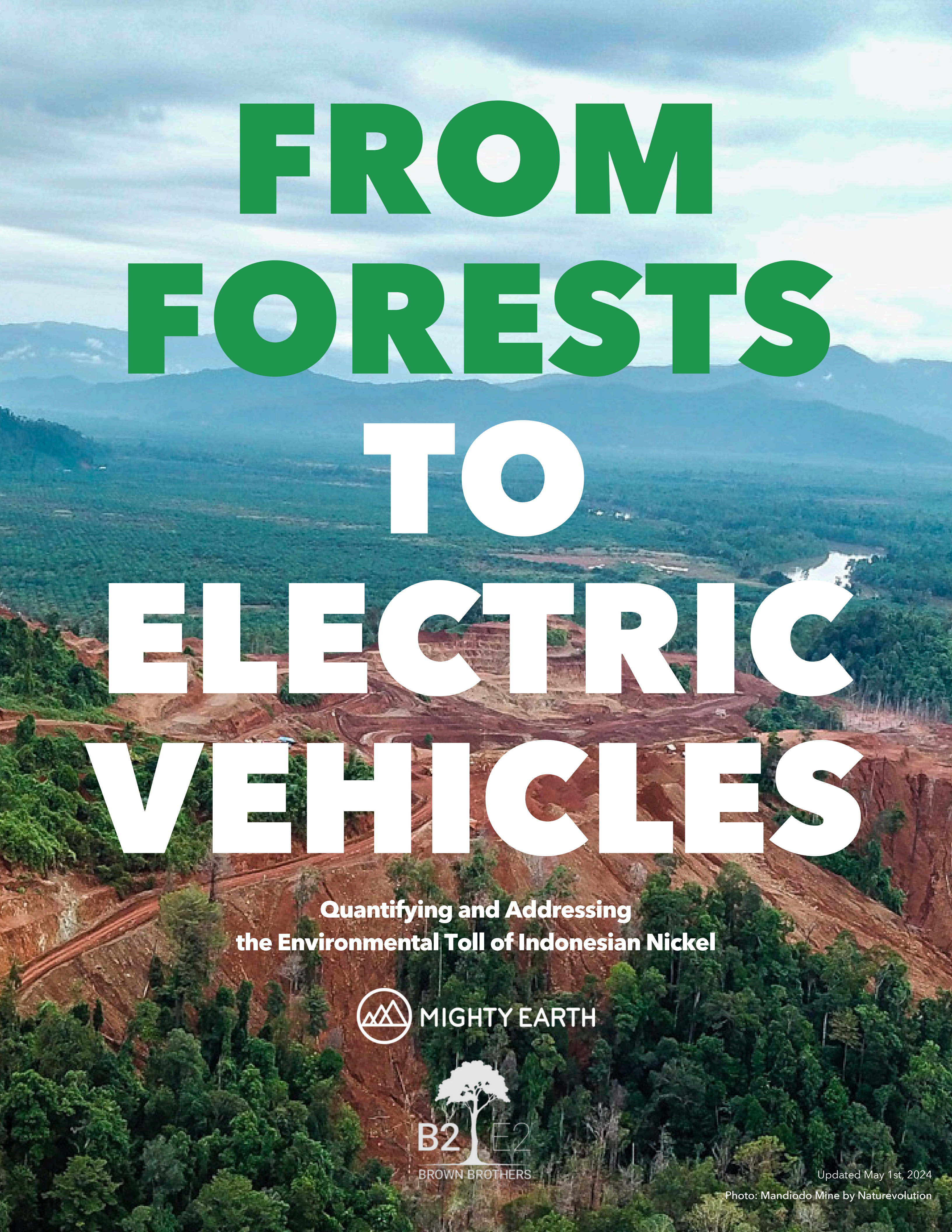

FROM FORESTS TO ELECTRIC VEHICLES

Quantifying and Addressing the Environmental Toll of Indonesian Nickel

MIGHTY EARTH

B2 E2
BROWN BROTHERS

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Photo: Mandiodo Mine by Naturevolution

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EXECUTIVE SUMMARY

Nickel is an important mineral for the manufacture of electric vehicles (EVs). The switch from internal combustion engines to electric vehicles offers major carbon benefits. But the rush to mine nickel as demand increases is having under-appreciated and significant impacts on the environment. To move forward and achieve a responsible transition to a low-carbon future, nickel mining must adequately protect forests and oceans while safeguarding human rights and health.

Found only in tiny amounts in the earth's crust, nickel is a significant mineral for global manufacturing with unique uses in creating alloys like stainless steel. It is also a key resource required for the transition to electric vehicles because of its use in relatively lightweight longer-range lithium-ion batteries. As the world rightly moves away from fossil fuels and the internal combustion engine, a new reliance on nickel is taking hold. It is mined worldwide, and the largest producers are Indonesia, the Philippines, New Caledonia, Australia, Russia and Canada. Currently, more than half of the world's nickel comes from Indonesia, home to the world's largest reserves, and its extraction is already having a significant impact on Indonesia's forests. Meanwhile, the availability of plentiful, low-cost nickel from Indonesia has caused the global price of nickel to plummet, threatening operations in other countries and causing mines to close.

Nickel mined in Indonesia is made into battery-ready materials, battery components and batteries in China, South Korea and Japan, which are then put into electric cars by at least twenty major EV manufacturers and sold in markets around the world.

Conservatively, Indonesia's nickel industry is already responsible for more than 75,000 hectares of tropical forest loss (an area larger than Singapore). If nickel mining continues with status quo practices, we will continue to see environmental devastation – an unintended consequence of the long-overdue transition to EVs and the resulting spike in demand for nickel. The lower grade nickel produced in Indonesia leads to deforestation, as new areas of critical forests are cleared by nickel strip mines. Moreover, coal-powered nickel refinery operations in Indonesia now exceed in size all coal power plants in the entire country of Pakistan. Toxic tailing piles from these refineries are building up, and there appears to be no easy way to dispose of them either legally or sustainably. Fortunately, there is another path: Better siting of nickel mines could prevent deforestation. Mining on already-developed land could protect critical habitats and protect the climate.

This report examines Indonesia as a case-study in nickel mining because of the large share of nickel that comes from Indonesia and the toxic process needed to refine this lower grade nickel into EV battery precursor materials. While our recommendations will focus on Indonesia, many will apply to best practices in other countries.

Findings

Mighty Earth investigated the 329 nickel concessions that are acknowledged by Indonesia's Ministry of Energy and Mineral Resources as the basis for this report, and we have highlighted the 25 nickel concessions in which the highest amounts of deforestation are taking place. We also examined some of the human and environmental impacts of nickel mining operations on a small island off the coast of Sulawesi.

- Conservatively, Indonesia's nickel mines have cleared more than **75,000 hectares** of forest to extract nickel.
- More than **half a million** additional hectares of Indonesian forest are within nickel concessions, putting them at risk for deforestation.
- **The rate of deforestation is likely accelerating**; RADD (radar) alerts show more than twice as much forest clearance in 2023 than in 2020.
- Of the 25 concessions we looked at in detail, six are 75% High Carbon Stock (HCS) forest or higher meaning these concessions contain significant amounts of intact forests. Fourteen are about 50% or less High Carbon Stock Forest meaning that they main contain substantial amounts of degraded land.
- Six of the 25 concessions contain forests classified by the International Union for the Conservation of Nature as "Key Biodiversity Areas," important habitats for critical species protection and unique ecosystems.
- The investigation **uncovered potential illegality** in some of these concessions.
    - At least three of these concessions have cleared Protection Forests (which are set aside to protect life and ecosystems) without the prior exemptions that would have allowed them to do so legally.
    - More than a quarter of the mines examined have strip-mined within 100 meters of the ocean, which is, at best, a legally contested practice.
    - Five of the top 25 deforesting nickel mines have cleared Production Forests (which are set aside for forestry uses) without the legally required Borrow and Use Permit (more recently known as a Forest Area Use Permit). 2,654 hectares of production forest have been illegally cleared by these mines.[1]
- A survey and photo documentation of Kabaena island found that nickel mining companies have illegally cleared Protection Forests and Production Forests and did not seek the FPIC (Free, Prior and Informed Consent) of local communities. Most inhabitants of these communities, many of whom are Bajau seafarers, have experienced **health,**

[1] A previous version of this report stated that 6,600 hectares of production forest have been illegally cleared. The updated number of 2,654 ha reflects the inclusion of Minerba One Map Indonesia data from the Ministry of Energy and Mineral Resources and the Persetujuan Pengunaan Kawasan Hutan (PPKH) layer from the Ministry of Environment and Forestry.

environmental, and economic impacts from mining-contaminated freshwater and seawater, and have not been adequately compensated.

Recommendations

There is a path forward for responsible mining of nickel. Not only can the Indonesian government further investigate the potential illegalities we have uncovered, but EV manufacturers and other downstream manufacturers can play a significant role in raising the standards for their supply chains.

1. The nickel mining industry and their customers need to uphold **Free, Prior and Informed Consent** (FPIC) of Indigenous and local communities, including the right to withhold consent to the development of nickel infrastructure. They also must ensure adequate compensation for communities who experience harms. We strongly encourage all actors to join the **Initiative for Responsible Mining** (IRMA) and adopt its standards. IRMA is the only independent third-party program for assessing industrial-scale mine sites for all mined materials. It is governed equally by the private sector, communities, civil society, and workers.
2. EV manufacturers must audit their full supply chains all the way back to the mines where the nickel in their EV batteries originates. Until the following EV brands **implement greater supply chain traceability and transparency**, it cannot be ruled out that their vehicles contain Indonesian nickel linked to deforestation: Dongfeng, SGMW, SRRC, Weltmeister, Xiamen Kinglong, Ford, GM, Lucid and Tesla, Audi, BMW, Daimler, Mercedes-Benz, Volkswagen, Honda, Toyota, Hyundai, Kia, PSA, Volvo, and Jaguar.
    - In the US, this audit is required under the US Inflation Reduction Act, and automakers must complete this process if they want their customers to qualify for a $3,750 per vehicle government tax rebate.
    - In the EU, the EU Battery Regulation requires this audit, as well as the identification of nickel mines that destroy biodiverse lands and forests or damage waterways.
    - Pressure from manufacturers to their suppliers could encourage nickel mines to reform their practices or (as stipulated in the EU Battery Regulation) manufacturers could consider removing those mines from their supply chains.
3. Nickel mines and their customers must ensure that the "mitigation hierarchy" of Avoid, Minimize, Restore and Offset is followed:
    - The nickel industry in Indonesia is in a position where it can embrace the "Avoid" part of the hierarchy by mining on already developed and deforested land, **leaving important forest habitats intact**.
4. In Indonesia, the government must find ways to **enforce existing laws and expand those laws** to further minimize environmental impacts.

a. The government should further examine potentially illegal mining and the breaking of national forestry laws.
b. Indonesia should award nickel concessions on already-degraded land, to minimize the environmental impact and avoid clearing of highly biodiverse forests.
c. Mining companies should rehabilitate any environmental degradation caused by their operations.
d. Indonesia should establish a moratorium preventing new permits for captive coal plants to smelt or refine nickel.

5. Elsewhere, the US and the EU must strengthen their tools to promote supply chain traceability and **ensure the highest environmental and social standards are upheld** in nickel mining anywhere in the world. Consumer countries like these must also adopt policies to promote mineral circularity to reduce demand for mined minerals.

The mining of nickel in Indonesia is inevitable and, in many ways, important for the global transition from internal combustion engines to the wider adoption of electric vehicles. Without a shift to EVs, it will be nearly impossible to meet our climate goals. However, the destruction of vital and unique habitats, causing further losses of key species and biodiversity, is not inevitable. The area of Indonesia affected by nickel mining is home a dizzying array of endemic species like anoas (miniature buffalo); the babirusa ("pig deer" in Indonesian) with long curved upper tusks; the critically endangered maleo bird, which uses geothermal vents to incubate eggs; and 17 different species of macaque monkeys and tarsiers. Deforestation remains the primary factor in the loss of species in Indonesia.

The alarming increase in the rate of deforestation threatens the habitats of these species, the health and safety of the Indonesian people through ever-growing toxic tailings piles, and the global climate through both deforestation and coal-powered nickel smelting and refining.

In the rest of the report, we will detail our findings across mining concessions and show how we can avoid the worst-case scenario of irreversible habitat and species loss.

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INTRODUCTION

"We can see that the energy transition depends on batteries; batteries depend on nickel, and nickel growth depends on Indonesia. Without Indonesian nickel, there will be no energy transition."
Stephen Brown, August 2022 (Nikkei Asia 2022)

"Nickel is the biggest challenge for high-volume, long-range batteries! Australia & Canada are doing pretty well. US nickel production is objectively very lame. Indonesia is great!"
Elon Musk, CEO of Tesla, July 2020 (Nikkei Asia 2022)

In recent years, nickel mining across Eastern Indonesia has laid waste to terrestrial and aquatic ecosystems, impacting communities. Most of Indonesia's nickel still flows into Chinese stainless-steel production, but demand for nickel from rechargeable battery manufacturers is projected to skyrocket.

It is difficult to overstate the importance of rechargeable batteries to EVs. In vehicles with internal combustion engines, batteries are used to start the engine. But in EVs, enormous electric batteries power the equivalent of an engine – an electric motor. Forty percent of the value in all EVs lies in the battery alone. Passenger vehicles make up most demand for EVs, but electric trucks, buses, and two and three-wheelers are also increasing in popularity. Global demand for EVs is shared roughly equally between China and Europe, with US demand set to increase. Most EV batteries are manufactured in China and either exported or sold domestically in the Chinese market. Nickel allows for higher energy density, enabling these batteries to store more energy for less weight and provide longer driving ranges for EVs.

A single electric vehicle (EV) battery is comprised of many battery cells. The two main components in any cell are its anode and cathode. The anode releases electrons. These electrons then flow through an external circuit to power an electric motor. The electrons are finally acquired by the cathode. Nickel is a key component in the cathodes of many types of batteries—including lithium-ion batteries, which are commonly used in EVs. Most (70%) EV cathodes are manufactured in China, while Korea and Japan together account for the remaining 30% (IEA 2022: 27).

Half of the world's nickel currently comes from Eastern Indonesia, particularly the Maluku islands and the island of Sulawesi. The islands in Maluku number in the thousands and are spread over a vast area of ocean between Sulawesi and Papua. These islands are known for their rare forests and endemic species, including many plant species which subsist exclusively on ultramafic (metal-rich) soil.

In the past, Sulawesi and Maluku were spared the high rates of deforestation observed across the neighboring Indonesian islands of Sumatra and Borneo, where deforestation has been driven most recently by palm oil, pulp and paper, rubber and coal extraction. Now, however, exponentially growing demand for Indonesian nickel by Chinese, Korean and Japanese battery manufacturers has put the natural forests of Sulawesi and Maluku at great risk. Over one third (36%) of Sulawesi's 1.5 million hectares of ultramafic forests currently stand inside nickel mining concessions (Brown 2023: 27).

Beyond deforestation, nickel strip mining in Indonesia is causing additional forms of severe environmental damage. For example, mine and refinery runoff often contains carcinogenic hexavalent chromium (Cr6+), which can be dangerous to workers and local communities and cause immense downstream damage to biodiverse, world-class coral reefs (Brown 2023: 42).

Indonesian nickel has an important role to play in decarbonizing the global transportation sector. However, greater care must be taken to limit the extreme forms of environmental damage caused by nickel mining. Over the course of six chapters, this report systematically explores why Indonesian nickel is needed, what it is used for, how its extraction is impacting Eastern Indonesia's forests and communities, and what can be done to reduce this impact.

Chapter I contains a case study of the environmental, health and human rights impacts of nickel mining on the island of Kabaena, in Southeast Sulawesi province.

Chapter II examines future global demand for Indonesian nickel.

Chapter III specifies and links important actors in Indonesia's nickel supply chain— from nickel mines to downstream stainless steel and EV battery producers.

Chapter IV is a deep dive into Indonesian nickel mines. The chapter quantifies total nickel-driven deforestation in Indonesia over the last few decades and examines three mines which are emblematic of the industry's practices of clear-felling biologically diverse forests and/or breaking Indonesian forestry laws. This chapter also considers the challenges posed by the disposal of tailings (waste) from Chinese-owned refineries that process nickel inside Indonesia.

Chapter V explores the extent to which multilateral (EU) and national (US) laws either (1) require EV manufacturers to investigate whether environmentally destructive nickel mines are in their supply chains and/or (2) prevent these mines from razing carbon rich and biologically diverse natural forests.

Chapter VI offers recommendations, partly based upon the laws and regulations presented in Chapters IV and V, including how these laws and regulations might be strengthened or better enforced.

I. CASE STUDY:

ENVIRONMENTAL, HEALTH AND HUMAN RIGHTS IMPACTS OF NICKEL MINING ON THE ISLAND OF KABAENA

Photo: Water pollution in Baliara village in West Kabaena

Kabaena is a relatively small island off the southern tip of Southeast Sulawesi, Indonesia. At 337 square miles, it is more vulnerable to destructive mining practices. Researchers investigated the impact of nickel mining on six villages, all home to the Bajau people. The Bajau are considered the world's last "sea nomads" and live across the Southeast Asia and Pacific islands and waters, including in the Philippines, Malaysia and Indonesia. Their culture is deeply intertwined with the ocean. They are renowned free divers that have evolved larger spleens and lung capacity, allowing them to stay below the surface of the water for up to 10 minutes on a single breath, foraging for sea cucumbers, seaweed, and other sea life.

Their unique way of life means that some Bajau are born and spend their entire life at sea, on traditional houseboats; in the case of the villages of Kabaena, they live on the shore or on stilted houses above the water and rely on the ocean for their sustenance and livelihoods. This way of life is disappearing; fewer Bajau than ever before live entirely at sea. Those who live on land are often still separated from other parts of society and are thus more vulnerable to changes in the climate and natural world – changes that threaten their survival and their culture.

When deposits of nickel were found on Kabaena island, the Bajau faced new threats. Across the island are upwards of 13 mining concessions. As many as nine are active.

The deforestation that is taking place across the island is partly occurring in areas zoned as Protection Forest (at least 17 hectares have been illegally deforested), and in areas of Production Forest where Borrow and Use permits have not yet been secured (at least 785 hectares have been illegally deforested).

The researchers' survey of Kabaena inhabitants included 53 respondents. Their occupations were primarily related to fishing and related trade, including fisherfolk, housewives, dried fish workers, fish net makers, boat makers, and stall merchants. The researchers also documented the very visible impacts of nickel mining on the land with photographs - deforested mountainsides, brown, cloudy water in the ocean near the villages, and houses flooded with the same brown cloudy water.

The impacts of nickel mining on Kabaena are significant and varied. For Bajau cultures that rely on the sea for their livelihood, the contaminated water around the island means they must go much further offshore to reach fishing grounds, where yields are lower, and they must buy more fuel putting them further in debt. Some had farmed seaweed, but that too is no longer possible given the poor water quality. A tragic and immediate consequence of the brown ocean waters is that three Bajau children drowned in Baliara village in the last decade. These deaths were attributed to the inability to see and rescue children in time, due to the water's cloudiness, and the fact that children are increasingly not being taught to swim from an early age because the water is so contaminated. In other Bajau communities where the water is still clear, children master diving by age three.

In both Puununu and Baliara villages, researchers documented significant skin conditions from the water: itchiness, festering and blistering. On March 26, 2024, a flood occurred in Baliara, after only half an hour of rainfall. Residents attribute the main cause of the flooding to the soil degradation at two nickel concessions, Trias Jaya Agung and Timah Investasi Mineral (the latter is believed to be a nickel subsidiary of Indonesia's state-owned tin giant Timah).

In Sikeli and Baliara villages, some Bajau reported taking mining or construction jobs because fishing was no longer an option. Of those surveyed, 71% reported impacts on their health and 83% reported disruption to their livelihoods; 94% reported environmental damage.

