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GREEN INDUSTRIALIZATION IN INDONESIA: LANDSCAPE AND TRENDS IN THE ENERGY SECTOR AND CRITICAL MINERALS VALUE CHAINS, WITH A FOCUS ON NICKEL

Project Appendix

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List of Acronyms and Abbreviations

AMIS	ASEAN Minerals Information System
APNI	Indonesian Nickel Miners Association (<i>Asosiasi Penambang Nikel Indonesia</i>)
ASEAN	Association of Southeast Asian Nations
BAPPENAS	Ministry of National Development Planning (<i>Badan Perencanaan Pembangunan Nasional</i>)
BEV	battery electric vehicle
BOE	barrel of oil equivalent
BOO	build, own, operate
BOOT	build, own, operate, and transfer
BRIN	National Research and Innovation Agency (<i>Badan Riset dan Inovasi Nasional</i>)
CBAM	Carbon Border Adjustment Mechanism
CBOG	community-based off-grid
CCD	counter-current decanting
CCSI	Columbia Center on Sustainable Investment
CO ₂	carbon dioxide
CO ₂ e	carbon dioxide equivalent
DEN	National Energy Council (<i>Dewan Energi Nasional</i>)
DMO	Domestic Market Obligation
EAF	electric arc furnace
ESDM	Ministry of Energy and Mineral Resources (<i>Kementerian Energi dan Sumber Daya Mineral</i>)
EU	European Union
EV	electric vehicle
FCEV	fuel cell electric vehicle
FEOC	Foreign Entity of Concern
GDP	gross domestic product
GHG	greenhouse gas
GR	Government Regulation (<i>Peraturan Pemerintah</i>)

HPAL	High-Pressure Acid Leaching
HSP	high-grade nickel sulfate precipitate
IEA	International Energy Agency
IMIP	Indonesia Morowali Industrial Park (Morowali Industrial Park)
IndoPhil	Indonesia–Philippines (Nickel Corridor)
USD	United States Dollar
IPP	independent power producer
IRA	Inflation Reduction Act
IWIP	Indonesia Weda Bay Industrial Park
JETP	Just Energy Transition Partnership
KEK	Special Economic Zone (<i>Kawasan Ekonomi Khusus</i>)
KEN	National Energy Policy (<i>Kebijakan Energi Nasional</i>)
kV	kilovolt
LCOE	levelized cost of electricity
LCCP	Low Carbon Compatible with Paris Agreement (scenario)
MCC	Millennium Challenge Corporation
MHP	mixed hydroxide precipitate
Mt	million tons
MWh	megawatt-hour
NPI	nickel pig iron
PLN	State Electricity Company (<i>Perusahaan Listrik Negara</i>)
PLTP	geothermal power plant (<i>Pembangkit Listrik Tenaga Panas Bumi</i>)
PNIA	Philippine Nickel Industry Association
POME	palm oil mill effluent
PPA	Power Purchase Agreement
PPU	Private Power Utility
PSN	National Strategic Project (<i>Proyek Strategis Nasional</i>)
PT	Limited Liability Company (<i>Perseoran Terbatas</i>)
PV	photovoltaic
R&D	research and development
RE	renewable energy
RKEF	Rotary Kiln Electric Furnace
RUKN	National Electricity Plan (<i>Rencana Umum Ketenagalistrikan Nasional</i>)
RUPTL	Electricity Supply Business Plan (<i>Rencana Usaha Penyediaan Tenaga Listrik</i>)
SAF	Sustainable Aviation Fuel
SERIG	Sustainable Energy for Remote Indonesian Grids
TWh	terawatt-hour
TJ	terajoule

Background

The Columbia Center on Sustainable Investment (CCSI) developed the project *Indonesia's Green Industrialization* with support from Yayasan Visi Indonesia Raya Emisi Nol Bersih (ViriyaENB). The three main deliverables of the project are:

- A policy report titled *Integrating Circular Economy Principles and Practices in Indonesia's Nickel Sector: Overview, Benefits, and Enabling Conditions*;
- An applied research paper titled *Financing Indonesia's Green Industrialization: System Pathways, Structural Diagnosis, and Tailored Solutions*; and
- A policy concept note titled *A Mining–Energy–Industry Feedback Loop in Indonesia's Nickel Sector: Structure, Benefits, and Enabling Conditions*.

