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Indonesia's Nickel Companies: The Need for Renewable Energy Amid Increasing Production

Increased nickel production will lead to higher greenhouse gas emissions without renewable energy integration

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Key Findings

Indonesia accounts for 51% of the world's nickel mine production and has four listed nickel companies, PT Aneka Tambang (Antam), Merdeka Battery Materials (MBMA), Trimegah Bangun Persada (TBP Harita), and PT Vale Indonesia (Vale), that are growing in scale and profit. These companies aim to more than double their production in the next 3-5 years.

The four Indonesian nickel companies produced 353,000 tonnes of nickel metal along with 15 million tonnes (mt) of greenhouse gas (GHG) emissions in 2023.

One of the four companies, Vale, had the lowest GHG emissions at 29 tonnes of carbon dioxide (CO_2) per tonne of nickel (tCO_2/tNi), due to 365 megawatts (MW) of hydropower capacity. The other three companies used coal-fired power mainly and had a GHG emissions range of 57-70 tCO_2/tNi.

The four nickel companies could expand output to 1.05mt of nickel metal by 2028. However, at current rates of GHG emissions for all companies, this could result in 39mt of GHG emissions or 5% of Indonesia's total 2023 emissions. Nickel companies can reduce the GHG intensity of production by using hydropower or other renewable energy sources.

Executive Summary

Indonesian nickel producers are emerging as key global players. According to the U.S. Geological Survey (USGS) for 2023, Indonesia accounted for 42% of global nickel reserves and 51% of global mine production.[1] The Indonesian government banned the export of all unprocessed nickel ore in 2020[2], however the processing of nickel for use in electric vehicle (EV) batteries comes with a significant environmental and carbon footprint.[3] This report examines the activities of four publicly traded nickel companies with significant operations in the country. These companies produced a total of 353,000 tonnes of contained nickel in 2023, which the Institute for Energy Economics and Financial Analysis (IEEFA) estimates accounted for 26% of Indonesia's primary nickel production of 1.36 million tonnes (mt) in 2023.[4] According to Standard & Poor rankings, Indonesia accounted for 40% of global primary nickel product output (such as ferronickel and matte).[5] Please see Appendix A for further information on the types of nickel metal products.

The four nickel companies analyzed in this report – PT Aneka Tambang (Antam), Merdeka Battery Materials (MBMA), Trimegah Bangun Persada (TBP or Harita), and PT Vale Indonesia (Vale) – reported US$996 million (m) total net profit and US$6.8 billion (bn) revenue for 2023. Compared to the seven listed coal companies examined in IEEFA's report, "Indonesia's coal companies: Some diversify, others expand capacity"[6], the net profit for the four nickel companies in 2023 was 22%, and total revenue was 35%, of the coal companies respectively.

Greenhouse gas emissions to increase alongside Indonesian nickel output

- The four Indonesian nickel companies analyzed by IEEFA represented 26% of Indonesia's primary nickel production with an output of 353,000 tonnes in 2023.
- The total GHG emissions for the four Indonesian nickel companies were 15.3 million tonnes (mt) in 2023. By 2028, the targeted nickel output is 1.05mt and GHG emissions at current rates would be 38.5mt.
- 38.5mt represents 5% of Indonesia's total 2023 emissions of 861.5mt.

These four companies produced 353,000 tonnes of primary nickel in 2023, generating greenhouse gas (GHG) emissions of 15.3mt. Vale had the lowest intensity of GHG emissions per tonne of nickel for matte or ferronickel, producing 28.7 tonnes of carbon dioxide (CO_2) per tonne of nickel (tCO_2/tNi). MBMA was ranked second with 56.9 tCO_2/tNi, with TBP (Harita) in third place at 68.4

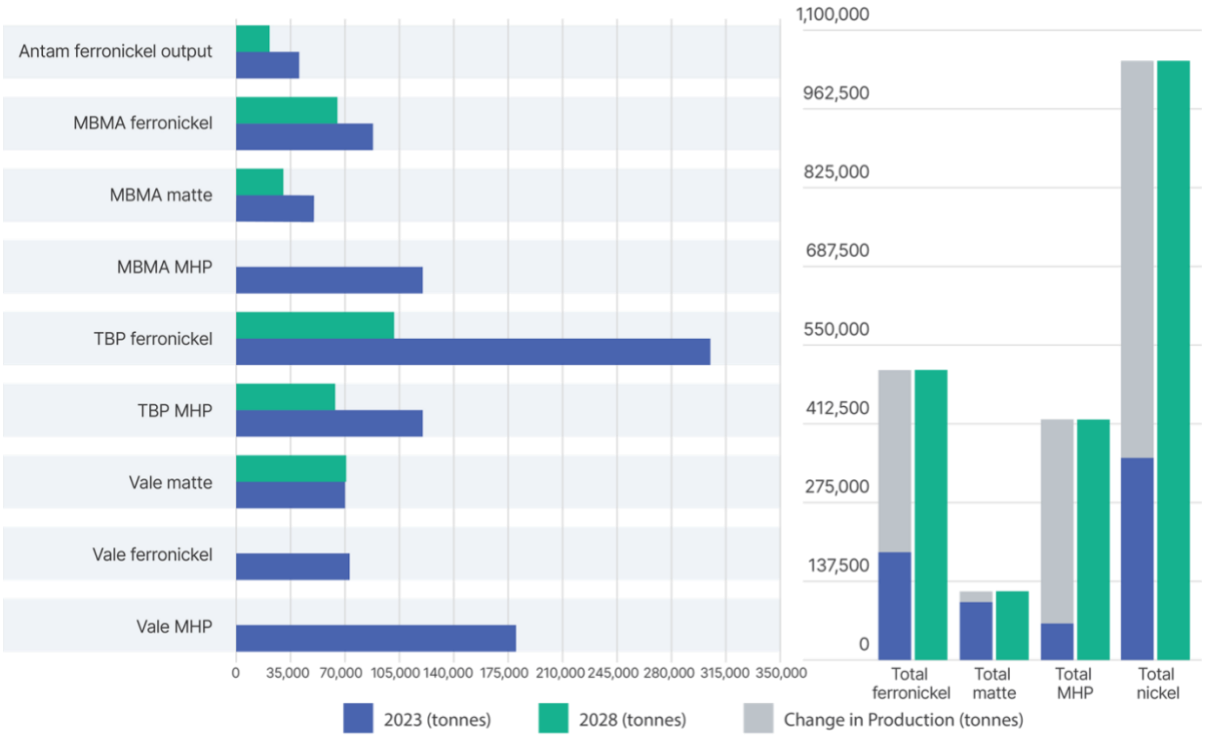
[1] US Geological Survey. Nickel Statistics and Information 2024. Page 124-125.
[2] East Asia Forum. Indonesia doubles down on nickel export bans and downstreaming. 07 December 2023.
[3] East Asia Forum. Indonesia doubles down on nickel export bans and downstreaming. 07 December 2023.
[4] S&P Global. Indonesian nickel production dominates commodity market. 06 February 2024.
[5] S&P Global. Indonesian nickel production dominates commodity market. 06 February 2024.
[6] IEEFA. Indonesia's coal companies: Some diversify, others expand capacity. 13 June 2024.

tCO_2/tNi, followed by Antam with 69.9 tCO_2/tNi. The main reason for Vale's lower GHG intensity is that it has three hydropower plants with 365 megawatts (MW) of capacity, while the other companies used mainly coal-fired power. TBP (Harita) uses a chemical-based leaching process, High Pressure Acid Leach (HPAL) to produce nickel in mixed hydroxide precipitate (MHP), which is less GHG intensive at 13.4 tCO_2/tNi.

Although the CO_2 emissions may be lower, Wood Mackenzie estimates that for every tonne of nickel produced using HPAL, around 1.4-1.6 tonnes of waste is also produced, which is considerably more than from nickel smelting. Tailings from the acid-based process are normally stored in dams. However, Sulawesi, where TBP (Harita) and Vale's HPAL plants are located, has limited space due to topography, thick vegetation, high rainfall, and seismic activity.[7]

By 2028, the four listed nickel companies plan to expand aggregate processed nickel output to 1.05mt. 420,000 tonnes of the total will be the lower GHG intensity nickel product based on the HPAL process (see Appendix A), while 507,000 tonnes of ferronickel and 120,000 tonnes of nickel matte will use higher GHG intensity processes. Figure 1 provides the breakdown of projected nickel ore conversion by company and process.

Figure 1: 2023 Production and 2028 Target for Indonesian Nickel Companies



Source: Company reports; IEEFA estimates.

[7] Wood Mackenzie. The rise and rise of Indonesian HPAL – can it continue? 04 April 2023.

According to IEEFA estimates, the targeted nickel output could produce 38.5mt of GHG emissions in 2028. This represents 4.5% of Indonesia's total CO_2 emissions of 861.5mt in 2023.[8] It is also estimated that if the companies can achieve Vale's standard of 28.7 tCO_2/tNi by using hydropower, GHG emissions could be reduced by 42% to 22.3mt. If nickel companies are to reduce the GHG intensity of production, hydropower or other renewable energy sources should be considered.

Table 1: GHG Intensity and Emissions for Indonesian Nickel Companies 2023 and 2028

	GHG Intensity	2023 (tonnes CO_2)	2028 (tonnes CO_2)
Emissions at current rates			
Antam	69.9	1,522,260	2,829,726
MBMA	56.9	3,816,802	6,706,880
TBP	68.4	7,981,627	22,459,100
TBP - MHP	13.4		
Vale	28.7	2,032,313	6,508,900
Total		**15,353,002**	**38,504,606**
Emissions at Vale standard			
Antam	28.7		1,162,350
MBMA	28.7		4,228,800
TBP	28.7		10,356,700
TBP - MHP	13.4		
Vale	28.7		6,508,900
Total			**22,256,750**

Source: Company reports; IEEFA estimates.

