Indonesia’s nickel: Aimed at EVs, but still parked in stainless steel

Syahdiva Moezbar
Katherine Hasan
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Authors

Syahdiva Moezbar, Industry Analyst

Katherine Hasan, Analyst

Contributor

Lauri Myllyvirta, Lead Analyst & CREA Co-founder as main reviewer

Editor

Jonathan Seidman, Communication Specialist

Cover photo

Marcel Ardivan, Unsplash

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Indonesia’s nickel: Aimed at EVs, but still parked in stainless steel

The nation’s battery-grade production surges to catch on the EV race, even as global demand pivots toward nickel-free alternatives

Key findings

- Branded as an EV-driven boom, 83% of Indonesia’s 2025 nickel production was absorbed by the stainless steel sector, according to publicly available industry data. Only 17% currently goes into the Electric Vehicle (EV) battery supply chain, revealing a significant mismatch between the country’s ‘green nickel’ marketing and actual market demand.
- Internal combustion engine (ICE) vehicles still form the majority of global sales, meaning a large share of nickel—used in stainless steel vehicle components—will continue to be tied to the ICE vehicle market, further off-roading Indonesia's ‘green nickel’ narrative.
- Meanwhile, Indonesia’s nickel downstreaming strategy faces a major threat as nickel-free batteries gain traction globally, with LFP (Lithium Iron Phosphate) batteries in particular commanding over 80% of the Chinese market due to lower costs and longer lifespans.
- The market in fact faces a ‘dirty nickel’ paradox due to reliance on captive coal power, thanks to regulatory loopholes and green taxonomy classifying such plants as 'transitional'.
- This carbon lock-in is made worse by a lack of anticipatory planning or mechanisms to ensure new industrial sites are located near renewable energy potential or designed for future grid connectivity.
- Globally, Indonesian nickel risks being locked out of premium Western markets with stricter emissions policies, and is vulnerable to disruptions to fossil fuel and essential materials imports, like the Hormuz Strait crisis.
- To future-proof Indonesia’s nickel industry and realize the Golden Indonesia 2045 vision, the nation must pivot from a volume-driven model to a high-value, low-emission ecosystem. By addressing rapid ore depletion and decoupling growth

from captive coal, Indonesia can transform 'green nickel' from a mere label into a financially and operationally incentivised reality.

Contents

Nickel as a strategic commodity in the global energy transition

Nickel is undergoing a structural shift in its global demand profile. While stainless steel dominates, the battery precursor sector is expected to emerge as a growth driver. This growth is concentrated in EV batteries and energy storage, although the market share of high-nickel chemistry batteries is declining in both.

The shift in nickel's end use is illustrated in Figure 1. While stainless steel remains the primary consumer at approximately 65%, its supply chain has reached a high level of circularity, with over 40% of global production currently derived from recycled scrap (USGS, n.d.; Wood Mackenzie, 2022).

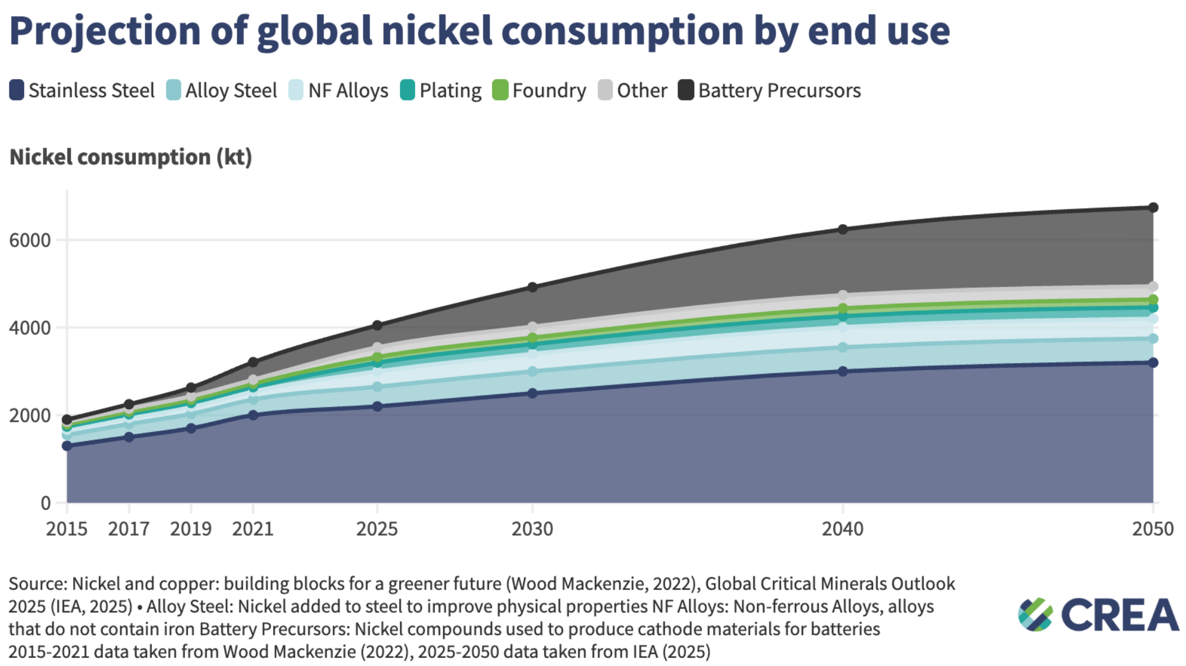


Figure 1 - Projection of global nickel consumption by end use

The remaining nickel consumption is rapidly reconfiguring; alloys and plating drove the majority of the growth in the past five years, while the nickel-based battery sector's share stagnated. This occurred despite a massive surge in global battery production, as the market share of high-nickel batteries fell steeply due to a sharp pivot toward nickel-free options (IEA, 2025; Wood Mackenzie, 2025).

After stagnating for four years, future nickel demand for batteries is highly uncertain. Growth projections for nickel demand are based on growth from stainless steel and EV batteries. The International Energy Agency (IEA) projects that nickel demand for batteries will almost double from 2025 to 2030, with the battery sector rising to roughly 20% of total global nickel consumption by the end of the decade. However, the 12.5% annual growth rate projected by the IEA is reliant on nickel-based chemistry retaining its share of the EV battery market, even if that share has fallen precipitously in the past few years. The fall in market share meant that from 2021 to 2025, there was essentially no growth in nickel use for batteries even as battery production volumes surged (IEA, 2025).

This is driven by a major split in the EV market. Low cost and mid-range EVs are leaning towards nickel-free technologies, while the high-grade nickel market becomes an exclusive driver for the premium tier. High-performance long-range EVs rely on nickel-based chemistries such as Nickel-Manganese-Cobalt (NMC) and Nickel-Cobalt-Aluminum (NCA) for their superior specific energy in watt-hour per kilogram (Wh/kg). Higher nickel content directly translates to the energy density required for long-distance travel (Akhter et al., 2025; Koech et al., 2024).[1]

Beyond 2030, nickel will no longer serve as a base industrial commodity, shifting to a strategic energy metal. The annual growth rate for battery precursors may stabilize at a lower percentage at around 3.5 to 5%, but the market will be significantly larger, more circular, and increasingly focused on high-purity materials required for advanced solid-state transportation (IEA, 2025).

[1] Earlier NMC iterations, such as NMC 111, contain equal parts nickel, manganese, and cobalt. The industry has since pivoted toward high-nickel variants: for instance, NMC 811 utilises eight parts nickel for every one part of manganese and cobalt, effectively reducing reliance on expensive and ethically sensitive cobalt. Similarly, NCA cathodes in premium models have a very high nickel content, often exceeding 80% to achieve maximum power output.

Indonesia is navigating a dual-path strategy for the nickel industry

Indonesia’s nickel downstreaming strategy follows a dual path: large-scale stainless steel production, and a growing push into EV batteries. Supported by Chinese investments, this strategy has made Indonesia the world’s top nickel producer. At the same time, reliance on captive coal power plants—off-grid power generation facilities dedicated for supplying energy to industry—creates a structural vulnerability, decoupling the nation’s economic engine from greening global demands. Despite high renewable potential, the absence of clean-energy frameworks and asset-level decarbonisation roadmaps threatens Indonesia's competitiveness against rising environmental standards and carbon border taxes.

Indonesia, with the world's largest saprolite and limonite ore reserves, has aggressively pursued a downstreaming strategy through a series of nickel ore export bans, starting in 2014 and most recently in 2020 (MEMR, 2019). This policy was designed to maximise economic benefits from its natural resources, ultimately establishing domestic processing bases. Such an initiative has invited a massive influx of foreign capital investments, primarily from China, reportedly exceeding USD 31 billion by 2025 (Tempo, 2025; C4ADS, 2025). **The shift in Indonesia’s downstreaming strategy has transformed Indonesia into the world's preeminent nickel refining hub, now accounting for over 50% of global refined nickel supply** (C4ADS, 2025; Kompas, 2025).

Class 2 dominance from RKEF vs. Class 1 evolution from HPAL

At the heart of this downstreaming boom is the Rotary Kiln Electric Furnace (RKEF) process, a pyrometallurgical method for processing nickel laterite ore or saprolite. The energy and emission-intensive RKEF process produces Class 2 nickel products in the form of Ferronickel (FeNi) and Nickel Pig Iron (NPI), both used in stainless steel production.

Nickel production through RKEF now accounts for roughly 80% of the national output, holding a strong grip on the global supply of stainless steel-grade nickel. Among the most prominent is Tsingshan Holding Group, a Chinese stainless steel behemoth and the primary developer of IMIP, which secured a steady supply of NPI for their stainless steel production, consuming 500,000 tons of nickel per year.

In contrast, other Chinese firms, such as Zhejiang Huayou Cobalt and Contemporary Amperex Technology (CATL), are targeting the rapidly growing EV battery market. They are primarily investing in High-Pressure Acid Leaching (HPAL) facilities, a process that produces Class 1 intermediates from limonite ore, ensuring a secure supply for the high-value battery supply chain. While RKEF has been the undisputed major force of the country's downstreaming push, HPAL has gathered the spotlight as an emerging technology due to its ability to directly feed the EV battery sector.

While the RKEF process can be modified to produce battery-grade nickel matte, it is a more complex and energy-intensive conversion. HPAL, by contrast, is a more direct pathway from low-grade Indonesian ore to Mixed Hydroxide Precipitate (MHP), the essential precursor for high-purity nickel sulfate used in EV batteries (RMI, 2025).

