Vifada Assumption Journal of Law, E-ISSN 2987-1263

Mining Transformation Towards a Green Economy: A Normative Analysis of the Legal and Environmental Governance Framework in Indonesia

Mas Subagyo Eko Prasetyo[1*] *Giyarni* [2] *Cut Fitriyani Meilita* [3] *Mas Rara Tri Retno Heryani* [4] *Alwan Hadiyanto* [5] *Linayati Lestari* [6]

[1,2,3] *Faculty of Law, Universitas Nasional, Indonesia*
[4] *Faculty of Law, Universitas Kediri, Indonesia*
[5,6] *Graduate Program, Master of Law, Universitas Riau Kepulauan, Indonesia*

Received: 2025, 08, 18 **Accepted:** 2026, 04, 20
Available online: 2026, 05, 15

* Corresponding author.
E-mail addresses: maseko@civitas.unas.ac.id, metro_ugie@yahoo.com, tjutlita@gmail.com, alwan.hadiyanto@gmail.com, linayati@fisip.unrika.ac.id

KEYWORDS

Keywords:
Mining; Green Economy; Environmental Law; Natural Resource Management; Sustainable Mining.

Conflict of Interest Statement:
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ABSTRACT

Purpose: Indonesia's mining sector holds a strategic position in national development and the energy transition, but it also generates significant ecological and social pressures. This study examines how mining can be repositioned as an instrument of the green economy through the strengthening of legal norms and environmental governance in Indonesia.

Research Design and Methodology: This study employs normative legal research using statute, conceptual, and limited comparative approaches. The legal materials consist of legislation on mineral and coal mining, environmental protection and management, reclamation and post-mining obligations, low-carbon development policies, and scientific literature on the green economy, sustainable mining, and natural resource governance. These materials are analysed through qualitative normative analysis.

Findings and Discussion: The study finds that Indonesian law provides a normative basis for integrating sustainable development, environmental protection, social justice, reclamation, and public participation into mining governance. However, its implementation remains constrained by regulatory fragmentation, institutional overlap, weak enforcement, limited incentives, and unequal community protection. The article argues that green mining governance requires legal strengthening, institutional harmonization, technological innovation, economic incentives, and collaborative accountability involving the state, business actors, local communities, and epistemic communities.

Implications: As a normative framework for green mining governance in Indonesia, this study connects its findings with practical contributions for policymakers, regulatory agencies, and law enforcement agencies. The study integrates mining law, environmental governance, sustainable development, and community protection as a basis for more responsible natural resource policies and future legal reforms in the mining sector.

Introduction

The mining sector remains one of the main pillars of economic development in many countries, including Indonesia. Its strategic position has become even more significant in the context of industrial expansion, energy transition, and the growing demand for critical minerals needed for low-carbon infrastructure and technology.[1] At the same time, mining continues to generate serious ecological and social pressures, including deforestation,[2] land degradation, pollution, and the

[1] Suwari Akhmaddhian et al., "The Strengthening Government Policies on Mineral and Coal Mining to Achieve Environmental Sustainability in Indonesia, Africa and Germany," *BESTUUR* 11, no. 1 (August) (May 2, 2023): 95, https://doi.org/10.20961/bestuur.v11i1.71279.
[2] Richard Jeremy Herrington, "The Raw Material Challenge of Creating a Green Economy," *Minerals* 14, no. 2 (February 17, 2024): 204, https://doi.org/10.3390/min14020204.

vulnerability of communities around mining areas.[3] This condition shows that mining cannot be viewed solely as an extractive economic sector, but must also be assessed in relation to environmental sustainability and social responsibility.[4]

Within the global shift toward sustainable development and the green economy, mining occupies a paradoxical position.[5] On the one hand, minerals such as nickel, copper, and bauxite are essential to support green industrialization, battery production, and electric vehicle development.[6] On the other hand, the expansion of extractive activities may intensify ecological degradation if it is not governed through clear legal norms and effective institutional control.[7] This paradox underlines the urgency of transforming mining governance toward a more sustainable and accountable model.[8]

In this context, the concepts of green economy, sustainable mining, and environmental governance become increasingly relevant to the Indonesian regulatory setting. Previous studies have generally approached mining transformation from technical, economic, or policy perspectives, whereas this article places legal norms and governance arrangements at the centre of the analysis.[9] The main issue is not merely whether mining can support the green economy, but how mining law, environmental law, reclamation obligations, public participation, and institutional supervision can be integrated into a coherent normative framework.[10] Therefore, this article develops its argument by linking the urgency of mining transformation with the need for legal strengthening and collaborative governance in Indonesia.

