

Electric Vehicle Strategy in Indonesia and The Difficulties of Structural Transformation: Green Industry or Green Dependence?

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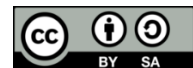
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ABSTRACT

This study examines Indonesia's electric vehicle (EV) strategy through nickel downstreaming and evaluates whether this policy has generated green and autonomous structural transformation. Using a qualitative case study approach, the research analyzes policy documents, government and international institutional reports, academic studies, and industry documents covering the period 2014–2026. The findings show that state intervention has successfully shifted Indonesia's position from a raw nickel exporter toward a major hub for nickel processing, battery materials, and EV-related production. However, the expansion of physical production capacity has not been matched by equivalent growth in domestic technological capabilities, industrial linkages, labor absorption, and decarbonization. Downstreaming has also increased capital intensity and dependence on foreign capital, technology, markets, and industrial networks. Moreover, the dominance of coal-based captive power creates a contradiction between EV production and green industrialization. The study concludes that Indonesia is still building, rather than consolidating, green industrialization. To achieve greater developmental autonomy, future policy should prioritize technology transfer, domestic supplier development, research and development, workforce upgrading, partner diversification, and low-carbon energy.

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1. INTRODUCTION

The shift to a low-carbon economy is changing international commerce, investment, and production structures in addition to energy technologies. Since the manufacturing of batteries and car parts depends on vital minerals like nickel, electric vehicles constitute a critical industry in this transition. Developing nations with an abundance of natural resources now have the

chance to shift from exporting raw commodities to higher-value operations in manufacturing, processing, and technology-intensive services. Nevertheless, development is not always the result of these chances. From the standpoint of economic development, structural transformation necessitates reallocating resources to more productive endeavors, enhancing value addition, fortifying intersectoral connections,

and building up domestic production capacities [1],[4].

The Indonesian government has utilized nickel downstreaming as a tool to transform the country's position within the critical mineral value chain [33], [34]. Measures such as the ban on nickel ore exports, mandates for domestic processing, investment incentives, the development of industrial estates, and support for the battery and electric vehicle ecosystem signal a shift from a commodity export-oriented approach to a policy that actively shapes the production structure. According to the International Monetary Fund, by 2024, Indonesia accounted for about 60% of the world's nickel production due to the strengthening of the nickel export ban in 2020, which attracted foreign investment into refining operations and, subsequently, into the supply chains for batteries and electric vehicles [13], [14], [20], [24], [25], [28]. As a result, the country has effectively used its possession of vital resources to obtain more negotiating influence in the global supply chain.

This change is frequently seen as an illustration of a state of development. The state does not merely improve the business climate; rather, it directly alters economic incentives, directs investment, and identifies sectors deemed strategic. Lahadalia et al. [7] interpret nickel downstreaming as a form of industrial policy renewal and a developmental state approach to building the electric vehicle industry in ASEAN. Industrial policy also demonstrates that state intervention is justified when markets fail to coordinate the investment, knowledge, infrastructure, and innovation required for economic transformation [2], [18], [19], [34]. From this perspective, Indonesia's success in building processing capacity and attracting investment represents a significant achievement.

Research by Asyono, Samputra, and Djatmiko [11] indicates that forward linkages for nickel declined from 16 to 8 and backward linkages shifted from 75 to 73, while the labor multiplier fell from approximately 6,514 to 3,366 jobs per IDR 1 trillion of final demand. These findings suggest that downstream

processing leads to a deepening of more capital-intensive activities, thereby narrowing certain production linkages and reducing labor absorption intensity.

Then, there is the issue of the environment. Electric vehicles are often positioned as a technology that supports the decarbonization of transport, yet the processes of battery production and nickel refining require vast amounts of energy. RMI [30] indicates that captive power generation capacity in Indonesia's mineral sector reached 22.9 GW in 2024, with over 81 percent of that capacity being coal-based. This reveals a contradiction between a product positioned as part of the green transition and a production process still underpinned by high-carbon energy. This issue is increasingly critical, as environmental standards in global markets are exerting a growing influence on the competitiveness of mineral and battery products. Thus, green industrialization must be assessed not just by the final product but also by how it is made.