Bappenas and World Resources Institute Indonesia (WRI Indonesia) released a nickel industry decarbonisation roadmap that categorises three nickel clusters. Central Sulawesi make up Cluster 1, North Maluku in Cluster 2, and South Sulawesi and Southeast Sulawesi make up Cluster 3. Cluster 1 and Cluster 2 are tied to the highest emissions, 59.7 million tonnes of CO_2 ($MtCO_2$) and 60.3 $MtCO_2$, respectively, largely driven by the scale of their smelting capacities and reliance on captive coal power as its energy source. Cluster 3 has relatively lower emissions, 48.6 $MtCO_2$, due to the smaller number of smelters and the pioneering use of hydropower in smelter operation by established players such as Vale Indonesia (Bappenas & WRI Indonesia, 2025).

Other major integrated complexes include the Indonesia Morowali Industrial Park (IMIP) in Central Sulawesi, the Indonesia Weda Bay Industrial Park (IWIP) in North Maluku, and the Virtue Dragon Nickel Industry (VDNI) complex in Southeast Sulawesi. These integrated facilities combine mining, smelting, power generation, and logistics infrastructure.

The majority of Indonesia's current capacity remains anchored in Class 2 nickel production through RKEF technology. This segment, focused on NPI for the global stainless steel market, is led by massive-scale operations such as Obsidian Stainless Steel (OSS) and Gunbuster Nickel Indonesia (GNI). FeNi production, another critical RKEF output, is primarily driven by Sunny Metal Industry and the domestically-led Ceria Nugraha Indotama, which has significantly scaled its capacity through 2025.

Simultaneously, the industry is pivoting toward battery-grade intermediates to serve the global EV supply chain. Nickel Matte production, a high-purity intermediate, remains the hallmark of Vale Indonesia's Sorowako operations, which continue to act as a primary bridge to the Japanese and Western battery markets. Meanwhile, the strategic surge in Mixed Hydroxide Precipitate (MHP) capacity is being spearheaded by pioneer HPAL projects, most notably Halmahera Persada Lygend (HPL) and Huayue Nickel Cobalt.

Figure 2 presents the overview of these nickel processing facilities in Indonesia, with most facilities dominated by RKEF processing technology and a small number of HPAL projects.

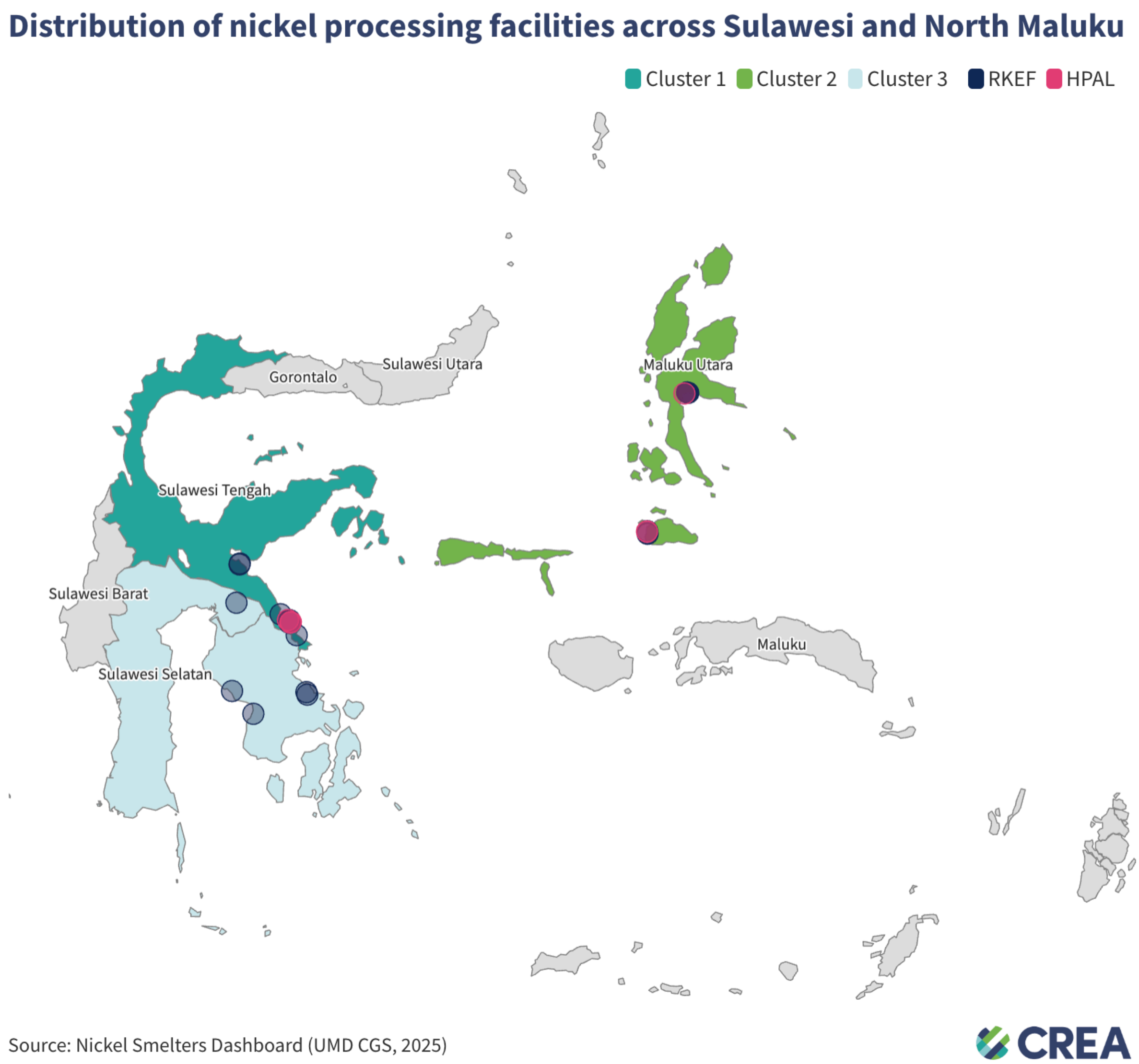


Figure 2 - Distribution of nickel processing facilities in Indonesia by technology

Figure 3 shows the extent of nickel processing dominance in Central Sulawesi, South East Sulawesi, and North Maluku, as well as other provinces with minor shares.

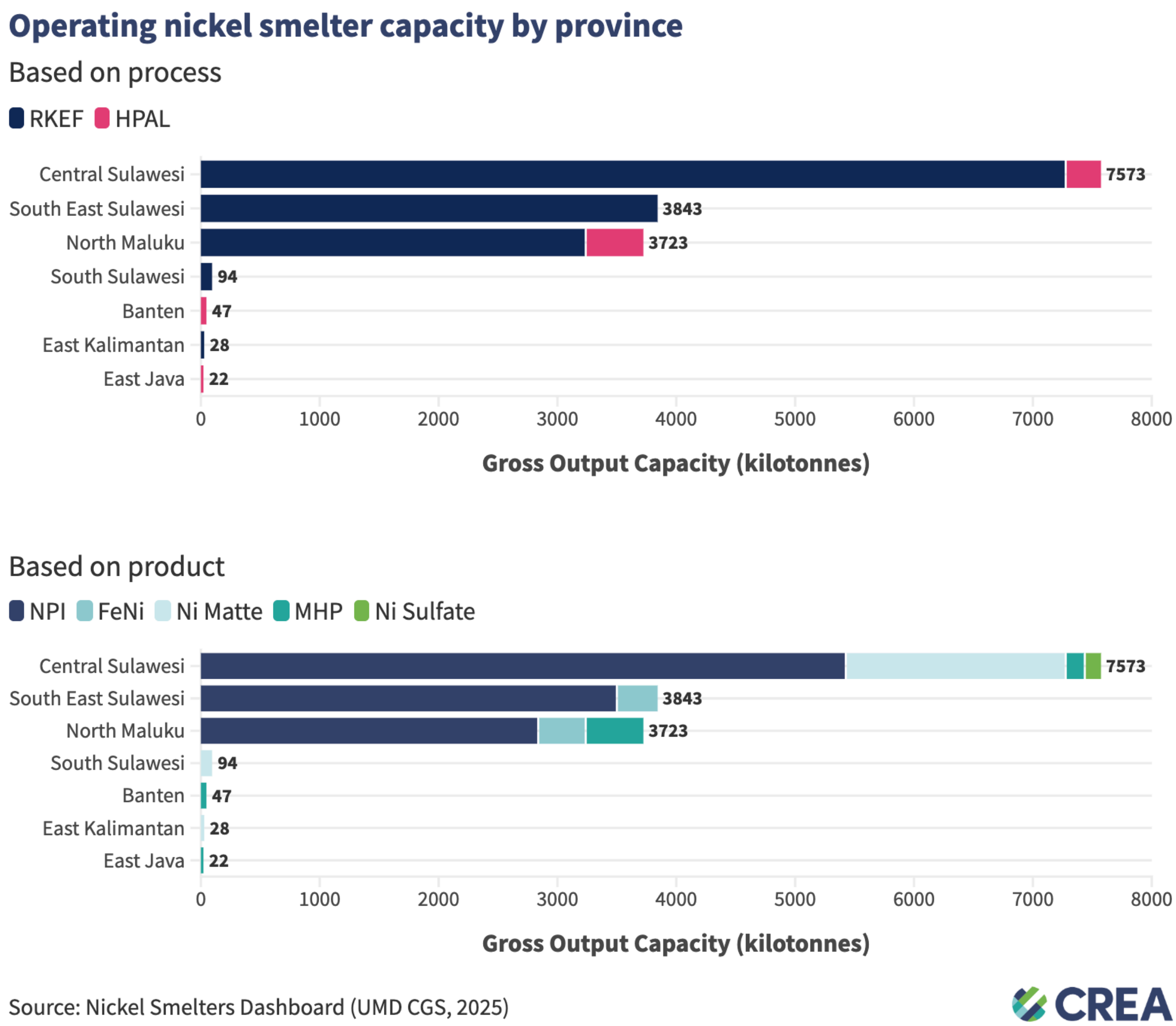


Figure 3 - Nickel processing capacities across Indonesian provinces

The figure shows that nickel processing activities are clustered into a few key industrial hubs. Central Sulawesi stands out as the primary province for nickel processing with a total output of 7,573 kilotonnes of nickel equivalent, nearly twice that of any other province. The large output is mainly due to proximity to abundant ore reserves and supporting infrastructures (Sunuhadi et al., 2024).

In terms of technology, RKEF still dominates Indonesia's installed capacity, producing NPI, ferronickel and nickel matte, reinforcing the industry's focus on stainless steel value chains. While currently having a relatively smaller capacity, new HPAL smelters have been commissioned in recent years in Sulawesi and North Maluku, signalling efforts to expand the country's capacity for battery-grade nickel intermediates.