However, various studies show that the main challenges in realising sustainable mining do not stop at technical aspects or the availability of technology alone, but also concern issues of governance, resource politics, and regulatory effectiveness. In the case of Indonesia, resource nationalism and downstreaming policies in the transition minerals sector have proven to strengthen the position of the state and national businesses, but at the same time have created inequalities in the distribution of benefits and new vulnerabilities for local communities and the environment.[11] On the other hand, studies on green innovation in mining companies show that environmental legitimacy, regulatory pressure, and green absorptive capacity play an important role in encouraging investment in clean technology and more environmentally friendly operational practices.[12] However, empirical findings also show that without a consistent regulatory framework, aligned incentives, and effective oversight, these green innovations tend to be partial and difficult to integrate comprehensively into mining companies' business models.

Previous studies on the green economy and sustainable mining tend to follow two relatively separate streams. On the one hand, the green economy literature focuses on aggregate green performance measurement, the macroeconomic impact of low carbon development scenarios, and the relationship between green policies and economic growth.[13] On the other hand, studies on

[3] Ana Sofía Aron and Oswaldo Molina, "Green Innovation in Natural Resource Industries: The Case of Local Suppliers in the Peruvian Mining Industry," *The Extractive Industries and Society* 7, no. 2 (April 2020): 353–65, https://doi.org/10.1016/j.exis.2019.09.002.
[4] Asep Saepudin et al., "Indonesia Green Mining Industry," *European Journal of Development Studies* 2, no. 5 (November 23, 2022): 22–31, https://doi.org/10.24018/ejdevelop.2022.2.5.169.
[5] Hadi Sasana et al., "Can Green Economy Implementation Control Social Costs and Accelerate Welfare? Empirical Evidence from Developing Countries," *International Journal of Energy Economics and Policy* 16, no. 2 (January 30, 2026): 1142–49, https://doi.org/10.32479/ijeep.22823.
[6] Nourhane Houssam et al., "Assessing the Role of Green Economy on Sustainable Development in Developing Countries," *Heliyon* 9, no. 6 (June 2023): e17306, https://doi.org/10.1016/j.heliyon.2023.e17306.
[7] Eve Warburton, "Nationalist Enclaves: Industrialising the Critical Mineral Boom in Indonesia," *The Extractive Industries and Society* 20 (December 2024): 101564, https://doi.org/10.1016/j.exis.2024.101564.
[8] Alberto Biancardi et al., "A Flexible and Circular Management of Copper in Chile: New Perspectives Toward Sustainable Development," *Global Journal of Flexible Systems Management* 26, no. 4 (December 18, 2025): 813–37, https://doi.org/10.1007/s40171-025-00464-w.
[9] Min Zhou et al., "How to Drive Green Innovation in China's Mining Enterprises? Under the Perspective of Environmental Legitimacy and Green Absorptive Capacity," *Resources Policy* 72 (August 2021): 102038, https://doi.org/10.1016/j.resourpol.2021.102038.
[10] Dr. Muhammad Usman Khalid, "Mining and Environmental Sustainability: Collaborative Approaches for Improvement," *American Journal Of Mining Engineering* 3, no. 4 (August 31, 2022): 12–18, https://doi.org/10.71465/ajme1996.
[11] Warburton, "Nationalist Enclaves: Industrialising the Critical Mineral Boom in Indonesia."
[12] Xiaole Wan et al., "Executive Green Investment Vision, Stakeholders' Green Innovation Concerns and Enterprise Green Innovation Performance," *Frontiers in Environmental Science* 10 (September 23, 2022), https://doi.org/10.3389/fenvs.2022.997865.
[13] Hamza Alqudah et al., "A Decade of Green Economic Literature: An Analysis-Based Bibliometric," *International Journal of Energy Economics and Policy* 14, no. 3 (May 8, 2024): 497–511, https://doi.org/10.32479/ijeep.15579.

sustainable mining emphasise technical aspects, such as mine sustainability assessment, green productivity, and technology optimisation in mining operations.[14] Meanwhile, research that specifically discusses green mining policies and governance in developing countries, including Indonesia, is still relatively limited and often refers to the policy frameworks of developed countries that are not fully compatible with the local regulatory and legal policy context.[15] This gap opens up space for research that conceptually and normatively examines the transformation of mining towards a green economy by prioritising legal and governance perspectives in Indonesia.

Previous studies on the green economy and sustainable mining have generally developed in technical, economic, and policy-oriented directions. Studies on the green economy often focus on macroeconomic performance, low-carbon development scenarios, and green growth indicators, while sustainable mining studies tend to emphasize operational efficiency, technology adoption, and environmental impact reduction. Although these studies are important, they have not sufficiently explained how legal norms, regulatory design, institutional coordination, and governance accountability can be structured to transform mining into an instrument of the green economy in Indonesia.