Indonesian Nickel: Emerging Economic Driver

Indonesia's Value-Added Nickel Policy

According to the U.S. International Trade Commission (USITC), "Indonesia's 2009 Mining Law requires companies to process ore locally before shipping it abroad."[9] In 2014, the government prohibited the export of nickel ore.[10] In 2017, Indonesia removed its nickel export ban but reestablished it on 1 January 2020, effectively stopping all nickel ores and concentrates exports.[11]

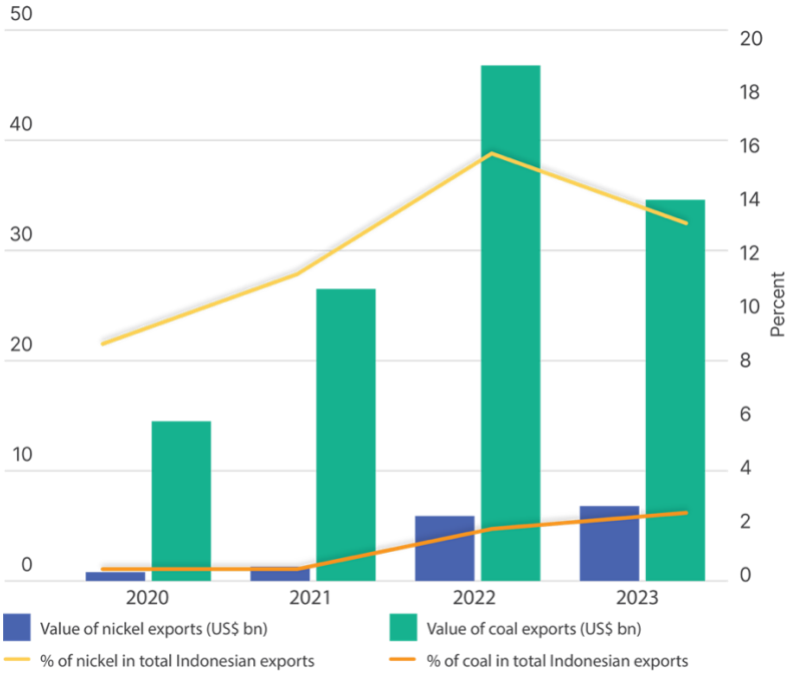
Indonesia highlighted three reasons for the ore export ban. First, the mining sector accounts for 12% of Indonesia's 2022 Gross Domestic Product (GDP) and nickel is a significant contributor. Second,

[8] Energy Institute. 2024 Statistical Review of World Energy. Page 18.
[9] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 11.
[10] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 11.
[11] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 11.

the nickel sector is a vital input to the domestic steel industry, which is unable to meet domestic demand, and third, there is a strategic plan to expand EV battery production in Indonesia.[12]

The Indonesian government has identified two benefits of the downstream nickel industry - the increase in export value and the increase in tax revenue on those exports.[13] Nickel export value has grown from US$1.3bn in 2021 to US$6.8bn in 2023, a direct result of the value addition focus of the downstream nickel development policy. IEEFA notes that nickel now accounts for 2.6%[14] of Indonesia's total export value in 2023[15] compared to 13.4% for coal.[16]

Figure 2: Indonesian Nickel and Coal Exports FY2020-2023

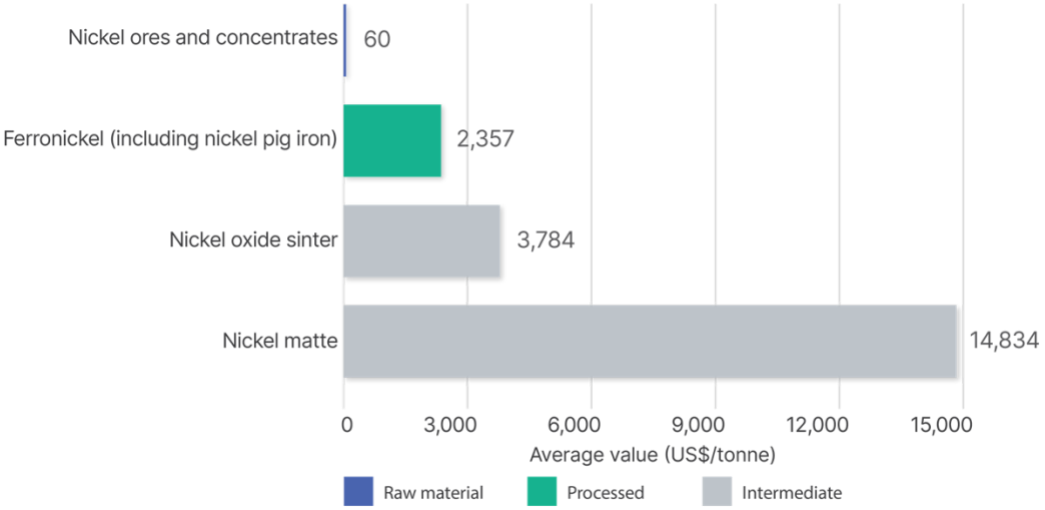


Source Statista; BPS-Statistics Indonesia; IEEFA estimates.

The rise in Indonesian nickel export values from US$1.3bn in 2021 to US$5.9bn in 2022 is largely due to the increased production of value-added nickel products. According to the USITC, unprocessed nickel ores and concentrates were exported at an average of US$60/tonne in 2022, while ferronickel was US$2,357/tonne[17], as moving down the value chain boosts the unit value of exported products.

[12] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 12.
[13] United Nations Conference on Trade and Development. Critical Minerals Value Added Policies: Indonesia's Story.
[14] Statista. Export value of nickel from Indonesia from 2019 to 2023.
[15] Statista. Indonesia: Export of goods from 2013 to 2023.
[16] BPS-Statistics Indonesia. Exports of Coal by Major Countries of Destination, 2012-2023.
[17] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 16 Table 3 .

Figure 3: Indonesian Primary Nickel Products and Unit Value for Exports



Source: S&P Global; USITC.

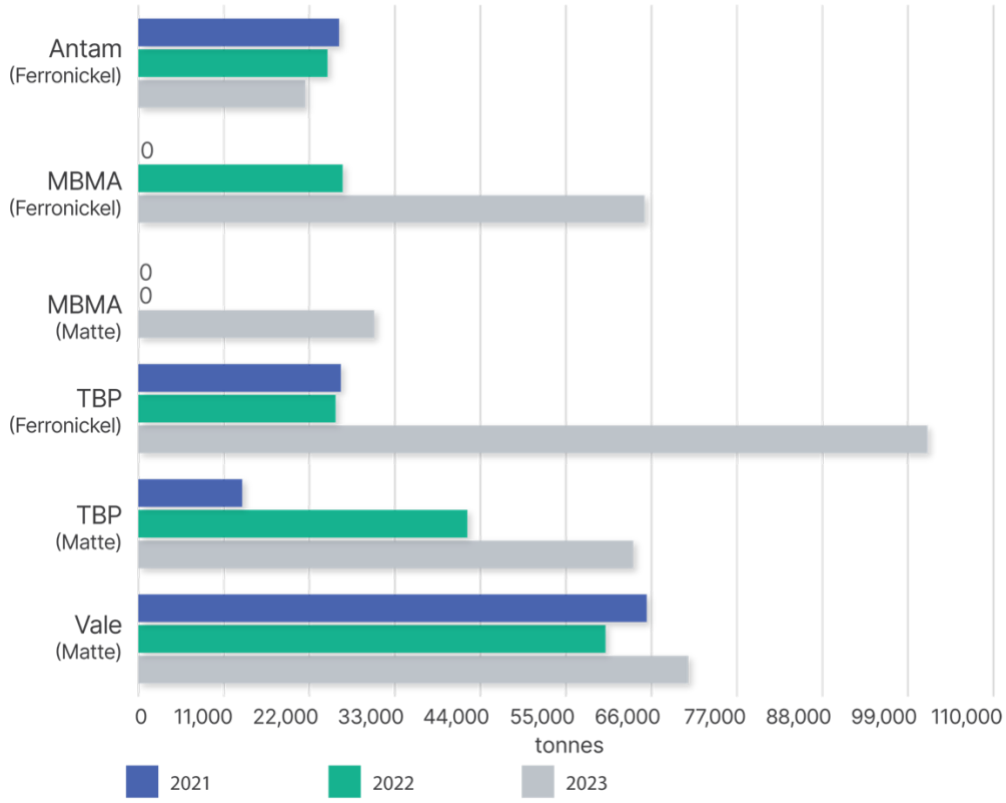
The USITC also recognizes the environmental costs, noting that pyrometallurgical nickel processes are energy intensive and "energy usually comes from coal-fired power stations built near the mines."[18] This produces "significant quantities of greenhouse gases, and many EV producers are likely to be concerned about the environmental aspects of production."[19] While the significant increase in nickel export values supports the economic side of the value-added downstream development policy, this report focuses on the emissions that could be produced as nickel output increases.

Rising Nickel Production and Revenue in Indonesia

The four Indonesian nickel companies, Antam, Merdeka Battery Material (MBMA), TBP (Harita), and Vale, have grown their primary nickel product output from 130,600 tonnes in 2021 to 353,000 tonnes in 2023. Please see Appendix B for further information on these companies. The largest nickel output is from TBP (Harita) with 165,200 tonnes in 2023, followed by MBMA with 93,200 tonnes. IEEFA estimates that these four companies accounted for 26% of Indonesia's primary nickel output in 2023.

[18] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 19.
[19] USITC Office of Industry and Competitiveness Analysis. Export Restrictions on Minerals and Metals: Indonesia's Export Ban of Nickel. February 2024. Page 19.

Figure 4: Product Output of Indonesian Nickel Companies FY2021-2023



Source: Company reports and IEEFA estimates.