The influx of investment into HPAL facilities in Indonesia then becomes a direct response to the global demand for EV batteries and to China's strategic interest in securing a stable supply of battery-grade nickel (Asia Society Policy Institute, 2025). This creates a dual-track downstreaming strategy in Indonesia: one focused on maintaining Class 2 dominance in stainless steel via RKEF, and the other on capturing a sizable share of the Class 1 battery market with HPAL.

However, this phenomenon would not have been possible without Chinese investment. Faced with Indonesia's export ban, Chinese stainless giants chose to invest heavily in local processing, creating a win-win situation where China secured its supply and Indonesia developed industrial capacity.

Yet, the resulting ownership structure presents a strategic risk. Over 60% of Indonesia's nickel refining capacity is owned by Chinese companies, while Indonesian shareholders control just 13% (C4ADS, 2025). While Chinese investments have significantly contributed to the industry's growth, substantial foreign influence could limit Indonesia's ability to steer the sector in line with national development strategies.

Beyond this, as Western markets tighten Foreign Entity of Concern (FEOC) rules under the United States Inflation Reduction Act (IRA), this ownership skew — specifically the 25% threshold for covered nation control — could limit access to lucrative tax credits. Essentially, Indonesia's current dependency on Chinese capital is creating a trade barrier for its MHP in the North American and European markets (US Federal Register, 2024).

In response, the 2026 Indonesia-US Agreement on Reciprocal Trade (ART) signals a strategic pivot to reroute supply chains toward North America. However, this shift is anchored by the controversial Article 6.1, which enforces 'investment neutrality', that requires Indonesia to treat US investors no less favorably than domestic firms. This clause may allow US entities to bypass local content requirements and previous restrictions favoring state-backed or Chinese enterprises. While framed as a diversification effort, such an arrangement risks trapping Indonesia in a legal framework that undermines its downstreaming effort in favor of US supply chain security (Mongabay, 2026).

Captive coal power dependence as the main challenge, compounding risks

The divergence between Indonesia's nickel processing pathways creates a significant structural hurdle for the nation's decarbonisation agenda, as the high-emission RKEF route for stainless steel and the lower-emission HPAL route for batteries face vastly different constraints. The difference is well reflected in their respective emission intensities.

Compared to HPAL, the RKEF process is considerably more emissions-intensive, mainly driven by its dependence on captive coal-fired power plants and energy-intensive pyrometallurgical processes (RMI, 2025). This positions HPAL as an important technology to further advance Indonesia's EV battery value chain through a comparatively lower-emission nickel-processing pathway, when coupled with proper operational practices and efficient design to manage waste products.

Figure 4 compares the available emission intensities from 17 nickel smelters. Several RKEF smelters powered mainly by coal plants have very high emissions intensities. Halmahera Jaya Ferronickel, for example, shows an intensity of 99 tCO_2/t Ni output equivalent. This result reflects the energy-intensive nature of pyrometallurgical processing that is reliant on captive coal power.

In contrast, Vale Indonesia - Sorowako RKEF has a much lower emission intensity of 30.5 tCO_2/t Ni output equivalent, mainly for its use of hydropower. HPAL smelters have lower emission intensities overall. Facilities like Halmahera Persada Lygend (13.6 tCO_2/t Ni) and Huayue Nickel Cobalt (36 tCO_2/t Ni) mainly use captive coal for power (Halmahera Persada Lygend, 2024). These estimates show that energy sources significantly impact emissions, not just the processing route.

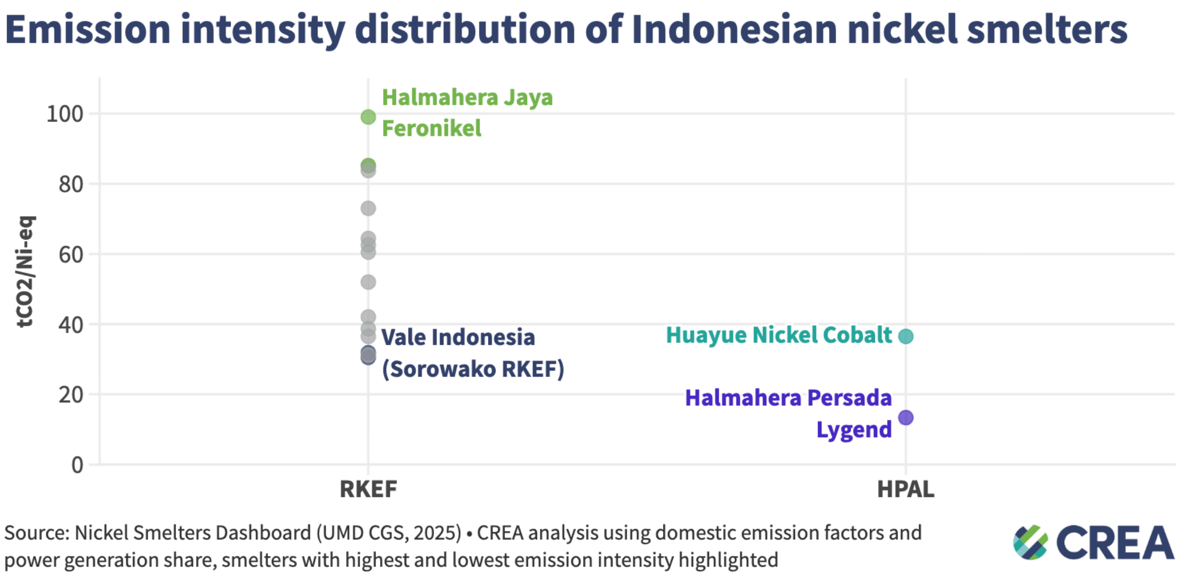


Figure 4 - Estimated emission intensity for RKEF and HPAL smelters in Indonesia

However, Indonesia's regulatory framework for nickel downstreaming has largely prioritised rapid industrial expansion over environmental safeguards. The Omnibus Law on Job Creation centralised the permitting process for industrial projects, weakening environmental safeguards and reducing local government authority. The law also greatly reduced public participation to facilitate more business permits, despite non-compliance with environmental regulations (LPEM FEB UI, 2025).

This emphasis on accelerating investment and industrial development indirectly incentivises companies to rely on captive coal as a cheap, readily available energy source. This is further bolstered by Indonesia's national green taxonomy released by Otoritas Jasa Keuangan (OJK), which classifies captive coal for mineral processing as a 'transitional' activity, thereby unlocking financing even for fossil-based projects. (OJK, 2025).

While the Presidential Regulation No. 112 Year 2022 mandates a 35% emission reduction within ten years; its proposed revisions continue to exempt expansion of captive coal plants powering National Strategic Projects (*Proyek Strategis Negara*, PSN). This creates a critical loophole where the government fails to implement a 'necessity test' that would legally compel developers to prove coal is the only viable energy source or to mandate the integration of renewable energy into early-stage planning and feasibility studies. Such a mandate is empirically justified by projects such as Vale's operation in Sorowako, South Sulawesi, where 365 MW of hydropower used to produce nickel matte has been reducing operational costs by up to 40% while eliminating 2.3 $MTCO_2$ annually (WRI, 2026).

Furthermore, there is no substantive commitment to interlink these industrial hubs with Sulawesi's future planned grid backbone. This lack of strategic coordination effectively isolates these facilities into carbon-locked islands, preventing them from tapping into Sulawesi's vast, untapped potentials for large-scale hydropower and geothermal (IESR, 2025). This misalignment does more than just undermine Indonesia's decarbonisation intent; it poses a direct threat to the long-term eligibility of its nickel in a global market increasingly defined by strict standards and compliance requirements.

Increasing the share of clean energy is essential to decarbonising the industry, yet there is no one-size-fits-all solution. However, a critical, often overlooked dimension is that the potential for future decarbonisation must be integrated into site selection today. For existing industrial clusters, proactive grid planning is required immediately, even if the actual transition to renewables occurs years later.

The crucial need for anticipatory planning is a central theme of strategic assessments, which argue that decarbonisation can be achieved through spatial coordination. Currently, Indonesia lacks a mechanism for clean energy readiness in the initial feasibility phase or environmental impact assessment stages — ensuring PSN to be sited near abundant renewable potential or designed for future grid connections (Climateworks Centre, 2025).

Bappenas and WRI Indonesia's scenario highlights that there is no single pathway to decarbonise Indonesia's nickel industry. In Cluster 1, hydro will make up more than half of the total capacity in 2045, while solar will make up the rest of the capacity supported by a battery storage system. Cluster 2 sees a vastly different approach, green hydrogen is projected as the most feasible energy source to replace the bulk of the coal requirement due to the low wind and hydropower potential in the area. Lastly, Cluster 3 combines hydro, wind, and solar power to generate reliable electricity throughout the operation.

Figure 5 shows the total capacity increase from 2017 to 2024, with most of the growth driven by its status as a readily deployable, reliable energy source for smelting operations, and also summarises national roadmaps developed to date, as released by Bappenas & WRI Indonesia in June 2025 and by the Just Energy Transition Partnership (JETP) Secretariat in November 2025.

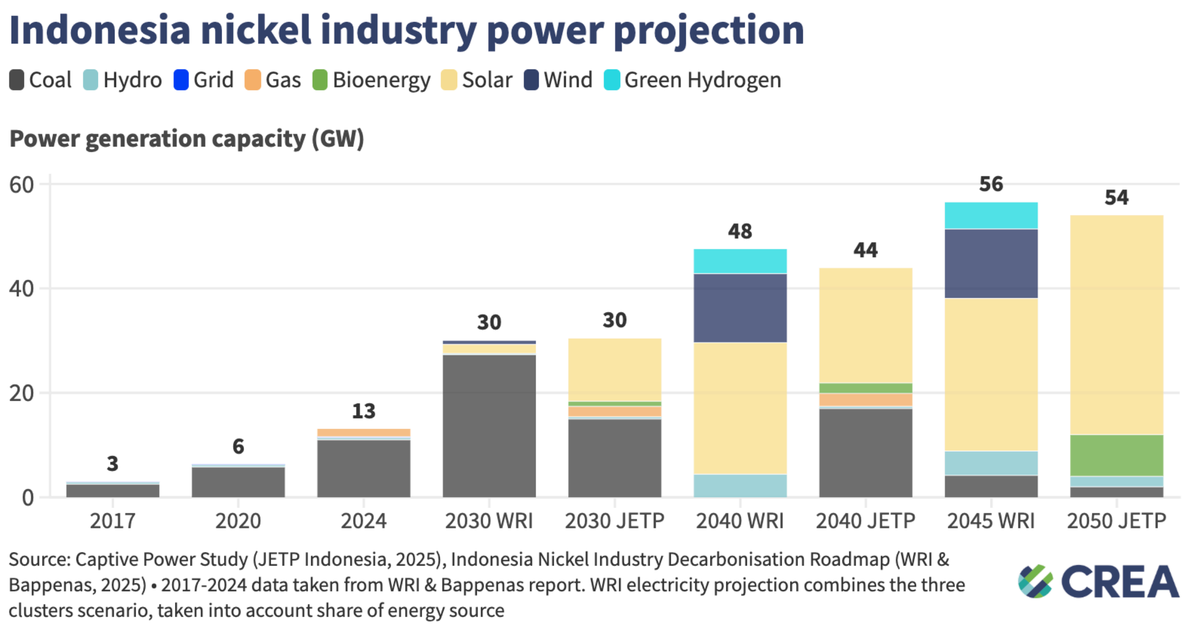


Figure 5 - Installed nickel industry electricity capacity

Both roadmaps projected an aggressive jump in renewable energy share between 2030 and 2040, with solar being the majority of the renewable energy capacity. Bappenas & WRI Indonesia project considerable potential in wind energy, making up around 20% of the total capacity in 2045. Bappenas & WRI Indonesia also project a highly optimistic role of green hydrogen as an alternative energy source for the industry, although its large-scale deployment remains uncertain given the infrastructure gaps and the current lack of commercial viability.