This policy appendix complements the three main deliverables, providing contextual information on Indonesia's current mining, energy, and industry landscape.

1. Energy Sector

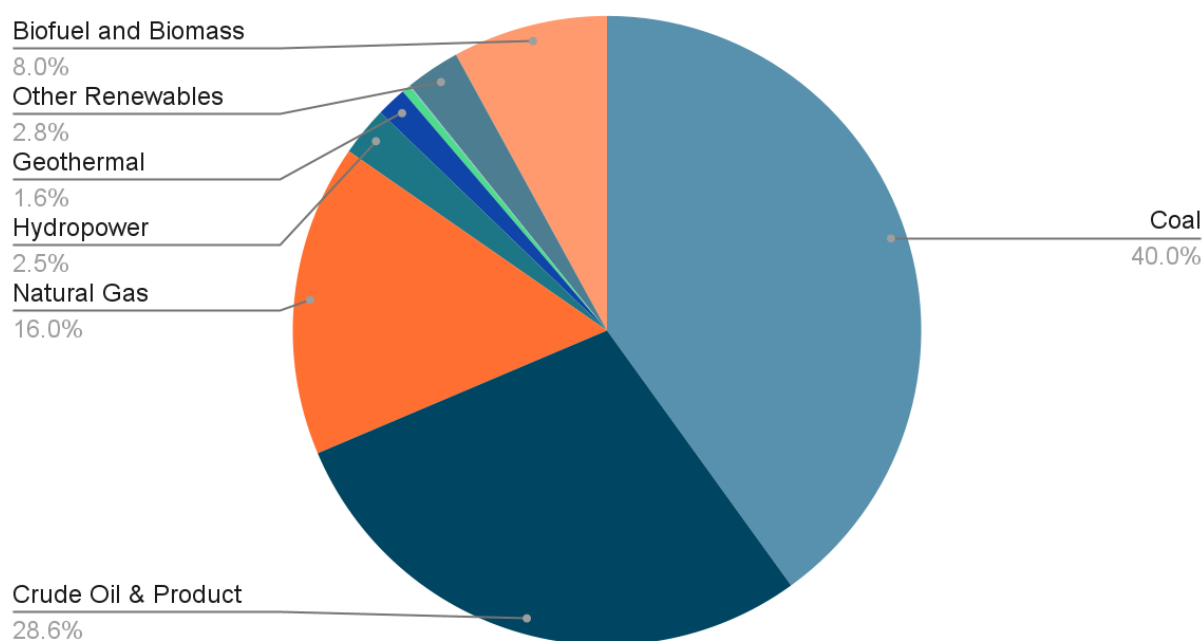
Indonesia is set to be in the top ten global economic powers, mainly via mining and the critical mineral industry,¹ which has high energy intensity. In total, annual energy demand in the country exceeds 7.3 million TJ. The industrial sector accounts for nearly half of the final energy demand (Table 1).²

Table 1. Energy consumption by sector, Indonesia

Energy Consumption by Sector	Value (Million BOE)	Percentage
Industry	586.25	44.28%
Transport	460.78	34.80%
Residential	175.51	13.26%
Commercial and Public Services	58.36	4.41%
Other non-specified	11.44	0.86%
TOTAL	1,292.34	100.00%

Source: Ministry of Energy and Mineral Resources of the Republic of Indonesia (ESDM), *Handbook* (2025).³

More than three-quarters of Indonesia's energy supply comes from fossil sources (Figure 1).⁴ Coal is the primary source, extracted from major coal basins located in two of the five main Indonesian islands.⁵ Indonesia relies on domestic production for 40% of its oil demand and on imports for the remaining 60%.⁶ Renewables accounted for approximately 14.65% of the energy mix and 18.1% of Indonesia's total electricity generation mix in 2024.⁷ Hydropower is the main source of renewable electricity, and other sources include biofuel, solar, geothermal, and wind.⁸



Energy Source	Value (BOE)	Percentage
Coal	803,864,256	40.04%
Crude Oil & Product	573,857,851	28.58%
Natural gas	321,925,780	16.03%
Hydropower	50,826,030	2.53%
Geothermal	31,142,575	1.55%
Solar	8,460,474	0.42%
Wind	1,146,302	0.06%
Other Renewables	56,317,737	2.80%
Biofuel and Biomass	160,250,786	7.98%
TOTAL	2,007,791,791	100.00%

Figure 1. Primary energy supply by source, Indonesia, 2024

Source: ESDM, *Handbook* (2025).⁹

Indonesia's industrial sector heavily relies on fossil fuels; coal, gas, and oil jointly account for approximately 60% of final energy consumption, mainly used for high-temperature heating processes and to power industrial facilities. Direct electricity use accounts for approximately one-quarter of the sector's energy consumption (Figure 2).

