of electric vehicles in Indonesia should be understood as a multidimensional transition process that involves technological innovation, infrastructure readiness, economic affordability, environmental sustainability, and long-term policy consistency to ensure the successful transformation toward sustainable transportation systems.

3. Research Method

This research employs a descriptive qualitative approach through the Systematic Literature Review (SLR) method to gain a comprehensive understanding of the growth of electric cars in the context of Indonesia's sustainable energy transition. This method was selected because it enables the systematic



identification, evaluation, and synthesis of prior studies on electric vehicles, energy efficiency, infrastructure readiness, and sustainable energy transition issues in the Indonesian context.

The study utilized secondary data from peer-reviewed journal articles, government reports, energy policy documents, and institutional publications on electric vehicles and the sustainable energy transition. Literature searches were conducted through several academic databases, including Scopus, ScienceDirect, SpringerLink, Wiley Online Library, and Google Scholar. The search process employed keywords such as "electric vehicles," "electric cars," "energy efficiency," "renewable energy integration," "sustainable transportation," "EV infrastructure," and "energy transition in Indonesia."

The literature selection process focused on publications from 2020 to 2025 to ensure the inclusion of recent and relevant evidence on electric vehicle development and sustainable energy systems. The inclusion criteria comprised studies that discussed electric vehicle technology, charging infrastructure, energy efficiency, renewable energy integration, transportation electrification, and EV adoption challenges, particularly in developing countries or in the Indonesian context. Meanwhile, publications unrelated to energy transition issues, duplicate articles, non-academic opinion papers, and studies lacking methodological clarity were excluded from the review process.

The screening process was conducted in several stages: identification, abstract screening, eligibility assessment, and full-text review. Initially, 126 publications were identified from database searches. After removing duplicate and irrelevant studies, 74 articles remained for abstract evaluation. Subsequently, 42 studies that met the relevance and quality criteria were selected for final analysis and synthesis.

The data analysis process employed qualitative thematic synthesis techniques involving three main stages: data reduction, thematic categorization, and interpretative synthesis. During the data reduction stage, studies were classified based on major themes, including energy efficiency, renewable energy integration, charging infrastructure, battery technology, electricity system readiness, and EV adoption barriers. The categorized findings were then systematically compared and synthesized to identify dominant patterns, research inconsistencies, technological challenges, and policy implications related to electric vehicle development in Indonesia.

This qualitative SLR approach enables a comprehensive and critical understanding of electric vehicle development by integrating multidisciplinary evidence from technological, environmental, infrastructural, and policy perspectives without relying on quantitative statistical modeling.

4. Results and Discussion

4.1 Energy Efficiency and Environmental Implications of Electric Vehicles

The findings indicate that electric vehicles provide significant advantages in transportation energy efficiency compared to conventional internal combustion engine vehicles. Furthermore, the use of electric cars contributes to reducing national fuel consumption, which ultimately reduces dependence on fossil fuel imports (Ministry of Energy and Mineral Resources, 2023). This has a positive impact on national energy security and long-term economic stability. On a macro scale, reducing fuel imports plays a crucial role in strengthening the trade balance and maintaining the country's foreign exchange reserves. The transition toward transportation electrification also offers opportunities to reduce reliance on national energy subsidies, as electricity-based transportation systems are considered more energy-efficient and operationally stable than fossil-fuel-based systems.

Furthermore, using domestic electricity promotes energy independence because the resources for power generation—such as natural gas, coal, and renewable energy—are abundantly available domestically. This minimizes the risk of global geopolitical turmoil that often triggers crude oil supply crises. Utilizing these local resources not only secures the national energy supply but also encourages the growth of supporting industries such as battery manufacturing and nickel processing, making Indonesia a strategic player in the global electric vehicle supply chain. However, the findings also reveal that the environmental sustainability of electric vehicles is closely tied to the characteristics of Indonesia's electricity generation systems, which remain partially dominated by fossil-fuel-based power plants. Therefore, the environmental benefits of EV adoption depend not only on transportation electrification but also on the expansion of renewable energy and the decarbonization of the electricity system.

The findings further demonstrate that electric vehicles have lower long-term operating costs than conventional vehicles, due to lower per-kilometer electricity costs and reduced mechanical maintenance requirements. From an energy economics perspective, electric vehicles offer lower operational costs than conventional vehicles. The cost of electricity per kilowatt-hour is generally lower than that of fossil fuels (International Renewable Energy Agency, 2022), thereby providing long-term economic benefits for users. The economic benefits for users are also increasingly apparent when comparing the total cost of ownership (TCO). While the initial purchase price may be higher, regular maintenance costs for electric cars are significantly lower due to the minimal moving parts and the absence of routine oil changes. When combined with stable household electricity rates, users can significantly save on monthly transportation costs compared to using fuel-powered vehicles, whose prices fluctuate with global market fluctuations. These findings suggest that energy efficiency and operational affordability are important factors that support the long-term attractiveness of electric vehicles in sustainable transportation systems.

4.2 Infrastructure Readiness and Energy System Challenges

Government support through incentive policies and the development of SPKLU (Public Electric Vehicle Charging Stations / Stasiun Pengisian Kendaraan Listrik Umum) infrastructure are key factors in accelerating electric vehicle growth (Ministry of Energy and Mineral Resources, 2023). However, from an energy perspective, several major obstacles remain, such as limited electricity grid capacity, uneven energy distribution, and relatively long charging times (BloombergNEF, 2023). The findings indicate that infrastructure readiness remains one of the most significant barriers influencing large-scale EV adoption in Indonesia, particularly regarding charging accessibility and electricity distribution outside major urban regions.