JETP case studies for the RKEF and HPAL processes highlight that decarbonisation efforts remain constrained by the need for coal power plants as a baseload to maintain system stability (JETP Indonesia, 2025). Crucially, pyrometallurgical RKEF operations require high levels of supply stability to prevent furnace freezing that is currently provided by coal-fired turbines but difficult to replicate with variable renewable energy without over-specification of storage. Under the JETP Optimistic Pathway, RKEF operations rely on an increased portion of solar PV and hydro, with Battery Energy Storage Systems (BESS) playing a role to reduce the load from coal power generation during periods of low variable renewable energy generation. For HPAL, the study identifies increased contributions from waste heat recovery, biomass co-firing, and renewables to reduce reliance on coal.

JETP's asset-level modelling further demonstrates the scale of potential gains from renewables while optimising generation cost. The baseline case features an HPAL nickel smelter that relies on a 73-MW captive coal power plant, emitting 0.55 $MtCO_2$/year. Shifting 70% of its power generation to renewables could achieve up to 90% emission intensity reduction to 0.12 kg CO_2/kWh. Another decarbonisation case scenario for an RKEF smelter linked to a 160-MW captive coal power plant, emitting 1.18 $MtCO_2$/year, shows that replacing coal with an 88% renewable share using solar PV is projected to cut emissions by up to 54% while maintaining operational reliability through battery storage and gas support during non-solar periods (JETP Indonesia, 2025).

Strengthening these efforts, DNV highlights that decarbonising Indonesia's nickel clusters requires a targeted technical approach. For high-emission RKEF smelters, the immediate transition hinges on the deployment of large-scale BESS and biomass co-firing to provide the essential rotational inertia and baseload stability, currently supplied by coal. For HPAL facilities, the focus is on optimising Waste Heat Recovery (WHR) and decarbonising auxiliary steam production; and for the industry at large, DNV advocates for cross-cluster grid interconnection to maximize the utilisation of regional hydro and solar potentials, effectively moving away from isolated, coal-dependent captive systems (DNV, 2025).

To date, several incremental greening steps have been taken by Indonesian nickel smelters through the integration of renewable energy and efficiency systems. Harita Group is currently developing a 300 MWp solar PV project on Obi Island, with the initial 40 MWp phase having commenced in the second quarter of 2025 (Harita Nickel, 2024). PT Dexin Steel Indonesia has integrated a 65.89 MWp rooftop solar installation at the IMIP as of early 2026 (IMIP, 2025). Efficiency improvements are also being realized through waste heat recovery; for instance, PT Huayue Nickel Cobalt utilises high-pressure steam from its sulfuric acid production process to offset operational electricity needs (IMIP, 2025).

More recently, larger-scale integration is emerging across key industrial parks and downstream value chains. At IMIP, the SESMO project commenced the construction of a 262 MWp solar project with 80 MWh of battery energy storage system in April 2026, designed to power the Excelsior Nickel Cobalt (ENC) HPAL plant (Petromindo, 2026; SESNA, 2026). Similarly, IWIP is developing a multibillion project comprising 2 GW of solar power plant and 500 MW of wind facility as a flagship project for green sustainable nickel industrial zone (Petromindo, 2025).

Supporting these industrial-scale efforts is the precedent set by Nickel Industries at the Hengjaya Mine, where a 396 kWp solar and 250 kWh battery pilot has been operating since 2022. While this initial pilot is scheduled for full-scale integration by 2025 to meet 20% of the mine's site demand, it provided the essential proof of concept for the larger decarbonisation projects currently under construction (Nickel Industries, 2023).

Despite these landmark projects, broader progress toward industry-wide decarbonisation remains gradual. These initiatives, while significant, are still small in scale when compared to the sector's total energy requirements and its continued reliance on captive coal-fired power for large-scale smelting operations.

The nickel ore-grade paradox: an overlooked detail

In addition to energy sources, ore grade is a key determinant of emissions intensity. While Indonesian saprolite ores historically average 1.5% to 3.0% nickel by weight, grades are projected to deteriorate as primary reserves are depleted (MEMR, 2020; SMM, 2025). As ore quality declines, refineries must process a larger volume of raw material to maintain output, significantly increasing energy consumption and the use of auxiliary reagents (Wei et al., 2020).

Figure 6 shows that energy requirements increase non-linearly as ore grade decreases, meaning more energy is needed to produce the same output at lower grades. Consequently, emission intensity from Indonesia's nickel products could rise by up to 20% if average ore grades fall below 1.5%.

With proper ore blending and management, the industry could maintain higher-grade feedstock across smelters as a practical near-term decarbonisation strategy. Some RKEF smelters are supposedly operating with ore grades around or below 1.5%, contributing to higher energy use and emissions. Macquarie estimated Indonesia's average nickel ore grades have declined to around 1.6% from 1.8% (Mining, 2025), raising the average emissions intensity by approximately 5.8%. Bappenas & WRI Indonesia estimate that enforcing a minimum ore grade threshold could reduce absolute emissions in the sector by up to 15% by 2045 (Bappenas & WRI Indonesia, 2025).

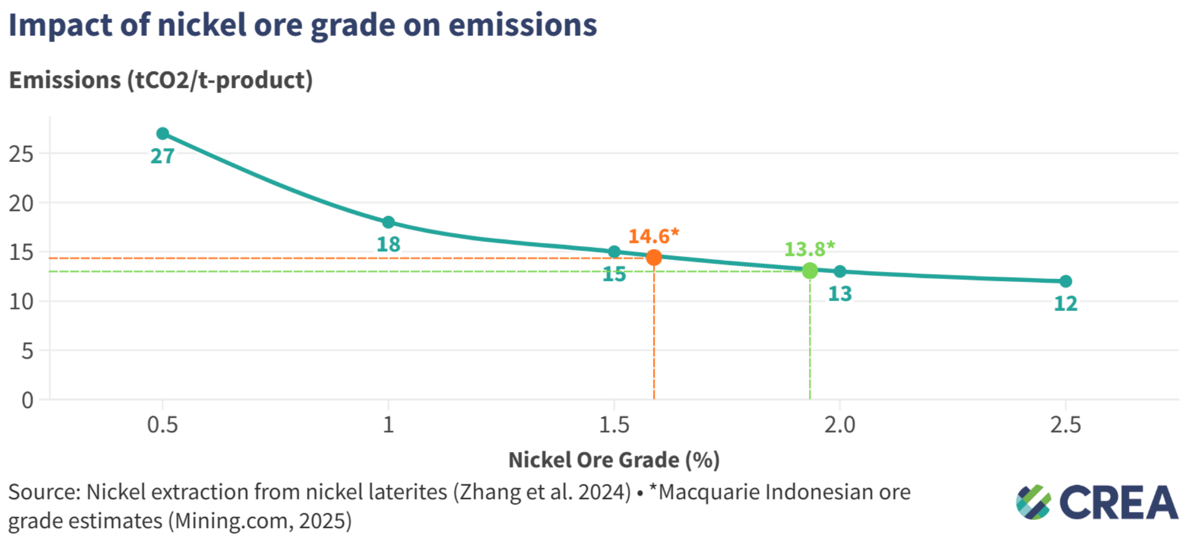
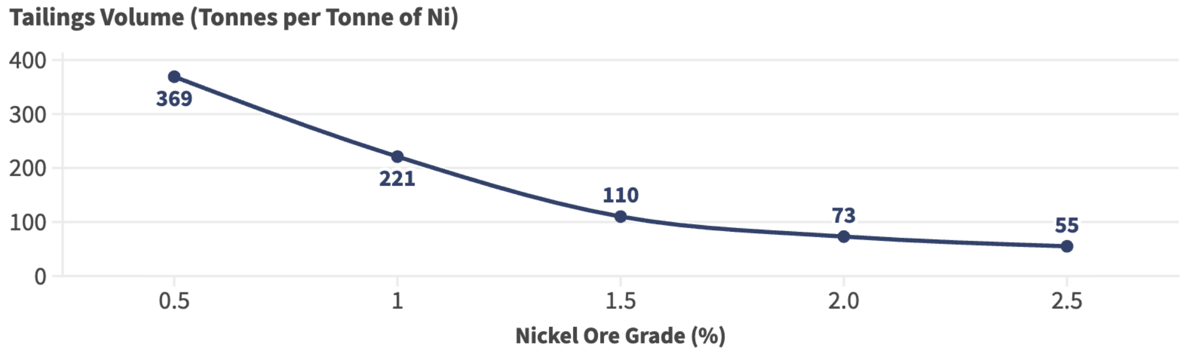


Figure 6 - Nickel ore grade and emission intensity relationship

Beyond energy, lower nickel ore grades also significantly increase the volume of tailings produced during hydrometallurgical processing. Figure 7 illustrates that with an average Indonesian ore grade of approximately 1.7% Ni and 90% recovery, there will be about 65 tonnes of tailings per tonne of nickel to be generated (Zhang et al., 2025).

