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EVALUATING THE ENVIRONMENTAL IMPACTS OF INDONESIA'S ELECTRIC VEHICLE POLICY: ALIGNING WITH SUSTAINABILITY AND CONSERVATION PRINCIPLES

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Abstract

This study analyzes the environmental implications of Indonesia's Battery Electric Vehicle (BEV) policy, as outlined in Presidential Regulation No. 55 of 2019. The policy aims to reduce greenhouse gas (GHG) emissions and promote a transition to renewable energy within the transportation sector. While the BEV program has contributed to a reduction in GHG emissions, the research identifies several environmental concerns associated with the policy. These include the environmental damage caused by nickel mining, the reliance on coal-fired power plants for electricity generation, and the inadequate handling of battery waste. The study evaluates these issues through the lens of Indonesia's Environmental Protection and Management Law, emphasizing the principles of sustainability and conservation. The findings suggest that the current implementation of the BEV policy does not fully adhere to these principles, as it neglects the broader environmental impacts of nickel extraction, fossil energy dependence, and improper battery waste management. To enhance the policy's effectiveness and ensure alignment with sustainable practices, the research recommends revisions in key areas such as raw material sourcing, energy generation for electric vehicle charging, and waste management protocols. The study highlights the need for a comprehensive and environmentally conscious approach to achieve the long-term goals of reduced emissions and a cleaner transportation system.

Keywords: Electric Vehicles; Environmental Impact; Sustainability; Greenhouse Gas Emissions; Nickel Mining; Legal Framework.

A. Introduction

The phenomenon of climate change is one of the most pressing global issues in recent years, driven by global warming, which manifests as rising atmospheric and surface temperatures. Climate change is becoming an interesting problem for the global community, including Indonesia, because of the increase in global temperature, which has caused climate change in various parts of the world. According to the Global Risk Report 2020 from the World Economic Forum, climate change is happening faster than people think. Global temperature is expected to increase by at least 3 degrees Celsius by the end of 2020 (Mursalim & Susanto, 2022).

Climate change, defined as "the change in average tempo lasts a long time," is already affecting various weather and climate extremes worldwide. There is evidence of extreme changes such as heat waves, heavy rains, droughts and tropical cyclones. In addition, their link to human influence is continuing to strengthen (Wibawa et al., 2023). One of the main causes is the increasing emission of greenhouse gases (GHG) (Rahmadania, 2022). According to data released by the United Nations, fossil fuels such as coal, oil, and gas are the largest contributors to GHG

emissions, accounting for 73% of emissions, with nearly 90% of all emissions in the form of carbon dioxide (CO_2) (Alhers et al., 2021).

Carbon monoxide (CO) is a colorless, tasteless, odorless, and non-irritating gas, yet it is highly toxic. This gas is abundant in the lower atmosphere as a result of the combustion of various hydrocarbons. Common sources of CO include vehicle exhaust, industrial emissions, tobacco smoke, and incomplete fuel combustion. CO persists in the atmosphere for approximately 1-2 months and can travel significant distances from its source (Irawan et al., 2023).

The increase in greenhouse gases which is a signal of climate change generally comes from human activities, industry, and natural processes. The influence of greenhouse gases due to human activities on climate change can be determined through the annual index produced by NOAA, namely the Annual Greenhouse Gas Index (AGGI). The index calculates the combination of the effects of the most essential long-lived greenhouse gases: Carbon dioxide (CO_2), Methane (CH_4), Nitrous dioxide (N_2O), and chemical elements contained in coolants or refrigerants and other cooling processes (Irma & Gusmira, 2023).

Indonesia is undeniably a mid-level contributor to global GHG emissions.(Nur & Kurniawan, 2021) Based on the GHG emissions inventory data from the Ministry of Energy and Mineral Resources in 2020, the sector that significantly contributes to the rise in GHG emissions in Indonesia is the energy-producing industrial sector, with a share of 43.83%. This is followed by the transportation sector at 24.64%, the manufacturing and construction industries at 21.46%, other sectors at 4.13%, fugitive emissions from oil and natural gas at 3.27%, miscellaneous sources at 1.18%, and fugitive emissions from solid fuels at 0,41% (Kementerian Energi dan Sumber Daya Mineral, 2019). The transportation sector ranks as the second-largest source of GHG emissions, closely linked to the use of fossil energy sources such as coal and oil. In 2019, the transportation sector emitted 157,325 Gg CO_2e, with an average annual increase of 7,17% (Kementerian Energi dan Sumber Daya Mineral, 2019).