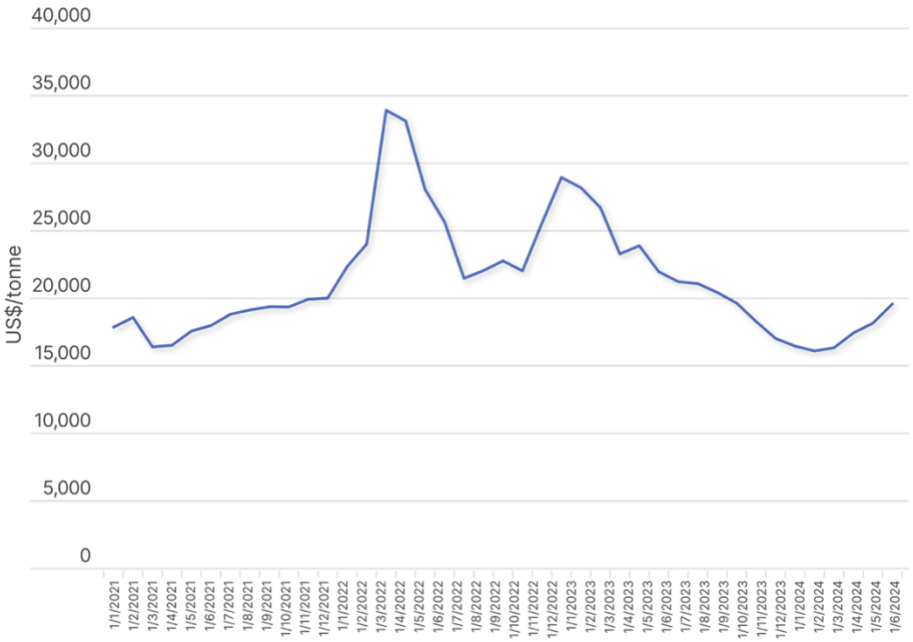
According to the Nickel Institute, nickel is used for two primary purposes - stainless steel (65%) and EV batteries (17%).[20] Nickel prices surged in 2022[21] as the global economy emerged from COVID-19. Following Russia's invasion of Ukraine, there were fears that Russian nickel may be banned by the London Metal Exchange (LME). According to the USGS, Russia was the world's third-largest nickel producer in 2022. From 13 April 2024, the LME stopped accepting Russian-made aluminum, copper, and nickel.[22]

In March 2022, there was a short squeeze on the LME which sent nickel prices rising above US$100,000/tonne before the Exchange canceled trades.[23] Afterwards, prices trended down as global supply increased but rose again in November of the same year due to the Goro mine in New Caledonia reducing output.[24] Nickel prices fell during 2023 after reaching over US$30,000/tonne in January but declined throughout the year and closed at US$16,375/tonne.[25] The main reasons for

[20] Nickel Institute. First use of nickel.
[21] Mining Technology. The nickel price rollercoaster of 2022. 10 January 2023.
[22] Reuters. Washington, London ban exchange trading of new Russian metal. 15 April 2024.
[23] International Banker. The Nickel Short Squeeze: What Happened? 26 April 2022.
[24] Mining Technology. The nickel price rollercoaster of 2022. 10 January 2023.
[25] Investing News Network. Nickel Price 2023 Year-End Review. 02 January 2024.

the decline were the increased supply from Indonesia combined with slower-than-expected demand from the EV sector and China.[26] The USGS estimates that Indonesian nickel mine production rose 14% year-over-year in 2023 to 1.8mt accounting for 50.5% of global production. Indonesia accounted for 48% of global output in 2022.

Figure 5: Global Monthly Nickel Prices 2022-2024



Source: Statista; World Bank.

The revenue and net profit of these four nickel companies have grown significantly due to the increase in nickel production and the high unit price of nickel (above US$16,000/tonne), and are comparable to the coal sector. The total revenue and net profit of the four Indonesian nickel companies are compared with that of the seven Indonesian coal companies covered in the IEEFA report "Indonesia's coal companies: Some diversify, others expand capacity".[27]

In 2023, the seven coal companies – Adaro Energy, Bayan Resources, Geo Energy Resources, Harum Energy, Indika Energy, Indo Tambangraya Megah (ITMG), and PT Bukit Asam Tbk (PTBA) – recorded a total of 217mt of coal production, based on IEEFA's calculations. This accounts for an estimated 27% of Indonesia's total coal production of 775.2mt.[28] These companies reported record profits of US$8.4bn in 2022 and a robust US$4.4bn for 2023. The total net profit for the seven coal companies rose 1.2 times year-on-year to US$8.4bn in 2022. In 2023, although net profit declined by 49% year-on-year, it remained high at US$4.4bn.

[26] Investing News Network. Nickel Price 2023 Year-End Review. 02 January 2024.
[27] IEEFA. Indonesia's coal companies: Some diversify, others expand capacity. 13 June 2024.
[28] Global Energy. Indonesia's coal exports reach all-time high. 03 February 2024.

Table 2: Comparison of Indonesian Nickel and Coal Companies' Revenue with Benchmark Coal and Global Nickel Prices 2021-2023

Company	2021 (US$ million)	2022 (US$ million)	2023 (US$ million)
Antam	2,694.3	2,918.0	2,662.7
MBMA	0.0	455.7	1,328.3
TBP (Harita)	576.7	608.2	1,547.6
Vale	953.2	1,179.5	1,232.3
Total revenue for the 4 nickel companies (US$ million)	4,224.2	5,161.4	6,770.9
Total revenue for the 7 coal companies (US$ million)	15,006.5	25,288.0	19,411.5
Nickel revenue as % of coal	28.1	20.4	34.9
Newcastle coal benchmark (US$/tonne)	138.1	344.9	172.8
Global nickel price (US$/tonne)	18,465	25,834	21,521

Source: Company public financial reports; Statista; World Bank; IEEFA estimates.

The combined revenue of the four Indonesian nickel companies increased from US$4.2bn in 2021 to US$6.8bn in 2023, a 60% increase. In 2023, their combined revenue was 35% of the total revenue generated by the seven coal companies. The coal companies benefited from the 150% year-on-year increase in the 2022 average benchmark coal price, but that declined 49% year-on-year in 2023. The nickel price was relatively less volatile, rising 40% year-on-year for 2022 and declining 17% year-on-year in 2023.

Table 3: Comparison of Indonesian Nickel and Coal Companies' Net Profit and Net Margin 2021-2023 (US$ million, %)

Company	2021 (US$ million)	2022 (US$ million)	2023 (US$ million)
Antam	130.5	242.9	199.6
MBMA	0.2	37.8	33.3
TBP (Harita)	145.5	291.7	458.5
Vale	165.8	200.4	274.3
Total net profit for the 4 nickel companies	442.0	772.8	965.8
Total net profit for the 7 coal companies	3,837.6	8,427.1	4,406.4
Nickel revenue as % of coal	11.5	9.2	21.9
Nickel companies' net margin (%)	10.5	15.0	14.3
Coal companies' net margin (%)	25.6	33.3	22.7

Source: Company public financial reports; Statista; World Bank; IEEFA estimates.

The total net profit for the four Indonesian nickel companies increased from US$442m in 2021 to US$966m in 2023, a rise of 118%. The nickel companies' net profit was 22% of the seven coal companies in 2023, compared to just 9% the previous year. The nickel companies' net margins were relatively stable (10-15%) for 2021-23, while the coal companies' net margins ranged from 23-33% for the same period. This volatility was due partly to the 150% year-on-year increase in 2022 coal

prices, followed by a 49% year-on-year decline. However, the nickel companies also benefited as total output rose 37% year-on-year in 2022 and nearly doubled (98% year-on-year) for 2023, alleviating the negative impact of a 16% year-on-year decline in average 2023 global nickel prices. Please refer to Figure 4 for further details.

Nickel Production to Increase 197% by 2028

The four Indonesian companies plan to expand total nickel output to 1.05mt by 2028, an increase of 197% compared to production in 2023. Assuming that nickel prices remain at current levels, the total revenue base of the four Indonesian nickel companies could rise from US$6.8bn to over US$20bn.

Table 4: Indonesian Nickel Output and Target Output 2023 and 2028

Primary Nickel Product	2023 (tonnes)	2028 (tonnes)	% Change
Antam ferronickel output	21,473	40,500	88.6
MBMA ferronickel	65,117	88,000	35.1
MBMA matte	30,333	50,000	64.8
MBMA MHP		120,000	
TBP ferronickel	101,538	305,000	200.4
TBP MHP	63,655	120,000	88.5
Vale matte	70,728	70,000	
Vale ferronickel		73,000	
Vale MHP		180,000	
Total from the 4 companies			
Total ferronickel	188,128	506,500	169.2
Total matte	101,061	120,000	18.7
Total MHP	63,655	420,000	559.8
Total nickel	352,844	1,046,500	196.6

Source: Company public financial reports; IEEFA estimates.

The four Indonesian nickel companies are expanding with 80% additional capacity, around 470,000 tonnes, to be completed by 2026. However, if there is continued reliance on fossil-fueled power generation, GHG emissions will have a significant environmental cost. IEEFA estimates that of the total 530,000 tonnes new nickel capacity, 51% is high-emission ferronickel (around 60 tCO_2/tNi) mainly using coal thermal power. Meanwhile, 49% is lower-emission MHP (13 tonnes GHG emissions per tonne of nickel) using the chemical-based HPAL process.