While a formal ban on Deep Sea Tailings Placement for new projects has been enforced by the government, the transition remains fraught with risk as high-grade ore is depleted and waste volumes surge (CNBC Indonesia, 2023). As ore grades drop below 1.5%, tailings production can skyrocket to 200 tonnes per tonne of nickel, potentially a burgeoning crisis for HPAL facilities. Recently, in February 2026, a worker in IMIP was killed in an incident at an HPAL tailings storage facility, highlighting real safety risks associated with large-scale tailings accumulation, even with dry stacking. The incident has been widely criticised by civil society groups as evidence of systemic failures in tailings management and workers' safety in the nickel industry (Mongabay, 2026a).

Impact of nickel ore grade on tailings production



Source: Nickel extraction from nickel laterites (Zhang et al. 2024)

Figure 7 - Impact of nickel ore grade on tailings production

Why global EV battery trends may outpace Indonesia's nickel strategy

While nickel has been positioned as one of the critical minerals powering an energy transition, the majority of Indonesia's nickel output remains tied to stainless steel. New HPAL projects have been announced and signal an intended shift and increase in capacity, but much of this is still in the early stages. At the same time, global EV battery trends are moving away from nickel dependence with the rise of LFP (Lithium Iron Phosphate) in major markets. This poses a major risk as Indonesia has made a heavy investment in a nickel-centric value chain that may become out of sync with a rapidly evolving market prioritising nickel-free alternatives.

While several HPAL projects are planned or under construction in Indonesia, recent data shows that most of the capacity remains at these early stages and has yet to materialise at scale (UMD CGS, 2025). As a result, the current development trajectory still falls short of the government's ambition to establish a large EV battery manufacturing ecosystem.

Figure 8 compares the comparative scale between RKEF and HPAL smelters, and the breakdown of HPAL smelter capacity distribution over the years.

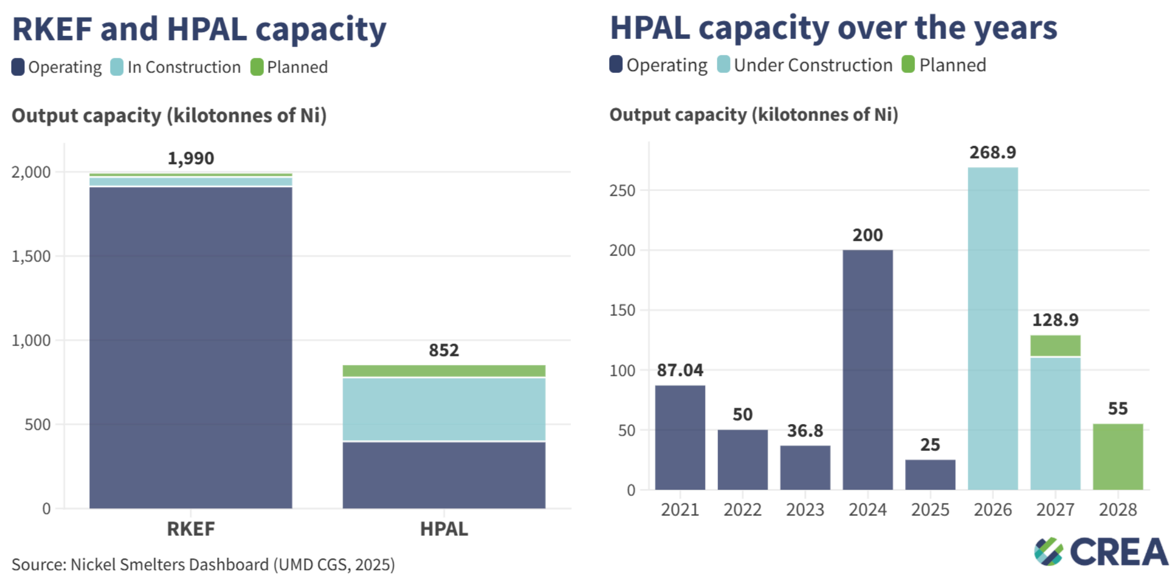


Figure 8 - RKEF and HPAL smelters capacities in Indonesia

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In 2025, approximately 83% of Indonesia's nickel production was used for stainless steel production, with only 17% going into battery precursors (UMD CGS, 2025). This aligns with current end-use demand patterns, which indicate that stainless steel continues to account for the majority of global Class 2 nickel demand. While the RKEF smelter dominance shown in Figure 8 remains the volume leader for stainless steel, the combined capacity of all HPAL projects is expected to bring total MHP output from Indonesia to reach over 800,000 tonnes in 2028, with anticipated additions over the next few years.

This anticipated surge would effectively push the battery precursor share of Indonesia's nickel production toward an estimated 30% in 2028, a significant shift from the 2025 figures, marking the country's ambition to make a leap from stainless steel to the global EV supply chain. This pivot represents a calculated institutional gamble: Indonesia is betting that by rapidly scaling HPAL capacity and downstream processing, it can secure its position as the indispensable supplier of nickel-intensive battery chemistries, even as the global market increasingly explores nickel-free alternatives.

As shown in Figure 9, global EV sales are projected to accelerate, but internal combustion engine (ICE) vehicles still account for the majority of global vehicle sales. Hence, a large share of nickel demand will continue to be tied to the ICE vehicle market, as stainless steel is commonly used in vehicle components.

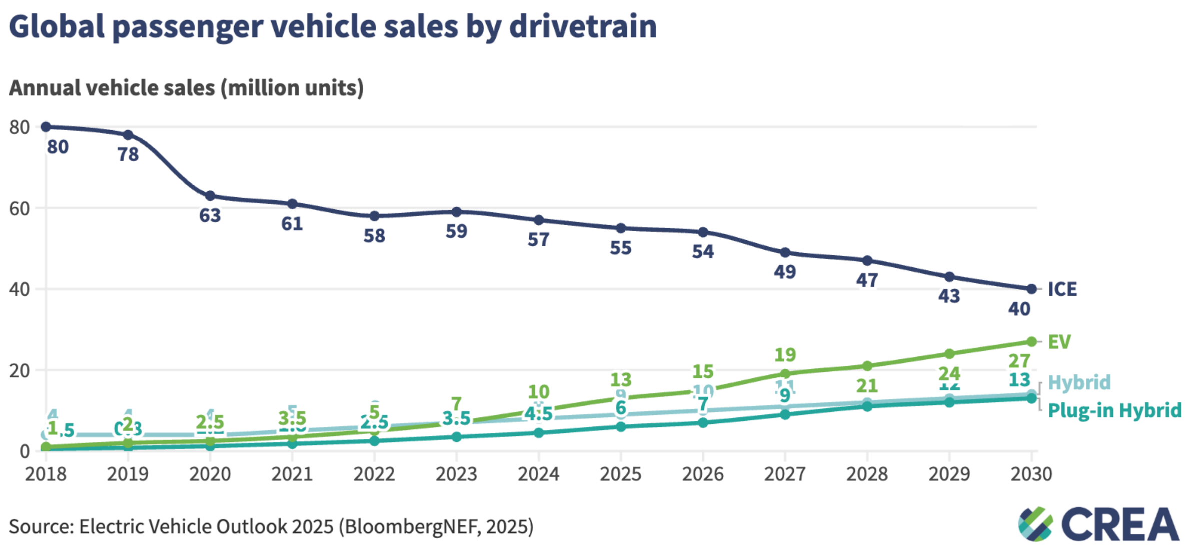

Figure 9 - Global passenger vehicle sales

Institutionally, Indonesia is attempting to force a pivot toward the battery industry. In 2021, the Ministry of State-Owned Enterprises launched Indonesia Battery Corporation (IBC) to develop Indonesia's integrated EV battery value chain and produce higher-value battery precursors. IBC is jointly owned by PT Antam Persero, state-owned mining holding MIND ID, PT Pertamina New & Renewable Energy, and PT PLN Persero with the aim of integrating upstream nickel extraction, battery materials processing, and battery recycling.

Several major battery projects have recently been advanced, signalling continued momentum in Indonesia's integrated battery strategy. Last year, *Proyek Dragon* was announced to be in the final investment decision phase of the project, estimated to reach USD 6 billion. This joint venture between PT Aneka Tambang Tbk (Antam) and CATL is targeting to produce 88,000 tonnes of NPI annually by 2027 and 55,000 tonnes of MHP by 2028 (Bloomberg Technoz, 2025).

More recently, the IBC has announced the commencement of feasibility studies for *Proyek Titan* with PT Aneka Tambang Tbk. (ANTAM) and Huayou consortium for the USD 6 billion project targeting 20 GWh capacity by the end of 2026 (BloombergTechnoz, 2026). This sparks further interest in Indonesia-China cooperation in the potential of stronger technology transfer and skill development framework in the battery supply chain (CELIOS 2025). What's more, the Ministry of Energy and Mineral Resources highlighted that beyond Indonesia's EV ambition, but this project also aligns with the government's broader 100 GW solar project announced by President Prabowo Subianto (Kompas, 2025a).

Together, these developments signal Indonesia's intention to lock in nickel-intensive battery chemistries as the backbone of its EV ecosystem. However, Indonesia's strategy is not monolithic, but rather adaptive to a diversifying global market. Other battery producers in Indonesia include PT HLI Green Power, a joint venture between Hyundai Motor Group and LG Energy Solution located in Karawang, with the capacity to produce 10 GWh of nickel-based batteries (HLI Green Power, n.d.). In contrast, Indonesia is also building capabilities in nickel-free battery components. PT LBM Energi Baru Indonesia in Kendal is developing LFP cathode production reaching 300,000 tonnes per year (Dewan Nasional Kawasan Ekonomi Khusus, 2024). PT Indonesia BTR New Energy Material also produces 80,000 tonnes of lithium battery anodes annually (Tempo, 2024).

While Indonesia remains bullish on its nickel reserves, the market is increasingly adopting nickel-free chemistries like LFP for mass-market applications. By fostering both NMC and LFP production, Indonesia is attempting to insulate the nickel industry against shifting global technology preferences, ensuring relevance regardless of whether the future favors energy density or cost-efficiency (IEA, 2025a).

Shown in Figure 10, LFP adoption in China has risen sharply in recent years. It has been reported that nickel-based batteries hold 19% share in the Chinese market in 2025, while LFP makes up over 80% (IEA, 2026).