This article addresses that gap by placing the legal and governance framework at the centre of the analysis. The main issue is not only whether mining can support the green economy, but how Indonesian mining law, environmental law, reclamation obligations, public participation, and institutional supervision can be integrated into a normative framework for green mining governance. In this sense, the article differs from previous studies that mainly discuss mining transformation from technical, economic, or general policy perspectives. Its contribution lies in formulating a normative legal argument that connects green economy principles, sustainable mining, and collaborative governance within the Indonesian regulatory context.

Based on this focus, the study examines three main questions: first, how the mining sector should be repositioned within the green economy framework in Indonesia; second, what normative and institutional strategies are required to support the transformation of mining practices in line with sustainable development principles; and third, how the roles of government, business actors, local communities, and epistemic communities can be integrated into a collaborative governance framework. Therefore, this article aims to contribute to natural resource and environmental law discourse by offering a normative model of green mining governance based on legal strengthening, institutional harmonization, innovation, incentives, and meaningful community protection. To clarify the conceptual and analytical basis of that argument, the following Literature Review discusses the relationship between green economy and sustainable mining transformation, the framework of mining law and environmental governance, and collaborative natural resource governance in Indonesia.

Literature Review

Green Economy and Sustainable Mining Transformation

The green economy is a development paradigm that integrates economic growth, social welfare, and ecological sustainability. In the context of natural resources, this concept requires that development activities be directed toward resource efficiency, low-carbon transition, pollution control, and intergenerational justice. Mining becomes relevant in this framework because it provides strategic minerals needed for renewable energy technology and green industrialization.

Sustainable mining is closely related to the green economy because it seeks to reduce the ecological and social risks of extractive activities. This concept requires mining practices to consider environmental protection from exploration, production, processing, reclamation, to post-mining recovery. Therefore, mining cannot be understood only as an economic activity, but also as a legal and ecological responsibility.

Previous studies on the green economy generally focus on macroeconomic indicators, low-carbon development, and green growth policy. Meanwhile, studies on sustainable mining often emphasize

[14] Jinhui Chen et al., "Evaluation and Future Framework of Green Mine Construction in China Based on the DPSIR Model," *Sustainable Environment Research* 30, no. 1 (December 16, 2020): 13, https://doi.org/10.1186/s42834-020-00054-8.
[15] Irsan Rahman et al., "Mineral and Coal Mining Regulatory Reform in Indonesia," *Journal of Law and Legal Reform* 6, no. 2 (July 21, 2025): 499–568, https://doi.org/10.15294/jllr.v6i2.19040.

technological innovation, cleaner production, and operational efficiency. These studies are important, but they have not sufficiently explained how legal norms and governance structures can transform mining into a green economy instrument in Indonesia.

This subsection shows that the relationship between green economy and sustainable mining is directly connected to the first problem formulation of this article, namely how the mining sector should be repositioned within the green economy framework in Indonesia. The literature confirms that mining transformation cannot be understood only in technical or economic terms, but must also be framed through legal certainty, environmental accountability, and governance responsibility. For that reason, the green economy and sustainable mining concepts provide the conceptual basis for examining the normative role of law in restructuring mining governance. This analytical position also becomes the starting point for the methodological and discussion framework developed in this study.

Mining Law and Environmental Governance Framework

Mining law and environmental law provide the main normative basis for governing mining transformation in Indonesia. Mining law regulates mineral and coal governance, licensing, downstreaming, reclamation, and post-mining obligations. Environmental law provides principles of sustainable development, precaution, pollution prevention, environmental approval, public participation, and the right to a good and healthy environment.

The relationship between mining law and environmental governance is important because mining directly affects land, water, forests, air quality, and local communities. If mining law is interpreted only as an instrument of economic extraction, environmental protection will remain secondary. Therefore, mining regulation must be read together with environmental protection norms to ensure that mineral utilization remains within ecological limits.

The main problem in Indonesia lies in the gap between normative commitment and implementation. Although the legal framework already recognizes reclamation, post-mining obligations, environmental approval, and public participation, its enforcement is still affected by regulatory fragmentation, institutional overlap, and weak supervision. This condition shows that green mining requires legal harmonization and stronger governance mechanisms.

This subsection is directly related to the second problem formulation concerning the normative and institutional strategies required to transform mining practices in line with sustainable development principles. The literature indicates that mining law and environmental governance cannot be treated as separate regulatory fields because both determine the legal structure of responsible mining management. Accordingly, this subsection provides the normative basis for examining regulatory harmonization, environmental obligations, reclamation, supervision, and accountability in the Indonesian context. It also strengthens the transition from conceptual discussion to the use of normative legal methods in the next section.

Collaborative Natural Resource Governance in Indonesia

Natural resource governance refers to the arrangement of authority, responsibility, and accountability in the management of natural resources. In the mining sector, governance involves the state, mining companies, local governments, affected communities, investors, and epistemic communities. Effective governance requires transparency, institutional coordination, public participation, and fair distribution of economic benefits.