The Indonesian government is currently focusing its efforts on the forestry and land-use sector (Forestry and Other Land Uses) as well as the energy sector. Within the energy sector, one of the government's key initiatives is transitioning to renewable energy (EBT) as part of its strategy to achieve Net Zero Emission (NZE) or zero carbon emissions by 2060. The current development of electrical energy is also used as renewable energy for a number of modes of transportation. The growth of transportation in Indonesia is very rapid, be it air, sea or land transportation. The biggest role of transportation is in economic activities, delivery of goods, transportation, and so on (Nuarta & Sukedi, 2024).

Therefore, the government has undertaken decarbonization in the transportation sector by transitioning from conventional vehicles to battery-based electric motor vehicles. This transition is part of the broader shift towards renewable energy. To provide a legal framework and certainty regarding the implementation of energy transition in the transportation sector through the adoption of electric vehicles, the government issued Presidential Regulation No. 55 of 2019 on the Acceleration of the Battery Electric Vehicle (BEV) Program for Road Transportation.

The transportation sector in Indonesia is currently experiencing continuous development, including an increase in the use of motor vehicles and motorcycles that run on petroleum and gas (mobile gasoline). The carbon emissions produced by motor vehicles as a result of combustion are compound gases that contain carbon (Fitrianto, 2023).

The implementation of the Battery Electric Vehicle (BEV) acceleration program under this regulation is carried out through five mechanisms: accelerating the development of the domestic BEV industry; providing incentives; ensuring the availability of charging infrastructure and regulating electricity tariffs for BEVs; complying with technical requirements for BEVs; and protecting the environment.

However, a review of this policy is necessary due to potential environmental impacts that may arise from its implementation. The use of electric vehicles is not entirely environmentally friendly, contrary to government claims. When viewed comprehensively, the components and supporting infrastructure of electric vehicles still rely on fossil resources such as coal and nickel, which have the potential to cause environmental damage.

This research is a continuation of previous research conducted by Muliana Mursalim and Agung Susanto in 2022, titled Ambivalence of Renewable Energy: Electric Vehicles for Reducing Carbon Emissions and Its Impact on Environmental Damage in Indonesia. The previous study broadly examined government policies related to renewable energy, particularly electric vehicles, and their environmental impact. In contrast, this research focuses specifically on the implications of the electric vehicle policy as outlined in Presidential Regulation No. 55 of 2019 on the Acceleration of the Battery Electric Vehicle Program for Road Transportation, assessing its environmental impact from the principles of sustainability and conservation. The policy is established in order to achieve efficiency, resilience, and energy conservation in the transportation sector, as well as the realization of clean energy, clean air quality, and an environmentally friendly approach, alongside Indonesia's commitment to reducing carbon emissions (Fitri & Samputra, 2024).

Based on the explanation above, the research problem can be formulated as follows: What are the implications of the electric vehicle policy on environmental impacts, How does Indonesia's electric vehicle policy compare to electric vehicle policies in several countries around the world? and How is the implementation of this policy when viewed from the principles of sustainability and conservation? The research aims to assess the prospects of policy implementation and its environmental implications.

This article is relevant to SDGs goal number 11 (Sustainable Cities and Communities) and goal number 13 (Climate Action) as it addresses the issue of climate change, which is closely linked to the increase in greenhouse gas (GHG) emissions, a direct result of human activities. Goal number 11 emphasizes the importance of creating environmentally friendly and sustainable cities, where Indonesia's efforts to transition to electric vehicles (Battery Electric Vehicles/BEVs) can reduce air pollution from the transportation sector, the second-largest emitter of GHGs. Moreover, this policy supports the achievement of goal number 13 by reducing dependence on fossil fuels and promoting the transition to renewable energy, which is crucial for climate change mitigation.

B. Method

This research employed a qualitative research approach with a doctrinal legal perspective using the statute approach. Doctrinal legal research examines the law as conceptualized and developed based on the doctrines adopted by its formulators or developers (Nurhayati et al., 2021). Rather than focusing on quantitative approaches, qualitative research emphasises qualitative analysis, giving understanding precedence over numerical data (Solechan et al., 2024).