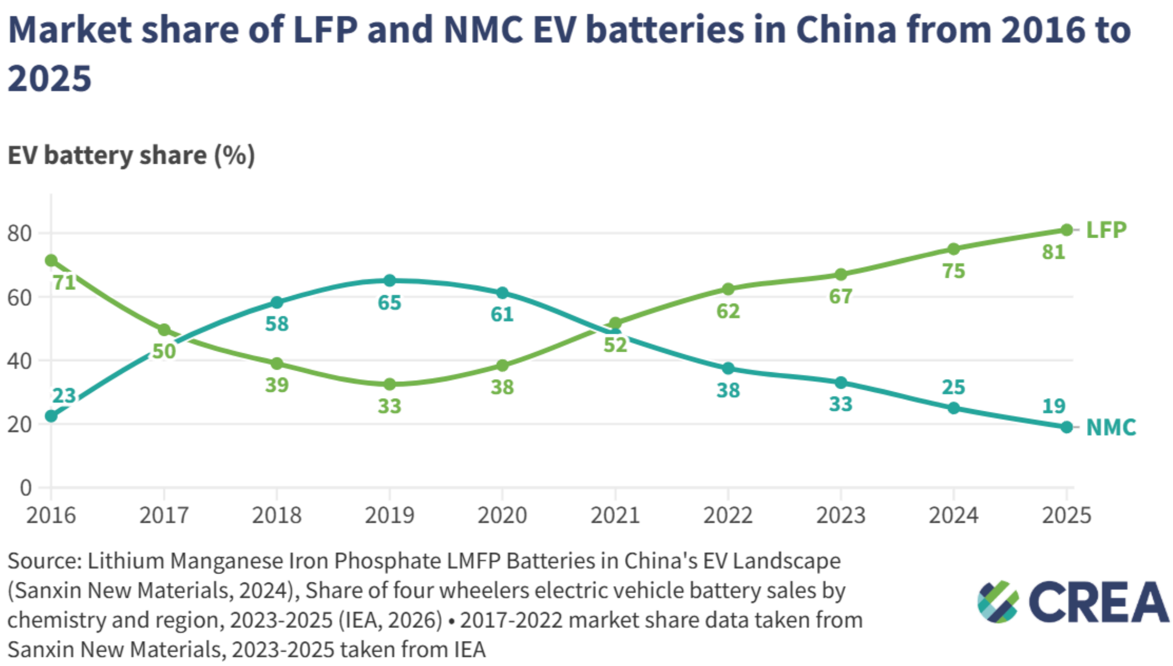

Figure 10 - Growing market share of LFP chemistry batteries in China

EV sales in Indonesia have grown rapidly in the last five years, growing from less than 500 units in 2021 to over 40,000 in 2024, and reaching the same volume only in the first half of 2025. The trend is also reflected in the domestic vehicle stock, which has grown to nearly 120,000 units, half of which was added in the last year (ICCT, 2025).

In 2025, nine out of 10 of EVs sold in Indonesia were made by Chinese brands. Chinese brand BYD alone makes up almost 50% of the total sales (Gaikindo, 2025). Chinese EV brands today heavily favor LFP batteries due to their cost effectiveness and lower overheating risks, as reflected in the growing market share in China. **Given the rapid uptake of LFP by these brands both domestically and across emerging markets, this trend is likely mirrored in Indonesia, indicating that a significant share of EVs sold in the country use nickel-free battery technologies (IEA, 2026).**

While NMC batteries remain more common in colder climates such as in North America and Europe, the global trend of LFP adoption in EVs is spreading beyond China. European manufacturers are beginning to adopt LFP to lower production costs and enhance competitiveness, signalling a gradual shift away from nickel-intensive battery chemistries. Although Europe's LFP expansion faces uncertainties due to China's proposed restrictions on the export of key battery technologies, the renewed interest in LFP nonetheless challenges Europe's historically strong focus on NMC (Brown, 2025). At the same time, sodium-ion batteries are gaining traction as a battery chemistry alternative suitable in sub-zero climates, making them a potential option if critical mineral supply tightens (Mashfy et al., 2026).

Nickel battery recycling represents a strategic pathway to manage rising demand amid tightening primary nickel supply. An estimate for nickel use in China's EV industry through 2050 shows that a closed-loop nickel recovery facility from end-of-life could supply between 68% and 97% of nickel demand (Zhang et al., 2023). This highlights the importance of prioritising efficient battery recycling to ease pressure on primary nickel extraction while improving the long-term sustainability of the battery supply chain.

Combined with advances in battery recycling and reuse, these developments indicate that EV manufacturers are structurally moving away from nickel-intensive chemistries, suggesting that future EV demand may not be sufficient to absorb Indonesia's rapidly expanding nickel supply. Furthermore, Indonesia risks disadvantaging domestic consumers by charging higher prices and offering shorter battery life compared to markets that adopt more flexible, cost-efficient battery technologies. As a result, Indonesia's nickel-heavy downstreaming strategy risks becoming increasingly misaligned with long-term global technological trends.

Futureproofing Indonesia's nickel hub in a fractured global market

As global markets transition to mandatory climate and environmental accountability standards, Indonesia risks marginalizing its nickel industry and losing access to high-value supply chains in strictly regulated jurisdictions. The industry's reliance on foreign capital and captive coal power, further exposes the sector to volatile price shocks and escalating geopolitical tensions. Without prioritising a clear and strategic pathway to a low-carbon future, Indonesia risks relegating its nickel output to lower-value, price-sensitive industrial segments, while premium, high-growth markets governed by stringent standards, shift their procurement to more compliant competitors.

The Government of Indonesia's ambition to position the country as an EV manufacturing hub remains a central justification for its nickel downstreaming push. State-owned initiatives such as the IBC reflect the government's long-term target of establishing 15 GWh of battery manufacturing capacity for EV and energy storage (MEMR, 2025). Despite recent developments, domestic capacity remains limited relative to the scale of nickel expansion. Given that nickel accounts for less than 2% of an electric car's value, there is a mismatch between Indonesia's nickel expansion strategy and domestic market absorption.

Today, Indonesia's high emission intensity increasingly limits competitiveness. Policy instruments such as the EU CBAM and Battery Passport are set to impose stricter environmental requirements on nickel products. The EU-Indonesia Comprehensive Economic Partnership Agreement (CEPA), expected to start in 2027, could help Indonesia expand its export markets for nickel and battery precursors if producers can meet the sustainability and traceability requirements (European Parliament, 2025). With the current landscape, Indonesian nickel risks being confined to the domestic market or to jurisdictions with weaker environmental standards.

The path to meeting these standards is heavily influenced by Chinese capital and technology, which dominate the Indonesian nickel sector. While China's 2022 Guidelines for Greening Foreign Investment first established the expectation for enterprises to follow international best practices, the recently launched 15th Five-Year Plan (2026–2030) has accelerated this into a mandatory compliance framework. Under China's 2025 Unified Green Taxonomy, financial institutions are now required to conduct portfolio-wide climate risk assessments, placing pressure on overseas nickel hubs such as IMIP and IWIP to align with international environmental benchmarks or risk losing access to competitive green credit (GFDC, 2022; GFDC, 2026).

Furthermore, the expansion of the China-EU Common Ground Taxonomy and the implementation of mandatory environmental disclosures for listed Chinese firms could provide a strategic bridge for Indonesian producers (Sino German Cooperation on Climate Change, 2025; China Briefing, 2026). By adhering to these harmonised standards, Chinese-Indonesian ventures can more effectively satisfy the EU Battery Passport and CBAM requirements. While a persistent gap remains between policy intent and on-the-ground implementation, alignment is no longer merely a preference, but a prerequisite for Indonesian nickel to bypass trade barriers and secure its position in high-premium global supply chains.

Low-carbon nickel demand is growing and beginning to command a price premium. Recently, the London Metal Exchange (LME) released low-carbon metal as a reference category. As of January 2026, low-carbon nickel has traded in the range of USD 18,800-19,300 per tonne, compared to USD 17,900-18,300 per tonne for higher carbon nickel (Kompas, 2026).

Indonesia's nickel industry is now unfortunately trapped in an 'energy and input vice'. Following the March 2026 Iran-Israel conflict, Brent crude surged toward USD 120 per barrel — a 1.5-fold surge from regular levels, triggering unexpected logistics cost inflation particularly for remote, off-grid industrial parks (BBC, 2026). Logistics expenses are estimated to have exceeded 40% of total operational costs, and as a consequence, nickel processing utilisation reportedly has dropped by 15–20% (Discovery Alert, 2026). Current geopolitical instability has paralysed the Strait of Hormuz as of the publishing this report, choking the supply of Middle Eastern sulfur that feeds 75% of HPAL needs. With sulfur prices up 440%, this single input now consumes nearly half of total MHP production costs (The Jakarta Post, 2026).

These external shocks are compounded by domestic regulatory constraints. The government has decided to cut coal and nickel ore production quotas, referred to as *Rencana Kerja dan Anggaran Biaya* (RKAB), to approximately 600 million (25% lower than 2025 quota) and 260 million tonnes (~32% lower than 2025 quota) for 2026, respectively (MEMR, 2025; Kontan, 2026). This has triggered local feedstock shortages as demands for high-premium coal exports driven by global energy insecurity increase. Consequently, nickel processing utilisation has dropped by 15–20%, leaving smelters to navigate a dual crisis of vanished margins and a massive ore deficit (Discovery Alert, 2026; SMM, 2026).

Indonesia's nickel industry is entering a new phase, shifting from rapid expansion towards stabilisation. Policies such as the nickel production quota reduction reflect the government's effort in stabilising nickel price and conserving high-grade ores (Tempo, 2026). The government previously moved to impose a moratorium on new intermediate nickel smelters under Government Regulation No. 28 Year 2025, putting focus on higher value-added processing (Petromindo, 2025a). While such a shift may address global imbalances in nickel supply and pricing, Indonesia has yet to establish a clear and concrete decarbonisation pathway, risking the long-term competitiveness and resilience of its industry.

Recommendations

The strategic pivot: Advancing high-value nickel production

The rapid expansion of the nickel industry has accelerated nickel ore depletion, particularly of higher-grade saprolite resources required for energy-intensive processing. When existing, under-construction, and planned capacities are combined, Indonesia's nickel ore reserves could be depleted as early as the early 2030s (Minviro, 2025).

As ore grades deteriorate, the industry faces compounding pressures from rising energy intensity, escalating costs, and higher carbon footprints. This accelerated depletion threatens to undermine the business case for clean energy infrastructure, as the operational life of many mines may now be shorter than the payback period required for large-scale renewable investments.

At the same time, Indonesia's EV-centric nickel ambition overlooks significant domestic technological and supply chain readiness. To transform these systemic risks into industrial resilience, the following strategic priorities are proposed for policy consideration:

- **Prioritise strategic diversification and value chain integration** — Expanding HPAL and other advanced refining technologies can support the production of higher-value derivatives, reducing the country's over-reliance on the stainless steel sector. Strengthening technology transfer and diversifying investment would serve as key levers for long-term industrial resilience.
- **Proactively address sustainability and governance challenges —** Institutionalizing rigorous environmental regulations and transparent governance is vital to resolving the 'dirty nickel' paradox, and securing access to markets where climate and environmental accountability is a core requirement and sustainability disclosure is a legal mandate.
- **Integrate circularity into downstreaming strategies** — Developing an efficient nickel recovery system would unlock meaningful emissions reductions, reduce pressure on primary mining, and cut emissions by up to 58% (EuRIC, 2022).
- **Cultivate a robust domestic workforce** — Investing in targeted human capital development would address the current gap in readiness, reducing vulnerability to external shocks and supporting the foundational goals of the Golden Indonesia 2045 vision.