Table 5: Planned Capacity, Product, Process, and Schedule for Indonesian Nickel Companies

Company	New capacity (tonnes)	Product	Process	Schedule
Antam	13,500	Ferronickel	Rotary Kiln-Electric Furnace (RKEF)	Commissioned
MBMA	120,000	MHP	HPAL	2025, 2027
TBP (Harita)	185,000	Ferronickel	RKEF	2025
	65,000	MHP	HPAL	2025
Vale	73,000	Ferronickel	RKEF	2025
	180,000	MHP	HPAL	2026
Total Ferronickel	271,500	Ferronickel		
Total MHP	365,000	MHP		
Total	**529,500**			

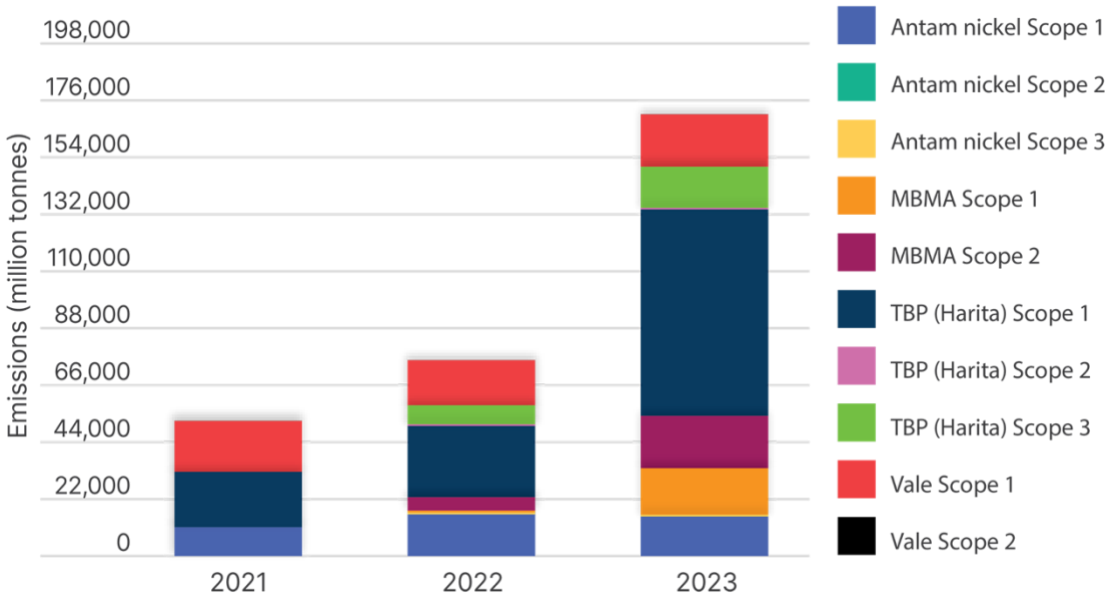
Source: Company reports; IEEFA estimates.

Emissions Analysis

GHG Emissions Disclosures

The four Indonesian nickel companies have detailed disclosures on Scope 1, 2, and 3 emissions. While there are several differences in classification, IEEFA notes that on a per-tonne basis, three companies (Antam, TBP Harita, and MBMA) using thermal power mainly have higher GHG intensity per tonne of nickel. The four companies produced 13.3mt of CO_2 equivalent Scope 1 emissions and 16.9mt of Scope 1-3 emissions.

Figure 6: Annual Scope 1, 2, and 3 CO_2 Emissions for Indonesian Nickel Companies 2021-23



Source: Company reports; IEEFA estimates.

Antam: Antam defines Scope 1 emissions as "direct GHG emissions owned or controlled by the organization (including mining, energy use, waste treatment, and chemical process)."[29] Scope 2 emissions are defined as indirect GHG emissions purchased from independent sources, via electricity supplied by national utility Perusahaan Listrik Negara (PLN), and Scope 3 emissions are from the travel of executives, supply chain, and product marketing. Antam has included CO_2, methane (CH_4), and nitrous oxide (N_2O) in its GHG emissions. IEEFA notes that the company completed a 2 x 30MW coal-fired plant for its ferronickel smelter in October 2016. The plant cost US$145m and requires 300,000 tonnes of coal annually.[30] In this analysis, IEEFA has only included the GHG emissions from the nickel businesses, not the gold refining and bauxite mining operations. Based on IEEFA's calculations, the nickel segment accounted for 94% of GHG emissions in 2021-2023.[31]

MBMA: The company uses the TruCount emissions calculation platform, proprietary carbon accounting software from Indonesian technology company TruClimate.[32] TruCount uses the Greenhouse Gas Protocol and OSP 14064-1 to calculate emissions.[33] Scope 1 emissions originate from the use of biodiesel fuel for operational vehicles and mining equipment, power generation units at the Konawe nickel mine, and coal usage at its smelters.[34] Scope 2 emissions stem from the use of

[29] Antam. Sustainability Report 2023. 16 April 2024. Page 106.
[30] Antam. ANTAM Completes the Construction of 2x30MW Coal Fired Power Plant as Part of the Pomalaa Ferronickel Plant Expansion Project. 10 October 2016.
[31] Antam. Sustainability Report 2023. 16 April 2024. Page 106.
[32] TruClimate. Corporate website. 2024.
[33] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 151.
[34] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 151.

PLN electricity. MBMA states that for entities like itself, operating in the Indonesia Morowali Industrial Park (IMIP), electricity is supplied by a coal-fired power plant operated by the Park.[35]

TBP (Harita): TBP (Harita) also adopts the GHG Protocol and the ISO 14064 standards. The company's Scope 1 emissions come from sources within the company's control, including stationary and mobile combustion, which accounted for 83% of 2023 emissions.[36] Scope 2 emissions are from purchased electricity. IEEFA notes that the parent Harita Group owns a 63% interest in Phase I and II of the PT Halmahera Persada Lygend Nickel Smelter coal-fired power station on Obi Island with a total capacity of 720MW.[37] Scope 3 emissions are from indirect sources such as upstream and downstream transport, business travel, purchased goods and services, and capital goods.[38]

Vale: Vale's Scope 1 emissions are from production activities and fuel consumption, while Scope 2 emissions are from electricity usage.[39] The company has not calculated Scope 3 emissions but plans to do so soon. It includes CO_2, CH_4, N_2O, and hydrofluorocarbons (HFCs) in its GHG emissions.

Company Ranking by GHG Intensity

In terms of ranking the four nickel companies from lowest to highest GHG intensity, there should be a differentiation between the smelting process, where heat is applied to produce a nickel primary (pyrometallurgical), and the chemical-based process, where the processed ore is dissolved in an acid solution (hydrometallurgical). Please refer to Appendix 1 for an explanation of these processes.

The four companies currently produce three main products - ferronickel, matte, and MHP. Ferronickel and matte are made using high heat from a rotary kiln-electric furnace (RKEF) process. The RKEF is an industrial furnace that uses electricity as its heating source. The laterite ores are calcinated and reduced, then smelted in an electric furnace to produce ferronickel. Ferronickel contains between 20% and 40% nickel. It can be further processed in a conversion facility, lowering the iron content and producing a nickel matte containing over 70% nickel. These electricity-intensive smelting processes can produce high levels of GHG emissions depending on the type of power source. Most nickel smelters in Indonesia currently rely on electricity from coal-fired power plants.

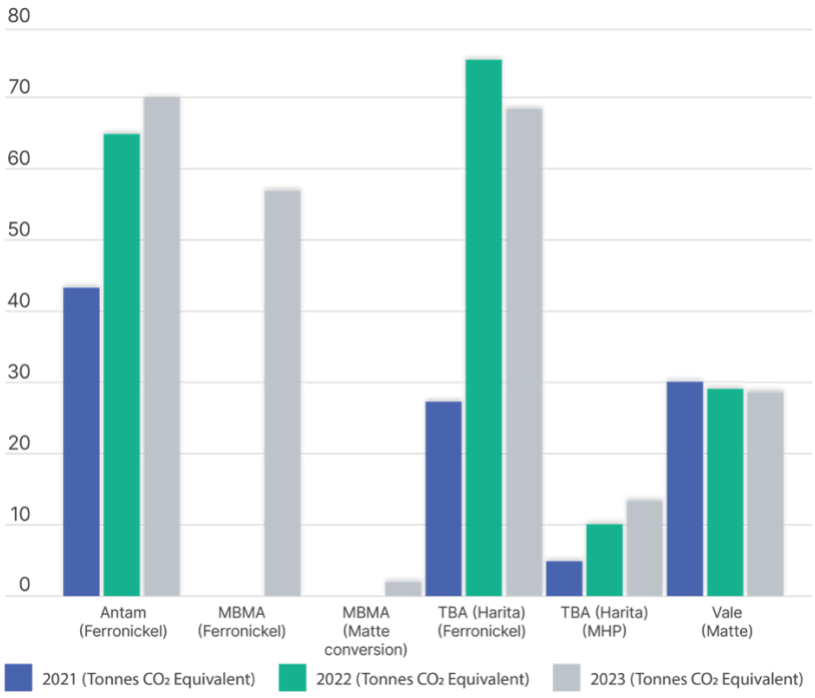
High pressure acid leaching (HPAL) is a process using elevated temperatures (255 degrees Celsius) and pressure (725 psi) combined with sulfuric acid to separate nickel and cobalt from laterite ore. This process produces MHP, a feedstock for nickel sulfate production used in lithium-ion batteries. According to TBP (Harita), HPAL is an inherently low-carbon technology used for MHP production, further refined into nickel and cobalt sulfate for battery value chains.[40]

[35] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 151.
[36] TBP. Sustainability Report 2023. 2023. Page 82.
[37] Global Energy Monitor. PT Halmahera Persada Lygend Nickel Smelter power station. 18 July 2024.
[38] TBP. Sustainability Report 2023. 2023. Page 83.
[39] Vale. Sustainability Report 2023. 2023. Page 35.
[40] TBP. Sustainability Report 2023. 2023. Page 83.

Wood Mackenzie identified that the HPAL process generates considerably more waste than nickel smelting at 1.4-1.6 tonnes per tonne of nickel produced. The on-land options include tailings as backfill in mines, dry stacking, or storage in conventional dams. It is difficult to build dams to store tailings in Sulawesi, where Vale and TBP (Harita)'s HPAL plants are located, due to its topography, thick vegetation, high rainfall, and seismic activity. Unlike at Ramu in Papua New Guinea, Indonesia does not permit deep sea tailing disposal. Dry stacking is challenging due to rainfall, and Sulawesi has insufficient hard rock to secure dam walls.[41]

For the higher energy primary nickel products, ferronickel and matte, made using the RKEF process, Vale had the lowest GHG intensity with 28.7 tCO_2/tNi, followed by MBMA at 56.9, TBP (Harita) at 68.4, and Antam at 69.9. MHP is a lower GHG intensity product with 13.4 tCO_2/tNi.