The research specification used in this research was descriptive-analytical, aiming to comprehensively describe issues factually, systematically, and accurately. The research presented existing facts and analyzed them concerning the enforcement of prevailing legal regulations, specifically assessing the legal implications of the Battery Electric Vehicle (BEV) Acceleration Program policy on environmental impact.

This legal study relied on secondary data obtained through a literature review, comprising: (1) Primary Legal Materials – it included the 1945 Constitution of the Republic of Indonesia, Law No. 30 of 2007 on Energy, Law No. 32 of 2009 on Environmental Protection and Management, Government Regulation No. 79 of 2014 on National Energy Policy, and Presidential Regulation No. 55 of 2019 on the Acceleration of the Battery Electric Vehicle

Program for Road Transportation. (2) Secondary Legal Materials – there are journals, legal publications, books, literature, and research related to the study's subject. (3) Tertiary Legal Materials –consists of legal dictionaries and articles that complement and explain secondary legal materials.

The data collection technique in this legal study involved a literature review, with secondary data from relevant regulations and literature related to the research problem. The data analysis technique used was qualitative descriptive analysis, which is employed to identify, describe, and explain the qualitative characteristics or social influences that cannot be measured through quantitative methods (Sugiyono, 2013). The collected data were structured and analyzed qualitatively to produce an objective and accountable conclusion that answers the research problem.

C. Results and Discussions

1. Regulation of Sustainability and Conservation Principles in the Environmental Protection and Management Law

Law No. 32 of 2009 on Environmental Protection and Management stipulates in Article 2 the principles guiding environmental protection and management. These consist of state responsibility, sustainability and conservation, harmony and balance, integration, utility, precautionary measures, justice, ecoregion, biodiversity, polluter pays principle, public participation, local wisdom, good governance, and regional autonomy. The principle of sustainability and conservation is a fundamental principle in environmental protection and management. As explained in Article 2(b) of Environmental Protection and Management Law, this principle means that every individual has obligations and responsibilities towards future generations and their contemporaries by making efforts to preserve the carrying capacity of ecosystems and improve environmental quality.

These two principles are the main reference framework in efforts to maintain a balance between development and environmental protection to ensure that the needs of the present generation are met without compromising the capabilities of future generations. Overall, both principles (sustainability and conservation) serve to ensure that development does not compromise the quality of the environment, and that we are able to preserve nature for future generations. The Environmental Protection and Management Law emphasizes the importance of collaboration between the government, the community, and the private sector in implementing these principles, with the main goal of achieving a balance between economic development and environmental preservation.

The principle of sustainability emphasizes meeting current needs without reducing the ability of future generations to meet their needs. In this context, sustainability includes three main dimensions, namely environmental, social, and economic, known as the Triple Bottom Line concept. This sustainability also includes maintaining the quality of ecosystems that function as life supports, such as the management of water, air, and land resources which must be carried out carefully and sustainably. Article 1 number 14 of the Environmental Protection and Management Law stipulates that environmental carrying capacity is the capacity of nature to support human life and other living things without exceeding the established limits. This shows the importance of maintaining a balance in the use of natural resources to support long-term life.

The conservation principle in the Environmental Protection and Management Law is more directed at efforts to preserve and maintain the sustainability of natural resources and ecosystems. Conservation does not only include protection of rare species, but also maintaining the sustainability of the ecosystem as a whole. This principle is regulated in various articles, one of which is in Article 1 number 5, which states that environmental protection and management are efforts to maintain the sustainability of ecosystem functions and prevent environmental

damage. This law also emphasizes the importance of conservation through the regulation of conservation areas and protection of biodiversity. Article 18 of the Environmental Protection and Management Law states that conservation areas are areas that have a protective function for life support systems, such as national parks, nature reserves, and other conservation areas. In this case, human activities must be carried out by paying attention to the capacity of the ecosystem, and must not damage or reduce the existing biodiversity.

2. The Implications of the Electric Vehicle Policy on Environmental Impact

The electric vehicle (EV) policy, as outlined in Presidential Regulation No. 55 of 2019 on the Acceleration of the Battery Electric Vehicle (BEV) Program for Road Transportation, aims to reduce greenhouse gas (GHG) emissions in Indonesia and facilitate the energy transition towards renewable energy in the transportation sector. In addition to the Presidential Regulation, the Ministry of Transportation also issued Minister of Transportation Regulation (Permenhub) Number 45 of 2020 concerning Certain Vehicles Using Electric Motors, which covers other vehicles such as electric scooters, electric bicycles, electric mopeds, electric bicycles, and hoverboards. The Ministry of Energy and Mineral Resources also issued Minister of Energy and Mineral Resources (ESDM) Regulation Number 13 of 2020 concerning the Provision of Electric Charging Infrastructure for Battery-Based Motorized Vehicles (Ramadhina & Najicha, 2022).