Figure 1: Findings of research on impacts of nickel mining on Kabaena Island

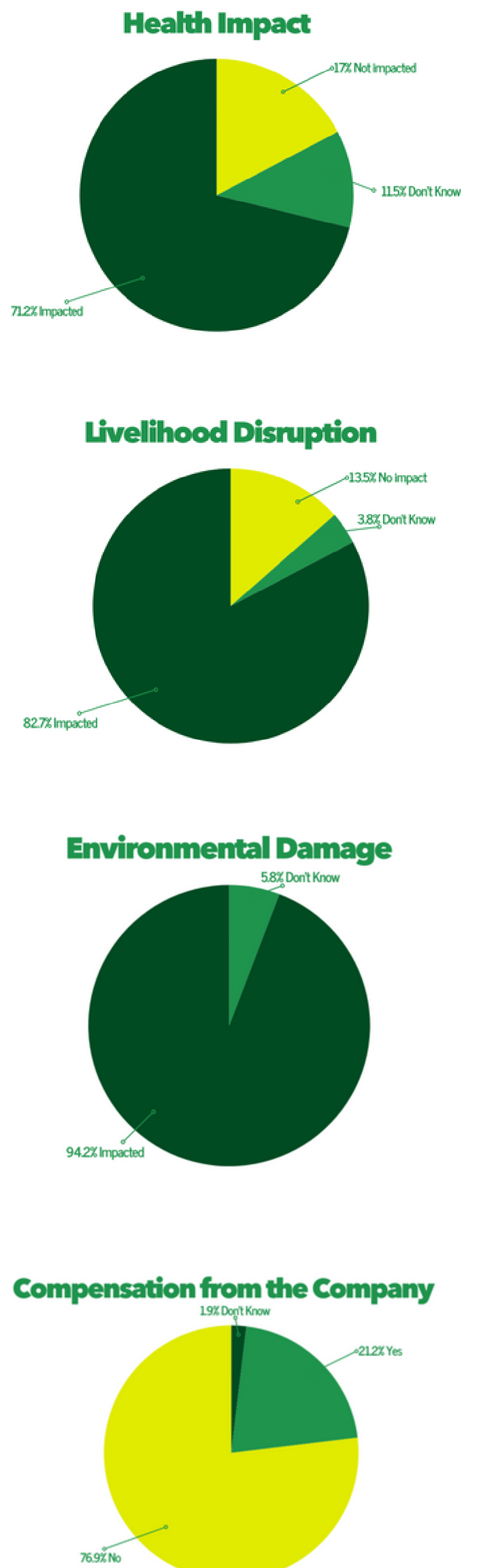
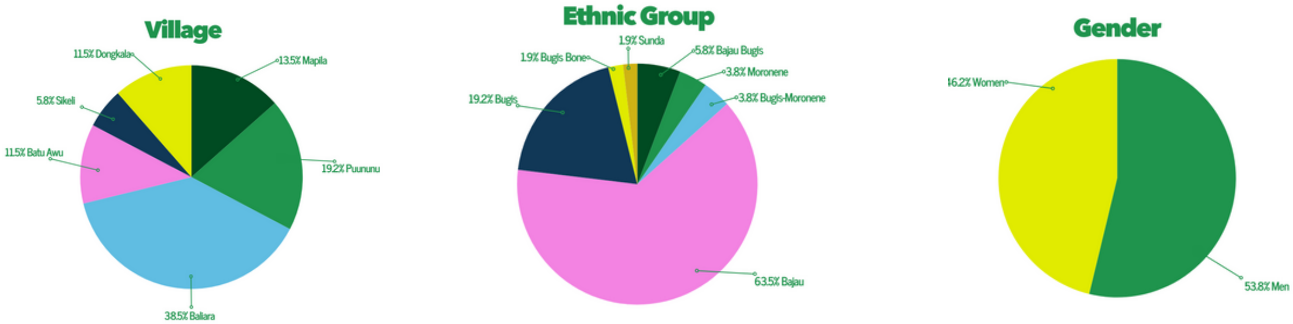


Figure 2: Scope of research on impacts of nickel mining on Kabaena Island



Interviews in the six villages named in Figure 2 (above) found that no meaningful consultation had taken place on the impacts of mining, and no FPIC (Free Prior Informed Consent) was sought. Other findings from the interviews included reports of potentially illegal behavior. Tambang Bumi Sulawesi was reported as illegally using a community port for its jetty. Geospatial analysis performed by Mighty Earth shows that Tonia Mitra Sejahtera and Anugrah Harisma Barakah both cleared Protection Forests on Kabaena Island. Mighty Earth's data shows up to 802 hectares of forest cleared, either non-exempted Production Forest or non-permitted Protection Forest.

Photo: Deforestation in PT Anugerah Harisma Barakah on Kabaena

The human rights and human health impacts in Kabaena are particularly severe in the context of a culture so reliant on the water. But as Indonesia invests more into nickel mining, these same health, environmental and cultural impacts may affect many more. Runoff and tailings disposal is a continuing problem, as well as mining close to the shoreline. Not only do the people of Kabaena deserve justice and clean water, but their situation is a stark reminder of the destruction that unregulated nickel mining can bring to communities and ecosystems. Kabaena Island represents only a small part of the nickel-driven environmental damage taking place across Eastern Indonesia because of growing global demand for Indonesian nickel. The forecasted future dimensions of this demand are quantified in the next chapter.

II. DEMAND FOR INDONESIAN NICKEL IS LIKELY TO REMAIN HIGH FOR DECADES

Global demand for nickel will remain high for the next few decades (and beyond), for use in both stainless steel and EV batteries. This will be true under any one of three different emissions reduction scenarios defined and modeled by the International Energy Administration (IEA):

- The Announced Pledges Scenario – "A scenario which assumes that all climate commitments made by governments around the world, including Nationally Determined Contributions (NDCs) and longer-term net zero targets … will be met in full and on time."
- The Stated Policies Scenario – "A scenario which reflects current policy settings based on a sector-by-sector and country-by-country assessment of the specific policies that are in place, as well as those that have been announced by governments around the world."
- The Net Zero Emissions by 2050 Scenario – "A scenario which sets out a pathway for the global energy sector to achieve net zero CO2 emissions by 2050. It doesn't rely on emissions reductions from outside the energy sector to achieve its goals" (IEA 2022: 49-64).

Under each of these three IEA scenarios, overall demand for nickel will skyrocket by 2030 (see Table 1).

Table 1: Annual demand for nickel by EVs will triple by 2030 (figures in thousands of metric tons)

Comparison of actual annual demand in 2022 with projected annual demand in 2030		**EVs**	**Other clean technologies**	**All other uses (including stainless steel)**	**Total**
Actual annual demand in 2022		326	129	2,477	**2,932**
Demand in 2030 under three IEA emissions reduction projections:	**Announced Pledges**	988	393	2,520	**3,901**
	Stated Policies	1,498	634	3,398	**4,530**
	Net Zero 2050	2,414	1,038	2,363	**5,815**

Source: Figures originate from the IEA's Critical Minerals Demand Dataset (2023).
Note: "Other clean technologies" include solar, wind, other low emission power generation, grid battery storage and hydrogen generation.

Although the IEA (in **Table 1** above) predicts that demand for nickel by EVs will increase by three to seven-fold, ongoing developments in battery chemistry make it difficult to be completely certain about future levels of demand for nickel by the EV industry. Some reports speculate that both Chinese battery makers and the EV manufacturer Tesla, are moving in the direction of nickel-free LFP[2] batteries (IEA 2022: 12-13). However, in general, LFP battery cathodes have a lower ability to store lithium atoms per unit mass than nickel-rich lithium-ion cathodes (also known as NCA[3] or NMC[4] cathodes). This lower energy density means that LFP battery packs weigh more than lithium-ion packs of equivalent power, tending to reduce the overall range of the vehicle. For now, most EVs on the market use nickel-based lithium-ion batteries, and if the EV industry continues to mass manufacture NCA & NCM cathodes, demand for nickel will only increase.

Another reason demand for nickel will likely remain strong is because, in NCA & NMC cathodes, the use of nickel dilutes the amount of cobalt that would otherwise be necessary. Until a few years ago, the typical ratio of nickel to cobalt in EV batteries was 1:1, but now it is as high as 8:1.[5] In other words, Nickel:Cobalt batteries now require only one-eighth as much cobalt as they used to. Most of the world's cobalt comes from the Democratic Republic of the Congo (DRC), where it is often produced in quasi-legal mines with deplorable working conditions. Battery manufacturers have, in part, moved away from cobalt due to widespread reporting on environmental problems and human rights issues associated with the metal, which demonstrates that the EV industry is receptive to criticism.

Not only does the use of Indonesian nickel in EV batteries serve as a multiplier for (and, hence, reduce the demand for) cobalt produced in the DRC, but some nickel ore mined in Indonesia contains material amounts of cobalt. In at least five large refineries that have been (or are scheduled to be) built, cobalt is refined alongside nickel—these refineries are named in **Figure 4** and **Table 3** in **Chapter III** (below).

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[2] In lithium iron phosphate batteries, "L" stands for lithium, "F" stands for iron and "P" stands for phosphate.

[3] In NCA batteries, "N" stands for nickel, "C" stands for cobalt, and "A" stands for aluminum. The full name is "lithium nickel cobalt aluminum oxide" (IEA 2022: 10).

[4] In NMC batteries, "N" stands for nickel, "M" stands for manganese, and "C" stands for cobalt. The full name is "lithium nickel manganese cobalt oxide" (IEA 2022: 10).

[5] NMC batteries have transitioned from "111" configurations, where equal parts nickel, manganese and cobalt are used, to 532, to 622, and now to 811 configurations. In the latter, there are eight parts nickel, one part manganese, and one part cobalt (IEA 2021: 96).

III. HALF OF THE WORLD'S EV BATTERY SUPPLY CHAINS START WITH NICKEL FROM INDONESIA

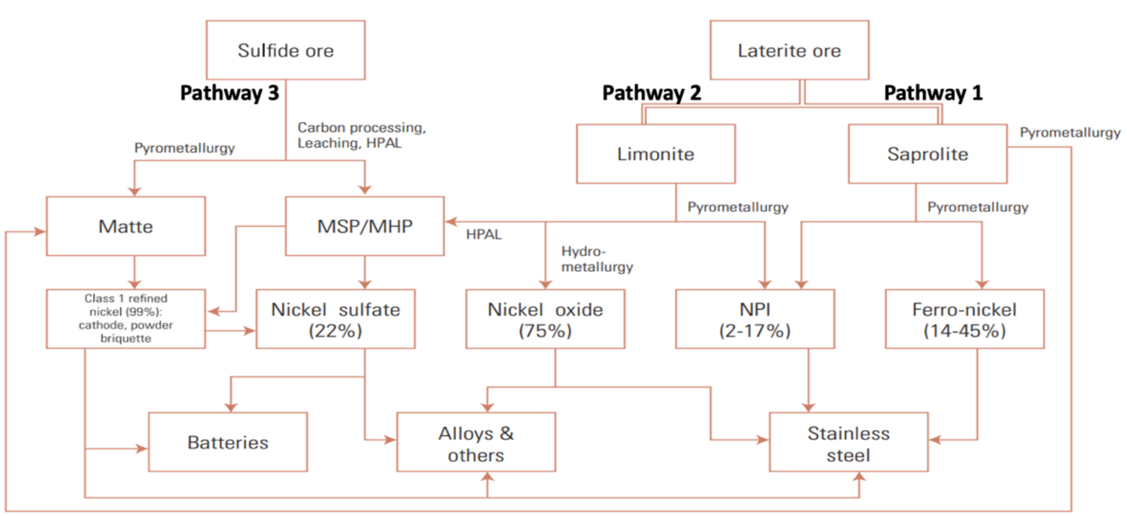
Understanding nickel supply chains is necessary to understanding which consumer goods contain Indonesian nickel. Nickel ore has been mined and exported from Indonesia for at least the last half of a century. But during the last decade, it has mostly been smelted or acid-leached onshore into more concentrated forms, and only then exported, predominantly to China, but also to Korea and Japan. There, it is used to manufacture stainless steel or, increasingly, EV batteries. These batteries are placed into vehicles that are sold mainly in China, the EU, and the US.

A deep dive into the different links in the nickel supply chain should start with an examination of the three main pathways taken by the two types of nickel ore found in Indonesia –**laterite ore** and **sulfide ore**–to be integrated into stainless steel and/or EV batteries. These three main pathways are:

- Nickel laterite ore being taken through a range of **pyrometallurgical** processes, or
- Nickel laterite ore undergoing **hydrometallurgical** processes, or
- Nickel sulfide ore undergoing **pyrometallurgical** processes.

Box 1 (below) attempts to describe as succinctly as possible these three pathways.

Box 1: Pathways of Indonesian nickel ore to stainless steel and EV battery production



Source: Young 2019, with "Pathway" annotations added by authors

The figure above includes the three main pathways taken by Indonesian nickel ore as it undergoes transformations to become either stainless steel or EV batteries.

- The first pathway (on the right) starts with laterite ore, the most common type of nickel ore mined in Indonesia. Laterite ore has two sub-types: saprolite ore and limonite ore.
    - Saprolite ore is found further below the surface. It is relatively nickel-rich (1.5% - 2.1% pure nickel), but more difficult to break down in chemical and physical terms. Therefore, Saprolite ore is more difficult to process. Saprolite must be refined through pyrometallurgical processes—either heating in smelters to become nickel pig iron (2% - 17% pure) or heating in rotating kiln electric furnaces (RKEF) to become ferronickel (14% - 45% pure). Converters can be used to further upgrade ferronickel into nickel matte (60% - 70% pure). Nickel pig iron and ferronickel are both used for stainless steel, as is nickel matte, but nickel matte is also increasingly used as a precursor for EV cathodes.
    - Limonite ore is found closer to the surface. It is less nickel-rich (1.1% - 1.4% pure) but easier to process. Although limonite lacks the purity to be smelted into ferronickel, it can be smelted into nickel pig iron.
- In the second pathway, low purity limonite ore can also be refined through a two-staged hydrometallurgical process to become a high-purity cathode precursor.
    - In the first stage, limonite undergoes high pressure acid leaching (HPAL) and is converted into a powdery substance called mixed hydroxide precipitate (MHP), which is about 30 to 50% pure.
    - In the second stage, MHP can be processed into one of two other cathode precursors, either Class 1 nickel or nickel sulfate. Class 1 nickel and nickel sulfate can both reach a purity of 99.9%. Class 1 nickel is solid (in the form of powder or briquettes) while nickel sulfate can be either solid or in solution. At least seven existing or planned refineries in Indonesia either produce nickel sulfate now or will in the future (see **Figure 4** and **Table 3** below).
- The third pathway is the oldest and can be seen on the left side of the diagram. Sulfide ore (which is purer, but less common in Indonesia, and is mainly found in Russia, Canada, China, Australia and South Africa[6]) is smelted into nickel matte. This takes place only at Indonesia's oldest nickel smelter, Vale Indonesia in Soroako. While Vale's matte was historically utilized more often as a precursor for stainless steel, it is now also exported to Japan, where it is processed into nickel sulfate for EV batteries (see **Row 1** in **Table 3** below).

Note: Vale Indonesia also has substantial limonite reserves from which saprolite has, since 2007, been processed through RKEF in Soroako into ferronickel (see *Pathway 1* above).

[6] For map of significant sulfide and laterite nickel deposits see: https://www.researchgate.net/figure/World-distribution-of-significant-sulfide-and-laterite-nickel-deposits-Sulfide-deposits_fig3_237945035

The chart in **Box 1** helps us understand the main upstream links in the Indonesian nickel supply chain. [7] These links are:

A. The mining of nickel ore.

B. The smelting of nickel ore into stainless steel precursors, such as nickel pig iron, ferronickel, and nickel matte (which is also a battery precursor).

C. The refining of nickel ore into cathode precursors such as mixed hydroxide precipitate, nickel sulfate and cobalt sulfate.[8]

Links A, B, and C are described in **Sections A, B and C** (below). How these three links connect to global supply chains is described in **Section D**.

A. Nickel mining

The mining of nickel ore has a decades-old history in Indonesia. Until recently, nearly all nickel ore was mined and processed by Inco, a large Canadian mine in Sulawesi. There was also a smaller nickel mine in Sulawesi operated by the state-owned mining company Aneka Tambang, and a third mine on the island of Halmahera called Weda Bay Nickel, previously operated by Eramet (France), but now operated by Tsingshan (China). Some, or all, of these mines are still classified as Contracts of Work (CoW), the original modern form of mining contract in Indonesia. Of the 200-plus Contracts of Work issued during the Suharto presidency (1968 to 1998), a few dozen at most were for the mining of nickel.

With the fall of President Suharto came a wave of political decentralization. The authority of district (*kabupaten*) and provincial governments was increased vis-à-vis the central government. District heads (called *bupati*) and governors were empowered to issue many different types of land-based natural resource licenses, including mining licenses. Decentralization laws and regulations stated that if a proposed mine was located within a district, a mining license could be issued by the *bupati*. If the area of the proposed mine overlapped two districts, the license could be issued by the governor. If the proposed mine overlapped two provinces, the license could be issued by the central government. Indonesian mining licenses were given a new name, Izin Usaha Pertambangan or IUP. The issuance of IUPs exploded during the first decade of the 21st century and by the end, there were well over 10,000 IUP. Most nickel concessions today are IUPs.

[7] The chart in **Box 1** contains two notable inaccuracies. First, the chart suggests that the purity of nickel sulfate is only 22 percent, whereas in fact the purity of nickel sulfate is on the order of 99 percent or higher. Second, the chart suggests that converting nickel matte into Class 1 nickel is the only way to further convert it into MSP. In fact, there are other more efficient ways to convert nickel matte into MSP including, but not limited to, atmospheric leaching and HPAL. Notwithstanding these and other more minor inaccuracies, the chart does an excellent job of mapping out the multiple pathways that can be followed by the different types (and sub-types) of nickel ore found in Indonesia before they end up in stainless steel or EV batteries.

[8] As discussed briefly in **Chapter II**, some nickel deposits in Indonesia contain small amounts of cobalt. This cobalt can be separated out into cobalt sulfate which, like nickel sulfate, is a cathode precursor.

During the extractive resource boom in the first decade of the century, nickel ore mined by IUPs was mainly exported to China, where it was primarily used to make stainless steel. Starting in 2014, the Indonesian government began to restrict the export of nickel ore. The government set a gradually rising floor beneath the level of purity at which nickel ore could be exported. In 2020, the Indonesian government banned the export of raw nickel.

As the Indonesian government made it harder to export nickel ore, Chinese stainless-steel companies saw the writing on the wall. As a defensive measure, they began moving their smelters and furnaces to Indonesia. At a strategic level, it was probably not important to the government of China *where* the smelting of Indonesian nickel ore took place, so long as the refined nickel ended up in China.

B. Smelting nickel ore into precursors for stainless steel

Nickel is a key component of stainless steel. When added to ordinary steel, nickel makes it shinier and less prone to rust. To this day, Chinese companies own many of the refiners in Indonesia that convert nickel ore into more concentrated forms of nickel, which can then be used as precursors to stainless steel. The two main stainless-steel precursors produced in Indonesia are nickel pig iron and ferronickel. As explained in **Box 1** (above), the former is less pure; the latter is purer. The following figure shows some of the producers of nickel pig iron and ferronickel in Indonesia as of late 2019, and their locations. Of the twenty-five smelters named in **Figure 3** (below), six are on Java, 14 on Sulawesi, and 10 are located across the Maluku islands.

Figure 3: Some of the producers of nickel pig iron and ferronickel in Indonesia

PT Arthabumi Sentra Industri (Morowali) *Kapasitas produksi 180.000 metrik ton NPI per tahun*	PT Elit Kharisma Utama (Cikande, Banten) *Kapasitas produksi 97.450 metrik ton NPI per tahun*	PT Vale Indonesia (Sorowaku, South Sulawesi) *Kapasitas produksi 80.000 metrik ton NPI dan FeNi per tahun*	PT Indoferro (Cilegon, Banten) – *Kapasitas produksi 97.450 metrik ton NPI per tahun*	PT Cahaya Modern Metal Industry (Unaha, Konawe) *Kapasitas produksi 22.677 metrik ton NPI per tahun*
PT Sulawesi Mining Investment (Morowali) *Kapasitas produksi 300.000 metrik ton NPI per tahun*	PT Gebe Industry Nikel (Gresik) *Kapasitas produksi 97.000 metrik ton NPI per tahun*	PT Fajar Bhakti Lintas Nusantara (Pulau Gebe) *Kapasitas produksi 100.000 metrik ton NPI per tahun*	PT Megah Surya Pertiwi (Pulau Obi) *Kapasitas produksi 198.000 metrik ton FeNi per tahun*	PT Century Metalindo (Cikande, Banten) *Kapasitas produksi 5.000 metrik ton FeNi per tahun*
PT Indonesia Guang Ching Nickel & Stainless Teel (Morowali) *Kapasitas produksi 100.000 metrik ton FeNi per tahun*	PT Heng Tai Yuan (Cilegon) *Kapasitas produksi 11.000 metrik ton NPI per tahun*	PT COR Industri Indonesia (Morowali Utara) *Kapasitas produksi 11.000 metrik ton NPI per tahun*	PT Virtu Dragon Nikel (Kendari) *Kapasitas produksi 600.000 metrik ton FeNi per tahun*	PT Bintang Smelter Indonesia (Konawe Selatan) *Kapasitas produksi 80.000 metrik ton NPI per tahun*
PT Kinlin Nickel Industry Indonesia (Konawe Selatan) *Kapasitas produksi 17.000 metrik ton NPI per tahun*	PT First Pacific Asia Mining (Halmahera Tengah, Maluku) *Kapasitas produksi 6.000 metrik ton FeNi per tahun*	PT Huadi Nikel Alloy Indonesia (Bantaeng) *Kapasitas produksi 5.300 metrik ton NPI per tahun*	PT Titan Mineral (Bantaeng) *Kapasitas produksi 5.300 metrik ton NPI per tahun*	PT Artabumi Sentra Industri (Sulawesi Tengah) *Kapasitas produksi 180.000 metrik ton NPI per tahun*
PT Bintang Timur Multi Steel (Tigarakasa, Banten) *Kapasitas produksi 80.000 metrik ton NPI per tahun*	PT FeNI Haltim (Antam), East Halmahera, North Mollucas *Kapasitas produksi 64.000 metrik ton FeNi per tahun*	PT Wanatiara Persada (Pulau Obi) *Kapasitas produksi 161.000 metrik ton FeNi per tahun*	PT Macika Mineral Industry (Konawe Selatan, Sulawesi Tenggara) *Kapasitas produksi 34.000 metrik ton FeNi per tahun*	PT Integra Mining Nusantara (Konawe Selatan, Sulawesi Tenggara) *Kapasitas produksi 285.000 metrik ton NPI per tahun*

Source: Deloitte Indonesia 2022: 7
Note: The figure above mentions each factory's capacity to produce ("kapasitas produksi") either nickel pig iron ("NPI") or ferronickel ("FeNi") in metric tons ("metrik ton") per year ("per tahun").