Figure 7: GHG Intensity per Tonne of Nickel for Indonesian Nickel Companies by Product 2021-23



Source: Company reports; IEEFA estimates.

MBMA owns three RKEF smelters, the Cahaya, Bukit, and Zhao Hui Nickel smelters. The Cahaya and Bukit smelters were acquired in mid-2022. The GHG intensity was calculated on partial data which reflected a lower figure not comparable to 2023.[42] In 2023, total GHG increased with the acquisition of the Zhao Hui Nickel smelter and a nickel matte conversion facility.[43] TBP (Harita) used 2022 as its

[41] Wood Mackenzie. The rise and rise of Indonesian HPAL – can it continue? 04 April 2023.
[42] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 14.
[43] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 152.

base year for calculating emissions[44] and included emissions from calcium carbonate for its MBP product. If excluded, the GHG intensity would have been 10.1 instead of 14.3 tCO_2/tNi.[45]

These calculations appear consistent as the smelter-based products (ferronickel) range from 56-70 tCO_2/tNi. Vale produces a matte from the ferronickel product with 28.7 tCO_2/tNi. In comparison, MBMA converts its ferronickel into matte with emissions at 2.0 tCO_2/tNi.[46] IEEFA's view is that MBMA would produce 56.8 tCO_2/tNi in ferronickel and an additional 2 tonnes of CO_2 to produce one tonne of matte. Vale's lower emissions are due to its three hydropower plants at Sorawako, with a total capacity of 365MW. Thus, the company sources 31% of its energy from hydropower and biodiesel. This compares to around 5% for TBP (Harita) and MBMA, and 1% for Antam.

Table 6: GHG Intensity per Tonne of Nickel and Renewable Energy Distribution for Indonesian Nickel Companies 2023

Company	Product	2023 (Tonnes CO_2 Equivalent)	Renewable Energy %
Antam	Ferronickel	69.9	1.2
MBMA	Ferronickel	56.9	4.9
TBP (Harita)	Ferronickel	68.4	5.3
TBP (Harita)	MHP	13.4	5.3
Vale	Matte	28.7	30.1

Source: Company reports; IEEFA estimates.

These three companies are transparent about using coal-fired power. MBMA states that it sources coal-fired power and discloses it as Scope 2 emissions.[47] In its Sustainability Report 2023, it states that business entities operating in the IMIP are supplied with electricity from a coal-fired power plant run by the Park.[48] Global Energy Monitor has documented this as a 2,080MW plant.

TBP (Harita) states that the remote location of operations means they do not have ready access to non-coal alternatives and current renewable energy is "not yet efficient enough for all our operational energy requirements."[49]

Antam completed construction of two 30MW coal-fired units in October 2016.[50]

[44] TBP. Sustainability Report 2023. 2023. Page 22.
[45] TBP. Sustainability Report 2023. 2023. Page 83.
[46] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 14.
[47] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 151.
[48] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 151.
[49] TBP. Sustainability Report 2023. 2023. Page 77.
[50] Antam. ANTAM Completes the Construction of 2x30MW Coal Fired Power Plant as Part of the Pomalaa Ferronickel Plant Expansion Project. 10 October 2016.

Table 7: Thermal Plants Location, Capacity, and Year of Completion for Indonesian Nickel Companies

Company	Thermal Plant	Location	Capacity (MW)	Year
Antam	Poamalaa	Pomalaa	2 x 30	2016
MBMA	Halmahera Persada	Obi Island	2 x 30, 2 x150	2020, 2022, 2023
TBP (Harita)	Sulawesi Mining	Morowali	2,080	2015-2020

Source: Global Energy Monitor.

Antam has said it will explore new and renewable-based energy solutions in accordance with Indonesia's Roadmap Towards Net Zero by 2060.[51] It currently uses a small amount of solar energy and biofuel[52] and aims to explore solar power and hydropower as an alternative to fossil fuels.[53] Antam announced in November 2023 that it would no longer use coal power and would shut down its coal-fired power plant as PLN enters Pomalaa[54], Antam also plans to source power from PLN's Gas Engine Power Plant for its ferronickel facility in East Kalimantan.[55] While the company aims to shut down its below scale coal-fired power plants, it may still be sourcing coal-fired power from PLN. Additionally, gas-fired energy is still fossil fuel based, and emissions would shift from Scope 1 to Scope 2.

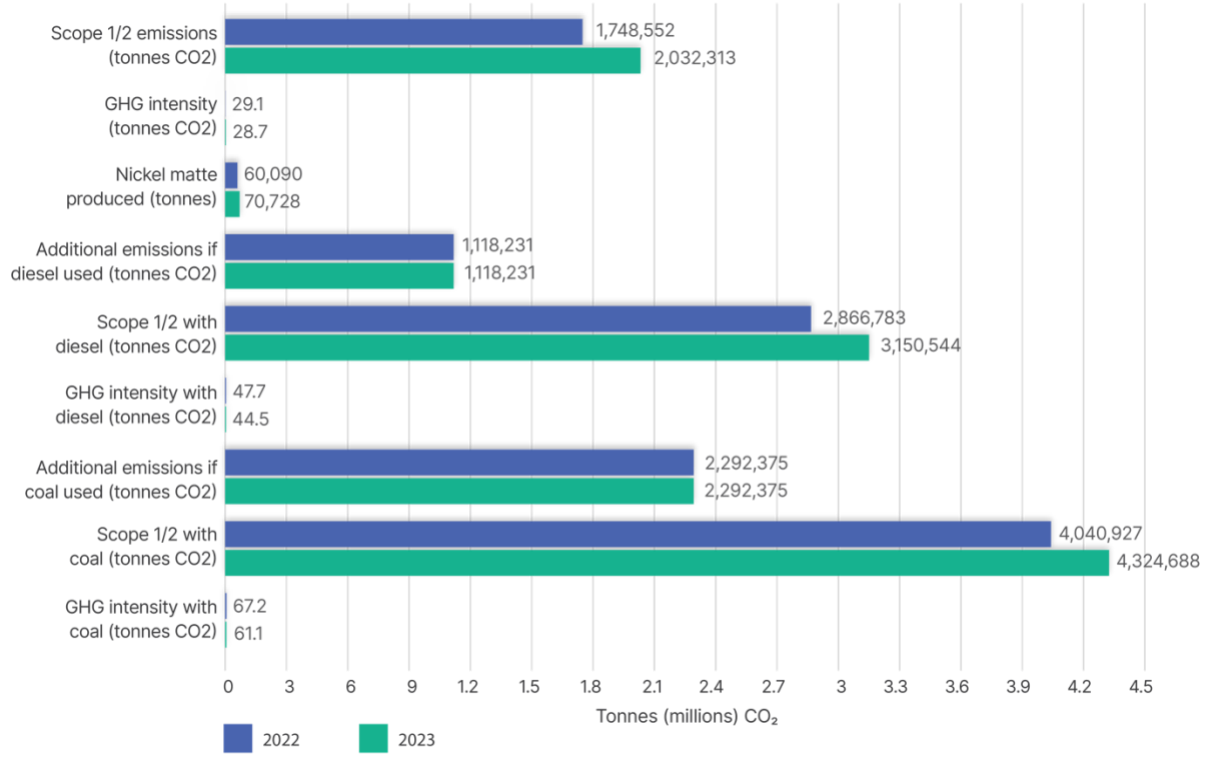
In its Sustainability Report 2023, MBMA referred to using solar panels to replace fossil fuels but did not provide capacity guidance.[56] Its current 5% energy use from renewable sources is mainly from biodiesel.[57] The report states a commitment to invest in renewable energy to replace dependence on fossil fuels but offers no further details.[58]

TBP (Harita) aims to install 300MW of solar power by the end of 2025 to reduce coal consumption at smelter facilities[59], which may result in a GHG intensity similar to that of Vale with its three hydropower plants of 365MW capacity.[60] These hydropower plants have capacities of 165MW, 110MW, and 90MW respectively.[61] Vale also has two diesel generators of 30MW and 14MW capacities.[62] The company estimated that its hydropower plants prevented 1.18mt of CO_2 emissions

[51] Antam. Sustainability Report 2023. 16 April 2024. Page 251.
[52] Antam. Sustainability Report 2023. 16 April 2024. Page 74.
[53] Antam. Sustainability Report 2023. 16 April 2024. Page 105.
[54] Indonesia Miner. Aneka Tambang (ANTM) will stop using coal power plants. 30 November 2023.
[55] Indonesia Miner. Aneka Tambang (ANTM) will stop using coal power plants. 30 November 2023.
[56] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 147.
[57] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 97.
[58] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 150.
[59] TBP. Sustainability Report 2023. 2023. Pages 22 and 79.
[60] Vale. Sustainability Report 2023. 2023. Page 08.
[61] Vale. Annual Report 2023. Page 45.
[62] Vale. Annual Report 2023. Page 45.

based on diesel power usage, and 2.3mt of CO_2 based on coal usage for steam power plants in 2022[63] and 2023.[64]

Figure 8: Vale's Emissions in 2022-23 if Using Coal or Diesel Power Instead of Hydropower



Source: Company reports; IEEFA estimates.

If Vale had used diesel generation instead of hydropower in 2022 and 2023, the GHG intensity of its nickel matte would have been 47.7 and 44.5 tCO_2/tNi for those years, respectively. Had coal-fired power been used instead of hydropower, the company's Scope 1 and 2 GHG intensity would be 67.2 and 61.1 tCO_2/tNi for 2022 and 2023. Vale would then have been in the same range as the other three nickel companies, which varied between 56.9-69.9 tCO_2/tNi produced as ferronickel using a smelter (pyrometallurgical) process.