Additionally, this policy seeks to improve energy efficiency, energy security, and energy conservation, ultimately promoting clean energy, cleaner air quality, and an environmentally friendly transportation system. The implementation of this policy has significantly contributed to reducing the carbon footprint of transportation in Indonesia (Indonesia, 2023).

The Director General of New, Renewable Energy and Energy Conservation (EBTKE) of the Ministry of Energy and Mineral Resources (ESDM) reported that in 2022, GHG emissions reductions reached 118.2 million tons of CO_2, exceeding the 2023 target of 116 million tons of CO_2. The energy sector contributed the most to this reduction, with 91.5 million tons of CO_2 saved through energy efficiency, the adoption of renewable energy, the use of low-carbon fuels, and cleaner power generation technologies (Kementerian Energi dan Sumber Daya Mineral, 2023). If Indonesia fully adopts electric vehicles and ensures that their electricity sources come entirely from renewable energy (EBT), the transport sector has a high potential to achieve net zero emissions by 2050 (Oktavianto, 2023).

A study conducted by Hariadi Fitrianto (2023) analyzed the use of electric vehicles as an effort to reduce environmental emissions, using a case study from North Sumatra Province. The study confirmed that EV adoption aligns with the primary objective of GHG emission reduction. The findings indicated that EV usage in North Sumatra has led to daily emission reductions of 872 KGeq CO_2, 0.42 KGeq CH_4, and 0.4 KGeq N_2O. Therefore, these results demonstrated that electric vehicles have effectively contributed to reducing GHG emissions in Indonesia.

While the electric vehicle (EV) policy has successfully contributed to reducing GHG emissions in Indonesia's transportation sector, its implementation has revealed adverse environmental impacts. The environment is directly affected by the Battery Electric Vehicle (BEV) acceleration policy, which was initially introduced as a solution to carbon emissions and air pollution caused by conventional vehicles (Publik, 2022). However, in practice, the Battery-Based electric vehicle policy has other impacts that can pose a threat to the environment (Wisanggeni et al., 2022).

Three out of the five mechanisms in the EV policy implementation pose a direct threat to environmental sustainability: battery-based EV industry development, electric charging infrastructure development, and environmental protection.

The first environmental threat is related to the mechanism for accelerating the development of the Battery Electric Vehicle (BEV) industry. Referring to the provisions of Article 4(1) and Article 5(1) of the Presidential Regulation on BEVs, the acceleration of BEV industry

development in Indonesia must align with the national motor vehicle industry roadmap and be carried out through BEV industry activities and/or BEV component industries. Based on this provision, policies regarding the development roadmap of the national motor vehicle industry were issued through Minister of Industry Regulation No. 27 of 2020, later updated by Minister of Industry Regulation No. 6 of 2022 on Specifications, Development Roadmaps, and Local Content Calculation of Battery Electric Vehicles.

According to Article 4 of this regulation, the development of the BEV industry follows the national motor vehicle industry roadmap, as outlined in Annex I of the regulation. The roadmap and minimum local content (TKDN) target indicate that BEVs require battery components containing High-Pressure Acid Leach (HPAL) Smelter Minerals (MHP), Nickel Sulfate & Cobalt Sulfate, Cathode, and Anode Materials, as well as the processing of NiMH and LiB battery waste.

In the making, BEVs require six times more raw materials than conventional vehicles (Hudzaifi, 2023). Specifically, an electric vehicle contains approximately 39.9 kg of nickel per unit, which is essential for its battery. However, nickel mining and processing pose significant risks to human health and the environment (Dzulkarnaen, 2021). On average, producing 1 kg of nickel generates around 13 kg of CO_2 emissions. Given that the demand for nickel for EV batteries is projected to reach 59.5 thousand tons by 2035, the CO_2 emissions from nickel components alone could reach 773 thousand tons (Gunawan et al., 2023).