Collaborative governance is relevant because mining transformation cannot be carried out by the government or business actors alone. The government is responsible for regulation and supervision, companies are responsible for compliance and environmental management, communities participate in monitoring and decision-making, while epistemic communities provide scientific knowledge. This cooperation is needed to prevent green mining from becoming merely a formal policy discourse.

In Indonesia, collaborative governance must respond to regulatory fragmentation, environmental degradation, and unequal community protection. Green mining requires coordination between mining policy, environmental protection, investment policy, low-carbon development, and regional governance. Without such coordination, mining transformation may support downstream industrialization but fail to protect ecological sustainability and social justice.

This subsection corresponds directly to the third problem formulation, namely how the roles of government, business actors, local communities, and epistemic communities can be integrated into a collaborative governance framework. The literature demonstrates that mining transformation requires more than regulatory reform because effective governance depends on coordination, participation, innovation, incentives, and community protection. Therefore, this subsection provides the analytical bridge for assessing how collaborative governance may operate as a normative model of green mining governance in Indonesia. In this way, the literature review moves systematically toward the method and the two main lines of analysis in the discussion section.

Taken together, these three strands of literature establish the conceptual foundation of this study and clarify the relationship between the problem formulation, the normative legal method, and the structure of the discussion. The first subsection explains the need to reposition mining within the green economy framework, the second identifies the relevant legal and institutional basis, and the third clarifies the governance model required for implementation. On that basis, the next section explains the normative legal method used to analyse the relevant legal materials and policy framework. This structure ensures that the discussion remains focused on the article's central contribution, namely the formulation of a normative model of green mining governance in Indonesia.

Research Design and Methodology

This study utilises normative legal research with conceptual characteristics, which relies on analysis of legal materials and scientific literature to address issues concerning the transformation of mining towards a green economy. Normative legal research positions law as written norms and principles contained in legislation, court decisions, doctrines, and policy instruments, which are then systematically analysed to explain how the law should regulate an issue.

The approaches used in this study are the statute approach, conceptual approach, and limited comparative approach. The statute approach is employed to answer the first and second problem formulations by examining the principal Indonesian legal instruments governing mining transformation, including Law No. 4 of 2009 on Mineral and Coal Mining as amended by Law No. 3 of 2020 and Law No. 6 of 2023, Law No. 32 of 2009 on Environmental Protection and Management, reclamation and post-mining regulations, and national low-carbon development policies. The conceptual approach supports all three problem formulations by clarifying the meaning of green economy, sustainable mining, environmental governance, and collaborative governance within a normative legal perspective. The limited comparative approach is used only to provide supporting references on selected international policy frameworks relevant to green mining and sustainable natural resource governance.

The legal materials in this study consist of primary, secondary, and tertiary legal materials. Primary legal materials include legislation and policy instruments on mineral and coal mining, environmental protection, reclamation, post mining obligations, and low carbon development. Secondary legal materials include books, journal articles, international reports, and policy documents relevant to green economy, sustainable mining, environmental law, and natural resource governance. Tertiary legal materials are used only to clarify legal terms and supporting concepts relevant to the analysis.

The literature was selected based on relevance, recency, academic credibility, and direct connection with the research questions. The main sources were taken from academic journal databases and repositories such as Scopus indexed journals, Google Scholar, ScienceDirect, SpringerLink, and official institutional websites. The literature range primarily covers publications from 2020 to 2026, while older sources are used only when they remain conceptually or normatively relevant. This selection was intended to ensure that the analysis reflects current debates on green economy, sustainable mining, and environmental governance.

The legal materials were analysed through normative qualitative analysis by linking each research question to the relevant legal norms and literature. The analysis was carried out in three stages, namely identifying the applicable norms and concepts, interpreting their relationship to green economy governance, and formulating normative arguments concerning regulatory strengthening and collaborative governance. Through this mechanism, the study explains how Indonesian law may

reposition mining within the green economy framework, strengthen normative and institutional strategies, and integrate the roles of key stakeholders in green mining governance. The limited comparative approach remains supportive and is used only to enrich the normative assessment, not to conduct a full comparative legal study.

Findings and Discussion

Normative Framework for Mining Transformation Towards a Green Economy

The normative analysis shows that the mining sector occupies a strategic but ambivalent position within the green economy framework. On the one hand, minerals such as nickel, copper, and bauxite are essential for low-carbon technologies, battery industries, and electric vehicle development. On the other hand, mining remains associated with deforestation, pollution, landscape degradation, and social vulnerability. This ambivalent position requires mining to be legally repositioned from a purely extractive sector into an instrument of sustainable development.[16]

The transformation of mining towards a green economy cannot be understood only as an economic or technological agenda. It must also be placed within the framework of legal norms that regulate the relationship between resource utilization, environmental protection, and social justice. The law has an important role in determining whether mining becomes a source of ecological damage or a controlled instrument of sustainable development.[17] Therefore, the main issue is how the legal framework can direct mining practices toward green economy principles.