The connection between foreign investment and development autonomy is the subject of the third dimension. Capital, technology, marketing networks, and large-scale industrial capabilities are all brought about by foreign investment. These elements can be important growth drivers in the early phases of industrialization. If more investment is not accompanied by the development of domestic businesses, technology transfer, research skills, and mastery of high-value-added stages, issues can occur. In these circumstances, a nation may see a growth in physical capability without a corresponding rise in technological independence. The fact that EV value chains are international in nature and greatly impacted by the businesses, technology, markets, and industrial policies of other countries further complicates this dependency [15], [17], [20], [22], [23].

The literature highlights two key findings regarding downstreaming. First, state capacity can drive changes in production structures and foster industrial development [7], [18], [19]. Second, downstreaming still faces challenges such as industrial

concentration, reliance on foreign capital and technology, socio-environmental costs, and limited domestic linkages [10], [16], [17]. Downstreaming can lead to "structural narrowing," where the economy becomes increasingly specialized and capital-intensive [11]. Consequently, the issue is no longer merely whether downstreaming succeeds, but rather how enhanced industrial capacity can be translated into an autonomous, green structural transformation.

This study asks: how has state intervention through nickel downstreaming shaped Indonesia's electric vehicle industry, and why has this capacity expansion not yet fully resulted in an autonomous, green structural transformation? The study argues that downstreaming demonstrates the capacity of a developmental state to build industries and strengthen Indonesia's position within the global electric vehicle value chain [33], [34]. However, the growth in investment and physical capacity has not been fully matched by the strengthening of domestic technology, local industrial linkages, labor absorption, or decarbonization. This situation poses a risk of green dependency, as external actors largely control capital, technology, markets, and strategic energy sources.

This research contributes in three ways. First, it expands the concept of the "developmental state" by evaluating success not only through investment and industrial development but also through the cultivation of domestic capabilities. Second, it integrates structural transformation with green industrialization to demonstrate that increased value-added does not automatically lead to diversification, job creation, and decarbonization. Third, it links Indonesia's industrial development to the dynamics of international relations, specifically the competition surrounding electric vehicle supply chains, investment, trade, and critical mineral governance. Thus, nickel downstreaming is understood as a strategy employed by a developing nation to leverage global interdependence while simultaneously expanding its policy space for development [28], [33], [34].

2. LITERATURE REVIEW

2.1 *The Developmental State and Industrial Policy*

The developmental state concept emphasizes the state's role in steering the market through selective protection, credit provision, export support, and investment coordination [5], [8]. Evans [6] adds the concept of "embedded autonomy," a bureaucracy that is sufficiently autonomous yet remains connected to economic actors. From this perspective, the state does not replace the market but rather creates the conditions for productive transformation.

Modern industrial policy asserts that state intervention is necessary to address coordination problems, knowledge externalities, and long-term investment needs [2]. Rodrik [1], [3] emphasizes adaptive policy-making through processes of problem identification, evaluation, and adjustment. Mazzucato [21] also views the state as an actor that shapes market and drives innovation.

This framework aids in analyzing Indonesia's EV policies, such as the nickel export ban, investment incentives, industrial estates, and Domestic Component Level (TKDN) requirements, which aim to foster domestic processing and manufacturing. However, the success of a developmental state is not measured merely by the influx of investment but by the ability to generate technology transfer, the growth of domestic firms, and learning processes that endure after state incentives expire.

2.2 *Structural Transformation and Resource-Based Industrialization*

Structural transformation refers to a shift in the composition of economic activities toward sectors and activities with higher productivity. Hausmann, Hwang, and Rodrik [4] demonstrate that the types of products a country masters have implications for its development trajectory, as productive activities entail distinct knowledge and capabilities. In a natural resource-based economy, the challenge lies in avoiding a scenario where rising export values are not accompanied by a sufficiently broad transformation of productive capabilities.