The International Energy Agency (IEA) predicts a global increase in nickel production of at least 65% by 2030, driven by demand for EV battery materials.(Baraputri, 2023) Indonesia, which has the world's largest nickel reserves, is also the leading nickel producer globally. Approximately 90% of Indonesia's nickel reserves are located in Central Sulawesi, South Sulawesi, Southeast Sulawesi, and North Maluku. According to a USGS report, Indonesia was the world's largest nickel producer in 2022, with a production of 1.6 million metric tons, accounting for 48.48% of global nickel production (Kementerian Energi dan Sumber Daya Mineral, 2020). However, nickel mining activities in practice have resulted in significant environmental damage (Syarifuddin, 2022).

Nickel mining has the potential to release emissions from various pollutants, including Total Suspended Particles (TSP), NOx, SO_2, H_2S, nickel dust, and SO_3+H_2SO_4.(Kramawijaya, 2017) The most emitted pollutant from nickel mining is TSP, with an emission rate of 35,173.96 tons per year, originating from mining activities to nickel ore processing.(Kramawijaya, 2017) Beyond the mining process, the environmental destruction caused by the nickel industry can also be seen in the large areas of forest taken over for mining operations, leading to increased deforestation. Additionally, there are serious risks of water pollution in rivers, lakes, and coastal areas, which are vital for indigenous communities and local populations (WALHI, 2022)

According to an investigative report by the Indonesian Forum for the Environment (Walhi) in South Sulawesi, one example of this environmental impact is the nickel processing activities carried out by PT Huadi Nickel-Alloy Indonesia (HNI), which have caused severe pollution in the Balla' Tinggia River and the coastal areas of Papanloe and Baruga villages (WALHI, 2023) PT HNI generates dust from the sintering process, contributing to air pollution. Moreover, raw material loading and transportation activities occur less than 50 meters from residential areas, leading to serious health complaints from residents.

Furthermore, nickel mining in Indonesia has contributed to increased deforestation. Deforestation is the transformation of land cover from forested areas to non-forested categories (Putra et al., 2019). In Indonesia, deforestation and forest degradation have been the main contributors to greenhouse gas (GHG) emissions between 1990 and 2020 (Greenpeace, 2023). According to Climate Watch data, the land use, land-use change, and forestry (LULUCF) sector accounts for an average of 47% of Indonesia's annual GHG emissions. Therefore, despite claims that nickel mining for electric vehicle (EV) batteries is environmentally friendly, the reality is

that nickel extraction has led to environmental destruction and significant GHG emissions, contradicting its original sustainability goals.

Furthermore, aside from the environmental ecosystem damage caused by nickel mining, another major issue is the presence of captive coal-fired power plants (PLTU) at nickel smelters as electricity suppliers. One example is PT Gunbuster Nickel Industry (GNI) in Central Sulawesi, which built a 712.80-hectare captive coal-fired power plant without obtaining proper land ownership permits. As a result of this Steam Power Plant (PLTU), the air in nearby residential areas is suspected to be heavily contaminated with sulfur dioxide (SO_2), a toxic gas produced from coal combustion in captive power plants (WALHI, 2023).

The second environmental threat is related to the mechanism for providing electric charging infrastructure in Indonesia. The regulations governing the provision of charging infrastructure and electricity tariff arrangements for Battery Electric Vehicles (BEVs) are outlined in Chapter IV, Articles 22 to 27 of Presidential Regulation No. 55 of 2019 on the Acceleration of the Battery Electric Vehicle Program for Road Transportation. The implementation of electric vehicle charging infrastructure is assigned to one of the State-Owned Enterprises (SOEs), specifically PT PLN (Persero), which can collaborate with other SOEs and/or private enterprises. The provision of charging infrastructure for electric vehicles is carried out through the establishment of Public Electric Vehicle Charging Stations (SPKLU) and Public Electric Vehicle Battery Exchange Stations (SPBKLU) (Fauzan, 2023).

Referring to Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for Electricity Supply, Article 2(1)(a) mandates PT PLN (Persero) to develop a General Plan for Electricity Supply while considering the development of Renewable Energy in line with the national renewable energy mix targets. Furthermore, Article 3(5) states that in efforts to increase the proportion of Renewable Energy in the electricity mix, PT PLN (Persero) is required to accelerate the phase-out of its own coal-fired power plants and/or terminate Power Purchase Agreements (PPA) with coal power producers. However, based on the 2021-2030 Electricity Supply Business Plan (RUPTL), Indonesia's electricity supply is still dominated by coal-fired power plants, accounting for 67% of the total energy mix.