Indonesian law already provides an important normative basis for this transformation. Law No. 4 of 2009 on Mineral and Coal Mining as amended by Law No. 3 of 2020 and Law No. 6 of 2023 regulates mineral and coal governance, licensing, downstreaming, reclamation, and post-mining obligations. Law No. 32 of 2009 on Environmental Protection and Management also affirms the principles of sustainable development, precaution, environmental protection, and public participation.[18] These legal instruments show that mining transformation toward a green economy can be developed from existing normative foundations.

From a green economy perspective, mining can no longer be positioned only as a source of state revenue and industrial raw materials. Mining must be understood as part of a broader value chain that is bound by resource efficiency, ecological protection, and intergenerational justice. This shift is important because the demand for transition minerals will continue to increase along with the development of low-carbon industries. Without legal control, the energy transition may reproduce new forms of environmental degradation in mining areas.

The concept of sustainable development in environmental law provides a basis for limiting extractive activities that exceed ecological carrying capacity. This principle requires economic development to be balanced with environmental sustainability and social welfare.[19] In the mining sector, this balance must be reflected in licensing, environmental approval, reclamation planning, and post-mining recovery. Therefore, sustainable development must become an operational legal standard rather than a general policy statement.

The principle of precaution is also central to the normative framework of green mining. Mining activities often create long-term ecological impacts that cannot be fully restored after exploitation. The precautionary principle requires the state and business actors to prevent environmental risks

[16] Mahdi Pouresmaieli et al., "Building Ecological Literacy in Mining Communities: A Sustainable Development Perspective," *Case Studies in Chemical and Environmental Engineering* 9 (June 2024): 100554, https://doi.org/10.1016/j.cscee.2023.100554.
[17] Suwari Akhmaddhian et al., "The Strengthening Government Policies on Mineral and Coal Mining to Achieve Environmental Sustainability in Indonesia, Africa and Germany," *BESTUUR* 11, no. 1 (August) (May 2, 2023): 95, https://doi.org/10.20961/bestuur.v11i1.71279.
[18] Mia Banulita and Titik Utami, "Legal Construction of Anti-Eco-Slapp Reinforcement In Indonesia," *Yuridika* 36, no. 3 (September 1, 2021): 721, https://doi.org/10.20473/ydk.v36i3.30383.
[19] L. Marfungah et al., "CONSOLIDATING MINING AREAS LEGAL POLICY FOR SUSTAINABLE SPATIAL PLANNING," *Russian Journal of Agricultural and Socio-Economic Sciences* 143, no. 11 (November 25, 2023): 90–103, https://doi.org/10.18551/rjoas.2023-11.11.

before damage occurs.[20] In this context, environmental impact assessment and environmental approval must function as substantive instruments of risk control.

Reclamation and post-mining obligations are important legal mechanisms for transforming mining into a responsible activity. These obligations indicate that the legal relationship between mining companies and the environment does not end when extraction activities stop. Mining companies must be responsible for restoring land, managing environmental impacts, and ensuring post-mining sustainability.[21] Therefore, reclamation and post-mining provisions must be strengthened through strict supervision and enforceable sanctions.

The findings show that Indonesia already has legal norms that regulate reclamation and post-mining responsibilities. However, the main problem lies in the gap between normative design and implementation. Weak supervision, limited institutional capacity, and inconsistent enforcement often reduce these obligations to administrative requirements. This condition shows that green mining requires not only legal norms, but also effective mechanisms to ensure compliance.

Regulatory fragmentation remains a major obstacle in mining transformation. Mining governance intersects with environmental law, spatial planning, forestry regulation, investment policy, regional government authority, and low-carbon development planning.[22] When these regulations are not harmonized, mining activities may obtain economic legitimacy while creating ecological and social risks. Therefore, harmonization of sectoral regulations is necessary to build a coherent legal framework for green mining.

Institutional overlap also affects the effectiveness of green mining governance. Different ministries, agencies, and levels of government may have authority over licensing, supervision, environmental approval, and law enforcement. If coordination is weak, legal norms become difficult to implement consistently.[23] This condition requires clearer institutional design and stronger coordination among regulatory authorities.

The macro policy framework on low-carbon development provides an additional basis for mining transformation. Indonesia's commitment to green development and energy transition creates a policy space for integrating mining governance with low-carbon planning.[24] However, this integration must not be limited to downstream industrialization and investment facilitation. It must also ensure that environmental standards, community protection, and ecological recovery remain central to mining policy.

The downstreaming policy in the mineral sector has strategic economic importance for Indonesia. It aims to increase added value, strengthen industrial capacity, and reduce dependence on raw material exports.[25] However, downstreaming may also create new environmental pressures if it is not supported by strong legal safeguards. Therefore, downstreaming must be linked with green industrial standards, pollution control, and responsible supply chain governance.