Downstreaming can enhance domestic value added if it generates demand for local suppliers, technical services, machinery, logistics, financial services, and skilled labor. However, downstreaming can also result in a narrower economic structure if production is concentrated in large-scale facilities with specific input requirements that rely heavily on imported technology or capital goods. Findings by Asyono et al. [11] indicate that nickel downstreaming in Indonesia does not automatically lead to broad diversification; instead, it involves a combination of specialization, increased activity in supporting sectors, and reduced labor intensity.

Abdullah and Sumner [16] emphasize that industrial policy in resource-rich nations must foster "linkage development." This means the objective of downstreaming should not stop

at commodity processing but should extend to broadening the connections between the resource sector and other sectors of the economy. In the context of electric vehicles (EVs), success must be measured by Indonesia's ability to progress from mining to refining, battery materials, components, vehicle manufacturing, technical services, engineering, and ultimately, innovation.

2.3 *Green Industrialization*

Green industrialization combines two objectives often treated separately: increasing productivity and reducing environmental impact. Rodrik [3] emphasizes that green industrial policy faces a dual challenge: governments must drive the transformation of production while simultaneously correcting environmental externalities. Consequently, investment in the EV industry cannot be deemed a "green success" simply because the product supports electrification; the quality of such industrialization is also determined by production processes, energy sources, water usage, waste management, and emissions throughout the supply chain.

This method requires a differentiation between green products and green production. Although using an electric vehicle can cut emissions, the carbon footprint of battery manufacturing and mineral refinement must be considered. According to Acemoglu et al. [12], the decarbonization process depends on the direction of technological change. The crucial question in the Indonesian context is whether industrial

policy locks in carbon-intensive energy infrastructure or directs investment toward increasingly clean technology.

2.4 Global Value Chains and Green Dependency.

The concept of the global value chain (GVC) illustrates that EV production is segmented into various stages involving companies and networks across national borders [22]. Consequently, integrating into a GVC does not equate to mastering the value chain itself. A country may increase production and exports while remaining dependent on external actors for technology, design, branding, standards, and markets.

Green dependency is used as a diagnostic term to look at

situations in which Indonesia enters the green sector but still depends on outside actors in four areas: energy, money, technology, and markets and standards. This idea makes it easier to discern between FDI as a source of dependency and FDI as a driver of development. FDI is not intrinsically detrimental, but it becomes problematic when it doesn't support innovation, learning, technology transfer, and the development of domestic suppliers. As a result, the study focuses on evaluating Indonesia's ability to direct foreign investment toward the development of domestic capabilities rather than on rejecting foreign capital.

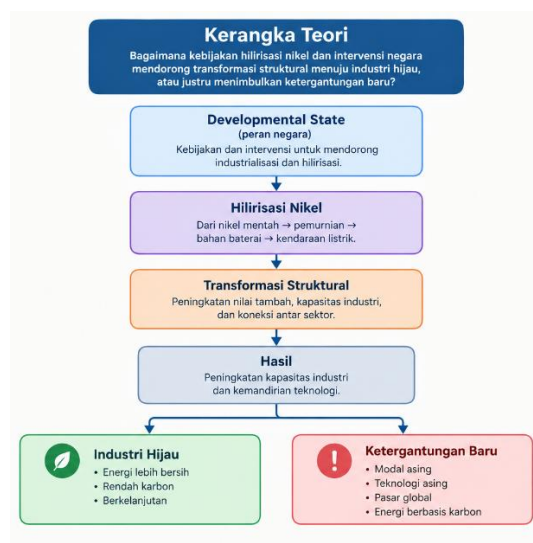


Figure 1. Research Result Model

3. METHODS

3.1 Research Design

This research employs a qualitative approach with a case study design. The case under study is Indonesia's electric vehicle (EV) development strategy through nickel downstreaming. A case study design was selected because the research focuses on policy processes within a real-world context

and aims to explain the relationships among state intervention, changes in industrial structure, foreign investment, technological capabilities, and environmental sustainability. The 2014–2026 period was chosen to ensure the analysis encompasses the initial phase of strengthening downstreaming policies, the reinforcement of the nickel ore export ban, smelter expansion, the influx of

investment into battery and EV supply chains, and more recent developments in green industrial policy.