Capacity of production does not equate to realized production. Smelters can produce more or less than their nameplate capacity.

Many smelters and furnaces producing nickel pig iron and ferronickel in **Figure 3** are Chinese owned. For instance, Tsingshan Group, the world's largest producer of stainless steel, owns at least 46% of the Sulawesi Mining Investment smelter, and nearly 100% of the Fajar Bhakti smelter. A senior Tsingshan official sits on the board of commissioners of PT Bintang Delapan Mineral which, in turn, likely owns the PT Bintang Smelter and PT Bintang Timur Multi Steel smelter. Another Chinese company, Virtue Dragon, owns the furnace bearing its name and may be buying nickel from mines on Kabaena Island.[9]

Dozens of other nickel smelters and furnaces in Indonesia churning out precursors to stainless steel are not listed in **Figure 3**, and many of these are also owned by Chinese companies. For example:

- Tsingshan now owns 51.3% of the Weda Bay Nickel smelter (BHRRC 2023: 14).
- Tsingshan is also the largest shareholder in five clusters of other existing or forthcoming nickel furnaces and smelters: Nickel Industries, the Hengjaya Nickel Project, the Ranger Nickel Project, the Angel Nickel Project, and the Oracle Nickel Project.
- Tsingshan and Zhefian Huaju Investments, both Chinese, jointly own the Yashi Indonesia Investment smelter in Indonesia Weda Bay Industrial Park, which has a capacity of 300,000 tons of ferronickel (CRI 2032: 78).

New construction is now dominated by refineries (as opposed to smelters and furnaces) that aim to transform nickel ore into precursors for EV battery cathodes. It is estimated that just five of the new refineries that are being (or will be) built in Indonesia for this purpose will produce twice as much nickel (the equivalent of 60 million tons of pure nickel/year) as all the present and future Indonesia-based smelters and furnaces (Deloitte Indonesia 2022: 33).

C. Refining nickel ore into cathode precursor materials

Both main types of nickel ore found in Indonesia are currently being processed into cathode precursor materials. Around 19 facilities exist, or are planned to exist, for the purpose of converting Indonesian nickel ore into precursors for nickel cathodes. Of these 19, six were carefully examined in a report by the Rosa Luxemburg Institute. The first six are listed in **Figure 4** (below).

[9] Although PT Virtue Dragon Indonesia is a Chinese company, its Commissioner is Lodewijk Friedrich Paulus, the Secretary General of the Golkar political party, originally founded by Indonesia's former President Suharto.

Figure 4: Locations, names, installed capacities, investment values, and timelines for six existing (or planned) Indonesia-based refineries for the processing of nickel ore into cathode precursor materials

Location	Company Name	Products	Production Capacity (tonnes / year)	Equivalent Weight (tonnes / year)	Investment Value (USD)	Estimated Production
Indonesia Morowali Industrial Park	PT QMB New Energy Materials	MHP	142,857	50,000 Ni	998.57 million	2021
		Nickel sulfate	136,364	30,000 Ni		
		Cobalt sulfate	19,512	4,000 Co		
	PT Huayue Nickel & Cobalt	MHP	163,000	60,000 Ni	1.28 billion	2021
	PT Teluk Metal Industry	MHP	160,000	60,000 Ni	1.26 billion	2023
		Nickel sulfate	168,000	N/A*		
		Cobalt sulfate	24,000	N/A*		
	PT Fajar Metal Industry	MHP	160,000	60,000 Ni	1.26 billion	2025
		Nickel sulfate	168,000	N/A*		
			24,000	N/A*		
Obi Island	PT Halmahera Persada Lygend	MHP	365,000	55,875 Ni	1.06 billion	2020
		Nickel Sulfate	246,750	52,000 Ni		
		Cobalt Sulfate	31,800	6,000 Co		
Indonesia Weda Bay Industrial Park	PT Youshan Nickel Indonesia	Nickel matte	43,600	37,000 Ni	406.79 million	2020

Source: Rosa Luxemburg Institute 2023: 35

Of the six refineries named in **Figure 4**, five use (or will use) HPAL technology to convert limonite ore into MHP. [10] Chinese companies are taking a risk investing in HPAL in Indonesia, for two main reasons.

- First, building an HPAL facility is expensive; the level of investment required for HPAL technology is between two (Washington Post 2023) and five (Deloitte Indonesia 2022) times the investment required for rotary kiln electric furnaces (RKEF).
- A second risk of using HPAL to produce MHP is that it is a comparatively new technology, and prone to failure. Elsewhere in the world, some very large HPAL refineries have failed on technical grounds. For example, the Goro refinery in New Caledonia and the Ambatouy refinery in Madagascar both closed because their operators *could not figure out how to manufacture MHP using the HPAL process* (RLI 2023: 32). So far, however, the use of HPAL to refine MHP seems to be succeeding in Indonesia. The first recorded shipment of MHP from Indonesia took place in February 2022 (Reuters 2022). However, HPAL refining in Indonesia is just beginning. Reading between the lines, Deloitte Indonesia speculates that some of the HPAL refineries being built in Indonesia may still fail on technical grounds, stating that "The effectiveness of the HPAL technology may vary significantly depending on the composition of the nickel ores and leaching chemicals: its

[10] The figure above suggests that Youshan Nickel produces nickel matte, which is frequently under demand not only as a stainless steel input, but also as a cathode input. However, the Indonesia Weda Bay Industrial Park website states that Youshan Nickel will produce 130,000 tons of nickel sulfate per year, not nickel matte.

success rate has been estimated to be no more than 25 percent. Much time and effort will need to be invested to conduct laboratory tests to identify the mineral composition of Indonesia's nickel ores and experiment with the planned extraction method prior to a pilot test" (Deloitte Indonesia 2023: 33).

Photo: Nickel Mining at PT Tonia Mitra Sejahtera on Kabaena Island

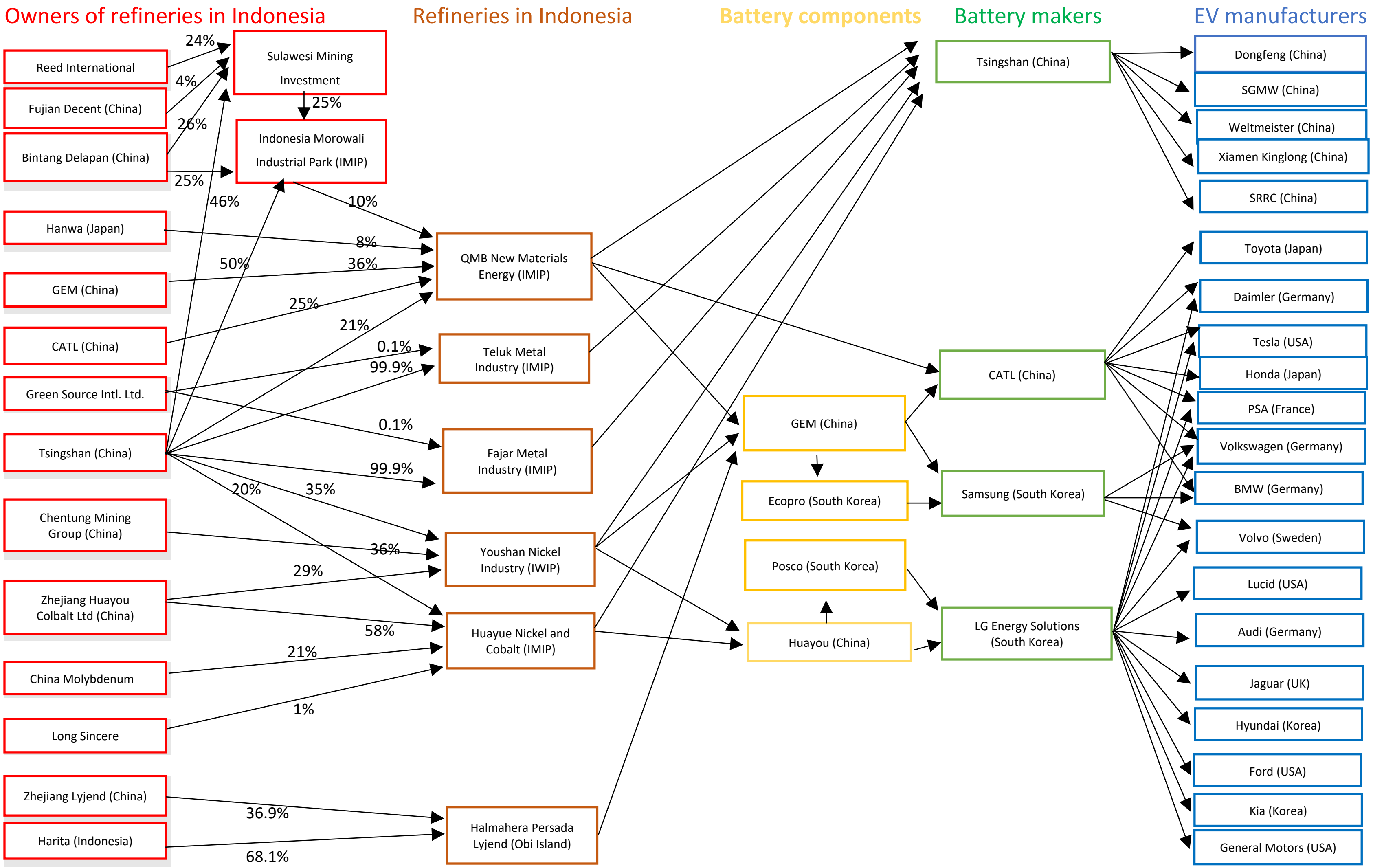
D. Manufacturing of cathode precursor materials into cathode ready materials, battery cells, batteries, and EVs

Indonesian nickel is (or will be) purchased and refined into cathode precursors. *Three matters require further clarification:*

- First, who owns these refineries? Which are majority-owned by investors from China, and which are majority-owned by investors from Indonesia?
- Second, given that these refineries mainly produce cathode precursors, how do they connect to factories which produce cathode-ready materials, cathodes, and batteries, and where are these latter factories located?
- Third, once the batteries are fully assembled, to which EV manufacturers are the batteries sold? In other words, which global EV brands have rechargeable batteries that contain Indonesian-mined nickel?

All three of these questions are answered in **Figure 5** on the following page.

Figure 5: How nickel mined and refined in Indonesia by Chinese-owned companies makes its way into EV batteries



Source: Visualization by Brown Brothers Energy and Environment LLC based on potential supply chain information found in Rosa Luxemburg Institute 2023: 19-30.
Notes: (1) Arrows from "Owners of Refineries in Indonesia" to "Refineries in Indonesia" denote percentages of ownership by the former of the latter. (2) All other arrows denote flow of Chinese-refined Indonesian nickel, through manufacturers of battery components, of batteries and of EVs.

MIGHTY EARTH

Figure 5 (above) shows:

1. six of the main refineries in Indonesia where nickel is (or is planned to be) refined into cathode precursors and the extent to which these refineries are owned in the majority by one or more companies domiciled in The People's Republic of China[11];
2. where the resulting Indonesian-refined cathode precursor materials will be further transformed into cathode ready materials, cathodes, and batteries;
3. which EV brands potentially use Indonesian nickel in their batteries.

First, all but one of the six existing (or planned) refineries in Indonesia which produce cathode precursor materials are majority owned by companies domiciled in mainland China (see **Table 2** below).

Table 2: Name, location, and minimum percentage of Chinese ownership of six existing or planned Indonesia-based nickel refineries which (will) produce cathode precursor materials

Name of nickel refinery	Location of nickel refinery	Province	Minimum Chinese ownership
QMB Materials	Indonesia Morowali Industrial Park (IMIP)	Central Sulawesi	**82.0%**
Teluk Metal			**99.9%**
Fajar Metal			**99.9%**
Youshan Nickel	Indonesia Weda Bay Ind. Park	N. Maluku	**100.0%**
Huayue Nickel and Cobalt	IMIP	C. Sulawesi	**99.0%**
Halmahera Lygend Persada	Obi Island	N. Maluku	**36.1%**

Source: Calculated based on adding up percentages of "Owners of Refineries in Indonesia" in **Figure 5** (above).
Note: Washington Post (2023) reports Halmahera Lygend Persda is not minority-owned but, rather, is majority-owned by a mainland Chinese company, Zhejiang Lyjend Resources.

Second, although these six Chinese-owned refineries produce cathode *precursor* materials within Indonesia, they do not produce cathode *ready* materials, nor do they produce battery components (like cathodes), battery cells, or batteries.

Figure 5 shows the four EV battery-ready material factories, and battery component factories, that these six refineries supply now or will supply in the future. The four are:

- GEM (China)
- Ecopro (South Korea)
- Posco (South Korea)
- Huayou (China)

[11] Throughout the paper, mention of a nickel refinery is owned by a "Chinese" company means that it is beneficially owned in the majority by one or more companies domiciled in the People's Republic of China.

Furthermore, **Figure 5** shows the four EV battery factories that are indirectly supplied by the six Indonesian refineries. These are:

- Tsingshan (China)
- CATL (China)
- Samsung (Korea)
- LG Energy Solutions (Korea)

Finally, **Figure 5** reveals which EV brands sell models containing Indonesian nickel. All EV manufacturers listed in **Figure 5** reportedly sell models that contain Indonesian nickel refined by Chinese majority-owned, Indonesia-based nickel refineries. These EV manufacturers include:

- Five Chinese companies: Dongfeng, SGMW, SRRC, Weltmeister and Xiamen Kinglong
- Four US companies: Ford, GM, Lucid and Tesla
- Five German companies: Audi, BMW, Daimler, Mercedes-Benz and Volkswagen
- Two Japanese companies: Honda and Toyota
- Two Korean companies: Hyundai and Kia
- One French company: PSA
- One Swedish company: Volvo
- One UK company: Jaguar

Until these EV brands have greater supply chain transparency, it cannot be ruled out that their vehicles may contain Indonesian cathode precursor materials linked to deforestation. In addition to these six existing or planned producers of cathode precursor materials (in **Figures 4 and 5**), there are up to 13 more (in **Table 3** below) that currently exist or are slated to be built. At least nine of these 13 are (or will be) majority owned by Chinese companies.

Table 3: Thirteen more existing (or planned) furnaces or refineries which (will) process Indonesian nickel into cathode precursor materials

Name of known refinery & owners	Nickel supplier	How much will be produced & buyers	Year of operation	Location	Citation
Niihama Plant: Sumitomo Metal Mining	Vale Indonesia, Sorowako mine	Vale Indonesia refines nickel ore into matte and sends it to Niihama for further refinement into MSP. Niihama then sells the MSP to Primearth EV, a Toyota and Panasonic JV, which sells to Tesla.7	Already operating	Shikoku Island, Japan	FOE 2023
Huake: Zhejiang Huayou Cobalt (China)	Unknown	Rotary kiln electric furnace producing 45,000 metric tons of nickel matte.	Reported to be operating	Weda Bay Ind. Park, N. Maluku	Seetao 2022

MIGHTY EARTH

Name unknown: Merdeka Battery Materials (Indonesian majority; Chinese minority)	PT Sulawesi Cahaya Mineral	Two HPAL plants that will produce MHP. Size of production unspecified.	2025 for first plant	Konawe Ind. Park, SE Sulawesi	Merdeka Copper Gold 2023
Huashan: Zhejiang Huayou Cobalt (China, 68%) and Tsingshan subsidiary Glaucous International (Cayman Islands, 32%)	Unknown	HPAL with MHP output equivalent to 120,000 metric tons of nickel.	2025	Weda Bay Ind. Park, N. Maluku	Reuters 2022b; Seetao 2022
Pomaala Project: Zhejiang Huayou Cobalt (China, percentage unknown), Ford (US, percentage unknown) and Vale Indonesia (30%)	Vale Indonesia, Kolaka mine	HPAL with MHP output equivalent to 120,000 metric tons of nickel.	2026	Kolaka Regency, SE Sulawesi	Financial Times 2023
PT Huayu Nickel Cobalt: Three Tsingshan subsidiaries - Yongrui Holding (China, 31%), Glaucous International (Cayman Islands, 30%), and Lindo Investment (Cayman Islands, 2%), Zeijang Huayou Cobalt (20%), EVE Energy (China, 17%)	Unknown	HPAL refinery with MHP output equivalent to 120,000 tons of nickel sulfate, and 15,000 metric tons of cobalt sulfate.	Unknown	Weda Bay Ind. Park, N. Maluku	CRI 2023: 80
Huaxing Refining Indonesia: Zheijang Huayou Cobalt subsidary Huayao International Invesment (China), and Tsingshan subsidairies Strive Investment and Lindo Investment (Cayman Islands).	Unknown	Probable HPAL refinery with proposed output of 50,000 metric tons nickel sulfate	Unknown	Weda Bay Ind. Park, N. Maluku	CRI 2023: 78

Sonic Bay: Eramet (France) and BASF (Germany).	Weda Bay Nickel	HPAL refinery to produce 60,000 metric tons of nickel sulfate and cobalt sulfate	Unknown	Weda Bay Ind. Park, N. Maluku	CRI 2023: 78
Name unknown: POSCO (South Korea).	Unknown	50,000 metric tons of nickel matte	Unknown	Weda Bay Ind. Park, N. Maluku	CRI 2023: 78
Name unknown: CNGR (through its subsidiary ZhongTsing New Energy, China, 70%); Tsingshan subsidiary Rigqueza (Cayman Islands, 30%)	Unknown	Three smelters to produce 120,000 metric tons of nickel matte	Unknown	Weda Bay Industrial Park, N. Maluku	BHRRC 2023: 14; CRI 2023: 78, 83
Name unknown: Zhejiang Huayou Cobalt (China), Volkswagen (Germany), and Tsingshan (China).	Vale Indonesia, unspecified	Unspecified product equivalent to 120,000 metric tons	Unknown	Location unspecified	Seetao 2022
Name unknown: Zhejiang Huayou Cobalt (China) and Vale Indonesia.	Vale Indonesia, unspecified	HPAL refinery that will produce 60,000 metric tons of MHP	Unknown	S. Sulawesi	Nikkei Asia 2022a; Sina 2022
Name unknown: SK On (S. Korea), EcoPro (S. Korea) and GEM (China).	Unknown	HPAL refinery that will produce MHP.	Unknown	Morowali Industrial Park, C. Sulawesi	Nickel Indonesia 2023: 5

Note: Six of the 13 planned refineries in the table above (in Rows 1, 2, 6, 7, 11 and 12) are reported to be substantially owned and/or intended to be operated by Zhejiang Huayou Cobalt, according to six different sources named in the citation column of the table. Based on information published by these six sources, the six planned Zheijang Huayou Cobalt companies are all reported to be distinct from one another. But it cannot be ruled out that two or more are duplicates

It is reasonable to assume that Indonesian nickel which passes through the 13 existing or planned refineries listed in Table 3 (above) either currently ends up in, or will end up in, many of the world's major EV brands.

From an industrial development perspective, Indonesia has moved further down the EV supply chain, but only by a single link: Indonesia has transitioned from producing nickel ore to producing cathode precursor materials. This is a big step, but Indonesia is only just starting to produce some of the following even more highly value-added products: cathode ready materials, cathodes, battery cells, batteries, and EVs. So far, there appear to be five factories in Indonesia that are achieving (or could potentially achieve) these types of value-added breakthroughs. They include one cathode assembly factory, two for the assembly of battery cells, and two more for the production of EVs. The five are listed in **Table 4** (below).

Table 4: Existing (or possible future) Indonesian cathode precursor, cathode, battery cell or EV assembly factories

No	Factory owners	Supplier	Product	Cost	Where	Source
1	LG Energy Solutions and Indonesia Battery Corporation	Aneka Tambang to supply ore	Cathode precursor materials, cathodes	IDR 142 trillion	Batang Integrated Industrial Area, Central Java	Nikkei Asia 2022a, Tirto 2023
2	Hyundai and LG Energy Solutions	Factory in **Row 1** (above) will supply cathodes	EV battery cells	USD 1.1 billion	Karawang, West Java	Deloitte Indonesia 2022: 27
3.	CATL and Indonesia Battery Corporation	Aneka Tambang to supply ore	EV battery cells	USD 5.97 billion	Unknown	Nikkei Asia 2022a
4.	Hyundai	?	EVs	?	?	Nickel Indonesia 2023: 5
5.	SAIC Motor Corp Ltd, General Motors and Wuling Motors	?	Production of "Wuling Air EV"	?	?	Nickel Indonesia 2013: 5

Note: Tirto (2023) indicates that the factory in Row 2 will produce batteries. However, Deloitte (2022) indicates the factory in Row 2 will only produce battery cells. Erring on the side of caution, the table reflects the views of Deloitte.