Mining transformation toward a green economy must also be based on ecological justice. Ecological justice requires that the benefits and burdens of mining are distributed fairly among the state, companies, communities, and future generations. Communities around mining areas should not bear environmental costs without receiving meaningful protection and fair benefits.[26] This

[20] Angga Kurniawan, Abdul Madjid, and Istislam Istislam, "Reconstructing Legal Frameworks for Post-Mining Reclamation Guarantees and Ecological Justice," *Jurnal Ius Constituendum* 10, no. 3 (October 19, 2025): 491–514, https://doi.org/10.26623/jic.v10i3.12779.
[21] Jürgen Kretschmann and Jürgen Brune, "Post-Mining - Challenges and Responsibilities," *Mining Journal*, November 6, 2025, 3–16, https://doi.org/10.36073/1512-407X/2025-2/3-16.
[22] Andreas Endl et al., "The Transformative Potential of European Mineral Extraction: Scratching the Surface or Digging Deep for the Sustainability Transformation?," *Sustainability Science* 21, no. 1 (January 26, 2026): 237–50, https://doi.org/10.1007/s11625-025-01741-4.
[23] Sudi Haryansyah, Rachmadi Usman, and Muhammad Ananta Firdaus, "The Role of The Government in Enforcing Mining Rehabilitation Laws: Environmental Law and Mining Law," *Law and Justice Research Journal* 1, no. 4 (October 31, 2025): 20–30, https://doi.org/10.70062/ljrj.v1i4.127.
[24] Ari Wijayanto, Annisa Hafizhah, and Muhammad Rudy Aqbar, "Mission-Oriented Policy for a Greener Nickel Industry in Indonesia: Challenges and Pathways," *Acta Law Journal* 3, no. 1 (December 31, 2024): 14–24, https://doi.org/10.32734/alj.v3i1.18818.
[25] Nooraini Dyah Rahmawati and Erbin Swara, "Indonesia's Nickel Export Ban: Between Industrial Downstreaming and International Trade Disputes," *Fortiori Law Journal* 5, no. 01 (June 26, 2025): 19–36, https://doi.org/10.47200/flj.v5i01.3051.
[26] Haoxuan Yu et al., "Elevating Community Well-Being in Mining Areas: The Proposal of the Mining Area Sustainability Index (MASI)," *Environmental Sciences Europe* 36, no. 1 (April 4, 2024): 71, https://doi.org/10.1186/s12302-024-00895-9.

principle gives normative direction to the regulation of mining permits, benefit sharing, and environmental liability.

The right to a good and healthy environment must become a substantive foundation of mining governance. This right places communities not merely as affected objects, but as rights holders in environmental decision-making. Mining policies must therefore ensure access to information, public participation, and access to justice. These elements are essential to prevent green mining from becoming only a technocratic policy.

Legal certainty is also required to support green mining transformation. Business actors need clear standards regarding environmental obligations, reclamation duties, waste management, and sanctions. Communities need certainty regarding their rights, participation mechanisms, and protection from environmental harm.[27] The state needs certainty regarding institutional authority, supervision mechanisms, and enforcement procedures.

The findings confirm that the existing Indonesian legal framework already provides an initial basis for green mining governance, but this basis still requires normative strengthening. Green economy principles need to be expressly integrated into sectoral mining regulation, while reclamation, post-mining recovery, pollution prevention, waste management, public participation, and environmental approval must operate as binding and substantive legal obligations. In this respect, the issue is not the absence of legal norms, but the need to refine their coherence, enforceability, and institutional effectiveness. Accordingly, legal strengthening should be directed toward making the normative basis of green mining more operational and more consistent with ecological justice and environmental rights.

This strengthening also requires legal harmonization across mining law, environmental law, spatial planning, climate policy, and community protection. Mining regulation should not remain a sectoral regime oriented mainly toward extraction and investment, because such an approach weakens the integration of sustainability principles within mining governance. A more coherent normative framework is necessary to connect mineral resource utilization with environmental accountability, social protection, and intergenerational responsibility. Through such harmonization, the law can function more effectively as an instrument for directing mining transformation toward ecological asset management.

At the level of implementation, green mining governance must also be supported by clear liability and enforcement mechanisms. Administrative sanctions, civil liability, and criminal enforcement remain necessary to ensure compliance with environmental obligations and to respond to serious ecological harm. However, law enforcement should be understood not as a separate issue from legal strengthening, but as the practical expression of a coherent and enforceable normative framework. In this sense, effective supervision and consistent enforcement are essential to prevent green mining norms from remaining merely declarative.[28]

Based on this analysis, the first finding of this article is that mining transformation toward a green economy already has a normative basis in Indonesian law, but its effectiveness depends on stronger regulatory harmonization, clearer legal obligations, and more consistent enforcement. This confirms that the legal framework must move beyond extractive regulation and direct mining toward ecological sustainability, social justice, and accountable governance. The practical implication is that green mining governance requires not only normative recognition, but also institutional capacity to implement and enforce those norms in an integrated manner. This conclusion forms the first pillar of the normative model of green mining governance advanced in this article.