3.2 Research Object, Subjects, and Data Sources

The object of the research is the industrialisation policy and the transformation of production structures related to nickel and electric vehicles. The subjects of analysis are not individuals but rather the institutions and economic actors shaping this process, including the Indonesian government, corporations, foreign investors, international institutions, and actors within global value chains. The research utilises secondary data obtained from government regulations and policies, ministerial reports, reports from the IMF, IEA, RMI, World Bank, UNCTAD, and WTO, academic journal articles, and relevant industry documents.

3.2.1 Data Selection Techniques

Document selection was conducted purposively. Documents were included if they met four criteria: first, relevance to downstreaming policies, nickel, batteries, or EVs; second, origin from credible academic institutions, government bodies, international organisations, or industry sources; third, the presence of information useful for tracking changes throughout the research period; and fourth, the ability to enable the researcher to link policies to outcomes regarding industrial structure, technology, employment, investment, or the environment.

3.2.2 Data Analysis Techniques

Data analysis was conducted using thematic coding. The first stage involved identifying forms of state intervention and policy changes. The second stage mapped changes within the value chain, including the shift from extraction to refining, battery materials, and EV manufacturing. The third stage assessed domestic capabilities based on evidence regarding technology, local suppliers, the workforce, and R&D. The fourth stage evaluates production sustainability through energy sources, captive

power usage, and decarbonisation demands. The final stage compares the overall findings against the characteristics of a developmental state to determine whether the country has succeeded merely in building production capacity or has also achieved developmental autonomy.

3.2.3 Triangulation

The validity of the analysis is reinforced through source triangulation. Information regarding policies is cross-referenced with reports from international institutions and academic research. Data on industrial structure is compared with input-output studies and sectoral reports. Meanwhile, claims concerning environmental sustainability are checked against energy and industry reports. This research does not utilise the data to draw quantitative causal inferences; instead, the data is used to construct a contextual explanation of the transformation patterns and tensions arising within the EV industrialisation strategy.

4. RESULTS AND DISCUSSION

4.1 Shift from Ore Exports to Domestic Processing

Downstreaming has changed Indonesia's role in the nickel industry from being a supplier of ore to a major hub for the production of processed nickel. Since 2020, strict processing requirements and a ban on ore exports have encouraged foreign investment in refining facilities, which has since spread to the supply chains for batteries and electric vehicles (EVs) [29]. About 60% of the world's nickel production was produced in Indonesia by 2024. Additionally, this policy has encouraged the development of industrial zones that boost the expansion of manufacturing, energy, logistics, and technical services.

However, increased production does not equate to full control over the value chain. While Indonesia has strengthened its position in resource-based production and physical investment, areas such as technology, design, branding, and certain high-value-added components still rely on external actors. Thus,

downstreaming demonstrates a tangible deepening of production, though this has not yet been fully matched by a deepening of domestic capabilities.

4.2 Emergence of an EV Industrial Ecosystem

Nickel downstreaming has evolved beyond smelter construction to encompass battery materials and electric vehicle manufacturing [9], [24], [25], [26], [27]. This development has forged links between the mineral and manufacturing sectors while generating cross-sectoral effects. Asyono et al. [11] highlight an increase in output multipliers within sectors supporting the EV supply chain, such as technical services, machinery, fabricated metals, transportation, energy, and finance.

However, this increased interconnectedness has not yet resulted in broad economic diversification. A decline in forward linkages suggests that industrial connectivity is becoming increasingly concentrated within specific strategic sectors. Consequently, this development is best understood as the formation of concentrated industrial clusters rather than comprehensive economic diversification.