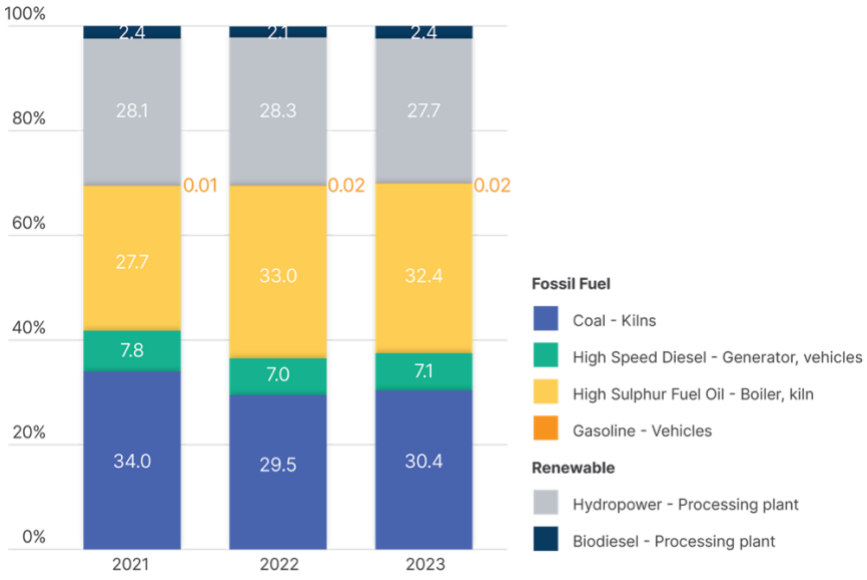
This suggests two key findings. First, all four companies calculate CO_2 emissions using similar methods. Second, apart from Vale, the other companies mainly use coal-fired power and their emissions are around or above 60 tCO_2/tNi compared to 28.7 for Vale.

[63] Vale. Sustainability Report 2022. 2022. Page 29.
[64] Vale. Sustainability Report 2023. 2023. Page 35.

A Closer Look at Vale's Energy Use

Vale's combination of biodiesel and hydropower advanced its renewables share to 30.1%, the highest among the four companies. In comparison, Antam had a 1.2% renewable energy share, MBMA had a 4.9% share, and TBP (Harita) had a 5.3% share in 2023. However, as TBP's 300MW solar power begins operation in 2025, its renewable energy use percentage is expected to increase while GHG intensity decreases from 68.4 tCO_2/tNi (ferronickel produced in the smelter process).

Figure 9: Fossil Fuel and Renewable Energy Used by Vale 2021-23



Source: Company reports; IEEFA estimates.

Vale achieved the lowest GHG intensity among the four nickel companies examined in this report, with 28.7 tCO_2/tNi. This is just 41% of the GHG intensity of Antam's ferronickel, which had the highest at 69.9 tCO_2/tNi. Yet, Vale still uses fossil fuels for most of its smelter and some production processes, resulting in ongoing CO_2 emissions. Vale has also been transparent in disclosing the total tonnes, barrels, and liters of coal, fuel oil, and diesel used in its production processes. The company has two diesel generators with capacities of 30MW and 14MW. Vale could reduce its overall emissions further.

Table 8: Vale's Fossil Fuel Usage and Nickel Output 2021-23

Fuel Source	2021	2022	2023
Fossil Fuel			
Coal (thousand tonnes)	374.9	292.3	347.4
High Speed Diesel (million litres)	69.5	58.6	68.1
High Sulphur Fuel Oil (million barrel)	1.3	1.5	1.7

Nickel matte output (tonnes)	65,388	60,090	70,728

Source: Company reports; IEEFA estimates.

Vale has set a standard among smelters of 28.7 tCO_2/tNi GHG intensity. TBP (Harita) seems encouraged to address its emissions with a new 300MW solar power plant that will begin lowering its GHG intensity after 2025. However, the Indonesian nickel sector is continuing to expand. The following section explores the potential GHG emissions that could be produced in 2028.

Calculation of Future Emissions

As Indonesian companies expand nickel production up to 2028, IEEFA has estimated the emissions produced under two scenarios. In the first scenario, the GHG intensity of these companies remains at the 2023 levels. In the second scenario, all four companies achieve the Vale standard of 28.7 tCO_2/tNi produced using the smelter process. The detailed production and emissions assumptions for each scenario are as follows:

Antam: Antam's new ferronickel smelter, in production since 2023[65], will add 13,500 tonnes to the current capacity of 27,000 tonnes.[66] The GHG intensity for 2023 was 69.9 tCO_2/tNi.

MBMA: By 2028, the company plans to increase production to 90,000 tonnes of MHP, 50,000 tonnes of matte, and 88,000 tonnes of ferronickel.[67] The GHG emissions intensity for ferronickel is 56.9 tCO_2/tNi, while nickel matte, which is produced from ferronickel, has an emission rate of 2 tonnes of CO_2 per tonne of matte.[68] For MHP products, it is assumed that emissions will be similar to those of TBP (Harita) at 13.4 tCO_2/tNi, as it is produced using the HPAL (hydrometallurgical) process.[69]

TBP (Harita): The company plans to increase MHP production to 120,000 tonnes by 2024 and expand matte and ferronickel production to 305,000 tonnes by 2025.[70] The current GHG emissions intensity for ferronickel was 68.4 tCO_2/tNi.[71] However, the completion of a 300MW solar PV project by 2025 could help reduce these emissions by 2028. For MHP products, which are produced using the HPAL (hydrometallurgical) process, the emissions are 13.4 tCO_2/tNi.[72]

Vale: The company plans to increase its MHP production capacity to 180,000 tonnes by 2026 and its ferronickel capacity to 73,000 tonnes by 2025.[73] In 2023, the GHG emissions intensity for nickel

[65] Antam. Annual Report 2023. 16 April 2024. Page 19.
[66] Antam. Annual Report 2023. 16 April 2024. Page 99.
[67] Merdeka Battery Materials. HSBC Global Investment Summit. 08 April 2024. Page 11-13.
[68] Merdeka Battery Materials. Sustainability Report 2023. 2023. Page 14.
[69] TBP. Sustainability Report 2023. 2023. Page 83.
[70] TBP. Company Presentation 1H24. August 2024. Page 08.
[71] TBP. Sustainability Report 2023. 2023. Page 83.
[72] TBP. Sustainability Report 2023. 2023. Page 83.
[73] Vale. Annual Report 2023. Page 14.

matte was 28.7 tCO_2/tNi. For MHP products, which are expected to use the HPAL (hydrometallurgical) process, emissions are estimated to be similar to TBP (Harita) at 13.4 tCO_2/tNi.[74]

[74] TBP. Sustainability Report 2023. 2023. Page 83.

Scenario 1: Calculation of Future Emissions in 2028 at 2023 Standard

Table 9: GHG Intensity and Output of Indonesian Nickel Companies 2023 and 2028 at 2023 Standard

Companies	Product	GHG Intensity (tonnes CO_2)	2023 (tonnes)	GHG Intensity (tonnes CO_2)	2028 (tonnes)
Antam	Ferronickel	69.9	21,473	69.9	40,500
MBMA	Ferronickel	56.9	65,117	56.9	88,000
	Matte	2.0	30,333	2.0	50,000
	MHP			13.4	120,000
MBMA Total			95,450		258,000
TBP (Harita)	Ferronickel	68.4	101,538	68.4	305,000
	MHP	13.4	63,655	13.4	120,000
TBP (Harita) Total			165,193		425,000
Vale	Matte	28.7	70,728	28.7	70,000
	Ferronickel			28.7	73,000
	MHP			13.4	180,000
Vale Total					323,000

Source: Company reports; IEEFA estimates.

Under scenario one, the total possible emissions could be 38.5mt, equal to 4.5% of Indonesia's emissions in 2023 of 861.5mt.[75]

Table 10: GHG Intensity and Total Emissions for Indonesian Nickel Companies 2023 and 2028 at 2023 Standard

Companies	Intensity (tCO_2/tNi)	2023 (million tonnes CO_2)	Intensity (tCO_2/tNi)	2028 (million tonnes CO_2)
Antam	69.9	1.5	69.9	2.8
MBMA	56.9	3.8	56.9	6.7
TBP (Harita)	68.4	8.0	68.4	22.5
Vale	28.7	2.0	28.7	6.5
Total		15.3		38.5

Source: Corporate annual reports and quarterly filings.

[75] Statista. Territorial carbon dioxide (CO_2) emissions in Southeast Asia from 1960 to 2021, by country.

Scenario 2: Emissions to Decrease by 43% if Vale's Standard is Adopted

Total emissions would decrease by 43% to 22.3mt of CO_2 in 2028 if the other three companies can achieve Vale's 28.7 tCO_2/tNi standard. The completion of TBP (Harita)'s 300MW solar power plant in 2025 should help lower the GHG intensity of its ferronickel production from 68.4 tCO_2/tNi in 2023. The lower CO_2 emissions of 22.3mt would represent 2.6% of Indonesia's 2023 emissions of 861.5mt.

Table 11: GHG Intensity and Output of Indonesian Nickel Companies 2023 and 2028 at Vale's Standard

Companies	Product	Intensity (tCO_2/tNi)	2023 (tonnes)	Intensity (tCO_2/tNi)	2028 (tonnes)
Antam	Ferronickel	69.9	24,173	28.7	40,500
MBMA	Ferronickel	56.9	65,117	28.7	88,000
	Matte	2.0	30,333	2.0	50,000
	MHP			13.4	120,000
MBMA Total			95,450		258,000
TBP (Harita)	Ferronickel	68.4	101,538	28.7	305,000
	MHP	13.4	63,655	13.4	120,000
TBP (Harita) Total			165,193		425,000
Vale	Matte	28.7	70,728	28.7	70,000
	Ferronickel			28.7	73,000
	MHP			13.4	180,000
Vale total					323,000

Source: Company reports; IEEFA estimates.