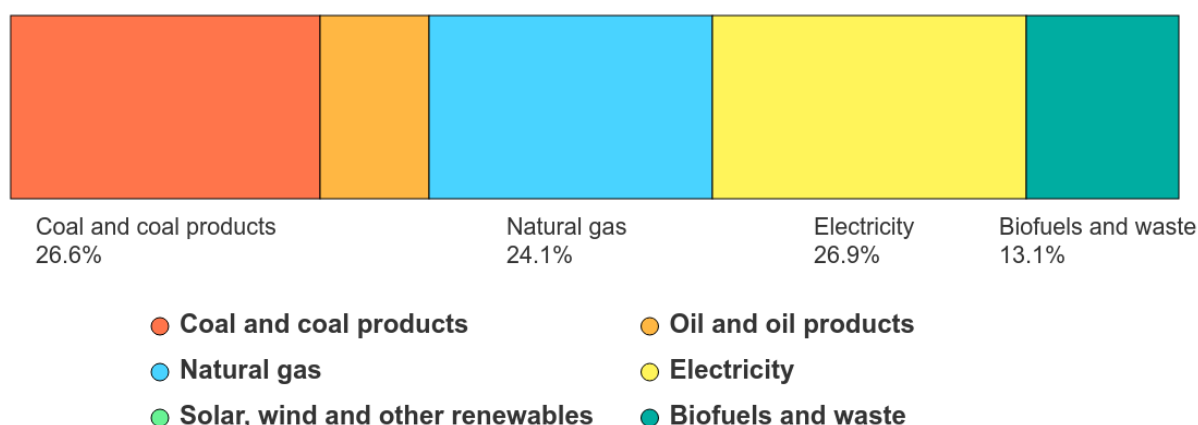


Figure 2. Final energy consumption in the industrial sector by source, Indonesia, 2023

Source: IEA (2023).¹⁰

As a result, reported greenhouse gas (GHG) emissions from fuel combustion in Indonesia exceeded 790 million metric tons of carbon dioxide equivalent (Mt CO₂e) in 2024 (Table 2).¹¹ Electricity and heat production are the country's largest emission sources, accounting for more than 45% of emissions.¹²

Table 2. Reported GHG emissions from the energy sector, Indonesia, 2024

Emission Source	Value (GgCO ₂ e)	Share (%)
Fuel Combustion from Energy Industries	321,886	40.72
Fuel Combustion from Manufacturing Industries and Construction	244,334	30.91
Fuel Combustion from Transport	168,516	21.32
Fuel Combustion from Other Sectors	35,904	4.54
Fugitive Emissions from Oil and Natural Gas and Other Emissions from Energy Production	15,219	1.93
Fugitive Emissions from Solid Fuels	4,706	0.60
TOTAL	790,565	100.00

Source: ESDM, *Handbook* (2025).¹³

1.1 Electricity

Electricity production amounted to 371.6 TWh in 2024,¹⁴ electrifying 99.83% of the country.¹⁵ However, the electricity systems are not interconnected across the islands, creating issues of unequal power supply and distribution (Figure 3). The two main islands, Sumatra and Kalimantan, have their own grid, while Sulawesi island's grid is divided into two, North and South. These four grids are equipped with 150 and 275 kV lines.¹⁶ The busiest grid is located in the most populous island, Java, and extends to Bali island to the West, with lines of 500 kV capacity.¹⁷ The other main island, Papua, and smaller islands (Ambon, Lombok, Sumbawa, Timor, and Flores) have isolated grids only in populated areas, with 150 kV electrical lines.¹⁸ Rural areas and islands are mostly supported by diesel-powered microgrids, with a capacity of around 100 kW.¹⁹



Figure 3. Power grid system, Indonesia

Source: Hazarabedian, O'Neill, and Witto (2023).²⁰

These grid systems are all managed by Perusahaan Listrik Negara (PLN), the state-owned power utility, with a monopoly over distribution. PLN generates most of the country's electricity from its 137 coal-fired power plants with a total capacity of 21 GW (Tables 3, 4, and 5).²¹ Aside from its own plants, PLN also purchases electricity from Independent Power Producers (IPP) and Private Power Utilities (PPU).