Considered purely in isolation, advances in downstream nickel processing in Indonesia are a hard-won achievement and a genuine industrial policy success story, albeit one paid for by China, and for which China itself is the main beneficiary. Moving beyond the industrial policy implications of these developments, however, sight should not be lost of the fact that while Indonesia's nickel may be an essential part of the global energy transition, Indonesia's new nickel refineries, as well as the nickel mines that supply them, pose a grave set of environmental risks to the nation (and the world). These risks are examined in the next chapter.

IV. ENVIRONMENTAL DAMAGE AND RISKS FROM NICKEL MINING

This chapter explores evidence of environmental destruction caused by Indonesian nickel mining and the subsequent refining process. In particular, the chapter focuses on deforestation caused by Indonesian nickel mines (**Section A**) while briefer consideration is given to the environmental impacts of nickel refining (**Section B**).

A. Environmental damage of nickel mining

With nickel mining in Indonesia comes widespread clearance of endemic rainforests. Many of these disappearing forests store great amounts of carbon and house high levels of biodiversity. Moreover, some of these nickel mines may be illegally operating in Production Forest and illegally clearing Protection Forests for open pit mining. Others are mining in harmful proximity to oceans – a practice that is legally contested.

1. Quantifying deforestation caused by nickel mining

Indonesia has 329 nickel mines, according to information published by the Ministry of Energy and Mineral Resources (MODI 2023). We measure deforestation caused by these 329 mines to be approximately **76,031 ha** according to deforestation estimates based on the leading open-source global alert systems.[12]

Our estimates encompass all tree cover loss within the legal boundaries of nickel concessions.[13] We measure deforestation that has been caused by nickel mines in both Indonesia's "Forest Zone" (the name for the vast area of public lands managed by the Indonesian Ministry of Environment and Forestry (MoEF), which comprise nearly two thirds of the land area of Indonesia), and in forested areas in Indonesian public lands that are not administered by the MoEF (called "Areas for Other Uses," which account for most of the remaining third of Indonesia). Because the responsibility falls on each mine to secure its concession area from encroachment (except where mining concessions overlap with those for other resource uses), tree cover loss that has occurred inside a mining concession is *most likely* to have been carried out by the concession

[12] One of the limitations of our approach is that our estimates have not all been confirmed via satellite imagery and/or ground-truthing. Accordingly, we invite readers to consult additional mapping efforts. TheTreeMap, for instance, works to manually confirm mining infrastructure (including mining pits, mining roads, and processing facilities) based on satellite imagery from Sentinel-2 and Planet. TheTreeMap found approximately 56,000 hectares of nickel mining infrastructure across Indonesia as of December 2023.

[13] World Wildlife Fund's (WWF) recent study, *Extracted Forests*, demonstrates that the indirect deforestation footprint of mines -- or that which occurs in the surroundings of mining areas -- often outweighs the direct deforestation footprint of mines – or that which occurs within mining areas themselves.

holder itself.[14] We use three specific methodologies to evaluate historical and ongoing deforestation within nickel concessions.

First, recent (post-January 2020) deforestation has been measured with high-resolution RADD (**RA**dar for **D**etecting **D**eforestation) alerts. This dataset allows for the detection of forest loss every six to 12 days, even in clouded conditions. This open-source dataset is managed by the Wageningen University in the Netherlands, is published on Google Earth Engine, and within the World Resources Institute's (WRI) Global Forest Watch. Using Google Earth Engine, we overlaid the current boundaries of Indonesia's 329 nickel acknowledged concessions onto areas which are indicated by radar to have been deforested since January 2020, and found that Indonesia's nickel mines cleared **15,408 hectares** forests between 1 January 2020 and 31 December 2023. In 2023 alone, RADD alerts picked up **6,115 hectares** of forest clearance, *which indicates that nickel-related deforestation may be accelerating* compared to previous years. In fact, since 2020, RADD alerts indicate steadily increasing deforestation, with 2023 seeing nearly twice as much land clearance as 2021. This trend is illustrated in **Table 5** (below).

Table 5: Annual deforestation within Indonesian nickel concessions according to RADD Alerts (2020 to 2023)

Year	2020	2021	2022	2023
Hectares Forest Loss	2,601.4	3,177.0	3,514.9	6,114.8

To track deforestation further back in time, our second measurement encompasses all deforestation that has occurred within the current boundaries of these same 329 concessions since 2001. The University of Maryland (UMD) Global Forest Change (GFC) dataset alerts draw on satellite (Landsat) data to measure annual change in global forest coverage. Summing the Global Forest Loss map coverage, we found that **153,364 hectares** of forest loss occurred within the boundaries of Indonesia's 329 nickel concessions between 2001 and 2022.

Because not all 329 mines have been in operation since 2001, our third measurement examines how much forest loss has occurred in each concession since the year it was awarded the most recent iteration of its license, or its license was adjusted, according to MODI 2023 records. Limiting the measurement of how much forest was felled within concession boundaries since their latest license award or license adjustment may result in underestimates of the amount of forest clearance that was perpetrated by these mines, because many were operating and clearing forests prior to their most recent license award or adjustment. For example, **Table 6** (below) shows that of Indonesia's ten highest-deforestation nickel mines, four were in existence prior the

[14] Our estimates may encompass deforestation from other industries where, for example, nickel mining concessions overlap with concessions for other resource uses.

year in which MODI 2023 indicates was their most recent license adjustment or award (according to MODI 2014).

Table 6: Of Indonesia's ten highest-deforestation nickel mines, nearly half were in existence (and were presumably clearing forests) prior to the years that MODI 2023 indicates were their most recent iteration of license award or license amendment

Name of Indonesian nickel mining concession (and year of the latest adjustment in its license, or the latest award of its most recent iteration of license, according to MODI 2023)	Tree loss from year of latest adjustment in license (or most recent award of license) through 2022		Year of the latest adjustment in/award of the license according to MODI 2014	Minimum number of years by which each mine's initiation of operations is understated by MODI 2023
	Ranking	Hectares deforested		
Vale Indonesia – Sorako Block (2014)	1	14,558.94	2010	4
Aneka Tambang – Konawe Utara Block (2010)	2	2,775.80	2010	0
Bintang Delapan Mineral (2010)	3	2,737.76	2010	0
Vale Indonesia – Pomala Block (2014)	4	2,614.35	2010	4
Vale Indonesia – Bahodopi Block (2014)	5	2,465.37	2010	4
Mulia Makmur Perkasa (2009)	6	1,835.82	2009	0
Bukit Makmur Istindo Nikeltama (2012)	7	1,708.28	2010	2
Multi Dinar Karya (2011)	8	1,414.24	2011	0
Pertambangan Bumi (2009)	9	1,380.54	2009	0
Lawaki Tiar Raya (2013)	10	1,250.60	2013	0

Source: MODI 2014 and MODI 2023

Our most conservative deforestation estimate limits our measurement of forest loss within each nickel concession to the year that MODI 2023 lists as its most recent license adjustment or award. We know, with a high degree of confidence, that from the year of the most recently recorded license adjustment or award until the present, the legal boundary of each concession is unlikely to have changed. We also know that each concession holder held (or was legally required to maintain) control over that precise area of land over that period.

In other words, even though we know that just under half of the concessions in **Table 6** were clearing forests prior to their latest recorded period of license adjustment or award, we have decided to measure deforestation starting only in the year that each concession underwent its most recently recorded license adjustment or award, likely resulting in an underestimate of the amount of deforestation that has occurred.

Conservatively speaking, therefore, our minimum estimate of the amount of forest clearance carried out across Indonesia's 329 nickel concessions amounts to **76,030.71 hectares**. All three of the measurements of total deforestation described on the preceding pages are summarized in **Table 7** below.

Table 7: Three ways of measuring total deforestation carried out by Indonesian nickel mines

No.	Measurement Dataset	Years measured	Hectares Tree Cover Loss
1	RADD	January 2020 through December 2023	**15,408.16** hectares
2	UMD Forest Loss	2001 through 2022	**153,364.18** hectares
3	UMD Forest Loss	From latest license award/adjustment through 2022	**76,030.71** hectares

Of the three different measures of nickel deforestation provided in **Table 7** (above), the most methodologically solid is the estimate of 76,030.71 hectares. All the numbers derived in **Table 7** (above) are based on our acceptance of MODI 2023 acknowledging the existence of only 329 nickel mining concessions in Indonesia. However, there is evidence that Indonesia has mines – quite possibly a lot of mines – that MODI does not acknowledge. If MODI 2023 does not acknowledge them, then it does not map them. And MODI 2023 does not map them, then we cannot map them, nor overlay their boundaries on (disappearing) forests. In other words, the incompleteness of the MODI 2023 list is another piece of evidence that the nickel deforestation estimates in this paper are on the low side. One indication of just how incomplete MODI 2023's list of nickel mines may be is the reported existence of ten unacknowledged mines in just one of Indonesia's mining districts, East Halmahera. See **Box 2** (p. 34).

Box 2: Unacknowledged nickel mines in East Halmahera District

According to the database attached to MODI 2023, there are 15 nickel mining concessions operating in East Halmahera district. Of these 15, three are among Indonesia's top 25 nickel deforesters, namely, Weda Bay Mineral, Halmahera Success Mineral, and Wana Kencana Mineral (see **Table 9** below).

At the same time, according to a report by Transparency International Indonesia (TII), a complaint has been submitted (it's not clear by whom) to the Ministry of Energy and Mineral Resources against ten concessions that are said to be physically located in East Halmahera District, which are alleged to be unlicensed. The submission of this complaint is confirmed by an agency head in North Maluku Province (TII 2024: 31). These same ten concessions are also reported to be under investigation by the Indonesian Anti-Corruption Commission (TII 2024: 33).

We have checked these ten names against the MODI 2023 database. Of the ten, two (Arumba Jaya Perkasa and Cakrawala Agro Besar) are named in MODI 2023, but its database does not indicate in which districts these two are located. As for the other eight, they do not appear at all in MODI 2023. The names of the eight are Kasih Makmur Abadi, Blocks I to IV, and Harum Cendana Abadi, Blocks I to IV. (It is highly likely that the latter four are licensed to the Tanito mining group, which attaches the appellation "Harum" to most of its mines).

The fact that at least eight of the nickel mines operating in East Halmahera district do not appear in MODI 2023, would point to the probability that nickel mines in other parts of Indonesia are also operating below the radar, and are un-governed.

Because of the presence of unlicensed nickel mines, our measurement of nickel deforestation is incomplete. However, it is still crucial, for reasons of transparency and accountability, to identify who are the acknowledged nickel mines that are deforestation leaders. These figures are summarized in **Table 8** (below) which names Indonesia's top 25 nickel concessions, measured in terms of the amount of forest clearance detected within each since their latest license award or adjustment. For data on all 329 concessions please see the footnote.[15]

[15] Concession deforestation data can be found at www.mightyearth.org/nickelconcessions

Table 8: The 25 Indonesian nickel mining concessions that lead in the destruction of tropical forests

Name of nickel mining concession and/or block	Type of license	Year of latest adjust-ment/ award of the license	Tree cover loss from latest adjustment in license through 2022 – UMD Forest Loss		Tree cover loss 2001 through 2022 – UMD Forest Loss		Tree cover loss 2020 through 2023 – RADD Alerts	
			Rank	Hectares Lost	Rank	Hectares Lost	Rank	Hectares Lost
Vale Indonesia – Sorako Block	CoW	2014	1	14,558.94	1	20,833.07	1	1,400.61
Aneka Tambang – Konawe Utara Block	CoW	2010	2	2,775.80	5	4,033.98	6	430.38
Bintang Delapan Mineral	IUP	2010	3	2,737.76	8	2,923.70	5	461.12
Vale Indonesia – Pomala Block	CoW	2014	4	2,614.35	2	4,872.02	18	160.43
Vale Indonesia – Bahodopi Block	CoW	2014	5	2,465.37	6	3,461.01	9	346.99
Mulia Makmur Perkasa	IUP	2009	6	1,835.82	14	2,150.91	23	131.92
Bukit Makmur Istindo Nikeltama	IUP	2012	7	1,708.28	9	2,730.59	8	348.99
Multi Dinar Karya	IUP	2011	8	1,414.24	7	2,936.58	34	99.82
Pertam-bangan Bumi	IUP	2009	9	1,380.54	10	2,623.30	39	85.77
Lawaki Tiar Raya	IUP	2013	10	1,250.60	21	1,341.96	7	389.53
Weda Bay Nickel	CoW	2019	11	1,247.99	3	4,230.38	2	1,105.36
Bahodopi Utara Block	WIUPK	2018	12	1,192.34	28	1,219.92	54	65.20

Wana Kencana Mineral	IUP	2016	13	1,118.82	22	1,332.37	26	122.29
Halmahera Sukses Mineral	IUP	2016	14	1,078.70	4	4,041.44	60	59.54
Ceria Nugraha Indotama	IUP	2012	15	949.02	36	1,017.56	12	272.24
Riota Jaya Lestari	IUP	2020	16	917.03	27	1,258.82	92	38.48
Adhi Kartiko Pratama	IUP	2010	17	906.82	37	979.12	45	78.87
Gemilang Mandiri Perkasa	IUP	2015	18	887.85	15	1,860.55	37	88.86
Mulia Pacific Resources	IUP	2011	19	870.99	30	1,161.12	29	109.4
Toshida Indonesia	IUP	2010	20	669.47	42	912.89	35	95.33
Sulawesi Cahaya Mineral	IUP	2019	21	613.54	32	1,114.48	3	661.94
Gemilang Bangun Perkasa	IUP	2015	22	602.27	20	1,350.13	66	55.79
Cahaya Ginda Ganda	IUP	2010	23	596.33	62	612.26	4	508.94
Anugerah Bumi Gemilang	IUP	2015	24	591.92	25	1,267.92	150	14.62
Sambaki Tambang Sentosa	IUP	2009	25	587.47	45	865.51	116	28.98

Note: Figures include all nickel mining-caused deforestation to have taken place on all Indonesian public lands, whether inside the Ministry of Environment and Forestry-managed "Forest Zone" or on forested public lands outside the Forest Zone (known as "Areas for Other Uses").

Table 8 (above) shows which nickel concessions in Indonesia lead the nation in terms of deforestation and by how much. Many of the forests being cleared by these same high-deforestation Indonesian nickel concessions also contain high amounts of carbon and/or biodiversity hotspots. Some of these concessions may also be breaking laws or regulations that are explicitly designed for the purpose of protecting forests and/or oceans.

2. Nickel mines clearing large areas of forests with high carbon stocks, high concentrations of biodiversity and/or breaking Indonesian laws and regulations

Many of the forests being cleared by Indonesia's highest-deforestation nickel mines have intact blocks of High Carbon Stock (HCS) forests and/or high levels of biodiversity. Moreover, some of Indonesia's highest deforestation nickel mines are breaking laws which prohibit mining within Protection Forests. Still others are clearing vast swathes of Production Forest without the necessary "Borrow and Use Permits" from Indonesia's Ministry of Forestry and Environment (MoEF). Since 2019, Borrow and Use Permits have been renamed "Forest Area Use Approvals." But in this report we use the old name.

Table 8 (above) shows which nickel concessions in Indonesia lead the nation in terms of deforestation and by how much. Many of the forests being cleared by these same high-deforestation Indonesian nickel concessions also contain high amounts of carbon and/or biodiversity hotspots. Some of these concessions may also be breaking laws or regulations that are explicitly designed for the purpose of protecting forests and/or oceans.

<u>Indonesia's nickel mines are clearing vast areas of natural forest</u>: **Table 8** (above) shows a remarkable degree of correlation across Indonesia's highest-deforestation nickel mines, in terms of those which have (1) cleared the most forest since the latest adjustment in their licenses, (2) those whose lands have experienced the highest rates of deforestation since 2000, and (3) those that that have deforested the most in the last five years. Of these three categories, the first is the arguably the most methodologically defensible measure of the extent to which nickel mines have cleared forests, even though (for reasons explained in the preceding section) it almost certainly represents an underestimate. See **Column A** in **Table 10** (below).

<u>The natural forests cleared by Indonesia's highest-deforestation nickel mines are in largely intact forest landscapes</u>: We compared the boundaries of Indonesia's nickel concessions with areas of forest assessed as High Carbon Stock[16] forests. The High Carbon Stock Approach was developed to identify natural forest areas and help the palm oil sector to implement no deforestation pledges during the past decade. The High Carbon Stock Approach helps to distinguish between viable forest areas and degraded areas. High Carbon Stock forests should be conserved due to their value as carbon stores and for their biodiversity conservation. They range from intact old growth forest to young regenerating forests which, if left alone, will easily recover. According to the Lang et al. 2021 indicative map, HCS forests still cover over 60 percent of the land area of 40 percent of Indonesia's 25 highest-deforesting nickel mines, and more than three quarters of the land area in a quarter of those mines. In other words, when Indonesia's nickel mines clear forests,

[16] For the definition of HCS forests, see: https://highcarbonstock.org/. For more information please refer to https://www.greenpeace.org/static/planet4-africa-stateless/2018/10/a4a4affe-a4a4affe-hcs_tk_2015_sng_aw1.pdf

they are destroying important stores of carbon and ecologically viable forests landscapes.[17] See **Column B** in **Table 10** (below).

Many of the natural forests being cleared by Indonesia's highest-deforestation nickel mines contain globally recognized high levels of biodiversity: We compared the boundaries of Indonesia's nickel concessions with land areas deemed by the International Union for the Conservation of Nature (IUCN) to constitute Key Biodiversity Areas (KBAs). These are critical habitats where many different plants and animals reside; biodiversity in intact landscapes allows ecosystems to thrive.[18] More than a quarter of the 25 highest-deforestation mines contain Key Biodiversity Areas. See **Column C** in **Table 10** (below).

Indonesia's highest-deforestation nickel mines are clearing large areas of Production Forest: We overlaid concession boundaries with Production Forests, defined by the MoEF as forest areas whose main function is to yield forest products, primarily natural forest timber (and increasingly to accommodate pulp and paper plantations, although much less so in Sulawesi or Maluku). More than 23 of Indonesia's 25 highest-deforestation nickel concessions have yet to clear 75% or more of the forests on their lands zoned as Production Forest. At least 21 of Indonesia's highest deforestation mining concessions contain at least 1,000 hectares each of as-yet-uncleared Production Forest. Thus, *there is still an opportunity to conserve these forests*. Nevertheless, the process of clearing Production Forests by Indonesian nickel mines is underway. All of Indonesia's 25 highest-deforestation nickel concessions have begun to clear areas of Production Forest.

Nickel in Indonesia is strip mined. The Ministry of Forestry is supposed to carefully regulate the clearance of Production Forest, including that which stands atop future strip mines. To receive authorization to strip mine in Production Forest, nickel concessions must first secure "Borrow and Use Permits."[19] These permits allow nickel mines to clear Production Forest within their concession areas, but also require them to replant areas of natural forest outside their mining concessions that are double the size of the area of Production Forest that they clear inside their concessions. If a mine clears Production Forest without having first received a Borrow and Use Permit, this amounts to illegal logging. We have been advised by our Indonesian legal counsel that if a mining concession clears Production Forest without a Borrow and Use Permit,

> *[T]hen the business entity is operating within the forest area illegally. This makes it liable for various forms of accountability, including criminal charges for forest usage, civil lawsuits*

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[17] The HCS Approach also requires protecting land vital to local communities and High Conservation Value (HCV) areas as well as respecting Free Informed Prior Consent (FPIC) of communities.

[18] To understand how IUCN defines Key Biodiversity Areas, see: https://www.iucn.org/resources/conservation-tool/key-biodiversity-areas

[19] Borrow and Use Permits are regulated under Ministry of Environment and Forestry Regulation P.7/Menlhk/Setjen/Kum.1/2/2019 which amends Ministry of Environment and Forestry Regulation P.27/Menlhk/Setjen/Kum.1/7/2018 on Guidelines for Borrow and Use Permits.

for damages, and administrative fines. See anti-illegal logging law, environmental protection law, and government regulations on administrative sanctions in the Forest Zone. The Civil Investigator in MoEF can investigate and process the violation.

Of Indonesia's 25 highest-deforestation nickel mines, all contain and are clearing Production Forest (see Table 9 below). Therefore, all 25 should possess Borrow and Use Permits. Four sources allow us to determine which ones possess such permits.

The first source is the final known published list of mining concessions in possession of Borrow and Use Permits (MoEF 2013). According to this list, only ten of Indonesia's top 25 deforesting nickel concessions with Production Forest were (or may have been) in possession of Borrow and Use Permits as of 2013.

The second source is Presidential Decree 3 of 2023, which automatically grants Borrow and Use Permits to seven nickel concessions, [FN 19] five of which are among Indonesia's top 25 deforesting nickel concessions.