Out of the total emissions of 587 million tons of CO_2e in 2020, the transportation sector contributed 132.9 million tons of CO_2e, while coal-fired power plants (PLTU) accounted for 278.3 million tons of CO_2e, as each 1 GW PLTU generates approximately 5 million tons of CO_2.(Hudzaifi, 2023) Thus, the implementation of Battery Electric Vehicles (BEVs) as a means to reduce greenhouse gas (GHG) emissions in Indonesia still requires further improvements. If the electricity source for charging electric vehicles does not prioritize renewable energy, the presence of these vehicles may instead create new problems for climate change and environmental sustainability. The increasing demand for electricity amid the high dependency on fossil fuels as the primary energy source for power generation will lead to a rise in emissions from the energy sector.

The final environmental threat in implementing the BEV policy relates to the environmental protection mechanism. The implementation of environmental protection mechanisms in accelerating the BEV program in Indonesia is carried out through recycling and/or waste management methods, as stipulated in Article 32(1) of the Presidential Regulation on Battery Electric Vehicles. Battery waste management through recycling and/or processing is conducted by institutions, BEV industries, and/or domestic BEV component industries that hold official permits for battery waste management. However, to date, there are no specific derivative regulations governing the implementation of environmental protection mechanisms within the BEV policy framework.

Battery waste, as a primary component of electric vehicles, can cause environmental pollution if not properly managed. Used electric vehicle batteries are classified as hazardous and

toxic waste (B3) due to the electrolyte content, which negatively impacts the environment (Adi, 2022).

During its operations, the battery recycling industry generates wastewater, which can cause significant environmental and public health damage if not properly treated (Sulaeman et al., 2023). The Ombudsman, as a state institution overseeing public service implementation, has found several instances of battery waste from conventional vehicle-to-electric vehicle conversions remaining stored without proper processing or recycling.(Utami, 2023) Research conducted by the National Research and Innovation Agency (BRIN) has identified three major categories of hazardous waste requiring careful management: used batteries, waste from battery production processes, and waste from battery recycling, which contains heavy metals and hazardous chemicals.

3. Study on Electric Vehicle Policy in China, United States, and Nepal

China has made rapid progress in the electric vehicle (EV) industry through strategic and adaptive policies. Since 2009, the government has implemented a series of policies that have evolved in four major phases: early promotion (2009–2011), steady development (2012–2015), major breakthroughs (2016–2019), and high-quality development (2020–present) (Liu & Xie, 2024). The early phase focused on production incentives and subsidies, followed by infrastructure expansion and demand incentives, and then shifted to regulation and technological innovation. Several studies have shown that China's policies rely heavily on the interaction between supply-side support (subsidies, technology research), demand (purchase incentives, taxes), and environmental regulations (emission standards, battery recycling). However, the dominance of supply-side policies has led to path dependence, where production incentives are prioritized over long-term demand strategies. China's policies demonstrate the importance of a holistic approach that integrates regulation, technology support, and market incentives to ensure the sustainability of the EV industry. For other countries, tailoring strategies to domestic conditions is essential to balance industry growth with sustainable policies (Ramadan, 2022).

The United States has a policy that emphasizes an approach to addressing the gap between scientific research and technology commercialization due to weak industrial policies and lack of coordination between agencies. The United States' policy on electric vehicles focuses more on fiscal incentives, such as subsidies in the Inflation Reduction Act of 2022 and technology funding through the CHIPS and Science Act. However, the United States still lags behind in battery production and control of the supply chain of critical materials such as cobalt, which are mostly controlled by Chinese companies. Despite having large lithium reserves, the United States only accounts for 2% of global supply (Ramadan, 2022).

Nepal, as a country with no fossil fuel reserves, has great potential in utilizing hydroelectric power to support the adoption of electric vehicles (EVs). Policies and factors that drive EV adoption in Nepal through policies with a consumer preference approach and market simulation (Alhers et al., 2021). This approach means that consumers with high levels of environmental awareness, shorter monthly travel distances, and better knowledge about EVs are more likely to accept this technology. Furthermore, policies in Nepal show that a combination of price subsidies, infrastructure development, and technological innovation will be effective compared to implementing a single policy. Overall, policies in Nepal are directed at a combination of economic incentives, infrastructure improvements, and public education to accelerate the widespread adoption of EVs.