Table 3. Power plants owned by PLN, Indonesia, 2024

Plant Type	Units	Installed Capacity (MW)
Coal (Steam)	137	21,026.90
Combined Gas and Steam	91	13,187.80
Diesel	5,154	3,425.94
Hydroelectric	58	3,254.85
Gas	63	2,798.65
Gas Engine	191	2,071.31
Geothermal	18	579.26
Minihydro	106	409.43
Microhydro	92	44.77
Solar	312	33.65
Biomass	2	0.52
Wind	2	0.17
TOTAL	6226	46,833.25

Source: PLN (2024).²²

Table 4. Installed capacity by power plant type, Indonesia, 2024, in MW

Plant Type	Installed Capacity (PLN) (On-Grid)	Installed Capacity (Off-Grid)	Total Installed Capacity
Coal (Steam)	54,338.84	-	54,338.84
Combined Gas and Steam	18,798.41	-	18,798.41
Hydroelectric	4,929.16	1,118.00	6,047.16
Diesel	5,819.28	-	5,819.28
Gas	4,477.66	-	4,477.66
Biomass	54.00	2,852.36	2,906.36
Gas Engine	2,889.82	-	2,889.82
Geothermal	2,638.76	-	2,638.76
Minihydro	954.23	-	954.23
Solar	416.14	482.4	898.54
Coal Gasification	230.00	220.00	450.00
BioGas	20.58	136.67	157.25
Wind	151.82	0.48	152.30
Microhydro	22.22	28.86	51.08
Waste	36.47	-	36.47
Other	18.00	-	18.00
TOTAL	95,795.39	4,838.77	100,634.16

Source: ESDM, *Handbook* (2025).²³

Table 5. Production by power plant type, Indonesia, 2024, in GWh

Plant Type	Production (PLN)	Production (IPP & PPU)	Off Grid Production	Total Production	Percentage
Coal (Steam)	117,974.00	114,276.00	-	232,250.00	62.51%
Combined Gas and Steam	38,192.00	9,507.00	-	47,699.00	12.84%
Hydroelectric	11,656.00	9,849.00	5,633.00	27,138.00	7.30%
Biomass	0.01	192.00	19,989.00	20,181.01	5.43%
Geothermal	4,231.00	12,532.00	-	16,763.00	4.51%
Gas Engine	9,570.00	1,178.00	-	10,748.00	2.89%
Diesel	7,037.00	-	-	7,037.00	1.89%
Gas	2,839.00	3,752.00	-	6,591.00	1.77%
Solar	13.76	411.22	926.00	1,350.98	0.36%

continued...

Plant Type	Production (PLN)	Production (IPP & PPU)	Off Grid Production	Total Production	Percentage
BioGas	-	156.00	958.00	1,114.00	0.30%
Wind	-	465.00	2.00	467.00	0.13%
Microhydro	-	-	152.00	152.00	0.04%
Waste	-	60.00	-	60.00	0.02%
TOTAL	191,512.77	152,378.22	27,660	371,550.99	100.00%

Source: ESDM, *Handbook* (2025).²⁴

In 2024, PLN recorded electricity sales of 306 TWh. The biggest portion is for the residential sector, with over 40% (Table 6). However, according to International Energy Agency (IEA) data, industry is the biggest consumer of electricity (Figure 4). Some of the electricity consumption by the industry sector is not provided by PLN and instead is generated by the facilities themselves (captive sources).