The third source is a 2023 MoEF map which shows the boundaries of Borrow and Use Permits. Although this map does not state which Borrow and Use Permits have been assigned to which mines, it does show digitized polygons which are said to represent the boundaries of Borrow and Use Permits. These polygons can be overlaid on top of the boundaries of Indonesia's nickel concessions. Of Indonesia's top 25 deforesting nickel concessions, MoEF 2023 shows that 19 have Borrow and Use Permits. See **Table 9** (below).

The fourth source is the MOMI map published online by the Directorate General of Minerals and Coal. With that being said, MOMI's representation of Borrow and Use Permits is current only as of May, 2021. Perhaps because it is slightly dated, MOMI shows that Borrow and Use Permits have been issued to only 16 of the top 25 deforesting mines. See **Table 9** (below).

To arrive at a sense of which of Indonesia's top 25 deforesting nickel mines with Production Forest were (or are) in possession of Borrow and Use Permits, this report combines all four sources, and makes two generous assumptions:

- First, we assume that all 10 of the top 25 deforesters that were in possession of Borrow and Use Permits in 2013 are still in possession of such permits.
- Second, for any mine that either was in possession of a Borrow and Use Permit according to the 2013 MoEF report, or is still in possession of such a permit according to Presidential Regulation 3 of 2023, or the 2023 MoEF map, or the MOMI map, we assume that this mine has been in possession of that permit since the time of its most recent concession award (or boundary adjustment), and that this Borrow and Use permit allows any Production Forest inside the concession to be cleared.

Even with the benefit of these two assumptions, the fact remains that of the top 25 deforesting nickel mines (all of which contain Production Forest), five neither were, nor are, in possession of Borrow and Use Permits. It can therefore be concluded that all Production Forest cleared by any of these five was done so unlawfully. The total amount of Production Forest cleared by these five since their latest license adjustment or award was 2,654 hectares, more than the total area of Sacramento, the capital of California. These findings are summarized in **Table 9** (below).

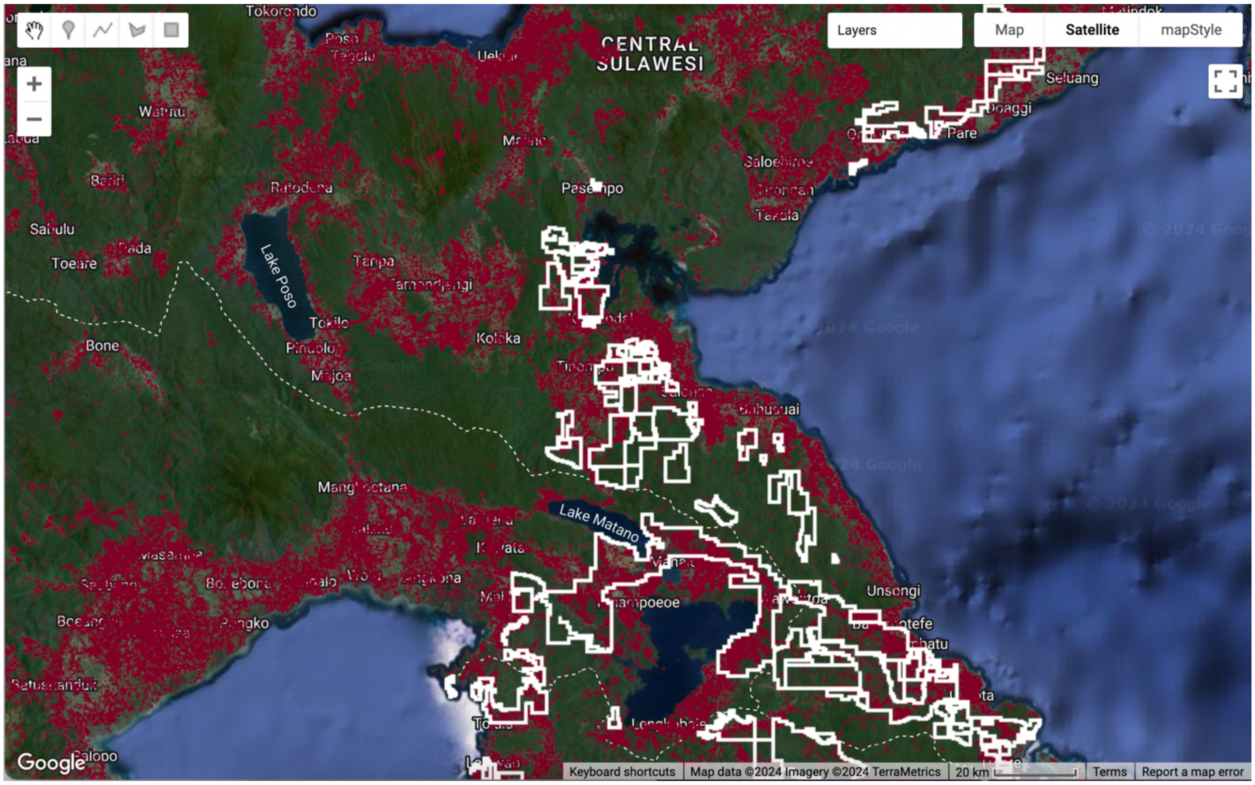


Photo: Google Earth Engine visualization of forest loss within nickel concessions in Sulawesi
Sources: UMD Forest Loss, MODIS Nickel Concessions, visualized in Google Earth Engine.

Table 9: Among Indonesia's top-25 deforesting nickel mines, 10 have illegally cleared 6,600 hectares of Production Forest, in the absence of possession of Borrow and Use Permits

Rank	Names of top 25 deforestation nickel mines, ranked according to total amount of deforestation (in all land types) since latest adjustment to or award of license	Production Forest cleared since latest change to and/or issuance of license	Mine was (or may have been) in full (or partial) possession of a Borrow and Use Permit, according to:				It cannot be ruled out that this amount of Production Forest was illegally cleared
			MoEF 2013	Presidential Regulation 3 of 2023	MoEF 2024 PPKH	MOMI 2024	
1	Vale Indonesia – Sorako	2,172.82	Maybe	Yes	Yes	Yes	0
2	Aneka Tambang – Kon Ut	1,392.45	Maybe	Yes	No	Yes	0
3	Bintang Delapan Mineral	2,485.60	Yes	No	Yes	Yes	0
4	Vale Indonesia – Pomala	1,330.06	Maybe	Yes	Yes	No	0
5	Vale Indonesia – Bahodopi	1,583.28	Maybe	Yes	Yes	Yes	0
6	Mulia Makmur Perkasa	772.62	No	No	Yes	No	772.62
7	Bukit Makmur Istindo Nikel	491.32	No	No	Yes	Yes	0
8	Multi Dinar Karya	614.34	No	No	Yes	Yes	0
9	Pertambangan Bumi	1,182.50	Yes	No	Yes	Yes	0
10	Lawaki Tiar Raya	1,136.25	No	No	No	No	1,136.25
11	Weda Bay Nickel	383.20	Yes	Yes	Yes	Yes	0
12	Bahodopi Utara Block	783.91	No	No	Yes	Yes	0
13	Wana Kencana Mineral	693.31	No	No	Yes	No	0
14	Halmahera Sukses Mineral	712.87	No	No	Yes	Yes	0
15	Ceria Nugraha Indotama	413.99	No	No	Yes	Yes	0
16	Riota Jaya Lestari	506.43	No	No	Yes	No	0
17	Adhi Kartiko Pratama	903.22	Yes	No	Yes	Yes	0
18	Gemilang Mandiri Perkasa	484.25	No	No	No	No	484.25
19	Mulia Pacific Resources	306.53	Yes	No	Yes	Yes	0
20	Toshida Indonesia	452.84	Yes	No	No	No	0
21	Sulawesi Cahaya Mineral	606.84	No	No	Yes	Yes	0
22	Gemilang Bangun Perkasa	88.50	No	No	No	No	88.50
23	Cahaya Ginda Ganda	581.07	No	No	Yes	Yes	0
24	Anugerah Bumi Gemilang	172.66	No	No	No	No	172.66
25	Sambaki Tambang Sentosa	340.77	No	No	Yes	Yes	0
	Total	**20,591.62**					**2,654.28**

Note: If a nickel concession either may have been or was (according to MoEF 2013 and Presidential Decree 3 of 2023), or is even partially (according to MoEF 2024 or MOMI 2024), in possession of a Borrow and Use Permit, then for purposes of this report, that nickel concession will be considered as having been fully authorized to clear any Production Forest within its concession area at any time.

<u>Some of Indonesia's highest deforestation nickel mines have illegally cleared substantial areas of Protection Forest</u>: Open pit nickel mines may not be located inside areas classified as Protection

Forest, nor may they clear Protection Forest, [20] whose main functions are to protect life, buffer the ecosystem to aid with water management, prevent floods and erosion, prevent brine water intrusion, and maintain land fertility. Although five nickel Contracts of Work were exempted from this rule at the beginning of this century,[21] three of Indonesia's top 25 nickel deforesters have *not* been exempted from this rule and have, between themselves, cleared nearly 300 hectares of Protection Forest, an area almost as large as New York's Central Park. The three are Halmahera Sukses Mineral, Mulia Makmur Perkasa, and Lawaki Tiar Raya. See **Column E** in **Table 10** (below).

Some of Indonesia's highest deforestation nickel mines have cleared forests and land within oceanic buffer zones: As explained in **Box 3** (below), this practice could be illegal, but provincial and district governments have not always taken the steps necessary to make it so. Seven of Indonesia's top 25 deforesters have, between themselves, cleared nearly over 60 hectares of land – an area larger than Vatican City – within one hundred meters of the ocean. See **Column F** in **Table 10** (below).

Box 3: Is it illegal to mine within a hundred meters of the ocean?

One observer (Brown 2023: 29) argues that mining activities may *not* occur within a hundred meters of the ocean in Indonesia. Indonesia's Ministry of Marine Affairs and Fisheries Regulation 21/2021 states that if provinces or districts have activities (presumably including strip mining) that cause "erosion or abrasion" within a hundred meters of the ocean's high tide mark (this hundred meter wide buffer zone is referred to as the "coastal boundary"), and if the economic loss from all such activities exceeds IDR 200 million (or USD 1,333 at an exchange rate of IDR 15,000 to USD 1) within the administrative area of any village (all land in Indonesia is administratively assigned to a village; in rural Sulawesi, one village can cover a very large area), then such activities shall be classified as posing a high risk of disaster. In such cases, provincial and district governments are then obligated to regulate (and presumably outlaw) such activities as a part of their provincial and district spatial plans. Does this mean it is illegal to strip-mine nickel within the coastal boundary? It does, but only if provincial and district governments have adopted planning documents that outlaw such activities. If they have not, then it may not yet be illegal. As of a few years ago, only about 55 of Indonesia's more than 500 districts had completed their spatial plans. Therefore, it remains a safe bet that most of Indonesia's mining districts do not possess district spatial plans, let alone those that outlaw mining within 100 meters of the ocean. For this reason, our report refers to the practice of mining within one hundred meters of the ocean as "legally contested," rather than "illegal."

[20] Based on the Forestry Law of 1999.

[21] Presidential Regulation 4 of 2004 granted five nickel Contracts of Work (CoW) exemptions from the prohibition on strip mining Protection Forest. The five were Inco (now Vale Indonesia), two Aneka Tambang CoWs (one in Southeast Sulawesi province the other in North Maluku province), Weda Bay Nickel, and Gag Island Nickel. These exemptions have now been extended by Presidential Regulation 3 of 2023.

The six key categories of environmental risk discussed above are quantified for each of Indonesia's 25 highest-deforesting nickel concessions in **Table 10** (below).

Table 10: The extent to which Indonesia's 25 highest-deforestation nickel concessions overlap with indicative High Carbon Stock forests or Key Biodiversity Areas, may have illegally cleared Production Forest or Protection Forest or are mining in the coastal boundary.

Names of highest-deforestation Indonesian nickel mining concessions	A		B	C	D	E	F
	Tree cover loss from latest license award or adjustment until the end of 2022		Percentage of land area inside the concession that is classified as "High Carbon Stock Forest"	Hectares within concession that are defined by IUCN as a "Key Biodiversity Area"	Production Forest illegally felled in absence of Borrow and Use Permit	Hectares of non-exempted Protection Forest illegally cleared	Hectares cleared within 100 meters of the ocean
	Rank	Hectares felled					
Vale Indonesia – Sorako Block	1	14,558.94	51%	17,105.26	0		
Aneka Tambang – Konawe Utara	2	2,775.80	61%		0		23.42
Bintang Delapan Mineral	3	2,737.76	85%		0		
Vale Indonesia – Pomala Block	4	2,614.35	32%	1,185.88	0		
Vale Indonesia – Bahodopi Block	5	2,465.37	80%		0		
Mulia Makmur Perkasa	6	1,835.82	44%	3,314.51	772.62	5.56	6.62
Bukit Makmur Istindo Nikeltama	7	1,708.28	51%		0		
Multi Dinar Karya	8	1,414.24	83%		0		5.87
Pertambang-an Bumi	9	1,380.54	17%	4,571.56	0		
Lawaki Tiar Raya	10	1,250.60	69%		1,136.25	24.16	

Weda Bay Nickel	11	1,247.99	86%		0		
Bahodopi Utara Block	12	1,192.34	19%		0		
Wana Kencana Mineral	13	1,118.82	42%		0		
Halmahera Sukses Mineral	14	1,078.70	49%		0	264.48	
Ceria Nugraha Indotama	15	949.02	34%		0		19.82
Riota Jaya Lestari	16	917.03	14%		0		
Adhi Kartiko Pratama	17	906.82	58%		0		
Gemilang Mandiri Perkasa	18	887.85	41%		484.25		
Mulia Pacific Resources	19	870.99	51%	1,236.00	0		7.10
Toshida Indonesia	20	669.47	62%	111.91	0		
Sulawesi Cahaya Mineral	21	613.54	91%		0		
Gemilang Bangun Perkasa	22	602.27	4%		0		
Cahaya Ginda Ganda	23	596.33	94%		0		
Anugerah Bumi Gemilang	24	591.92	4%	168.44	172.66		
Sambaki Tambang Sentosa	25	587.47	55%		88.50		5.06

3. CASE STUDY:
The ABCs of Deforestation

Presented below are a series of maps illustrating the environmental impacts of three nickel concessions. The three concessions, which have collectively cleared over 5,000 hectares of forest, are:

- **A**neka Tambang – an IDX traded, government-owned mining company which controls nine nickel concessions by the same name in Eastern Indonesia. The one with the largest area is a top-25 deforester and is presented below.
- **B**intang Delapan Mineral – owned by two Indonesians – Halim Mina (90 percent) and Hamid Mina (10 percent) – and affiliated with Tsingshan, a Chinese stainless steel and battery materials conglomerate.
- **C**eria Nugraha Indotama – owned by 50 percent each by two Indonesians, Derian and Cherisha Sakmiwata.

Figure 6: Map of locations of case study nickel concessions (Aneka Tambang, Bintang Delapan Mineral, and Ceria Nugraha Indotama)

These three companies were selected because satellite imagery of their concessions shows clear evidence of one or more of the following environmental issues:

- Clearing High Carbon Stock forests: This is not illegal under Indonesian law, but means that intact forest ecosystems are likely being destroyed. See discussion in **Section 2** (above).
- Destroying high biodiversity areas. This is not illegal under Indonesian law but would seem to be discouraged under the EU Battery Regulation. See discussion in **Chapter V, Section A** (below).
- Illegally clearing land in Protection Forests. See discussion in **Section 2** (above).
- Mining within 100 meters of the ocean. See discussion in **Section 2** (above).

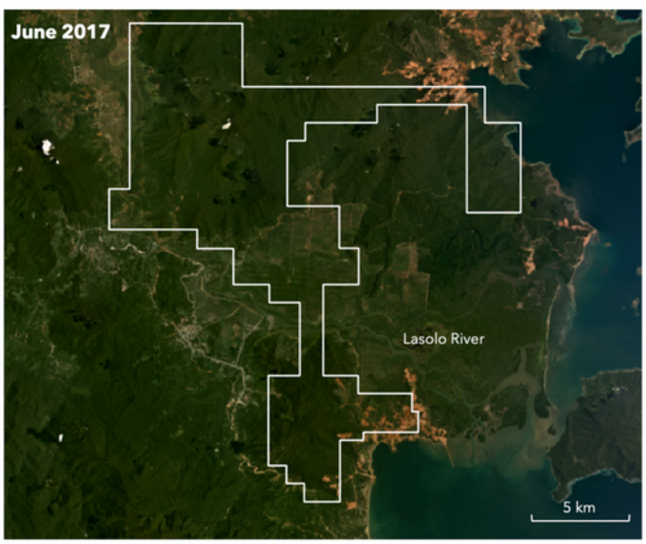
Aneka Tambang: Mining within 100 meters of the ocean

State-owned Aneka Tambang's largest nickel concession, Konawe Utara, is located on the eastern side of Central Sulawesi province.

The image in **Figure 7** (below) shows the concession in 2017, at a time when strip mining by the concession within one hundred meters of the ocean, and the subsequent discharge of sediments into the ocean, were not as prevalent as they are today. In comparison, **Figures 8 & 9** (right) shows Aneka Tambang's concession in September 2023.

Mining within one hundred meters of the ocean is evident, even from far-zoomed-out satellite imagery. As of 2022, strip mining within the concession less than one hundred meters from the ocean amounted to (legally contested) clearance of 23.4 hectares. In addition, the Lasolo river, which runs through the Aneka Tambang concession, is visibly loaded with sediment; the discharge of this sediment into the ocean is also clearly visible from orbit. This is not the case in the comparative imagery from 2017 in **Figure 7**.

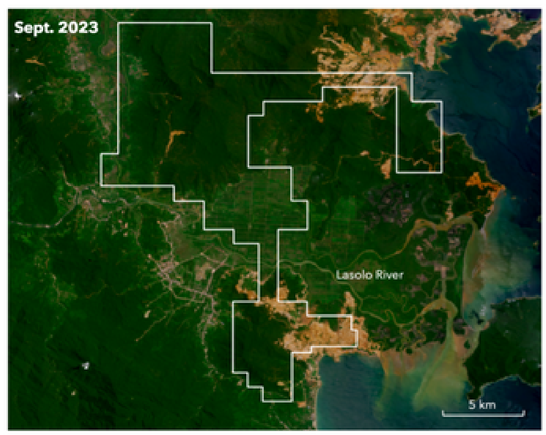
Figure 7: June 2017 satellite imagery of Aneka Tambang's largest nickel concession

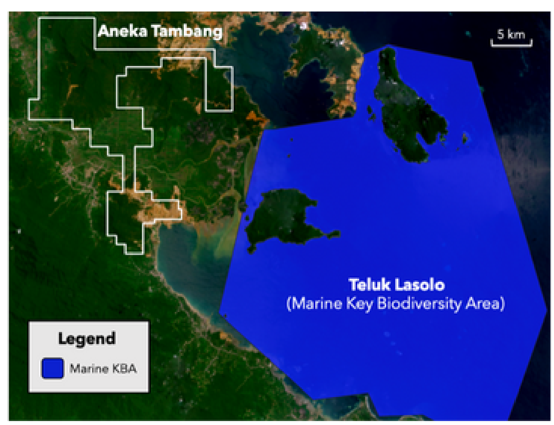


Source: Imagery © 2017 Planet Labs LBC

Lasolo Bay is the site of an IUCN-designated marine Key Biodiversity Area, as demonstrated in **Figure 9** (below). The EU Battery Regulation requires manufacturers and sellers of EVs in Europe to (1) identify suppliers of critical minerals (including nickel mines) which are a threat to water quality, (2) consider taking steps to encourage such suppliers to mitigate such actions and, (3) if no such steps are forthcoming, to consider removing that supplier. See discussion on the EU Battery Regulation in Chapter V, Section A (below).

Figures 8 & 9: September 2023 satellite imagery of Aneka Tambang's largest nickel concession, showing widespread clearance of land and forests for nickel mining as well as pollution of the Lasolo river, and the Lasolo Bay Key Biodiversity Area





Source: Imagery © 2023 Planet Labs LBC; KBA from BirdLife International (2023)

Bintang Delapan Mineral: Destroying Intact Forests and Key Biodiversity Areas

Bintang Delapan Mineral is located on the eastern side of Central Sulawesi province, just inland from the Indonesia Morowali Industrial Park (which it partly owns). Bintang Delapan's license was awarded (or most recently adjusted) in 2010.