Table 12: GHG Intensity and Total Emissions for Indonesian Nickel Companies 2023 and 2028 at Vale's Standard

Companies	GHG Intensity (tCO_2/tNi)	2023 Emissions (million tonnes CO_2)	GHG Intensity (tCO_2/tNi)	2028 Emissions (million tonnes CO_2)
Antam	69.9	1.5	28.7	1.2
MBMA	56.9	3.8	28.7	4.2
TBP (Harita)	68.4	8.0	28.7	10.4
Vale	28.7	2.0	28.7	6.5
Total		15.3		22.3

Source: Company reports; IEEFA estimates.

IEEFA estimates that the four companies could collectively reduce emissions by 16.2mt of CO_2 if they produce nickel smelter products at the Vale GHG intensity of 28.7 tCO_2/tNi.

Companies should reduce emissions by replacing coal-fired capacity with hydropower or solar power. This can help balance the environmental cost and economic benefits of increased nickel exports. Vale has already completed 365MW of hydropower capacity and TBP (Harita) plans to achieve 300MW solar photovoltaic (PV) capacity by 2025. Both companies have demonstrated that Indonesian nickel companies can reduce reliance on coal-fired power and reduce GHG intensity.

Table 13: GHG Intensity and Emissions Reduced for Indonesian Nickel Companies 2023 and 2028 at Vale's Standard

Companies	GHG Intensity 2023 (tCO_2/tNi)	GHG Intensity 2028 (tCO_2/tNi)	GHG Intensity 2028 Vale (tCO_2/tNi)	Emissions Reduced (million tonnes CO_2)
Antam	1.5	2.8	1.2	1.7
MBMA	3.8	6.7	4.2	2.4
TBP (Harita)	8.0	22.5	10.4	12.1
Vale	2.0	6.5	6.5	0.0
Total	15.3	38.5	22.3	16.2
Total Indonesia CO_2	861.5			
as a %		4.4	2.6	

Source: Company reports; IEEFA estimates.

Conclusion: Nickel Companies Should Use More Renewable Energy

Of the four Indonesian nickel companies in the IEEFA analysis, Vale uses 30.1% renewable energy due to its three hydropower plants with a total capacity of 365MW. In 2023, Vale had the lowest GHG intensity for smelter nickel products at 28.7 tCO_2/tNi. MBMA had the second lowest GHG intensity at 56.9 tCO_2/tNi, followed by TBP (Harita) at 68.4 tCO_2/tNi, and Antam at 69.9 tCO_2/tNi. The latter three companies rely more heavily on electricity from coal-fired generation.

> **Vale uses 30% renewable energy and has the lowest GHG intensity at 28.7 tCO_2/tNi compared to Antam at 69.9 tCO_2/tNi. If all companies can operate at Vale's benchmark, 2028 emissions could be reduced by 43%.**

These four companies produced 353,000 tonnes of primary nickel in 2023 and had total GHG emissions of 15.3mt. TBP (Harita) uses a chemical-based process to produce nickel in MHP form, which is less GHG intensive at 13.4 tCO_2/tNi. By 2028, the plan is to expand output to 1.05mt, of which 420,000 tonnes are the lower GHG intensity nickel product based on the HPAL process (see Appendix A). However, there are 507,000 tonnes of ferronickel and 120,000 tonnes of matte which are products with higher GHG intensity.

IEEFA estimated the emissions under two scenarios. The first scenario assumes that the companies' GHG intensity remains unchanged from 2023. The second scenario assumes that all four companies use the smelter process to achieve the Vale standard of 28.7 tCO_2/tNi for nickel products. Under scenario one, the total possible emissions could be 38.5mt, which is equal to 4.5% of Indonesian total CO_2 emissions of 861.5mt in 2023.[76]

If the other three companies can achieve Vale's standard of 28.7 tCO_2/tNi, this would reduce total emissions by 43% to 22.3mt in 2028. The completion of TBP (Harita)'s 300MW solar PV plant in 2025 should help lower the GHG intensity of its ferronickel production from 68.4 tCO_2/tNi in 2023. The lower 22.3mt of CO_2 emissions would represent 2.6% of Indonesia's total CO_2 emissions of 861.5mt in 2023.

Vale uses 365MW of hydropower capacity, and TBP (Harita) will complete 300MW solar PV capacity by 2025. Both companies have demonstrated that Indonesian nickel companies can reduce reliance on coal-fired power and lower GHG intensity. However, nickel producers can do more to decrease their GHG footprint through the use of hydropower, solar PV, or other renewable energy sources. Indonesian nickel companies must balance the economic benefits of increased downstream nickel exports with the environmental impact.

[76] Statista. Carbon dioxide (CO_2) emissions in the Asia-Pacific region in 2023, by country or territory.

Appendix A: Introduction to Nickel

Nickel is a metallic element with a silvery-white, shiny appearance. It is the fifth-most common element on earth. Nickel properties include a high melting point of 1,453 degrees, resistance to corrosion and oxidation, and can be readily used in alloys. Like all metals, nickel can be described in terms of a supply chain:

- **Upstream:** Nickel ore types and location of reserves.
- **Midstream:** This consists of refining products such as mixed sulfide precipitate (MSP), mixed hydroxide precipitate (MHP), and nickel matte. Further processed products include nickel sulfate, pure nickel, and ferronickel.
- **Downstream:** The two main uses of nickel are in stainless steel used in buildings and machinery, and in batteries used in new energy vehicles.

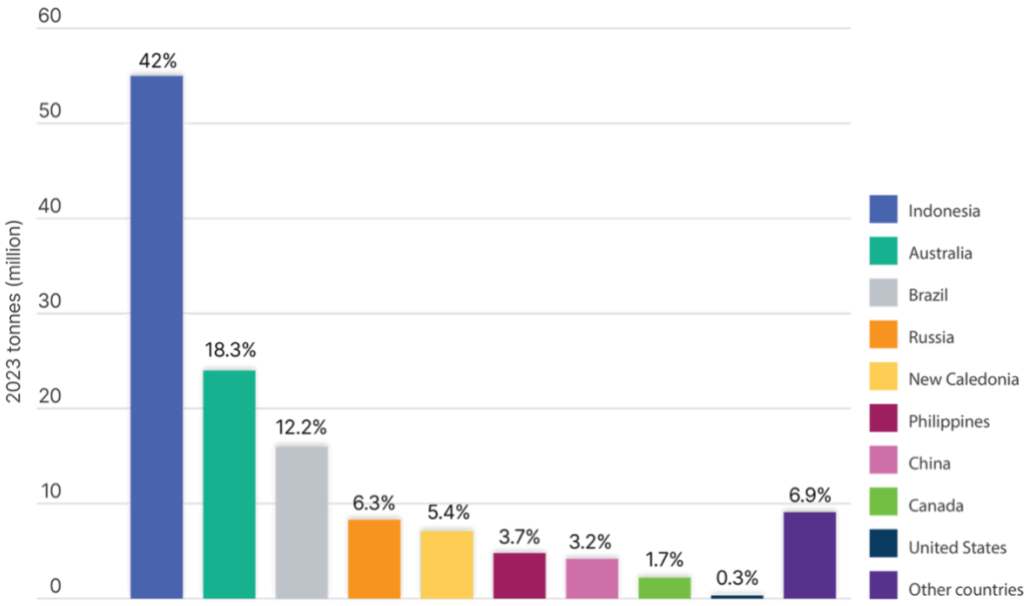
Upstream Nickel: Types of Ore and Global Reserves

Globally, about 60% of the world's nickel reserves are in the form of laterite ore and 40% as sulfide ores. Laterite ores are mainly found in Indonesia, Brazil, New Caledonia, and the Philippines. There are two types of laterite ore, limonite and saprolite. Limonite is closer to the surface and has a lower nickel content of 1.1-1.5%. Saprolite is below limonite and has a higher nickel content of 1.5-2.1%.

According to the U.S. Geological Survey[77], Indonesia accounted for 42% of the world's nickel reserves with 42mt in 2023. Australia was in second place with 18%.

[77] US Geological Survey. Nickel Statistics and Information 2024. Page 125.

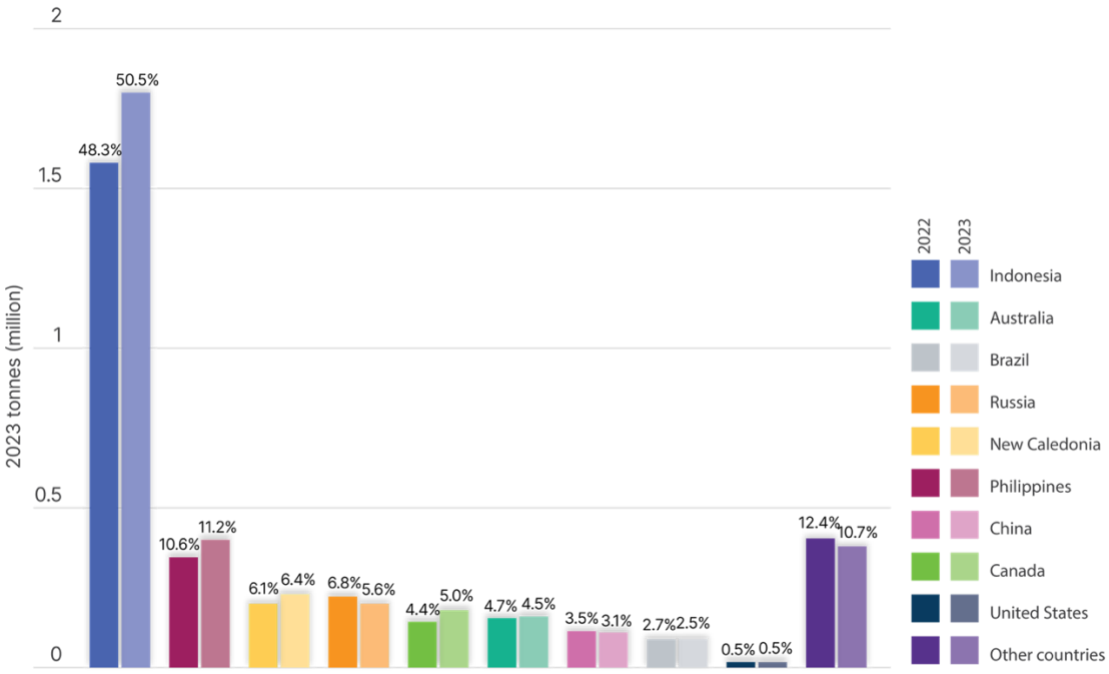
Figure 10: Global Distribution of Nickel Reserves



Source: US Geological Survey; IEEFA estimates.