Table 6. PLN electricity sales, 2024, in GWh

Sector	Amount (GWh)	Percentage
Residential	130,433.10	42.59%
Industry	92,915.69	30.11%
Business (Commercial)	58,771.14	19.19%
Other (Social, Government, Public Facilities)	24,819.50	8.11%

Source: PLN (2024).²⁵

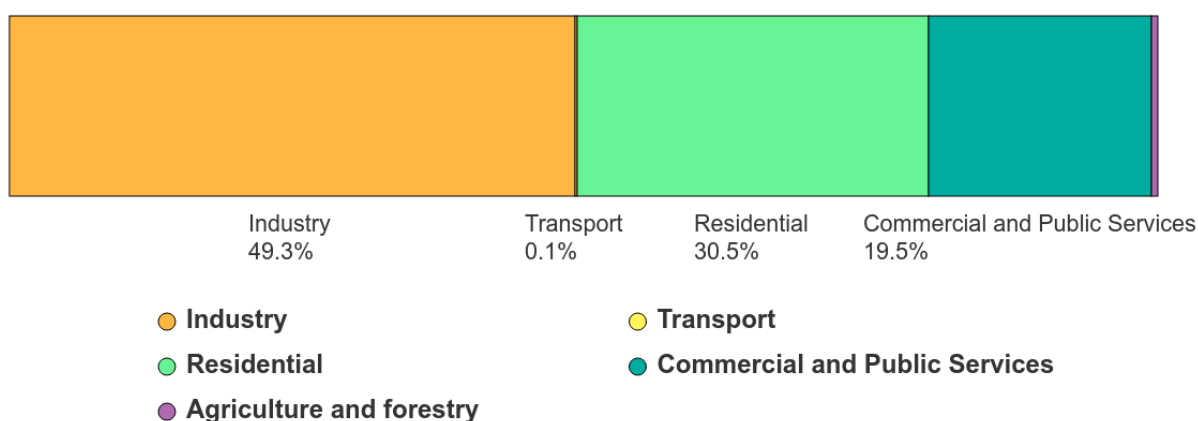


Figure 4. Electricity final consumption by sector, Indonesia, 2023

Source: IEA (2023).²⁶

1.2 Renewables

1.2.1 Existing and Untapped Potential

Indonesia's energy and electricity sources have depended heavily on coal. Renewable energy (RE) sourcing and infrastructure development have experienced slow growth since the start of the century (Figure 5). Table 7 summarizes Indonesia's renewable energy potential and the current installed capacity.

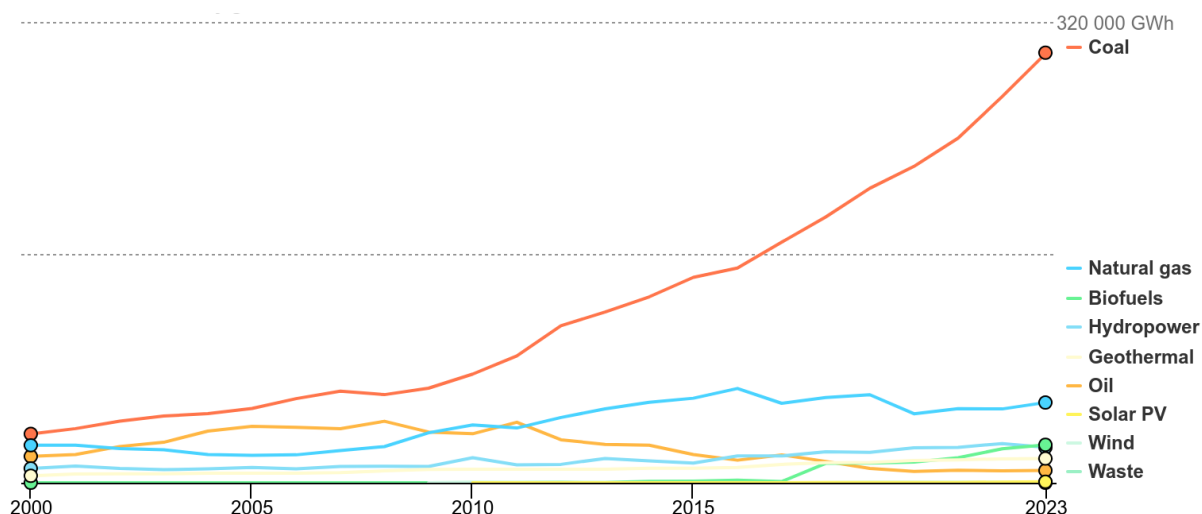


Figure 5. Evolution of electricity generation, Indonesia, 2000–2023

Source: IEA (2023).²⁷

Table 7. Renewable energy potential, Indonesia, in MW

Plant Type	Potential Capacity	Installed Capacity	Current RE Utilization Rate
Solar	207,898.0	78.5	0.04%
Hydroelectric	75,091.0	4,826.7	6.43%
Wind	60,647.0	3.1	0.01%
Bioenergy (biomass + biogas)	32,654.0	1,671.0	5.12%
Geothermal	29,544.0	1,438.5	4.87%
Mini + Micro hydro	19,385.0	197.4	1.02%
Tidal	17,989.0	0.3	0.00%