Strengthening Collaborative Governance of Green Mining Based on Innovation, Incentives, and Community Protection

The transformation of mining toward a green economy requires collaborative governance involving the state, business actors, local communities, and epistemic communities. Mining problems cannot

[27] Mohammad Jamin et al., "The Impact of Indonesia's Mining Industry Regulation on the Protection of Indigenous Peoples," *Hasanuddin Law Review* 9, no. 1 (February 26, 2023): 88, https://doi.org/10.20956/halrev.v9i1.4033.
[28] Nur Insani and Suud Sarim Karimullah, "Justice for Nature: Integrating Environmental Concerns into Legal Systems for Adequate Environmental Protection," *Jurnal Hukum Dan Peradilan* 12, no. 1 (March 31, 2023): 129, https://doi.org/10.25216/jhp.12.1.2023.129-158.

be solved only through state regulation or corporate initiatives. They involve complex ecological, economic, social, and technological dimensions. Therefore, collaborative governance is needed to ensure that every actor contributes according to its authority, responsibility, and capacity.

In collaborative green mining governance, the state, business actors, local communities, and epistemic communities occupy different but interrelated roles.[29] The state provides regulation, supervision, sanctions, and policy direction, while business actors operationalize environmental compliance, cleaner production, and post-mining responsibility. Local communities must be recognized as rights holders who are entitled to participation, protection, and fair benefit-sharing. Epistemic communities provide scientific knowledge and technical assessment needed to support evidence-based mining governance.[30]

These roles should not be understood separately, but as parts of an integrated governance structure. The state establishes the legal and institutional framework, business actors internalize environmental responsibility in operational practice, communities ensure social legitimacy and accountability, and epistemic communities strengthen the quality of policy and monitoring.[31] In this arrangement, collaborative governance is not merely cooperation among actors, but a normative mechanism for aligning authority, responsibility, and accountability. Through such alignment, green mining governance gains a stronger legal and institutional foundation.

Technological innovation is one of the main pillars of green mining. Digital monitoring, smart sensors, drones, artificial intelligence, and automated reporting systems can improve environmental supervision. These technologies can help detect pollution, monitor land change, and assess compliance in real time. However, technology must be supported by legal standards that determine how data is collected, verified, and used for enforcement.[32]

Cleaner production is also important in reducing the environmental impact of mining. Mining companies should be encouraged to use technologies that reduce emissions, water consumption, energy use, and hazardous waste. This approach is consistent with the green economy because it links operational efficiency with ecological responsibility.[33] Nevertheless, cleaner production will not develop effectively without regulatory pressure and economic incentives.

Circular economy principles can strengthen the sustainability of mining business models. Mining residues, waste materials, and processing by-products may be managed as secondary resources when supported by safe and lawful mechanisms.[34] This approach can reduce waste, increase resource efficiency, and create additional economic value. However, circular practices must remain subject to environmental standards to prevent new risks.

The findings show that innovation often remains partial when the legal and institutional framework is weak. Companies may adopt green technology for reputational purposes without changing their core business practices. This situation can create a gap between formal sustainability claims and actual environmental performance. Therefore, green innovation must be linked with measurable obligations, transparent reporting, and independent verification.

Economic incentives are needed to support companies that adopt sustainable mining practices. Fiscal incentives, green financing, research support, and recognition of responsible business conduct can reduce the cost of technological transition.[35] These incentives are important because some

[29] Gyula Bándi, "Sustainable Development, the Interests of Future Generations, and Moral and Legal Implications," 2022, 17–71, https://doi.org/10.54237/profnet.2022.jeszcpefg_2.
[30] Jana Kajanová and Peter Nováček, "Environmental Crimes and Bentonite Mining and Processing Companies in Slovak Republic," *TalTech Journal of European Studies* 12, no. 2 (December 1, 2022): 43–63, https://doi.org/10.2478/bjes-2022-0011.
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cleaner technologies require high initial investment. However, incentives must be selective and based on verifiable environmental performance.

Disincentives are equally important in green mining governance. Companies that violate environmental obligations should face administrative sanctions, liability claims, permit restrictions, or criminal consequences when required by law. Without disincentives, irresponsible mining practices may remain economically profitable.[36] Therefore, incentives and sanctions must be designed as complementary instruments.

Collaborative governance must also address the protection of indigenous and local communities. Mining activities often affect land rights, traditional livelihoods, water sources, and cultural relations with the environment. Green mining cannot be justified if it ignores these social and human rights dimensions.[37] Therefore, community protection must be placed at the center of mining transformation.