The policy driver: Decoupling from captive coal power

The defining policy challenge is the sector's over-reliance on captive coal power, which locks the industry into a high-emission pathway and creates market risk. Decoupling the industry from captive coal power is therefore not only an environmental objective, but also a strategic industrial policy imperative to ensure a sustainable and future-proof nickel sector. To ensure long-term resilience, the government should:

- **Stop the construction of new high-carbon assets** — This necessitates an immediate amendment of Presidential Regulation No. 112 of 2022 to explicitly remove the coal power exemption for mineral processing. This sends an unambiguous signal that future production must be green.
- **Employ economic realignment to reflect true costs** — This includes applying emissions pricing or carbon taxes and internalizing the hidden externalities of coal. This shift will make renewable energy economically competitive at the project level, reflecting the market costs of carbon-intensive power.
- **Realign fiscal incentives to prioritise renewable energy over captive coal** — This includes revising tax holidays and tax allowances framework. Instead of granting tax breaks based solely on the size of the investment, the government should tier incentives based on a company's verified RE-replacement ratio. Larger exemptions should be reserved for those who actively displace coal with clean energy.
- **Link production quota with carbon intensity** — This means transforming the annual production quota process into a regulatory lever for decarbonisation. By tightening quotas for high-emission facilities and offering a 'green quota' to low-carbon operations, the government creates a direct operational penalty for remaining coal-dependent.
- **Standardise "Green Nickel" through Lifecycle Metrics** — This requires establishment of national industry standards based on Lifecycle Carbon Footprint, ensuring greening efforts are measurable, verifiable, and interoperable with global frameworks, turning compliance into a competitive advantage.
- **Unlock transition-linked financing** — Deployment of strategic financing schemes that recognize RE integration and carbon reduction milestones would focus efforts on financial de-risking, providing companies with lower-interest credit lines specifically for decommissioning captive coal and scaling utility-size storage.

References

Akhter, M. S., Moossa, B., Kahraman, R., Rasul, S., & Shakoor, R. A. (2025). *Advancements in high voltage, high-energy density, lithium-ion cathode materials: A focused review*. *Applied Materials Today*, *45*, Article 102827. https://doi.org/10.1016/j.apmt.2025.102827

ANTARA News. (2026). Nickel Industries integrates climate risks into long-term strategy. *ANTARA News.* https://en.antaranews.com/news/405810/nickel-industries-integrates-climate-risks-into-long-term-strategy

Asia Society Policy Institute. (2025). *Indonesia's Energy Transition: Exercising Strategic Agency in Partnership with China.* *https://asiasociety.org/policy-institute/indonesias-energy-transition-exercising-strategic-agency-partnership-china*

Bappenas & World Resources Institute (WRI) Indonesia. (2025). Peta Jalan Dekarbonisasi Industri Nikel Indonesia. https://wri-indonesia.org/id/berita/kementerian-ppnbappenas-dan-wri-indonesia-memastikan-integrasi-dekarbonisasi-industri-nikel

BBC. (2026). Oil price jumps despite deal to release record amount of reserves. https://www.bbc.com/news/articles/c1w5141vx53o

Bloomberg Technoz. (2025). Antam-CATL Masuki Tahap Akhir FID Proyek HPAL Rp31,1 T. *Bloomberg Technoz.* https://www.bloombergtechnoz.com/detail-news/83745/antam-catl-masuki-tahap-akhir-fid-proyek-hpal-rp31-1-t

Bloomberg Technoz. (2026). Bos IBC Bidik Kajian Proyek Titan Bareng Huayou Rampung Tahun Ini. *Bloomberg Technoz.* https://www.bloombergtechnoz.com/detail-news/98191/bos-ibc-bidik-kajian-proyek-titan-bareng-huayou-rampung-tahun-ini

Brown, A. (2025). Chinese restrictions threaten Europe's hopes of absorbing battery tech. *Merics.* https://merics.org/en/comment/chinese-restrictions-threaten-europes-hopes-absorbing-battery-tech

BYD. (n.d.). *BYD Blade Battery: Why It's the Safest and Most Reliable Battery for Electric and Hybrid Cars*. https://www.byd.com/eu/technology/byd-blade-battery

Caixin Global. (2026). In Depth: How Indonesia Cornered the Nickel Market — and Itself. *Caixin Global.*

https://www.caixinglobal.com/2026-01-09/in-depth-how-indonesia-cornered-the-nickel-market-and-itself-102402085.html

Center of Economic and Law Studies (CELIOS). (2025). *China-Indonesia Energy Transition Cooperation: Progress, Prospects, and Recommendations.* https://celios.co.id/wp-content/uploads/2025/10/Celios-China-Indonesia-Energy-Transition.pdf

Center for Advanced Defense Studies (C4ADS). (2025). *Refining Power.* https://c4ads.org/commentary/refining-power/#Ownership

Centre for Research on Energy and Clean Air (CREA). (2025). *Biomass co-firing in Indonesia: Prolonging, not solving coal problem.* https://energyandcleanair.org/publication/biomass-co-firing-in-indonesia-prolonging-not-solving-coal-problem/

Centre for Research on Energy and Clean Air (CREA) & Center of Economic and Law Studies (CELIOS). (2024). *Debunking the Value-Added Myth in Nickel Downstream Industry.* https://energyandcleanair.org/wp/wp-content/uploads/2024/02/CREA_CELIOS-Indonesia-Nickel-Development_EN.pdf

China Briefing. (2026, January 6). *China's ESG compliance: 2025 review and 2026 outlook for businesses.* https://www.china-briefing.com/news/china-esg-compliance-year-in-review-and-2026-outlook/

Climateworks Centre. (2026, March 17). *Decarbonising Indonesia's high-value industrial sites through place-based action.* https://climateworkscentre.org/resource/decarbonising-indonesias-high-value-industrial-sites-through-place-based-action/

CNBC Indonesia. (2023, July 25). Tegas! Luhut: Limbah Nikel Tidak Diizinkan Dibuang Ke Laut. https://www.cnbcindonesia.com/news/20230725142816-4-457139/tegas-luhut-limbah-nikel-tidak-diizinkan-dibuang-ke-laut

Dewan Nasional Kawasan Ekonomi Khusus. (2024). *PT LBM Energi Baru Indonesia Dorong Ekosistem Kendaraan Listrik di KEK Kendal, Bawa Dampak Ekonomi Signifikan*. https://kek.go.id/media/press/pt-lbm-energi-baru-indonesia-dorong-ekosistem-kendaraan-listrik-di-kek-kendal-bawa-dampak-ekonomi-signifikan

Discovery Alert. (2026). Indonesia's Nickel Processing Faces 15-20% Utilisation Decline in 2026. https://discoveryalert.com.au/indonesia-nickel-processing-utilization-2026-challenges/

DNV. (2024). Decarbonizing the Nickel Industry in Indonesia. https://www.dnv.com/publications/decarbonizing-the-nickel-industry-in-indonesia/

Energy Shift Institute. (2025). A dual-track approach to mineral-led industrialisation in Indonesia. *Energy Shift Institute.* https://energyshift.institute/work/a-dual-track-approach-to-mineral-led-industrialisation-in-indonesia-evs-and-batteries-lead-the-headlines-but-metallurgical-applications-are-more-scalable-with-greater-scope-to-encourage-sme-inclusio/

EuRic. (2022). Metal Recycling Factsheet. https://euric.org/resource-hub/reports-studies/metal-recycling-factsheet

European Parliament. (2025). The EU-Indonesia Comprehensive Economic Partnership Agreement (CEPA). *European Parliamentary Research Service.* https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/782584/EPRS_BRI(2025)782584_EN.pdf

Gaikindo. (2025). *Penjualan Mobil Listrik Nasional Januari - November 2025 Capai 82.525 Unit.* https://www.gaikindo.or.id/penjualan-mobil-listrik-nasional-januari-november-2025-capai-82-525-unit/

Green Finance & Development Center (GFDC). (2022, January 18). *Interpretation of the 2022 "Guidelines for ecological environmental protection of foreign investment cooperation and construction projects".* https://greenfdc.org/interpretation-2022-guidelines-ecological-environmental-protection-of-foreign-investment-cooperation-and-construction-projects/

Green Finance & Development Center (GFDC). (2026, February 24). *China green finance status and trends 2025-2026.* https://greenfdc.org/china-green-finance-status-and-trends-2025-2026/

Halmahera Persada Lygend. (2024). Sustainability Update Report. https://hpalnickel.com/keberlanjutan/keberlanjutan

Harita Nickel. (2024). *Sustainability Report 2024.* https://tbpnickel.com/en/sustainability-report-2024

PT HLI Green Power. *Facility Overview.* https://www.hligreenpower.com/en/factory

Indonesia Morowali Industrial Park (IMIP). (2025). *Upaya Ciptakan Ekosistem Energi Bersih di Kawasan IMIP.* https://imip.co.id/upaya-ciptakan-ekosistem-energi-bersih-di-kawasan-imip/

International Council on Clean Transportation (ICCT). (2025). Electric Vehicle Market in Indonesia*. Market Spotlight.*
https://theicct.org/publication/electric-vehicle-market-in-indonesia-dec25/

Institute for Essential Services Reform (IESR). (2025, June 30). Flexibility in power system development Sulawesi case study.
https://iesr.or.id/en/pustaka/flexibility-in-power-system-development-sulawesi-case-study/

International Energy Agency (IEA). (2025). *Global critical minerals outlook 2025.*
https://www.iea.org/reports/global-critical-minerals-outlook-2025

International Energy Agency (IEA) (2025a), Global EV Outlook 2025, IEA, Paris
https://www.iea.org/reports/global-ev-outlook-2025, Licence: CC BY 4.0

International Energy Agency (IEA). (n.d.). *Reliable supply of mineral*s. International Energy Agency.
https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/reliable-supply-of-minerals

International Energy Agency (IEA). (2026). *Global battery markets are growing strongly - and so are the supply risks*. International Energy Agency.
https://www.iea.org/commentaries/global-battery-markets-are-growing-strongly-and-so-are-the-supply-risks