Figure 10: Location of Bintang Delapan Mineral and indicative High Carbon Stock (HCS) forest within the concession (as of 2020)

Source: Indicative High Carbon Stock map from Lang et al. (2021); Visualized in Google Earth Engine

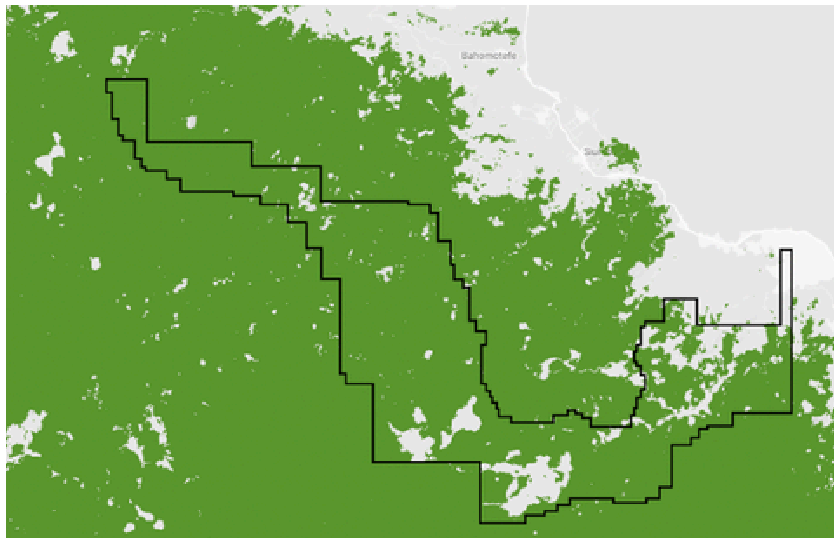


Figure 10 (above) shows that as of 2020, 85 percent of the Bintang Delapan concession area is covered with indicative High Carbon Stock forest. This, taken together with the fact that the concession has the third-highest rate of deforestation of any Indonesian nickel mine, suggests that destruction of intact forest landscapes will continue to take place here.

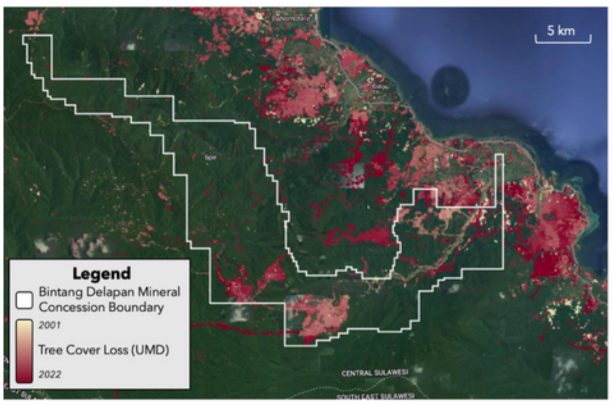
Figure 11: Photograph from the Bintang Delapan Mineral website

Translation: "Together against COVID 19: Cooperation in humanitarian aid in the form of medical equipment for medical personnel in Indonesia between PT Indonesia Morowali Industrial Park, Bintang Delapan Group, Tsingshan Charity Foundation." **Note:** This photograph from the Bintang Delapan Mineral Website in June 2023 features President-elect Prabowo Subianto. It has since been taken down.

Bintang Delapan Mineral

Figure 12 (below) illustrates satellite-detected deforestation within the boundaries of Bintang Delapan Mineral since the turn of the century.

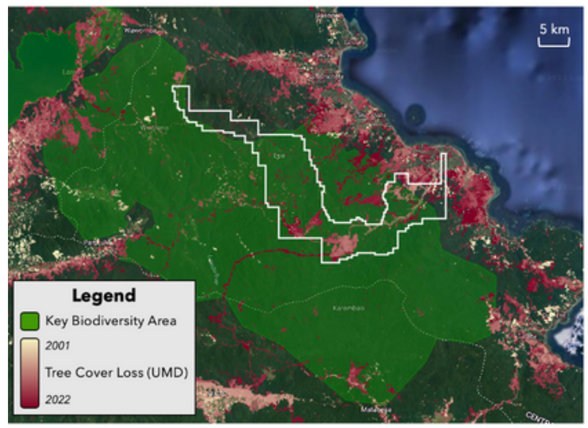
Figure 12: Tree Cover Loss (2001 to 2022) within Bintang Delapan Mineral



Source: Hansen/UMD/Google/USGS/NASA; Visualized in Google Earth Engine

Bintang Delapan Mineral is almost completely located within an area classified by the International Union for the Conservation of Nature as a Key Biodiversity Area, with 17,105 hectares of overlap. **Figure 13** (right) demonstrates forest loss within Bintang Delapan Mineral visualized with the Key Biodiversity Area overlapping with the concession. Biodiversity destruction would seem to be prohibited by the EU Battery Regulation; read the detailed discussion on the EU Battery Regulation in **Chapter V, Section A** (below).

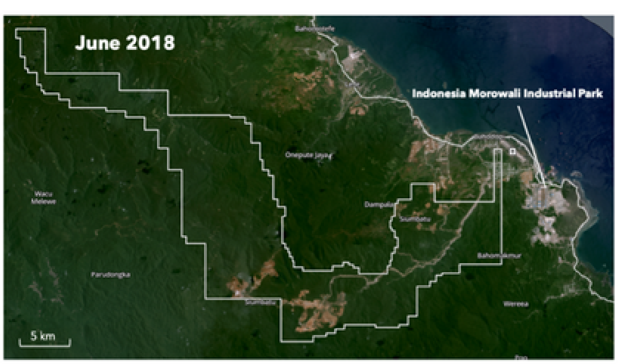
Figure 13: Tree Cover Loss (2001 to 2022) and KBA within Bintang Delapan Mineral

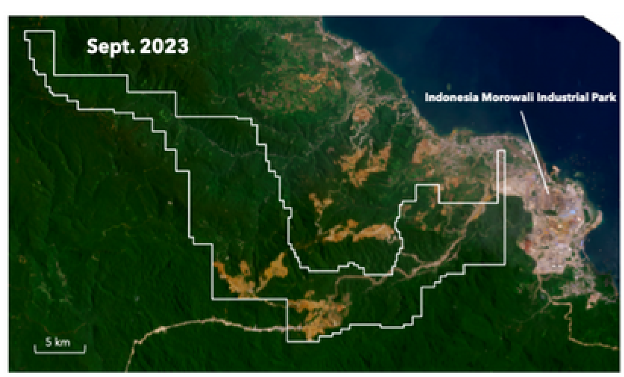


Source: Hansen/UMD/Google/USGS/NASA, BirdLife International (2023); Visualized in Google Earth Engine

The satellite photographs below show both the massive clearance of forest within Bintang Delapan Mineral as well as the expansion of the Bintang Delapan Mineral-owned Indonesia Morawali Industrial Park (IMIP), over a five-year period.

Figures 14 & 15: Satellite imagery (from the years 2018 and 2023) showing nickel mining and processing.



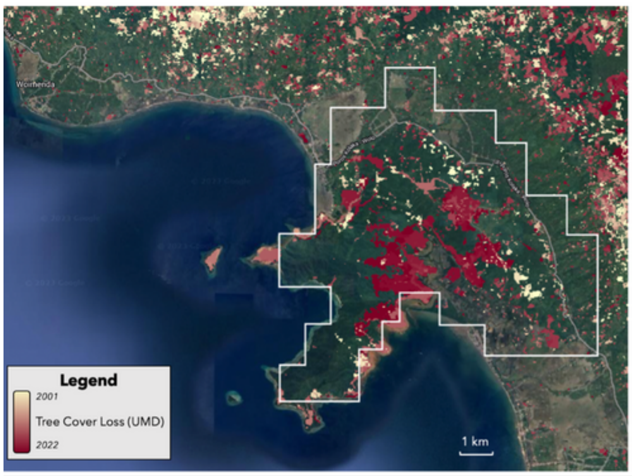


Source: Imagery © 2018/2023 Planet Labs LBC

Ceria Nugraha Indotama: Mining in areas without proper permits

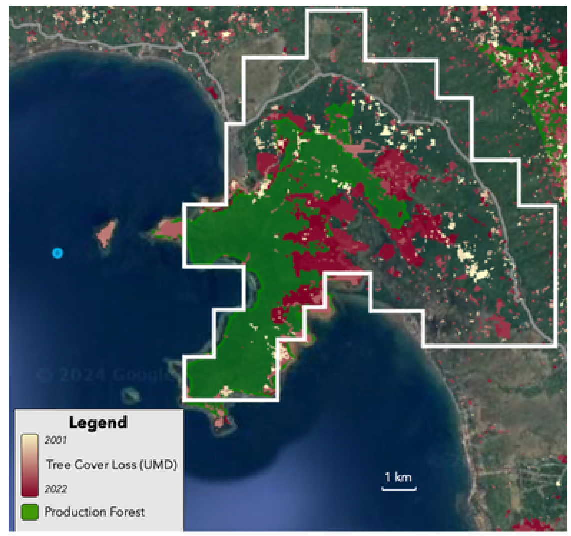
Ceria Nugraha Indotama is located on the western shore of SE Sulawesi Province. The license was awarded (or most recently adjusted) in 2013.

Figure 16: Satellite detected (UMD) forest loss within Ceria Nugraha Indotama (2001 to 2022)



Source: Hansen/UMD/Google/USGS/NASA; Visualized in Google Earth Engine

Figure 17: Recent forest loss (2020-2023) within Ceria Nugraha Indotama as detected by RADD Alerts

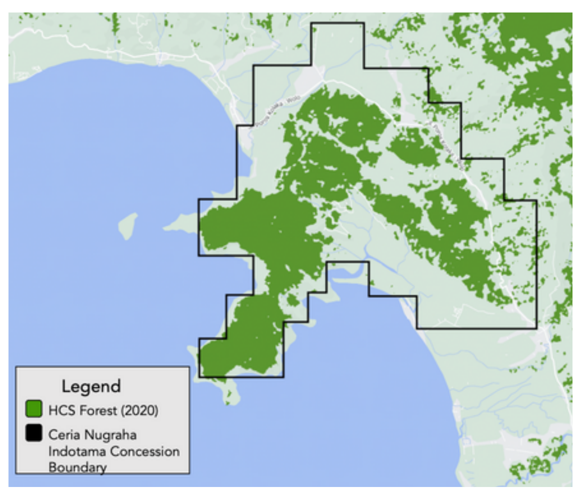


Source: RADD Alerts from Wageninen University/WRI/Google/ESA/UMD/Deltares; Visualized in Google Earth Engine

Figure 16 (above) presents satellite-detected deforestation within the boundaries of Ceria Nugraha Indotama, while **Figure 17** (right) presents radar-detected deforestation within the boundaries of Ceria Nugraha Indotama over the last five years, indicating ongoing forest clearance.

Figure 18 (right) shows the indicative HCS forest present within the boundaries of Ceria Nugraha Indotama. The map shows that over 40 percent of its area was still covered by indicative High Carbon Stock forest as of 2021. This, together with the fact that Ceria Nugraha Indotama was one of the highest deforesting nickel mines in Indonesia, strongly suggests that it will continue driving the destruction of intact forest landscapes.

Figure 18: Indicative High Carbon Stock Forest within Ceria Nugraha Indotama concession (as of 2021)



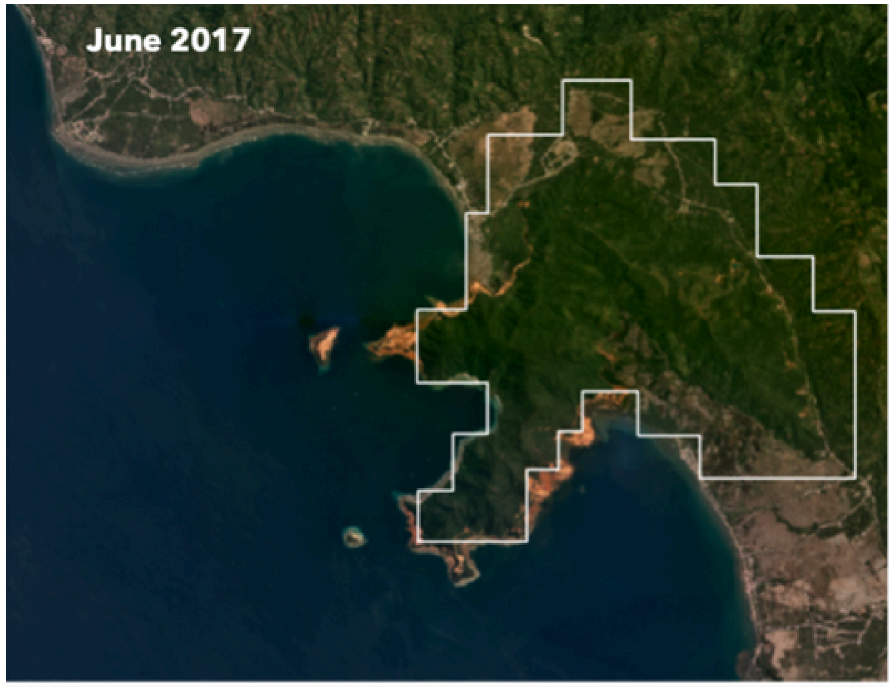
Source: Indicative High Carbon Stock map from Lang et al. (2021); Visualized in Google Earth Engine

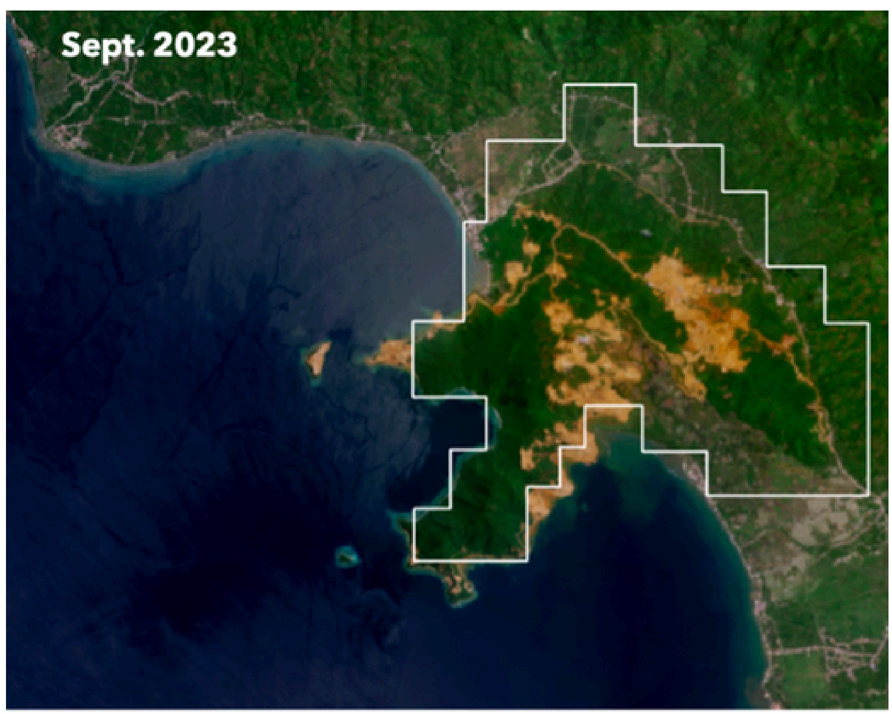
Figure 19 (right) shows June 2017 satellite imagery of Ceria Nugraha Indotama while **Figure 20** (right) shows September 2023 satellite imagery of the concession, illustrating forest clearance to mine nickel within 100 meters of the ocean.

Figure 20 demonstrates that, compared to six years earlier (in **Figure 19**), significant areas of land within one hundred meters of the ocean, both inside and immediately outside of the concession, have been (potentially illegally) strip-mined. As of 2022, the total amount of forest in the image below that was cleared within one hundred meters of the ocean amounted to nearly 20 hectares, an area twice the size of Battery Park on the southern tip of Manhattan.

The maps above demonstrate ongoing and historical deforestation within the concession boundaries of three major nickel mines in Indonesia. We show that all three mines are clearing indicative High Carbon Stock forests, two are destroying Key Biodiversity Areas and two are mining within 100 meters of the ocean.

Figures 19 & 20: Satellite imagery (2017 & 2023) of Ceria Nugraha Indotama clearing forests to mine nickel within 100 meters of the ocean





Source: Imagery© 2017 / 2023 Planet Labs

B. Environmental risk of nickel refining

Section A demonstrates how disastrous nickel mining has proven to be for Indonesian forests. Beyond deforestation from mining, the next steps down the nickel supply chain present new forms of ecological risk. This section (**Section B)** briefly explores the additional environmental risks of nickel refining.

Nickel processing has driven a huge build out of captive coal plants in Indonesia. These plants use coal to feed their industrial operations without connecting to the electricity grid. Indonesia's growing reliance on captive coal plants firmly maintains its position among the world's top ten greenhouse gas emitters. Defying the decarbonization trend in much of the rest of the world, Indonesia is increasing the proportion of coal it is burning relative to renewables. Coal consumption in Indonesia increased from 20.9 million metric tons in 2021 to 86.6 million metric tons in 2022 (EDSM 2022: 40), meaning Indonesia burned four times more coal in 2022 than the year before. The nation continues to build new coal-fired power plants with up to 14 new captive coal plants at three major nickel refining facilities.

To put the magnitude of this problem in perspective, just one Indonesian nickel-refining center, Weda Bay (IWIP), has plans to provide over 3.5 GW of coal energy, more than Spain or Brazil use in a year (CRI 2023). Another refining complex, the Indonesia Morawali Industrial Park (IMIP), "will soon have about the same amount of coal-fired generating capacity (at least 5 GW) as Mexico" (Norton Rose Fulbright 2023). The inhabitants of Morowali suffer from respiratory illness due to coal ash from the many coal plants in IMIP (Celios 2023). Furthermore, nickel mining and smelting processes pollute waterways and harm the communities dependent on these water sources (CRI 2023).

Another ecological risk arises from the tailings (or leftover materials from the refinement process) produced from nickel refining. There appears to be no safe or easy way to dispose of the highly toxic tailings produced by HPAL (defined in **Box 1** above), at least in Eastern Indonesia. While there are, to our understanding, four methods to get rid of toxic tailings, each comes with its own set of problems.

Table 11: HPAL tailings disposal in Eastern Indonesia

Disposal method	Description of disposal method	Risks of disposal method	Summary Risk Assessment
Deep Sea Tailings Placement (DSTP)	Tailings are released from a discharge pipe over 100 meters below the ocean's surface. In theory, the effluent is supposed to sink even deeper, because its density is greater than that of seawater.	DSTP is no longer permitted in Indonesia. The experience of China's Ramu NiCo in nearby Papua New Guinea shows that even with proximity to deep-water trenches, DSTP does not guarantee clean disposal. A major problem with DSTP is "shearing" - the upwelling of highly polluted water from the subsurface outlet of the discharge pipe back to the surface of the ocean.	Possible but extremely risky. No longer permitted in Indonesia.
Dry stacking	Tailings are placed in large, open spaces under dry conditions.	Dry stacking works in the Australian desert, and may even work in parts of Papua, but will probably not work in Sulawesi or Maluku[22] where there is high rainfall and potential for runoff.	Extremely difficult in rainy parts of Indonesia.
Tailings dam	A natural valley in the landscape is filled with tailings which are then held back from lateral movement by the construction of a dam or barrier.	In a wet climate, water accumulation places additional pressure on tailings dams. Sulawesi and Maluku are also areas of high tectonic activity, and dams may not be fully earthquake-proof. A 2019 breach of a Vale tailings dam in Brazil led to 270 fatalities. A dam holding the waste of the Indonesian Weda Bay Industrial Park collapsed and allegedly spilled into the sea on 30 January 2022 (BHRRC 2023: 15).	Possible but extremely risky.
Backfilling	Tailings are backfilled into an emptied mine pit.	Tailings from HPAL processes exceed mined material by a ratio of 1.4 to 1.6. Therefore, a mine whose ore is processed in an HPAL plant will not have room to accommodate all the tailings that exit the plant. Leaching into surrounding water tables is also a major risk.	Possible if the logistics can be managed, but still quite risky.

[22] With that being said, the Sonic Bay refinery in Maluku, which is slated to be built by Eramet (of France) and BASF (of Germany), claims that it will dry stack its tailings (CRI 2023: 81).

Table 11 (above) demonstrates that there is currently no straightforward solution to the problem of the outsized volume of tailings generated by HPAL plants in Eastern Indonesia. That said, of the four methods offered in **Table 11**, backfilling may be the safest. This method is now being used by the Halmahera Persada Lygend refinery on Obi Island. The refinery is said to be backfilling its tailings into an adjacent mine (Washington Post 2023). It may be possible that, with exceptionally careful planning (and great expense), some of the tailings generated by HPAL refineries could be deposited back into their original mining pits, and the remainder deposited in the empty pits of other nickel mines which did not sell their ore to HPAL plants.

In addition to the logistical challenge (and expense) of transporting HPAL tailings back to mining pits and dumping them there, it would also be necessary to install impermeable layers at the bottoms of each of the mining pits to avoid the leaching of heavy metals and acid into surrounding water tables. This too is quite costly.

It might be possible that the logistical management and mobilization of resources needed to manage backfilling on a national scale could be undertaken by an Indonesian state owned enterprise (SOE) created explicitly for this purpose, working in partnership with both a reputable mining waste disposal firm[23] as well as a firm with a global reputation for preventing leakage from mining pits.[24] This may be within the realm of possible: If Indonesia can create an SOE for battery manufacturing (i.e. the Indonesia Battery Corporation, a joint venture consisting of several SOEs) it can also create an SOE for managing the safe disposal of HPAL tailings. However, all of this

[23] Globally-recognized names in tailings disposal include:
• FLSmidth - an engineering company that provides sustainable solutions for mining operations, and water recycling technologies.
• Metso Outotec - a leading provider of mineral processing and filtration solutions. Their tailings management solutions include filtration and thickening.
• WesTech Engineering - a leader in tailings management and water treatment technologies. Their solutions include paste thickeners, filter presses, and vacuum belt filters.
• ANDRITZ - a technology company that provides innovative solutions for mining industries. Their tailings management solutions include thickening and dewatering.
• Tenova Delkor - tailings management solutions include filtration and thickening.