Source: PLN (2025).²⁸

Hydropower is Indonesia's biggest source of renewable electricity, with over 25 TWh installed capacity available from both on-grid and off-grid facilities.²⁹ The total hydropower potential has been estimated at approximately 94 GW: 75 GW from large hydro and 19 GW from micro-hydro installations.³⁰ The small plants have a more competitive levelized cost of electricity (LCOE) with lower negative environmental impact, and can be connected to the grid or function on their own, in comparison to large hydropower plants that have high capital costs. There is a potential for 34–95 GW of capacity from both large- and small-scale plants in the country. Specifically for Sulawesi, the Southeast region has ~300 MW, while Central Sulawesi has ~370 MW.

There is also tidal power national potential of around 17,989 MW,³¹ but aside from the currently installed 0.3 MW capacity (Table 7), there have not been any plans for additional infrastructure development.³²

Solar supplies nearly 1% in the energy mix with approximately 900 MW of capacity, half of which is owned by PLN and the other half by IPPs.³³ The largest solar farm is the 192 MW Cirata floating solar project.³⁴ Solar is the biggest development target under the country's national electricity plan, taking advantage of the geographical location (on the equator), the ease of installation, and the lowest cost in comparison to other sources.⁷ At a minimum, solar development can achieve 4,705 TWh/year by using 4.34% of the country's landmass,³⁵ which can power the country's annual electricity generation of 371.6 TWh twelve times over.

Wind. Installed wind power generation capacity currently amounts to over 150 MW and accounts for approximately 1% of the energy mix.³⁶ There is nearly 100 times more potential in the country, reaching 155 GW (60.6 GW of onshore wind and 94.2 GW of offshore wind).³⁷ As an initial investment plan, the Ministry of Energy and Mineral Resources (*Kementerian Energi dan Sumber Daya Mineral*, ESDM) has indicated the possibility of deploying 8 onshore wind farms in the Western islands of Java and Sumatra (Figure 6).³⁸ These farms can have 336 turbines with a capacity of 4 MW each, totalling a planned capacity addition of 1,344 MW. The investment requirement is calculated to be USD 1.59 to 1.789 million per MW, depending on farm location.



Figure 6. Potential onshore wind farms, Indonesia

Source: Pondera (2024).³⁹

Geothermal. Indonesia has 16 geothermal fields in operation as of 2022 (Figure 7 and Table 8), with a total capacity of 2,327.5 MW,⁴⁰ making it the second largest producer of geothermal energy, behind the United States. The country has the largest geothermal potential in the world of up to 28.5 GW—more than 12 times greater than the current installed capacity—because of the country's location in the Ring of Fire.¹⁶ The electricity produced contributed nearly 4% to the mix in 2023 at 17 TWh (Figure 5).



Figure 7. Geothermal plant locations, Indonesia

Source: ESDM, *Geoportal* (2025).⁴¹

Table 8. Geothermal power plants (*Pembangkit Listrik Tenaga Panas Bumi, PLTP*), Indonesia, 2025

Name	Units	Commercial Operation Year	Province	Total Capacity (MW)
PLTP Gunung Salak	6	1994 (2), 1997 (4)	West Java	573.6
PLTP Sarulla	3	2017 (2), 2018	Sumatra	330.0
PLTP Darajat	3	1991, 2000, 2007	West Java	270.0
PLTP Kamojang	5	1963, 1988 (2), 2008, 2015	West Java	235.0
PLTP Wayang	2	2000, 2009	West Java	227.0
PLTP Ulubelu	4	2012 (2), 2016, 2017	Lampung	220.0
PLTP Lahendong	6	2001, 2007, 2009, 2011, 2016 (2)	North Sulawesi	120.0
PLTP Muaralaboh	1	2019	West Sumatra	85.0
PLTP Dieng	1	2002	Central Java	60.0
PLTP Lumut Balai	1	2019	West Sumatra	55.0
PLTP Patuha	1	2014	West Java	55.0
PLTP Sorik Marapi	1	2019	North Sumatra	42.4
PLTP Karaha	1	2018	West Java	30.0
PLTP Sibayak Monoblok	1	1998, 2008	North Sumatra	12.0
PLTP Ulumbu	4	2013 (2), 2014 (2)	East Nusa Tenggara	10.0
PLTP Mataloko	1	2013	East Nusa Tenggara	2.5