Meaningful participation is a key element of community protection. Participation must be conducted before important decisions are made, not after mining policies have already been determined.[38] Communities must receive clear, accessible, and accurate information about environmental and social impacts. This process is necessary to ensure that consent and objections are treated as substantive elements of governance.

Benefit sharing must also be considered in collaborative governance. Mining generates economic benefits, but those benefits are often not fairly distributed to affected communities. Green mining requires mechanisms that ensure local communities receive social, economic, and environmental benefits.[39] Fair benefit sharing can reduce conflict and strengthen the legitimacy of mining governance.

Social impact assessment should be strengthened alongside environmental assessment. Mining transformation cannot focus only on emissions, land restoration, and technological efficiency. It must also assess impacts on livelihoods, health, social cohesion, and community vulnerability.[40] This assessment is important to ensure that green mining does not reproduce social inequality.

Transparency is another requirement for collaborative governance. Information on permits, environmental approvals, reclamation guarantees, monitoring results, sanctions, and corporate obligations should be accessible to the public. Transparency allows communities and civil society to monitor compliance. It also helps prevent regulatory capture and strengthens accountability.

Institutional coordination is needed to ensure that innovation, incentives, and community protection work together. Mining authorities, environmental agencies, local governments, and development planning institutions must operate under a coherent governance framework.[41] If coordination is weak, policy instruments may contradict one another. This condition may undermine the transformation of mining toward a green economy.

The findings also show that collaborative governance must be connected with law enforcement. Cooperation among actors does not mean reducing state authority to impose sanctions. Collaboration must strengthen compliance, not replace legal accountability. Therefore, collaborative governance should be understood as a structured legal mechanism rather than informal cooperation.

The findings further indicate that innovation, incentives, community protection, transparency, and law enforcement must operate as a single governance model rather than as separate policy elements. Innovation supports environmentally responsible mining practices, incentives and disincentives shape corporate behaviour, community protection secures social justice and human

[36] Angga Kurniawan, Abdul Madjid, and Istislam Istislam, "Reconstructing Legal Frameworks for Post-Mining Reclamation Guarantees and Ecological Justice."
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rights, transparency strengthens public oversight, and law enforcement ensures that all obligations remain binding. If one of these elements is weak, the governance model becomes fragmented and the transformation toward green mining loses its normative force. For that reason, their relationship must be reaffirmed as structurally interconnected within Indonesian mining governance.

Accordingly, the second finding of this article is that collaborative green mining governance requires an integrated normative model. This model is built on legal strengthening, regulatory harmonization, institutional coordination, technological innovation, selective incentives, transparency, meaningful community participation, and consistent law enforcement. Its significance lies in showing that green mining cannot depend only on voluntary commitments or technical reform, but must be secured through enforceable governance arrangements. Through this integrated model, mining can be directed toward ecological sustainability, social justice, and accountable development in Indonesia.

Conclusion

This study concludes that mining transformation towards a green economy in Indonesia must be understood as a normative and governance agenda, not merely as a technical or economic adjustment. The mining sector has a strategic role in supporting low-carbon industries through the supply of critical minerals, but it also creates ecological and social risks when managed through an extractive paradigm. Therefore, mining must be repositioned from short-term resource exploitation into ecological asset management that is bound by sustainable development, environmental protection, social justice, and community participation. This finding answers the main problem of the article by showing that green economy, sustainable mining, and natural resource governance must be integrated within a coherent legal framework.

The existing Indonesian legal framework already provides a basis for green mining transformation through mining regulation, environmental protection law, reclamation and post-mining obligations, and low-carbon development policies. However, this legal basis still requires strengthening because implementation is constrained by regulatory fragmentation, institutional overlap, weak supervision, and limited accountability. The transformation of mining towards a green economy therefore requires harmonization between mining law, environmental law, investment policy, spatial planning, and community protection. In this context, the law must function not only as a regulatory instrument, but also as a tool for directing mining practices toward ecological sustainability and social responsibility.

The main contribution of this article is the formulation of a normative model of green mining governance in Indonesia. This model is based on legal strengthening, institutional harmonization, technological innovation, economic incentives, environmental accountability, and meaningful community participation. It emphasizes that green mining cannot rely only on corporate commitment or technological change, but must be supported by binding legal obligations, effective enforcement, transparent governance, and fair protection for affected communities. Through this model, mining can be directed as part of the solution to sustainability challenges while still supporting national development and energy transition.

Future research should develop empirical studies in specific mining regions to examine the practical operation of supervision, reclamation, public participation, transparency, and benefit-sharing mechanisms within green mining governance. Accordingly, this article not only contributes theoretically by formulating a normative model of green mining governance, but also offers practical guidance for legislators, regulatory institutions, and law enforcement agencies in strengthening mining governance reform, while opening avenues for further empirical research on how this model operates in specific mining regions in Indonesia.

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