[24] Some globally recognized firms in providing geosynthetic lining solutions for a wide range of applications, including the building of impermeable barriers at the bottom of mine pits are:
• GSE Environmental - Their products include geomembranes, geotextiles, and geonets that provide impermeable barriers to prevent leaching.
• Solmax - Their products include geomembranes, geotextiles, and geocells that provide strong, reliable, and sustainable solutions for tailings management.
• CETCO – Their products include bentonite-based geosynthetic clay liners (GCLs) that are said to provide excellent hydraulic performance and chemical resistance to prevent leaching.
• Naue GmbH & Co. KG – Their products include geotextiles, geomembranes, and geosynthetic clay liners for tailings management.
• Raven Industries - A provider of geosynthetic solutions for agriculture, construction, and mining applications. Their products include geomembranes, geotextiles, and geonets that prevent leaching and contamination.

would have to be planned immediately for rapid implementation. If Indonesia wants to responsibly refine nickel, investments must also be made into the responsible disposal of toxic tailings.

Photos: Flooding incident in Baliara area, West Kabaena, Southeast Sulawesi occurred after only half an hour of rainfall on Tuesday, 26 March 2024.

V. OPPORTUNITIES IN RELATION TO THE EU BATTERY REGULATION AND THE US INFLATION REDUCTION ACT

Two types of regulations are critical to address the leakage of nickel mined within Indonesia's highest-deforestation concessions into supply chains:

- Laws and regulations that require full supply chain traceability
- Laws and regulations that discourage some of the more extreme forms of environmental degradation in mines or refineries

Multilateral and national laws and regulations now exist which mandate nickel supply chain traceability and/or the mitigation of destructive mining (and refining) practices. This chapter aims to provide a better understanding of which aspects of these laws and regulations should be prioritized for compliance. This chapter will focus on the EU Battery Regulation (**Section A**), the US Inflation Reduction Act (**Section B**), and opportunities for accountability (**Section C**).

A. EU Battery Regulation

In July 2023, the European Commission (EC) placed into effect a Battery Regulation which requires "economic operators" [25] [26] in the EU to implement due diligence policies. These policies will require critical minerals (including nickel) in EV batteries (alongside portable and industrial batteries) to be traced all the way back to the point where they were initially mined, by no later than 18 August 2025.

While the supply chain tracing requirements of the Battery Regulation are strong, the regulation is weaker in terms of protecting the environment. The regulation only asks economic operators to *consider* taking steps to identify and mitigate any major environmental damage that may have occurred along their battery supply chains (including at the point where the nickel was initially

[25] "Economic operators" are defined as "any persons or entities (e.g., manufacturers, importers, authorized representatives, distributors) placing on the EU market (including importation) rechargeable industrial batteries and e-vehicle batteries … as well as devices containing them" (Mertenskötter and Molyneux 2021).

[26] "The placing of a product on the market means the first making available of a product for the purpose of distribution and/or use in the EEA territory. An economic operator, in the context of the regulation, means a manufacturer, an importer or a distributor. In the context of EV batteries, an economic operator could be either a car manufacturer or a battery manufacturing company producing in the EU or outside of the EU market" (Transport and Environment forthcoming).

mined), and it only asks them to *consider* suspending engagement with suppliers that do not mitigate such damages.

The Battery Regulation requirements on disclosure are even weaker, lacking strong language to clarify the extent to which the public will be able to verify that economic operators *are* tracing the origin of minerals contained in EV batteries back to beginning of all supply chains or *are* considering whether to take steps to attempt to mitigate environmental damage occurring in those supply chains.

This section will explore whether the EU Battery Regulation adequately provides for:

- First, the tracing of critical minerals (including nickel) back through the supply chain to the location they were mined,
- Second, the mitigation of environmental damage that may have occurred at various points along the nickel supply chain (including at mines), and
- Third, the sharing of information collected by economic operators (with respect to the first two points) with the public.

Language of relevance to these three key areas can be found in Articles 48 through 52 and Annex X of the EU Battery Regulation.

1. Tracing supply chains back to the mine

The EU Battery Regulation requires economic operators -- that is to say, those who first make available a product (like an EV) containing selected raw materials (like nickel) for the purpose of distribution and/or use in the EEA territory -- to trace their supply chains all the way back to mining sites. This provision is helpful, because only if economic operators know the points of origin of the nickel in their batteries can they make inquiries into the full extent to which the environment was damaged in producing it.

The Battery Regulation requires economic operators to identify the "country of origin of the raw material and the market transactions from the raw material's extraction to the immediate supplier to the economic operator" [Article 49, Paragraph 2, Subparagraph (c)]. Requiring the determination of "market transactions from the raw material's extraction" is an unusually clear directive to economic operators that they must follow the nickel contained in their EV batteries all the way up the supply chain to the mine of origin.

2. Identifying and mitigating environmental damage

The EU Battery Regulation helpfully requires that economic operators gather information on the extent to which excessive environmental damage is occurring in their critical mineral supply chains (including at mines), but then only asks them to *consider* taking steps to mitigate this damage.

Identifying environmental damage along the supply chain

First, with respect to *identifying* environmental damage occurring in critical minerals supply chains, Article 50, Paragraph 1, Subparagraph (a) of the EU Battery Regulation requires economic operators to "identify and assess the adverse impacts associated with the risk categories listed in point 2 of Annex X" of the EU Battery Regulation. The environmental risk categories listed in Annex X, point 2 include, "(a) air; (b) water; (c) soil; (d) biodiversity." Moreover, Annex X, point 2 names the "Convention on Biological Diversity" as an example of an international instrument "covering the risks referred to in point 2." In other words, economic operators must determine whether the nickel in their supply chain is harmful to biodiversity and water quality.

Mitigating environmental damage on the supply chain

Second, with respect to *mitigating* environmental risk (or damage) in the supply chain, the EU Battery Regulation directs each economic operator to:

- "adopt risk management measures … considering its ability to influence, and where necessary take steps, to exert pressure on suppliers who can most effectively prevent or mitigate the identified risk" [Article 50, Paragraph (1), Subparagraph (b)(ii)], and
- implement "a risk management plan [while] considering suspending or discontinuing engagement with a supplier … after failed attempts at mitigation" [Article 50, Paragraph 1, Subparagraph (b)(iii)].

While the language in the two bullets (above) is a good start, it is not sufficient to merely ask economic operators to *consider* exerting pressure on unfit suppliers, or to *consider* suspending engagement with such suppliers if they do not improve. Instead, the EU Battery Regulation should require economic operators to exert pressure on unfit suppliers to mitigate risks and suspend engagement with such suppliers if they do not.

Even though the EU Battery Regulation has passed, the EC appears to have at its disposal an instrument that it has reserved for itself in the language of the EU Battery Regulation to "amend the obligations on the economic operators" [Article 48, Paragraph 8, Subparagraph (c)]. Were the EC to exercise this option, it could in theory remove the qualifiers "considering" from the two passages bulleted (above).

3. Disclosure

The EU Battery Regulation has weak language with respect to the obligation of economic operators to disclose -- either to governments or the public -- information on the chains of custody for minerals in EV batteries, or the status of efforts or to ameliorate instances of extreme environmental degradation in these supply chains, or the severance of certain suppliers.

Sharing information with government

With regard to the obligation of economic operators to share information with *government agencies*, the EU Battery Regulation stipulates that the economic operator "shall make available upon request to Member States' market surveillance authorities or national authorities … evidence of compliance with a supply chain due diligence scheme" [Article 52, Paragraph 1]. In other words, the *only* named government entities that have the right to request information from economic operators are "market surveillance authorities," presumably those in the EU state in which the economic operator is based.

Assuming oversight for compliance with the EU Battery Regulation is delegated only to the market surveillance authorities of individual member states, this policy risks market surveillance being uneven. It would have been more reassuring if the EU had added an additional layer of centralized EC-level oversight. But perhaps this is not possible under the current structure of the EU.

Sharing information with the public

With respect to the EU Battery Regulation's obligation to share information with *the public*, the EU Battery Regulation stipulates that the economic operators must report annually on "findings of significant adverse impacts" in their battery supply chains "and how they have been addressed."

Unfortunately, this language is then rendered potentially ineffective with the addition of the qualifier that such disclosure may be carried out "with due regard for business confidentiality and other competitive concerns" [Article 52, Paragraph 3].

This final clause appears to leave room for economic operators to omit whatever they like from their reports, merely by citing "business confidentiality and other competitive concerns." The notion that disclosing one's suppliers will erode one's competitive advantage is a decades-old excuse used by companies to avoid transparency about the identities and locations of their raw material suppliers. Without allowing the buyers of EVs to understand where the nickel in their EVs was mined, it will be very difficult for those buyers to verify whether those mines are sustainable.

Box 4: An argument for why BMW, Mercedes-Benz and VW should remove Indonesia's Bintang Delapan Mineral from their supply chains

The EU Battery Regulation provides a strong legal foundation for EV automakers in Europe – such as Mercedes-Benz, VW, and BMW – to consider removing Indonesia's third-highest deforesting nickel mine, Bintang Delapan Mineral, from their supply chains.

1. As shown in **Figure 13** (above), Bintang Delapan Mineral is clear-felling an IUCN-designated Key Biodiversity Area. This is a violation of a provision set out in Annex X, point 2 in the EU Battery Regulation, which designates biodiversity as an environmental risk category.

2. Bintang Delapan Mineral directly (and indirectly, through Sulawesi Mining Investment) owns Indonesia Morowali Industrial Park, which in turn owns the QMB New Materials Energy refinery (see **Figure 5** above). Given that Bintang Delapan Mineral owns the QMB refinery, it is likely that Bintang Delapan Mineral supplies the refinery with nickel ore.

3. The QMB New Materials Energy nickel refinery, in turn, indirectly (through GEM Co, Ltd) and directly supplies MHP to CATL battery factories (see **Figure 5** above).

4. CATL supplies batteries to Mercedes-Benz, VW, and BMW (see **Figure 5** above).

5. The proposed EU Battery Regulation requires economic operators to ***consider*** taking steps to mitigate biodiversity loss in their supply chains, and to also ***consider*** removing from their supply chains companies that do not undertake such mitigating actions.

6. Recalling that (as show in **Figure 13** above) nearly the entire area of the Bintang Delapan Mineral concession falls within an IUCN-designated Key Biodiversity Area (KBA), and further recalling that (as show in **Figure 13** above) Bintang Delapan has already begun to clear forests in that KBA, it is logical to infer that it is unlikely that Bintang Delapan can proceed with operations without continuing to deforest this KBA.

7. Therefore, the language of the EU Battery Regulation would appear to strongly encourage Mercedes-Benz, Volkswagen, and BMW to immediately remove Bintang Delapan Mineral from their supply chains.

B. US Inflation Reduction Act

The US Inflation Reduction Act (IRA) was passed into law in August 2022. The IRA allows US consumers who purchase EVs in the US in 2024 to recoup USD 3,750 per vehicle, if 50 percent of the critical minerals in the batteries of those EVs are mined and/or refined in *either* the US *or* in a country with which the US has a free trade agreement (FTA). In future years, the threshold will rise–see **Table 12**.

Table 12: For purposes of receiving a USD 3,750 IRA rebate, the required percentage of qualifying critical raw materials in EV batteries will increase over time.

Year EV is placed in service	Required % of value added by qualifying critical raw materials
2024	50
2025	60
2026	70
2027	80

Source: Federal Register 2023: 23371

1. Tracing supply chains back to the mine

To determine whether the percentage thresholds in **Table 12** are being met, manufacturers and/or sellers of EVs in the US must trace all critical mineral supply chains back to their points of origin. Full battery supply chain tracing is likely to become ubiquitous for EVs sold in the US because, for EV consumers to obtain the substantial credits provided for under the IRA, the companies from which the consumers are purchasing EVs must first determine where the critical minerals in the batteries of those EVs originated and were refined.

The steps required under the IRA for the mapping of "procurement chains," and the assigning of value to the individual parts of those procurement chains, have been determined. To allow their customers to qualify for the critical minerals tax credit, a US seller of an EV will have to take these three steps:

- First, the seller must identify all procurement chains for all critical minerals in the battery. In the case of nickel, the procurement chain would start at the mine and continue through every downstream company which buys and/or transforms the nickel. Each combination of mine, refiner, battery maker, and EV maker is considered as a distinct procurement chain. Therefore, even for a single critical mineral like nickel, not one, but many procurement chains must be identified.
- Second, sellers must calculate the value added at each transaction point in each procurement chain. The purpose of this calculation is to try to determine whether at least 50 percent of the value added at all phases of the nickel's extraction **and/or** refining took place in either the US **or** in a nation with which the US has a free trade agreement. If so, the entire procurement chain (including both the extraction and refining components) will be deemed "qualifying."
- Third, the value added among all **qualifying** procurement chains for all critical minerals in the battery of an EV will then be divided by the value added of **all** procurement chains (both qualifying and non-qualifying). If the EV was placed in service in 2024, and the resulting fraction has a value of greater than 50 percent, the EV will qualify for the rebate. In subsequent years, the required percentage will rise (see **Table 12** above).

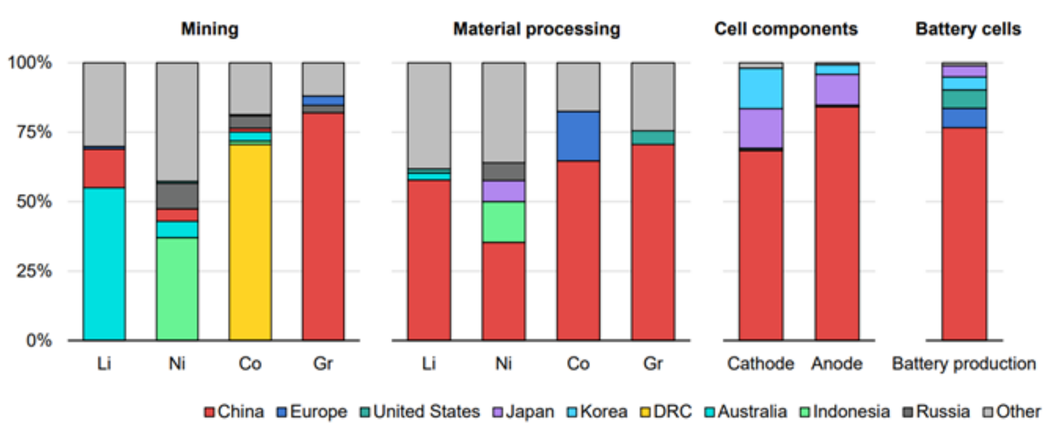
To summarize, for US EV consumers to be eligible for a credit of USD 3,750 per vehicle, sellers must fully trace their procurement chains - all the way back to the point of origin for all critical minerals contained in the EV batteries. This means that, apart from those US EV manufacturers who are willing to forego allowing their customers to avail themselves of this sizeable credit, most EV manufacturers in the US are now required to find out precisely where the critical minerals in the batteries in the EVs they wish to sell were mined.

The purpose of this requirement is to incentivize the "friend-shoring" of the mining and refining of critical minerals to nations with which the US has Free Trade Agreements (or the equivalent). For this reason, Korea and Japan may experience an increase in their US market shares of EV battery materials, components and EV batteries themselves, over and above what would have been the case in the absence of the IRA requirements. This is because Korea has a Free Trade Agreement with the US, while Japan has entered into a narrow agreement with the US for the free trade of critical minerals.

By the same token, the IRA seeks to *loosen* China's grip on critical minerals, in part by providing rebates for electric vehicles (EVs) sold in the US, but only as long as these EVs do not contain critical minerals mined or processed by China. Because China's domestic mines produce less than ten percent of the world's nickel (see the second column in the **Figure 20** below), geology dictates that China cannot control the world's supply of mined nickel ore.

However, Chinese-owned nickel refineries that upgrade nickel ore into battery grade nickel in China, and increasingly in Indonesia, make up half of the world's total (see the sixth column in **Figure 21**). China also controls three-fourths of the world's production of EV battery cell components (see the ninth and tenth columns in **Figure 21**) and three-fourths of the world's production of EV battery cells (see the eleventh column in **Figure 21**).

Figure 21: China and Indonesia hold an oligopoly on nickel material processing for EV batteries



Source: International Energy Agency. 2021. "Global Supply Chains of EV Batteries." Page 27.

MIGHTY EARTH

To ensure that rebates are not granted for EVs containing Chinese-refined critical minerals laundered through the factories in nations with which the US has free trade agreements, the IRA adds a second layer of protection: It prohibits rebates for EVs if they contain *any* critical minerals mined or processed by a "Foreign Entity of Concern." China is named as a Foreign Entity of Concern, together with Russia, North Korea and Iran. On its face, this should prevent *any* rebate in *any* amount for *any* EV sold in the US, if that EV contains *any* critical mineral that has been processed through *any* Chinese refinery located *any*where in the world, including Indonesia.

However, in a 4 December 2023 submission to the **Federal Register**, the US Department of Energy (DoE) argued that Chinese-owned critical mineral processing facilities will not be considered as Foreign Entities of Concern, if they happen to be *privately* owned *and* located *outside* of China. This is a very big loophole considering that in Indonesia, where more than half the world's nickel is now mined, almost all nickel upgraded to battery purity passes through Chinese majority-owned refineries *inside* Indonesia and constitutes one-sixth of the world's total supply of battery grade nickel (see the lime green segment in the sixth column in **Figure 21** above). If the DoE has its way, EVs sold in the US which contain this type of nickel will be eligible for IRA rebates.

Based on the new DoE interpretation, the only circumstance under which EVs containing nickel refined in Indonesia by Chinese corporations would *not* be eligible for an IRA rebate, is if the Chinese government (including a Chinese State-Owned Enterprise), the Chinese Community Party, or a current of former official from either, collectively control 25 percent or more of the shares in that refinery. In Indonesia, all nickel refineries (except those owned by Vale Indonesia, an Indonesian, Brazilian, Canadian and Japanese consortium) are owned in the majority and operated by subsidiaries of the seven Chinese corporations listed in **Table 13** below.

Table 13: Profiles of Chinese companies owning refineries in Indonesia to produce cathode precursor materials, and the extent to which they are owned by Chinese State-Owned Enterprises (SoEs)

No.	Name of company which owns existing or planned refinery in Indonesia	China headquarters of company	Name of founder	% owned by Chinese SOEs
1.	Chentung Mining Group Co, Ltd	Xiamen, Fujian	Zhenpeng Zhang	Unclear
2.	China Molybdenum Co, Ltd	Luoyang, Henan	Yuan Honglin	27.00
3.	Contemporary Amperex Technology Co, Ltd (CATL)	Ningde, Fujian	Robin Zeng Yuqun	Unclear
4.	GEM Co, Ltd	Shenzen, Guangdong	Xu Kaihua	0.52
5.	Lyjend Resources & Technology Co	Ningbo, Zhejiang	Cai Jianyong	2.24
6.	Tsingshan Holding Group Co, Ltd	Wenzhou, Zhejiang	Xiang Guangda	Unclear
7.	Zhejiang Huayou Cobalt Co, Ltd	Jiaxing, Zhejiang	Xue Hua Chen	0.00

Note: All seven of the companies named in this table are universally described as "private" in the business press. But such assertions cannot be fully verified because two of these companies (CATL and Tsingshan) have not published audited annual reports, while a third (Chentung Mining Group Co, Ltd) has not published audited annual reports in English. As for the remaining four companies, information on their ownership (as well as extent to which they are owned by Chinese government or Communist Party entities) is based on their most recent published, audited annual reports, or other sources.[27]

All seven of the companies described in **Table 13** (above) are generally classified in the business press as "private." To be sure, one of the seven, China Molybdenum Co. Ltd. is 27% owned by Chinese State-Owned Enterprises. But that amount of control exists only at the level of China Molybdenum's holding company and does not carry through in that amount to its control of the Huayue Nickel and Cobalt refinery in Indonesia.[28]

In the absence of evidence that any of the nickel refineries in Indonesia owned and operated by the seven companies named in **Table 13** (above) are more than 25% owned by the Chinese government or Chinese Communist Party, or their current or former officials, it is likely that none of these refineries will be classified as Foreign Entities of Concern, if the DoE's proposed interpretation holds. With that said, further verification of the ownership of three of the seven is

[27] Most recent published sources for these four companies are: China Molybdenum Co Ltd, 2020 Annual Report, page 70, https://en.cmoc.com/html/2022/Performance_0121/60.html ; GEM Co Ltd, 2022 Annual Report, pages 224-225, https://en.gem.com.cn/uploadfiles/2023/04/20230429002359523.pdf; Lyjend Resources and Technology Co Ltd, 2022 Annual Report, page 60; https://ir.lygend.com/uploads/iis/202304/10708085-0.PD; Zhejiang Huayou Cobalt Co,Ltd, CRI 2023: Appendix 2

[28] While it is true that China Molybdenum Co. Ltd. itself is 27% owned by two Chinese State-Owned Enterprises (SOEs), this amount of control does not carry through to the Huayue Nickel and Cobalt refinery in Indonesia. Since China Molybdenum owns only 21% of that refinery, this means that the portion of that refinery that is controlled by the two SOEs is only 5.67%, a figure derived by multiplying 27% by 21%. The resulting figure of 5.67% SOE control of the Huayue Nickel and Cobalt refinery is less than DoE's 25% threshold.

needed: Two have no publicly available audited accounts whatsoever, while a third has none that are available in English. [29]

2. Identifying and mitigating environmental damage

Unlike the proposed EU Battery Regulation, the IRA contains no requirement that EV sellers must determine whether their batteries contain minerals mined under environmentally adverse conditions. Nevertheless, because most manufacturers of EVs will want to know ***where*** the critical minerals in their batteries were mined, these US EV manufacturers will be in a stronger position to make inquiries about the environmental conditions ***under which*** the critical minerals in their batteries were mined, should they wish to do so. As a result, manufacturers of EVs in the US can less plausibly claim ignorance about the environmental conditions under which the critical minerals in their batteries were mined.