The Jakarta Post. (2026). *Indonesia's HPAL plants scramble as Iran war threatens sulfur supply.*
https://www.thejakartapost.com/business/2026/03/13/indonesias-hpal-plants-scramble-as-iran-war-threatens-sulfur-supply.html

Jaringan Advokasi Tambang (Jatam). (2026). *The 2025–2026 Indonesia–United States Reciprocal Trade Agreement: Entrenching Extractivism, Eroding Indonesian Sovereignty.*
https://jatam.org/id/lengkap/Indonesia-USA-Reciprocal-Trade-Agreement

Just Energy Transition Partnership (JETP) Indonesia. (2025). *Captive Power Study.*
https://jetp-id.org/news/captive-power-study

Koech, A. K., Mwandila, G., Mulolani, F., & Mwaanga, P. (2024). *Lithium-ion battery fundamentals and exploration of cathode materials: A review*. *South African Journal of Chemical Engineering*, *50*(1), 321–339. https://doi.org/10.1016/j.sajce.2024.09.008

Kontan. (2026). ESDM Setujui RKAB Batubara 390 Juta Ton dan Nikel 100 Juta Ton per 17 Maret 2026.
https://industri.kontan.co.id/news/esdm-setujui-rkab-batubara-390-juta-ton-dan-nikel-100-juta-ton-per-17-maret-2026

Kompas. (2025). *Indonesian Nickel Under Pressure from Global Trade and Environmental Pollution.* https://www.kompas.id/artikel/en-nikel-indonesia-dalam-tekanan-perdagangan-global-dan-isu-lingkungan

Kompas. (2025a). *Presiden Prabowo Berpeluang Jadikan Indonesia Pemimpin Transisi Energi lewat Program 100 GW Surya.* https://lestari.kompas.com/read/2025/10/28/160446486/presiden-prabowo-berpeluang-jadikan-indonesia-pemimpin-transisi-energi-lewat

Kompas. (2026). M*enata pasokan dan pacu hilirisasi: Bagaimana nasib tambang RI*. Kompas. https://www.kompas.id/pro/artikel/menata-pasokan-dan-pacu-hilirisasi-bagaimana-nasib-tambang-ri

Lembaga Penyelidikan Ekonomi dan Masyarakat Fakultas Ekonomi & Bisnis Universitas Indonesia (LPEM FEB UI) (2025). *Balancing Act: Complementary Strategies for Indonesia's Sustainable Nickel Downstream Industry.* https://lpem.org/balancing-act-complementary-strategies-for-indonesias-sustainable-nickel-downstream-industry/

Mining.com. (2025). Will Indonesia shut the nickel spigot to spur prices?. *Mining.* https://www.mining.com/will-indonesia-shut-the-nickel-spigot-to-spur-prices/

Ministry of Energy and Mineral Resources (MEMR-JDIH). (2019). Legal Documentation and Information Network (Jaringan Dokumentasi dan Informasi Hukum, JDIH). Regulation of the Minister of Energy and Mineral Resources Number 11 of 2019 concerning the Second Amendment to the Regulation of the Minister of Energy and Mineral Resources Number 25 of 2018 concerning the Business of Mineral and Coal Mining. https://jdih.esdm.go.id/index.php/web/result/1946/detail

Ministry of Energy and Mineral Resources (MEMR). (2020). *Booklet Tambang Nikel 2020.* https://www.esdm.go.id/id/booklet/booklet-tambang-nikel-2020

Ministry of Energy and Mineral Resources (MEMR). (2025). Indonesia Bangun Industri Baterai Listrik Teritegrasi, Ini Rincian Proyeknya. https://www.esdm.go.id/id/media-center/arsip-berita/indonesia-bangun-industri-baterai-listrik-terintegrasi-ini-rincian-proyeknya

Minviro. (2025). *Indonesia's Nickel Transition - From High-Carbon Production to Low-Carbon Nickel: Indonesia's Path to Sustainable Supply*. https://www.minviro.com/resources/guides/indonesias-nickel-transition

Mongabay. (2026). *US-Indonesia trade deal slammed as 'extractive colonialism' over mining, fossil fuels.*

CREA

https://news.mongabay.com/2026/03/us-indonesia-trade-deal-slammed-as-extractive-colonialism-over-mining-fossil-fuels/

Mongabay. (2026a). *Lagi, Pekerja Tewas Tertimbun Longsoran Limbah Nikel di Kawasan Industri PT IMIP.* https://mongabay.co.id/2026/02/23/lagi-pekerja-tewas-tertimbun-longsoran-limbah-nikel-di-kawasan-industri-pt-imip/

Nickel Industries. (2023, November). *Notice of Extraordinary General Meeting, November 2023*. https://nickelindustries.com/carbon/assets/2023/11/2639228.pdf

Otoritas Jasa Keuangan (OJK). (2025). Taksonomi untuk Kuangan Berkelanjutan Indonesia Versi 2. https://ojk.go.id/id/Publikasi/Roadmap-dan-Pedoman/Sektor-Jasa-Keuangan/Keuangan-Berkelanjutan/Pages/Buku-Taksonomi-untuk-Keuangan-Berkelanjutan-Indonesia-%28TKBI%29-Versi-2.aspx

Peh, G. (2024). *Indonesia's nickel companies need renewable energy to decarbonize operations (IEEFA Report).* https://ieefa.org/sites/default/files/2024-10/IEEFA%20Report%20-%20Indonesia%27s%20nickel%20companies%20need%20RE_Oct2024.pdf

Petromindo. (2025). *IWIP to invest $2 billion in renewables at Weda Bay nickel hub.* https://www.petromindo.com/news/article/iwip-to-invest-2-billion-in-renewables-at-weda-bay-nickel-hub-2

Petromindo. (2025a). *Indonesia's nickel industry in 2025: From expansion to stabilization*. https://www.petromindo.com/news/article/indonesia-s-nickel-industry-in-2025-from-expansion-to-stabilization

Petromindo. (2026). *SESMO starts construction of 262 MWp solar project in Morowali.* https://www.petromindo.com/news/article/sesmo-starts-construction-of-262-mwp-solar-project-in-morowali

RMI. (2025). *Advancing clean metals: Decarbonizing captive power in Indonesia's nickel and aluminum industries*. Rocky Mountain Institute. https://rmi.org/insight/advancing-clean-metals-decarbonizing-captive-power-in-indonesias-nickel-and-aluminum-industries

SESNA - PT Sumber Energi Surya Nusantara. (2026, April 6). *SESMO Siap Masuki Konstruksi Proyek PLTS 262 MWP dengan Dukungan Pembiayaan BNI.* https://sesna.id/media/news/detail/sesmo-siap-masuki-konstruksi-proyek-plts-262-mwp-dengan-dukungan-pembiayaan-bni

Shanghai Metals Market (SMM). (2025). *250M Ton RKAB Quota Gamble: Is Indonesia About to Break the Global Nickel Market?.*

https://news.metal.com/newscontent/103686533-%E3%80%90smm-analysis%E3%80%91250m-ton-rkab-quota-gamble-is-indonesia-about-to-break-the-global-nickel-market

Sino German Cooperation on Climate Change. (2025, September 11). *The Chinese and European Union's Common Ground Taxonomy (CGT).* https://climatecooperation.cn/climate/the-chinese-and-european-unions-common-ground-taxonomy-cgt/

Sunuhadi, D. N., Ernowo, Hilman, P. M., & Suseno, T. (2024). *Availability of Indonesian nickel reserves and efforts to improve reserves resistance and its impact to economic growth.* Mineral Economics, 37(3), 601-617. https://doi.org/10.1007/s13563-024-00443-0

Tempo. (2024). Pabriknya Diresmikan Presiden Jokowi, Apa Itu Anoda Baterai Lithium?. *Tempo.* https://www.tempo.co/arsip/pabriknya-diresmikan-presiden-jokowi-apa-itu-anoda-baterai-lithium--29429

Tempo. (2025). China's investment in Indonesia hits US$35.3 billion. *Tempo*. https://en.tempo.co/read/2043827/chinas-investment-in-indonesia-hits-us35-3-billion

Tempo. (2026). Nickel Prices Recover to US$17,000 as Indonesia Cuts Production. *Tempo.* https://en.tempo.co/read/2096829/nickel-prices-recover-to-us17000-as-indonesia-cuts-production#google_vignette

United States Geological Survey (USGS). (n.d.). *Nickel statistics and information*. Retrieved March 26, 2026, from https://www.usgs.gov/centers/national-minerals-information-center/nickel-statistics-and-information

University of Maryland, Center for Global Sustainability (UMD CGS). (2025). *Nickel Smelters Dashboard.* https://cgsnickelsmelters.org/index.html

Wei, W., Samuelsson, P. B., Tilliander, A., Gyllenram, R., & Jönsson, P. G. (2020). Energy Consumption and Greenhouse Gas Emissions of Nickel Products. *Energies (Basel)*, *13*(21), 5664. https://doi.org/10.3390/en13215664

Wood Mackenzie. (2022). *Nickel and copper: building blocks for a greener future.* https://www.woodmac.com/news/opinion/nickel-and-copper-building-blocks-for-a-greener-future/

Wood Mackenzie. (2025). *Nickel: Looking for a route back to safety.* https://www.woodmac.com/news/opinion/nickel-looking-for-a-route-back-to-safety/

World Resources Institute (WRI). (2026, January 6). *Nickel's climate cost and Indonesia's push for cleaner production.*

https://www.wri.org/technical-perspectives/nickels-climate-cost-and-indonesias-push-cleaner-production

Wuling Motors Indonesia. (2025). *Mengenal LFP, Baterai Mobil Listrk yang Digunakan Wuling.* https://wuling.id/id/blog/autotips/mengenal-lfp-baterai-mobil-listrik-yang-digunakan-wuling

Zhang, H., Liu, G., Li, J., Qiao, D., Zhang, S., Li, T., Guo, X., & Liu, M. (2023). Modeling the impact of nickel recycling from batteries on nickel demand during vehicle electrification in China from 2010 to 2050. *The Science of the Total Environment*, *859*(Pt 1), Article 159964. https://doi.org/10.1016/j.scitotenv.2022.159964

Zhang, Z., Zhang, W., Zhang, Z., & Chen, X. (2025). Nickel extraction from nickel laterites: Processes, resources, environment and cost. China Geology, 8(1), 187–213. https://doi.org/10.31035/cg2024124

Zhao, J. (2023). Lithium Manganese Iron Phosphate (LMFP) Batteries Receiving Renewed Attention in China. *Mitsui & Co. Global Strategic Studies Institute Monthly Report.* https://www.mitsui.com/mgssi/en/report/detail/__icsFiles/afieldfile/2023/09/19/2308t_zhao_e.pdf