Source: ESDM, *Geoportal* (2025).⁴²

Bioenergy. Biofuels are mainly used in the transportation sector in the form of biodiesel. The government is currently studying Sustainable Aviation Fuel (SAF) development utilizing feedstocks such as used cooking oil.⁴³ For electricity generation specifically, biofuel is used in rural areas to power isolated generators or as cofiring material in coal plants, amounting to 1.6 million tons throughout 2024.⁴⁴ Smelters can use torrefied wood pellets as bioenergy, but the main hurdle lies in securing the supply.

The government has regulations for a mandatory biodiesel program, requiring progressively higher levels of mixing with petroleum diesel. An August 2023 regulation pushes for a B35 biodiesel blend, which is a 35% biodiesel and 65% petroleum diesel mix,⁴⁵ by distributing 13.15 million kiloliters of the fuel during its first year. Palm oil constitutes the primary feedstock for biodiesel. Currently, trials for B40 integration have been conducted in off-road sectors, and with hopes for total implementation in 2026.⁴⁶

Another recent focus by the government is waste-to-energy generation. There are currently two main facilities in Central and East Java. The target is to have 33 plants in the next few years, worth 453 MW.⁴⁷ Key regions for these constructions are on the Java and Sumatra islands, near areas that generate over 1000 tons of waste per day.⁴⁸

Hydrogen is mainly used for urea production in the country, up to 88% of 1.75 million tons in 2023.⁴⁹ The government sees the potential for green hydrogen for fuel cell electric vehicles (FCEV), ammonia production, and energy for industries, such as iron and oil refinery.⁵⁰ PLN inaugurated the country's first green hydrogen power plant in 2023 with an annual production capacity of 51 tons.⁵¹

1.2.2 Institutional, Legal, and Policy Frameworks on Energy

Energy in Indonesia is primarily governed by the Ministry of Energy and Mineral Resources (ESDM) following the National Energy Policy (*Kebijakan Energi Nasional*, KEN),⁵² which is formulated by the National Energy Council (*Dewan Energi Nasional*, DEN) chaired by the President. Other ministries cooperate to realize this plan, including the Ministry of Industry, Ministry of Finance, Coordinating Ministry for Maritime Affairs and Investment, and Ministry of Environment and Forestry. The major commercial players are the previously mentioned PLN and state-owned oil and natural gas corporation, PT Pertamina.

The overarching direction of Indonesia's development currently follows the *Golden Indonesia 2045* vision: to be an independent, united, sovereign, just, and prosperous nation by 2045, the 100th anniversary of the country's independence (Table 9).⁵³

Table 9. Main targets of the National Long-Term Development Plan 2025–2045 (Golden Indonesia 2045)

No.	Target	Description
1	Income per capita equivalent to developed countries	Become the fifth largest economy with a GDP of USD 7.3 trillion via industrialization and human capital investment. ⁵⁴
2	Declining poverty and reduced inequality	Poverty rate drops to 0.5–0.8%, Gini coefficient reaches 0.29–0.32, Eastern Indonesia's Gross Regional Domestic Product reaches 28.5%.
3	Increase in leadership and influence in international platforms	Global Power Index to reach top 15 in the world.

continued...

No.	Target	Description
4	Increased competitiveness of human resources	Human Capital Index to increase to 0.73.
5	Decrease of GHG Emission Intensity towards Net Zero Emissions	Reduction of GHG emissions by 93.5%, Environmental Quality Index increased to 83.