3. Disclosure

No information on the provenance of critical minerals in US EVs *is required to be* ***publicly*** *disclosed*; at best, the origin of minerals will only be reported to the US Internal Revenue Service.

C. Opportunities for accountability

To understand the significance of the requirement for sellers of EVs in the US (and EU) to trace the nickel in their rechargeable batteries back to its mine of origin, consider the findings in **Chapter IV** (above), where images are provided of three mines that are felling intact High Carbon Stock forests, as well as destroying biodiversity and/or clearing illegally. *The current lack of information on exactly which nickel mines supply which EV manufacturer speaks directly to the importance of supply chain tracing requirements*, including those in the US IRA, as well as the forthcoming EU Battery Regulation.

The national and multilateral laws explored in this report provide opportunities for holding Indonesian nickel mines accountable for ravaging Eastern Indonesia's biodiverse forests. Indonesian law disallows certain environmentally destructive mining processes but does not require supply chain traceability or transparency. The US Inflation Recovery Act does not outlaw poor environmental practices but does require EV sellers to trace nickel in their batteries back to mining sites, although it does not seem to require any information to be publicly available. The EU Battery Regulation attempts to both disallow poor environmental practices and require supply chain traceability, but it also does not require information to be publicly available.

[29] This also highlights the potential financial risk of major western multinationals, like France's Eramet or Germany's Volkswagen, which are entering into multi-billion-dollar business agreements with China's Tsingshan, which does not publish audited financial accounts.

VI. RECOMMENDATIONS

There are many meaningful actions that government, civil society, the nickel industry, and downstream users of nickel like the EV sector can take to prevent the unsustainable and potentially illegal destruction of Eastern Indonesia's rainforests by nickel mines.

1. Uphold Human Rights

Companies and governments should commit to implement Free, Prior and Informed Consent (FPIC) of Indigenous and local communities, including the right to withhold consent to the development of nickel infrastructure. They also must ensure adequate compensation for communities who experience harms.

Recent investigations, including the description from Kabaena Island that begins this report, demonstrate nickel mining companies' lack of adherence to internationally recognized human rights standards including those involving indigenous people and, in at least one glaring example, an uncontacted tribe called the Hongana Manyawa.[30] These investigations implicate downstream purchasers of refined nickel. For additional examples of human rights violations beyond the Kabaena case study documented in this report, please see the Climate Rights International report, *Nickel Unearthed*.

2. Join the Initiative for Responsible Mining (IRMA) adopt its standards

Companies up and down the nickel supply chain should join the Initiative for Responsible Mining Assurance (IRMA). Along with becoming members, EV manufacturers should require upstream suppliers to adhere to IRMA standards and undergo the IRMA audit process. IRMA is currently the world's only independent third-party program for assessing industrial-scale mine sites for all mined materials. It is governed equally by the private sector, communities, civil society, and workers.[31]

The initiative works to hold mining companies accountable to following environmental best practices through an independent, publicly transparent audit protocol. Mines undergo assessments through an IRMA-approved firm to receive a score from 1 to 100, grading how well a mine meets IRMA standards for categories such as social and environmental responsibility (including subcategories such as waste management, biodiversity, water quality, etc.) as well as business integrity and legacy planning.

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[30] For more information on the Hongana Manyawa see: https://www.survivalinternational.org/tribes/honganamanyawa

[31] A recent report by Lead the Charge ranks IRMA highest among independent certification schemes.

IRMA leadership is truly multistakeholder, with equal say across the six sectors that make up the board – the mining industry, downstream purchasers, NGOs, affected communities, organized labor, and investment & finance. IRMA's public consultation process allows for revisions and improvements to better protect biodiversity and people in high-extractive areas. Ideally, initiatives like IRMA operate alongside legislative requirements to strengthen commitments, fill gaps, and offer model regulations for governments to adopt.[32]

3. Key Recommendations by Sector

Recommendations for the Nickel Industry

1. Utilize the mitigation hierarchy (avoid, minimize, restore, offset) with particular emphasis on avoiding intact forest landscapes and critical habitats like Key Biodiversity Areas. The mitigation hierarchy is followed by miners and refiners in many parts of the world, and holds that it is best to avoid negative environmental impacts altogether. Where that is not possible, it is next best to minimize those impacts. Where minimization is not possible, it is then preferable to restore areas where environmental impacts have occurred (such as replanting previously cleared forests with native species if they can take root). And where restoration is not possible, offsets should be undertaken elsewhere, with the goal of arriving at a position of *overall net gain* for any mining, smelting, or refining project.

2. To better implement the "avoid" part of the mitigation hierarchy, perform an integrated High Conservation Value/High Carbon Stock Assessment[33] for all new development. This means companies should mine degraded areas first.

3. Make a time-bound commitment to phase out the use of fossil-fuel energy during nickel smelting and refining. Research by Transport and Environment[34] outlines pathways to reach reduction targets.

4. Especially for HPAL refineries, utilize best tailings management practices, namely those outlined in Earthworks' *Guidelines for Responsible Tailings Management*,[35] including but not limited to: a) Mandating the use of best available technologies, such as dry stacking of filtered tailings (acknowledging that dry stacking may not be a feasible option in many parts of Sulawesi and Maluku due to the wet climate); b) not locating tailings disposal sites in evacuation corridors;

[32] In an interview with Bloomberg News (2023), a Deputy Minister in Indonesia's Coordinating Ministry for Maritime Affairs and Investment said that the nation's top nickel producers will be encouraged to get certifications from global entities like the Initiative for Responsible Mining Assurance (IRMA).
[33] For information on HCS see: https://highcarbonstock.org
[34] For Transport and Environment research see: https://www.transportenvironment.org/wp-content/uploads/2023/10/2023_10_Briefing_Paving_way_cleaner_nickel.pdf
[35] For Guidelines for Responsible Tailings Management see: https://earthworks.org/wp-content/uploads/2022/05/Safety-First-Safe-Tailings-Management-V2.0-Executive-Summary.pdf

c) developing emergency plans and using independent reviewers to promote safety; d) following existing environmental quality laws and standards; e) adopting public grievance mechanisms.

5. Mines without Borrow and Use Permits should stop clearing Production Forest. As shown in **Table 10**, all of Indonesia's 25 highest-deforestation mining concessions have already cleared some Production Forest. To have been allowed to do so legally, these concessions must first have secured Borrow and Use Permits. Five out of 25 are not in possession of such permits.

6. Stop clearing Protection Forest. Unless they have previously received an exemption, open pit mines may not be located in areas classified at Protection Forest. Although five mines had been exempted, as shown in **Table 11**, three of Indonesia's 25 highest-deforestation mining concessions have cleared some Protection Forest. This is illegal and must stop.

Recommendations for EV Manufacturers and other Upstream Users

1. Disclose relevant information to the public. EV manufacturers and other retailers need to take meaningful steps to increase transparency and traceability within their mineral supply chains, including: a) Publishing detailed supply chain information on suppliers, processors, and geographic sourcing areas (provinces, regions, and countries), b) specifying which supply chains are covered; c) publishing evidence of mineral percentages sourced in compliance with commitments; d) publishing grievances linked to mineral sourcing and corresponding actions taken; e) publishing third-party audits and screenings of mining operations and refiners; f) tracking and disclosing impacts on biodiversity; g) paying particular attention to land use change and deforestation in mining concessions.

2. Make time-bound commitments for deforestation-free nickel supply chains. This means sourcing from mines that avoid and minimize extraction of nickel that leads to tropical forest loss, setting 2025 as the latest cutoff date to stop sourcing from mines connected to deforestation.[36]

3. Automakers selling on the EU market should remove high-deforestation Indonesian nickel mines from their supply chains. Although some parts of the EU Battery Regulation do not go into effect until 2025, EV producers should start mapping out their supply chains, take actions to mitigate biodiversity loss in those supply chains, and/or remove offending companies from their supply chains. For example, Mercedes-Benz, Volkswagen, and BMW could remove Bintang Delapan Mineral—which is clearing land and forests designated by the IUCN as Key Biodiversity Areas—from their supply chains. **Box 4** in **Chapter V** (above) explores the rationale for such action.

[36] Refer to the Accountability Framework Initiative's *Operational Guidance* for information on cutoff dates for no-deforestation commitments.

4. Adopt and invest in new battery technologies that reduce the use of high emissions minerals like nickel, such as LFP batteries.

Recommendations for Indonesian Government

1. Stop issuing new nickel mining licenses in forested areas.

2. In view of a February 2023 ruling that nickel mining should not occur on the small island of Wawonii,[37] stop issuing mining permits on small islands.

3. To the extent that it is not already illegal, outlaw deep sea tailings placement (DSTP). Senior government officials have stated that permits for deep sea tailings disposal will not be issued, but this is not the same as outlawing DSTP in black-letter law.

4. Given the explosive growth of captive coal plants to support the nickel industry, stop issuing permits for new captive coal plants at nickel refineries and create a credible plan to retire these plants, possibly in the context of the Just Energy Transition Partnership.[38]

5. Enforce existing environmental regulations. As explored in **Chapter IV, Section 1** of this paper, it is illegal for mines to clear Protection Forests (unless mines were exempted from this requirement in 2004). It is also illegal for mines to clear Production Forests (unless Borrow and Use Permits have first been issued). The government should also carry out regular and independent monitoring from relevant government agencies such as Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources, law enforcement institutions and the Corruption Eradication Commission.

6. Encourage the finalization of spatial plans in mining districts and – as directed by Ministry of Marine Affairs and Fisheries Regulation 21/2021 -- ensure that those spatial plans outlaw mining within a hundred meters of the ocean.

7. Consider forming an SOE to manage tailings disposal. From the point of view of many international observers, the Achilles heel of the Indonesian nickel sector is how HPAL refineries dispose of tailings. Backfilling may be the best way to solve the problem. The logistical management and mobilization of resources needed to manage backfilling of HPAL tailings on a national scale could be undertaken by an Indonesian state-owned enterprise (SOE) created

[37] For discussion of rulings see: https://www.kompas.id/baca/nusantara/2023/02/03/warga-menangkan-gugatan-pulau-wawonii-tidak-untuk-ditambang

[38] For information on JETP see: https://id.usembassy.gov/united-states-supports-the-launch-of-the-just-energy-transition-partnership-jetp-in-indonesia/

explicitly for this purpose, working in partnership with internationally reputable mining waste disposal firms as well as firms with a global reputation for preventing leakage from mining pits.

8. Frequently update and release publicly relevant datasets, including the MODI list of mines and the maps of active Borrow and Use permits.

Recommendations for European Union and United States Government

1. Strengthen provisions in the EU Battery Regulation on sustainability of critical minerals. As explained in detail in **Chapter V, Section A** (above), the EU Battery Regulation leaves the door open for strengthening the obligations of economic operators under the Regulation. As things stand now, the EU Battery Regulation has weak language with respect to the obligations of economic operators to mitigate environmental damage caused by critical minerals in EV supply chains: The EU Battery Regulation only requires economic operators to *consider* encouraging their suppliers to mitigate biodiversity loss, and to *consider* removing from their supply chains suppliers who do not comply with such requests. The EU should strengthen this language to *require* economic operators to encourage suppliers to mitigate biodiversity loss and suspend business with noncompliant suppliers.

2. Regulate the Inflation Recovery Act (IRA) so that "Foreign Entity of Concern" is defined to include overseas Chinese business**.** "Foreign Entity of Concern" should refer *not only to* private Chinese corporations that operate inside China, or Chinese corporations that are 25 percent or more owned by the Chinese state, the Chinese Communist Party or their present and past officials, *but also refers to* private Chinese corporations that operate outside of China.

3. Ensure any trade, investment or agreements aimed at improving critical mineral supply chains include enforceable environmental and social protections.

4. Offer technical, financial, and other assistance designed to lower greenhouse gas emissions during critical mineral smelting and refining operations and to encourage sustainable and renewable energy development.

5. Adopt policies to promote mineral circularity. Scaling up programs for battery recycling and mineral recovery can reduce demand for mined minerals.

CONCLUSION

The growing demand for electric vehicles has the potential to reshape the nickel market, with Indonesia at the center of that change. Both Indonesia's production and market share have massively increased in the past years, from 800,000 tons of mined nickel in 2020 to 2.03 million tons in 2023. What happens in the next decade matters for the future of our climate.

While Indonesia is not the only producer, it remains to be seen if other countries can continue to compete in a market flooded with competitively priced Indonesian nickel. Australia and Brazil only account for a fraction of production in 2019, but both have immense reserves, roughly comparable to those in Indonesia. The Philippines, Canada and the United States are also potential sources. Will a new demand for green nickel rise alongside the proliferation of electric vehicles?

Mining nickel is not the only way to obtain the material. Setting ambitious targets for recycling and other elements of circular supply chains, along with smarter transportation planning, can help lower the need for mining. Ultimately wherever nickel is mined, the standards for clean nickel must be raised, and companies must make the choice to clean up supply chains. The problem of unsustainable nickel is already acute in Indonesia, but these standards must apply everywhere.

An increase in demand for clean nickel could disrupt the share of the market Indonesia holds, or even better, it could pave the way for Indonesia to take the recommendations referenced in the previous section and mitigate the harm of irresponsible and destructive mining. From siting on already developed and deforested land, to dealing with tailings and powering the refineries with energy sources other than coal, the opportunities for improvement abound. If these changes are made now, we may never have to face the reality of loss of biodiversity, impact on communities and carbon emissions forecasted in this report.

When consumers purchase an electric vehicle, they may not yet know the full scope and impact of its complex supply chain. They likely believe they are making a responsible choice for the future of the planet. The massive accomplishment of transitioning from internal combustion engines to electric vehicles will mean less if the choices made within the supply chain mean high embedded carbon emissions, a loss of critical habitats and unique species in one of the most biologically diverse regions of the world, and unacceptable impacts on the health and safety of communities.

The opportunity for improvement is significant and necessary and applies to every part of the nickel industry and its stakeholders: Consumers, EV manufacturers, refiners, battery manufacturers, miners and regulating governments, must step up to create conditions for change. Not only can environmental devastation be avoided, but a new era of clean transportation can be ushered in with responsible choices that value human rights and the environment.

ABBREVIATIONS, ACRONYMS AND TECHNICAL TERMS

Anode	The anode is one of two main components in an EV battery cell. The anode releases electrons which power an electric motor and are then acquired by the cathode.
Area for Other Uses	This refers to Indonesian public land outside of the Forest Zone. About a third of Indonesia's terrestrial area is zoned as "Area for Other Uses." About ten percent of the land zoned as Area for Other Uses is forested. This report not only measures nickel deforestation that has occurred in the Forest Zone, but also that which has occurred in forested parts of "Areas for Other Uses."
Borrow and Use Permit	This is the old name for a special MoEF permit that must be secured by mines (and other actors) before they clear Production Forest. This permit not only allows mines to cut down areas zoned as Production Forest but also requires them to replant an area of forest twice as large. The new name for Borrow and Use Permits is "Forest Area Use Approvals."
Cathode	The cathode is the second main component in an EV battery cell. After the anode releases electrons which power an electric motor, those electrons are then acquired by the cathode. Nickel is a key component in many cathodes.
Cathode precursor material	Many of the materials discussed in this report, including MHP, Nickel matte, Class 1 Nickel, or Nickel Sulfate, are "cathode precursor" materials. But none of them may be considered as a "cathode ready" material.
CATL	Contemporary Amperex Technology Co, Ltd – a Chinese battery manufacturer
Class 1 nickel	Class 1 nickel is 99.9 percent pure, in the form of powder or briquettes. It is a cathode precursor material, but not a cathode ready material.
CO2	Carbon Dioxide – the main greenhouse gas
CoW	Contract of Work – the original modern form of mining permits. Three of Indonesia's largest nickel mines are CoW.
CR6+	Hexavalent Chloride – a carcinogen
DSTP	Deep Sea Tailings Placement

EC	European Commission
EU	European Union
EV	Electric vehicle
FeNi	Ferronickel
Forest Zone	Public land under the management of Indonesia's Ministry of Environment and Forestry, which comprises more than 60 percent of the nation's terrestrial area. The three main land classifications in the Forest Zone are Production Forest, Protection Forest, and Conservation Forest.
GEM	A Chinese battery manufacturer
GHG	Greenhouse Gas
GLAD	A system for the detection of deforestation based on satellite data, maintained by the University of Maryland in the US.
HCS	High Carbon Stock forest
HPAL	High Pressure Acid Leaching – a complex process that uses heat, pressure and acid to refine Limonite ore into MHP
IEA	International Energy Agency
IMIP	Indonesia Morowali Industrial Park
IRA	US Inflation Reduction Act
IRS	US Internal Revenue Service
IUCN	International Union for the Conservation of Nature

IUP	Indonesia's current form of mining license (Ijin Usaha Pertambangan). Most of Indonesia's nickel mines are IUP.
IWIP	Indonesia Weda Bay Industrial Park
KBA	IUCN designated Key Biodiversity Area
Laterite	Laterite is the more common of the two types of nickel ore deposits found in Indonesia. It is strip mined.
LFP	Lithium Iron Phosphate battery
Limonite	One of two subtypes of laterite ore. Limonite is found relatively closer to the surface of the soil, is less nickel-rich, but is also easier to break down chemically and physically, and hence lends itself to being processed into precursors for both stainless steel and EV batteries.
MBM	Merdeka Battery Minerals – an Indonesian-Chinese nickel processing company
MHP	Mixed Hydroxide Precipitate – a cathode precursor material that is between 30 and 50 percent pure nickel.
MODI	Minerba One Data Indonesia – a database of all active mining concessions published by the Directorate General of Minerals and Coal (Mineral dan Batubara or "Minerba")
MOMI	Minerba One Map Indonesia – a map of all acknowledged mines in Indonesia, generated from data contained in MODI
NCA	This can refer either to a mixture of nickel, cobalt and aluminum -- before or after the mixture is cathode-ready -- or to a type of EV battery cathode containing these metals.
NCM	This can refer either to a mixture of nickel, cobalt and manganese -- before or after the mixture is cathode-ready -- or to a type of EV battery cathode containing these metals.

NDC	Nationally Determined Conditions – the name for each nation's pledge to reduce its GHG emissions, and plan for how they will do this.
Nickel matte	When ferronickel is upgraded to 60 to 70 percent purity, it is called nickel matte. It is a cathode precursor material, but not a cathode ready material.
Nickel sulfate	Nickel sulfate can be solid or in solution and is 99.9 percent pure. It is a cathode precursor material, but not a cathode ready material.
OECD	Organization for Economic Cooperation and Development
PNG	Papua New Guinea
Production Forest	Making up more than half the Forest Zone, the purpose of Production Forest is to yield commercial forest products, primarily natural forest timber.
Protection Forest	Making up about a fifth of the Forest Zone, the purpose of Protection Forest is to protect life, buffer the ecosystem to aid with water management, prevent floods and erosion, prevent brine water intrusion, and maintain land fertility.
PT	Abbreviation for "Perusahaan Terbatas," an Indonesian limited liability company
RADD	A system for the detection of deforestation based on radar data, maintained by the Wageningen University in The Netherlands.
RKEF	Rotating Kiln Electric Furnace – a type of furnace that is used to process Saprolite ore into Ferronickel
RMB	Abbreviation for "Renminbi" – the official name of China's currency
Saprolite	One of two subtypes of laterite ore deposits. Saprolite is found relatively further from the surface of the soil, is more nickel-rich, but is relatively resistant to being broken down chemical and physically, and hence lends itself mostly to being processed into precursors for stainless steel.

SCM	Sulawesi Cahaya Minerals – the name of a nickel IUP licensed to Indonesians Edwin Soeryadjaya, Gabriel (Boy) Thohir, Winarto Kartono, Hardi Liong, as well as to certain Chinese corporations, including CATL and Zeijiang Huayou Cobalt.
Sulfide	Sulfide ore is the purest type of nickel ore, but it is not common in Indonesia. Some is found in the nation's oldest nickel mine, Vale Indonesia.
WIUPK	An Indonesian Government-held, mineral-specific "Country Reserve Area," which is waiting to be auctioned.

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