4.3 A Shift Toward Greater Capital Intensity

Downstreaming has transformed the production structure, making it increasingly complex and capital-intensive. Asyono et al. [11] note a decline in forward linkages from 16 to 8 and in backward linkages from 75 to 73. Simultaneously, activities supporting the EV supply chain have gained in importance.

These changes are also evident in employment patterns. The labor multiplier declined from approximately 6,514 to 3,366 jobs per IDR 1 trillion of final demand [11]. This implies that increases in value added and productivity do not automatically generate more jobs. Therefore, the success of industrialization cannot be measured solely by the number of jobs created but also by job quality, productivity, and workforce skill enhancement.

4.4 Dependence on Foreign Capital and Technology

Foreign investment acts as a primary driver of industrial expansion by providing substantial capital, process technology, supplier networks, and market access. This accelerates the construction of facilities that would be difficult to realize using only domestic capital. However, technology transfer has not always been commensurate with the scale of investment. Studies on Indonesia-China smelter investments indicate that while facility construction proceeds rapidly, technology transfer continues to face challenges [31].

In the EV industry which requires constantly evolving battery technology, quality control, design, and manufacturing capabilities limited domestic capacity can perpetuate dependence on foreign firms. Consequently, hosting production facilities does not necessarily equate to controlling production itself. Indonesia's form of dependency is shifting from a reliance on raw material exports to a reliance on the capital, technology, and networks of global corporations.

4.5 Industrial Energy Base Remains Carbon-Intensive

The rise of electric vehicles and a coal-dependent mineral industry energy base are at odds, according to research. According to RMI [30], Indonesia's captive power capacity was 22.9 GW in 2024, with more than 81% of that power coming from coal. This issue is important because the manufacture of carbon-intensive battery raw materials might reduce the environmental advantages of electric vehicles and create competitive hazards as demand for low-carbon products grows on a global scale.

Industrialization policies and energy transition initiatives are still not entirely in sync. Although Indonesia has successfully increased its production capacity, the need for decarbonization is still not as urgent. Indonesia's industrialization's green component is still in a transitional stage.

4.6 Indonesia's Position in the Global Value Chain

Indonesia's standing in the global nickel and EV value chains has improved because to downstreaming. Indonesia has more negotiating power because it is a significant supplier of nickel and a vital link in the battery and electric vehicle manufacturing chain. Nonetheless, there is still a large reliance on foreign markets, technology, cash, and multinational enterprises.

This position is ambivalent. Global interdependence provides the capital, technology, and markets that support industrialization, yet simultaneously constrains Indonesia's policy space. The WTO dispute regarding nickel export policies demonstrates that domestic industrial policies can come into conflict with international trade rules [15],[32].

In conclusion, downstreaming is both a development policy and an international economic policy. Its success depends not only on domestic policies but also on Indonesia's ability to manage relationships with investors, global companies, international markets, and global economic institutions.

5. DISCUSSION

Research findings indicate that Indonesia has successfully employed a "developmental state" approach to drive nickel industrialization and the development of an electric vehicle (EV) ecosystem. Through measures such as ore export bans, investment incentives, the establishment of industrial estates, and support for the EV industry, the state has managed to alter incentive structures and boost domestic production capacity. These findings align with the work of Lahadalia et al. [7], Evans [6], Wade [5], and Amsden [8]. However, success in investment and production capacity does not automatically equate to comprehensive development success. The next challenges lie in enhancing technological mastery, workforce quality, and R&D capabilities, as

well as increasing the involvement of domestic firms and suppliers.

Downstreaming cannot be equated with broad structural transformation. Although Indonesia has successfully increased value-added through nickel processing, linkages with other sectors, job creation, and industrial diversification remain limited. Asyono et al. [11] demonstrate that downstreaming results in a combination of specialization and the formation of supporting sectors. Consequently, the government must strengthen "linkage policies" developing machinery industries, technical services, education, research, logistics, and domestic supply chains—to ensure that industrial estates do not evolve into "enclaves" characterized by high output but weak local economic linkages.