4. Inconsistency with the Principles of Sustainability and Environmental Preservation

Based on the issues and implications of electric vehicle policies on environmental impacts, as previously explained—namely nickel mining activities, the use of coal-fired power plants

(PLTU) as an electricity supply source, and the potential pollution from battery waste—it can be stated that the implementation of Battery Electric Vehicle (BEV) policies has not fully adhered to the principles of sustainability and environmental preservation as regulated in the Environmental Protection and Management Law.

The environmental damage caused by coal-fired power plants, such as air pollution, ecosystem degradation, and coal residue waste, has led to a decline in environmental quality, ultimately contributing to environmental pollution (Chandra, 2023). The environmental impact caused by nickel mining also continues to cause significant damage.

Nickel mining practices produce pollutant emissions from mining activities, along with deforestation and water pollution, which threaten environmental sustainability. Evidence of environmental damage and pollution in nickel mining areas, which still harm ecosystems and surrounding communities, does not reflect the principles of sustainability and environmental preservation in environmental management.

The final inconsistency in the implementation mechanism lies in environmental protection measures. The management of BEV battery waste is crucial, as it requires proper handling to reduce risks of contamination, safety hazards, and toxicity from heavy metal materials (Adi, 2022). However, the environmental protection mechanisms within Indonesia's BEV acceleration policy have not fully considered environmental governance principles—specifically sustainability and preservation—which are essential for maintaining ecosystem resilience and improving environmental quality. If battery waste is not properly recycled, it will contribute to further environmental pollution.

These three mechanisms—nickel mining, reliance on fossil energy, and inadequate battery waste management—fail to uphold sustainability and environmental preservation. The execution of these mechanisms is misaligned with the values and objectives of BEV policies, which are meant to provide environmental protection. The continued use of fossil fuels, mining activities, and the absence of a legal framework for battery waste management highlight the weaknesses in this policy, as it neglects the fundamental principles of sustainability and environmental preservation that should guide BEV policy implementation in managing the environment.

Based on the discussion regarding the policy implications on environmental impacts, electric vehicles have indeed been proven to reduce greenhouse gas (GHG) emissions in Indonesia. However, there are still several sectors that need improvement and appropriate regulations to ensure that the policy is implemented more effectively and in alignment with its objectives. Three key mechanisms that need to be refined to ensure that the use of battery-based electric vehicles (KBL Berbasis Baterai) effectively contributes to reducing GHG emissions include power plants utilizing environmentally friendly primary energy sources, regulation of mineral mining activities for battery raw materials, and the provision of battery waste processing facilities. These three issues must be promptly revised in the next Presidential Regulation so that the implementation of the battery-based electric vehicle policy can be optimized while considering environmental sustainability principles in environmental management.

D. Conclusion

The implications of the electric vehicle policy, particularly the policy on accelerating the battery-based electric vehicle program for road transportation, have had a significant impact on the environment. This policy has contributed to reducing GHG emissions in Indonesia's transportation sector. The realization of GHG emission reductions reached 118.2 million tons of CO_2 , exceeding the 2023 target of 116 million tons of CO_2 . The sector that contributed the most to this reduction was the energy sector, with a decrease of 91.5 million tons of CO_2 through energy efficiency, the use of renewable energy, the adoption of low-carbon fuels, and the implementation of cleaner power generation technologies. Although GHG emission reductions in

the transportation sector have been achieved, the implementation of the battery-based electric vehicle policy has had environmental impacts.

The implementation of this policy has not fully adhered to the principles of sustainability and environmental conservation in environmental management. The threats to environmental degradation include nickel mining activities that emit pollutants, contributing to air pollution and deforestation; the use of coal-fired power plants (PLTU) as an electricity source, which releases toxic gases from coal combustion; and battery waste that produces wastewater, potentially causing significant environmental damage. Therefore, the principles of sustainability and environmental conservation are not adequately reflected in the mechanisms of the electric vehicle policy. The government needs to evaluate the implementation of the battery-based electric vehicle acceleration program policy from its enactment to its current application. Additionally, there is a need for a review and revision of three key policy implementation mechanisms: the acceleration of domestic battery-based electric vehicle industry development, the provision of charging infrastructure for battery-based electric vehicles, and environmental protection measures. These revisions should take into account the actual positive and negative impacts on the environment.

Based on this, it is necessary to revise the policies in Indonesia regarding nickel exports, the policy of providing subsidies for electric vehicle users, and the tax relief policy to increase the use of electric vehicles in Indonesia.

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