In terms of nickel contained in mine production, Indonesia ranked first in 2022 and 2023, accounting for 48% and 50% of global output respectively. The Philippines ranked second for 2022 and 2023, accounting for 11% of nickel contained in mine production.

Figure 11: Global Share of Nickel Contained in Mine Production

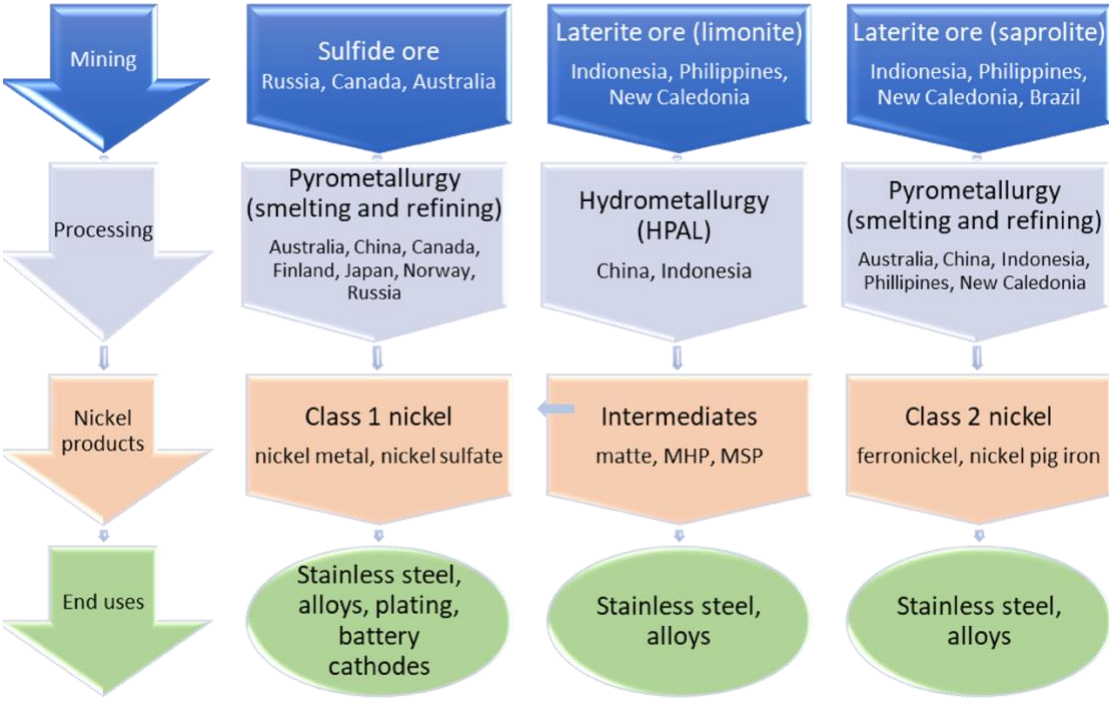


Source: US Geological Survey; IEEFA estimates.

Midstream Nickel: Types of Processing and Nickel Products

There are two types of nickel ore processing that produce different kinds of nickel products. The first is pyrometallurgical which uses heat to extract and purify the nickel and involves roasting, smelting, and refining. For the saprolite ores, a Rotary Kiln Electric Furnace (RKEF) is used to produce ferronickel. The second is hydrometallurgical which uses aqueous solutions to recover metals from ores. For the limonite ores found in Indonesia, High Pressure Acid Leach (HPAL) is used to produce mixed sulfide precipitate (MSP) and mixed hydroxide precipitate (MHP).

Figure 12: Simplified Nickel Production Process Flows by Product Type with Leading Producers



Source: USITC Office of Industry and Competitiveness Analysis.

The RKEF is an industrial furnace that uses electricity as its heating source. The laterite ores are subjected to calcination and reduction, then smelted in an electric furnace to produce ferronickel. Ferronickel is an alloy that contains 35% nickel and 65% iron. It is used to manufacture stainless and heat-resistant steel. Ferronickel can also be put into a conversion facility, which lowers the iron content, producing a nickel matte containing more than 70% nickel. This nickel matte can be used to produce nickel sulfate, which is part of the battery value chain.

HPAL is a process used to extract nickel and cobalt from laterite ores. It uses elevated temperatures (255 degrees Celsius) and pressure (725 psi), combined with sulfuric acid, to separate nickel and cobalt from laterite ore. The ore is first crushed and then mixed with water and pumped into an autoclave (which acts as a pressure cooker). The resulting slurry is then cooled down in stages and separated to recover nickel and cobalt.

MSP is around 55% nickel and is produced by exposing the HPAL solution to hydrogen sulfide. MHP is produced by precipitation of the HPAL solution using hydroxide compounds. MHP has a nickel content of 30-40% and a cobalt content of 1-10%. MSP and MHP are feedstock for the production of nickel sulfate, which is then used to produce lithium-ion batteries.

Downstream Nickel: Mainly Used in Stainless Steel and EV Batteries

According to the Nickel Institute, "first use" is defined[78] as the conversion of nickel products into intermediate products which undergo further processing. The two main uses of nickel are for stainless steel (65%) and batteries for EVs (17%).

Table 14: Uses of Nickel 2023 (%)

Company	%
Stainless steel	65
Batteries	17
Alloys and alloy steels	8
Plating	5
Others	4

Source: Nickel Institute.

At least three types of EV batteries[79] use nickel, Nickel-Cobalt-Aluminium (NCA), Nickel-Manganese-Cobalt (NMC), and Nickel-Metal-Hyride (NiMH). NCA batteries are used in high performance vehicles such as the Tesla Model S as it has high energy density. NMC batteries also have high energy density and are used in high performance vehicles such as the BMW iX3. NiMH batteries have lower

[78] Nickel Institute. About nickel.
[79] Electromaps. Electric vehicle batteries: types and characteristics.

energy density, are competitively priced, and contain no toxic metals. These are used in hybrid cars such as the Toyota Prius.

Table 15: Types of EV Batteries and Models

Company	Energy	Typical applications	Model
Nickel-cobalt-aluminium (NCA)	High	High performance long range	Tesla Model S, X
Nickel-Manganese-Cobalt (NMC)	High	High performance long range	BMW iX3, Volvo ES30
Lithium-Iron-Phosphate (LFP)	Medium	Economical vehicles	BYD Atto, Tesla Model 3
Sodim-Ion	Medium	Small electric vehicles	JAC, Jiangling Motors
Nickel-Metal-Hydride (NiMH)	Lower	Hybrid vehicles	Toyota Prius, Honda Insight
Solid and semi-solids	Very High	Future high performance	

Source: Electromaps; IEEFA estimates.

Appendix B: Nickel in Indonesia

According to the U.S. Geological Survey[80], Indonesia has 42% of the world's nickel reserves and accounted for 51% of the world's production of nickel metal in 2023. Indonesia's nickel ore is mainly located at Obi Island, Sulawesi, and Halmahera Island. Currently, Indonesia has four major listed nickel producers, Antam, Merdeka Battery Material, TBP (Harita), and Vale.

Antam has four mines[81] in Sulawesi, Maluku, and Papua and has a total reserve of 5.9mt[82] of contained nickel metal. Merdeka Battery Materials' mine is in Sulawesi and has a total reserve of 2.4mt of nickel metal. TBP's three mines on Obi Island contain 2.4mt of nickel and 0.2mt of cobalt. Vale's two mines are in Sulawesi and have a combined reserve base of 6.3mt.

Regarding midstream nickel products, Antam uses the RKEF process to produce ferronickel used mainly for stainless steel. Merdeka Battery Materials also uses the RKEF process to produce ferronickel and has a conversion plant to produce nickel matte from lower grade ferronickel. TBP (Harita) has a HPAL plant to produce MHP and a RKEF plant to produce ferronickel. Vale also has a RKEF and conversion facility to produce nickel matte.

[80] US Geological Survey. Nickel Statistics and Information 2024. Page 125.
[81] Antam. Sustainability Report 2023. 16 April 2024. Page 47.
[82] Antam. Annual Report 2023. Page 321.

Table 16: Output, Product, and Process of Indonesian Nickel Companies 2022-23

Company	Product	Process	2022 (tonnes)	2023 (tonnes)
Antam	Limonite	Mining	8,620,000	13,450,000
	Ferronickel	RKEF	24,334	24,173
Merdeka Battery Materials	Saprolite	Mining	100,000	2,300,000
	Limonite	Mining	900,000	4,100,000
	Ferronickel	RKEF	26,283	65,117
	Matte	Conversion	0	28,129
TBP (Harita)	Saprolite	Mining	4,430,000	6,090,000
	Limonite	Mining	6,290,000	14,660,000
	MHP	HPAL	42,310	63,655
	Ferronickel	RKEF	25,372	101,538
Vale	Saprolite	Mining	11,552,911	13,452,663
	Ni in matte	RKEF, Conversion	60,090	70,728

Source: Company reports; IEEFA estimates.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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