From an environmental perspective, EV industrialization presents a paradox. RMI [30] highlights that "captive power" within the minerals industry remains dominated by coal. This implies that products intended to support the energy transition are not yet fully manufactured through low-carbon processes. Consistent with Rodrik's [3] perspective, policies regarding minerals, industry, investment, and energy require coordination. Indonesia needs to transform its nickel-based comparative advantage into a low-carbon competitive advantage to maintain access to global markets.

While Foreign Direct Investment (FDI) is a crucial factor in accelerating industrialization, it can simultaneously create new forms of dependency. The issue is not merely one of foreign ownership but rather of control over technology, R&D, financing, and market access. If these aspects remain controlled by external actors, increased production will not necessarily translate into greater development autonomy. Therefore, investment policy needs to be directed toward enhancing the quality of FDI through technology transfer, workforce training, the utilization of domestic suppliers, R&D, and partnerships with universities.

As a producer of nickel, Indonesia gains resource power and strengthens its negotiating position in the international

political economy. Because the nation is still dependent on outside markets, finance, and technology, this negotiating strength does not automatically convert into developmental autonomy. It is essential to diversify partners, bolster domestic businesses, improve technological capabilities, and set reliable environmental standards. In this situation, a polyalignment strategy [17] is useful as a tool to support industrial autonomy in addition to being diplomatic.

In sum, Indonesia's nickel and EV industrialization has succeeded at the mobilization stage but has yet to fully achieve the consolidation of national capabilities. Three key gaps persist: the production-capability gap, where production expands faster than technological mastery; the value-added-employment gap, where value added rises but job creation remains limited; and the green product-green production gap, where products support the energy transition yet production processes still rely on high-carbon energy. Consequently, it is more accurate to describe Indonesia as currently building a green industrial sector rather than having already achieved consolidated green industrialization. The next phase requires shifting the orientation from merely "processing nickel in Indonesia" to "mastering an increasing number of value chain stages" through performance-based incentives, technology transfer, local supplier development, R&D, technical education, partner diversification, and low-carbon energy use. In this way, downstream industrialization can evolve from resource-based industrialization toward capability-based industrialization.

6. CONCLUSION

This study demonstrates that Indonesia's electric vehicle strategy centered on nickel downstreaming represents a successful "developmental state" intervention that has built industrial capacity and elevated the country's position in the global value chain. The state has effectively utilized export regulations, investment policies, and industrial ecosystem development to shift the

economic structure from raw ore exports toward processing, battery materials, and EV-related activities. However, this success is asymmetrical. The transformation of physical capacity has outpaced the development of domestic technological capabilities, broad industrial linkages, labor absorption, and energy decarbonization. Findings regarding narrowed linkages, increased specialization and capital intensity, and a declining labor multiplier indicate that downstreaming has generated a tangible yet concentrated structural transformation. Meanwhile, the dominance of coal in captive power generation highlights the contradictions inherent in the "green" dimension of this transformation.

Consequently, Indonesia is best understood as a nation currently building green industrialization rather than one that has achieved consolidated green industrialization. A risk of "green dependency" arises when expanded production capacity is not matched by increased control over technology, capital, markets, and energy. Therefore, the next phase of policy must shift its orientation from merely attracting investment to building national capabilities. The government needs to link incentives to technology transfer, domestic supplier development, R&D, skills upgrading, partner diversification, and low-carbon energy use. From the standpoint of development economics, this scenario shows that vital resources can only act as a basis for change if the state is able to increase connections and capacities. Additionally, as vital minerals become crucial resources in the global political economy, the scenario emphasizes the increasing interdependence of industrial policy and economic statecraft.

In order to measure technology transfer, employment quality, supplier connections, and environmental impacts more accurately, future research could expand assessments at the business and regional levels. To clarify the circumstances in which industrial policy promotes technological autonomy against reinforcing new kinds of dependency, comparative

studies including other crucial mineral-producing nations are also required.

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