Recent infrastructure expansion initiatives demonstrate that the Indonesian government continues to accelerate SPKLU development across strategic transportation corridors to support public confidence in electric mobility. However, despite ongoing infrastructure growth, charging accessibility remains uneven across regions, particularly outside Java and other metropolitan areas. The findings also reveal that electricity grid readiness and charging reliability remain important concerns, as large-scale transportation electrification may increase electricity demand pressures if not accompanied by sufficient improvements in power system capacity.

Furthermore, this operational cost efficiency can be further optimized through the use of independent renewable energy sources, such as rooftop solar panels. By charging vehicles with on-site-

generated electricity, households not only reduce carbon emissions but also enhance micro-level energy security. This innovation emphasizes that electric cars are not just a means of transportation, but also part of a more sustainable and financially profitable future energy ecosystem. These findings indicate that integrating EV systems with renewable energy technologies has the potential to strengthen sustainable transportation systems while supporting decentralized energy transition initiatives. However, broader implementation still requires substantial investments in infrastructure modernization, smart grid systems, and the integration of renewable electricity.

4.3. Economic and Technological Challenges in EV Adoption

However, challenges such as range anxiety and concerns about battery life remain barriers to electric car adoption (Costa *et al.*, 2022). Therefore, innovation in battery technology and the development of a broader energy infrastructure are needed to support the optimal use of electric cars. The findings demonstrate that technological limitations and consumer perceptions continue to influence the pace of EV adoption in Indonesia. Concerns about battery durability, charging time, and driving range remain the primary issues affecting consumer confidence in the transition from conventional vehicles to electric mobility systems.

Recent developments in battery technology indicate growing interest in advanced battery systems with higher energy density, improved thermal stability, and faster charging capabilities than conventional lithium-ion batteries. Nevertheless, large-scale commercialization, affordability, production scalability, and long-term sustainability remain significant challenges for future implementation. The findings also reveal that battery technology innovation alone is insufficient without simultaneous infrastructure expansion and electricity system readiness. Consequently, synchronization among charging infrastructure density, battery technology advancement, and electricity supply capacity is essential to support sustainable transportation transitions.

The transition from CBU incentives to strengthening local content-based industries marks a new chapter in Indonesia's economic independence. By encouraging domestic battery production—leveraging the nation's nickel resources—the government is striving to lower the selling price of electric cars, making them more affordable without relying on import subsidies. This has created a positive domino effect, creating new jobs in the high-tech manufacturing sector and strengthening the domestic energy supply chain. These findings suggest that EV adoption in Indonesia is not only associated with transportation modernization but also closely related to industrial transformation, domestic supply chain development, and long-term national energy security strategies.

5. Concluding Remarks and Recommendation

Electric vehicles (EVs) have become an important component of Indonesia's sustainable energy transition due to their potential to improve transportation energy efficiency and reduce dependence on fossil fuel-based transportation systems. This study aimed to analyze the role of electric vehicle development in supporting Indonesia's sustainable energy transition by examining energy efficiency, infrastructure readiness, electricity system preparedness, and the technological challenges associated with EV adoption. Using a qualitative descriptive approach through a Systematic Literature Review (SLR), this study synthesized findings from prior studies, government reports, and energy-related publications to identify key patterns and challenges in EV implementation in Indonesia. The findings indicate that

electric vehicles offer significant opportunities to reduce fuel consumption, improve operational energy efficiency, and support long-term transportation sustainability. However, the findings also reveal that the effectiveness of EV adoption remains strongly dependent on charging infrastructure readiness, electricity grid capacity, renewable energy integration, battery technology development, and the sustainability of Indonesia's electricity generation systems.

This study contributes theoretically by developing a more integrative understanding of electric vehicles not merely as transportation technologies but as part of a broader sustainable energy transition ecosystem encompassing energy systems, infrastructure readiness, industrial transformation, and environmental sustainability. In practical terms, the findings provide insights for policymakers, industry actors, and energy stakeholders on the importance of strengthening charging infrastructure, expanding renewable electricity integration, improving battery technology ecosystems, and developing coordinated transportation-energy policies. In addition, this study highlights that the environmental benefits of EV adoption are inseparable from electricity generation structures and renewable energy development pathways. Therefore, the originality of this study lies in its analytical emphasis on the interrelationships among transportation electrification, energy transition readiness, electricity systems, and sustainability challenges in the Indonesian context, rather than focusing solely on technological adoption or market growth.

Despite these contributions, this study has several limitations. First, the research relied exclusively on secondary data obtained through a literature review, without incorporating primary empirical evidence from EV users, policymakers, or energy industry stakeholders. Second, the study focused primarily on qualitative synthesis and did not include quantitative modeling related to electricity demand projections, lifecycle emissions analysis, or techno-economic simulations of EV systems. Third, the availability and consistency of recent data regarding charging infrastructure development, electricity system readiness, and battery technology advancements remain limited and rapidly evolving. Therefore, future studies are recommended to combine qualitative and quantitative approaches by incorporating empirical surveys, infrastructure performance analysis, electricity grid simulations, and lifecycle sustainability assessments to provide more comprehensive evaluations of electric vehicle implementation in Indonesia. Future research may also examine regional disparities in EV infrastructure readiness, renewable energy integration capacity, consumer adoption behavior, and the long-term implications of transportation electrification on national energy security and environmental sustainability.

Statement of Use of Generative AI

During the preparation of this work, the author used generative artificial intelligence tools to support the scientific writing process. Grammarly was used to check grammar, refine writing style, and improve clarity in scientific writing. All interpretations, analyses, and conclusions presented in this study are the sole responsibility of the author.

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