Source: BAPPENAS.⁵⁵

To achieve Indonesia's stated climate goal of reaching net-zero emissions by 2060,⁵⁶ the country is prioritizing making renewables the primary source in its energy mix, in line with the ESDM's National Electricity Plan (*Rencana Umum Ketenagalistrikan Nasional*, RUKN).⁵⁷ The main goal is to install 41.6 GW of renewable energy capacity by 2034 and 75 GW by 2045 (Figure 8).⁵⁸

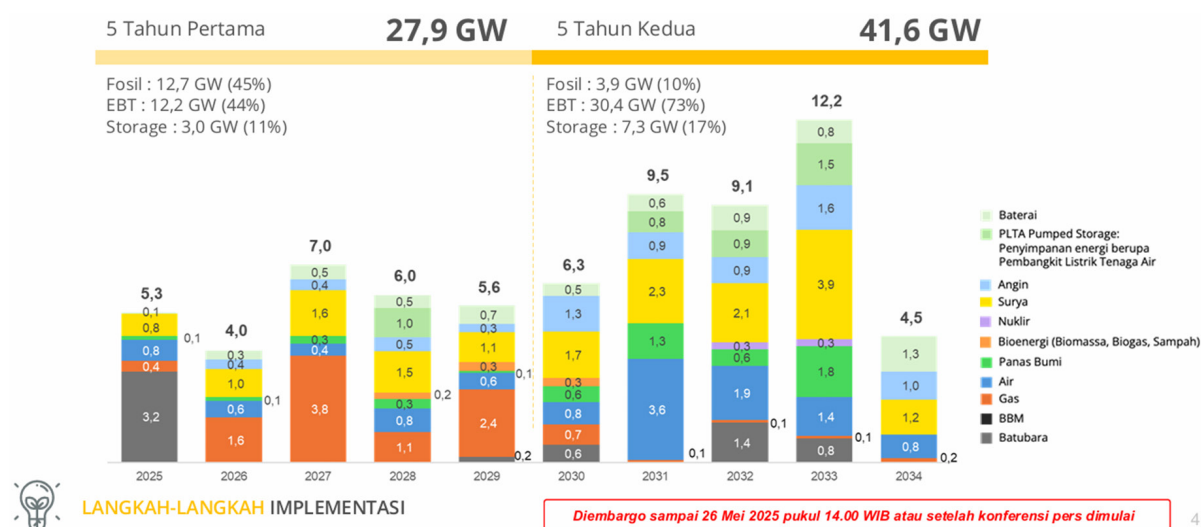


Figure 8. Power plant addition plan, RUPTL 2025–2034, Indonesia

Source: PLN (2025).⁵⁹

Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) is PLN's business plan to realize the goals of the RUKN. As noted before, solar energy has the most planned capacity of over 17 GW (Table 10). In addition, the plan includes installations of nuclear facilities (0.5 GW), battery storage (10.3 GW), and coal (16.6 GW).

Table 10. Planned capacity of renewable sources, Indonesia, in MW

Plant Type	Potential Capacity (RUPTL)	Installed Capacity (RUPTL)	Planned Capacity until 2034	Potential RE Utilization Rate (Installed + Planned)
Solar	207,898	78.5	17,100	8.26%
Hydropower ⁺	94,476	5,024.0	11,700	17.70%
Wind	60,647	3.1	7,200	11.88%
Bioenergy*	32,654	1,671.0	900	7.87%
Geothermal	29,544	1,438.5	5,200	22.47%

⁺ Includes mini and micro hydropower | * Biomass + Bioenergy

Source: ESDM, RUKN (2025).⁶⁰

The central government has declared the phase out of coal by prohibiting new power plants, including captive generation by industrial facilities for their own independent consumption.⁶¹ Incentives for renewable energy projects and developers are also provided, such as tax relief, licensing support, and other financing assistance of grants and low-interest loans, including the Just Energy Transition Partnership (JETP).⁶² However, even with this commitment, agreed-upon coal power projects can still continue even if construction has not started yet. The RUKN refers to coal-fired power plants expected to begin operation between 2025 and 2032, with around 26.7 GW of total capacity.

In March 2025, the ESDM revised the guidelines to ignite power purchase agreement (PPA) investments by allowing construction of IPPs under a build, own, operate (BOO) scheme, shifting away from the build, own, operate, and transfer (BOOT) scheme, which provided for infrastructure to be transferred to a public entity after a certain period. Furthermore, the possibility of extending the PPAs is now less rigid, beyond reasons of force majeure.⁶³ Carbon credits can also now be included in the PPAs so buyers can purchase them with the electricity to offset their footprint.

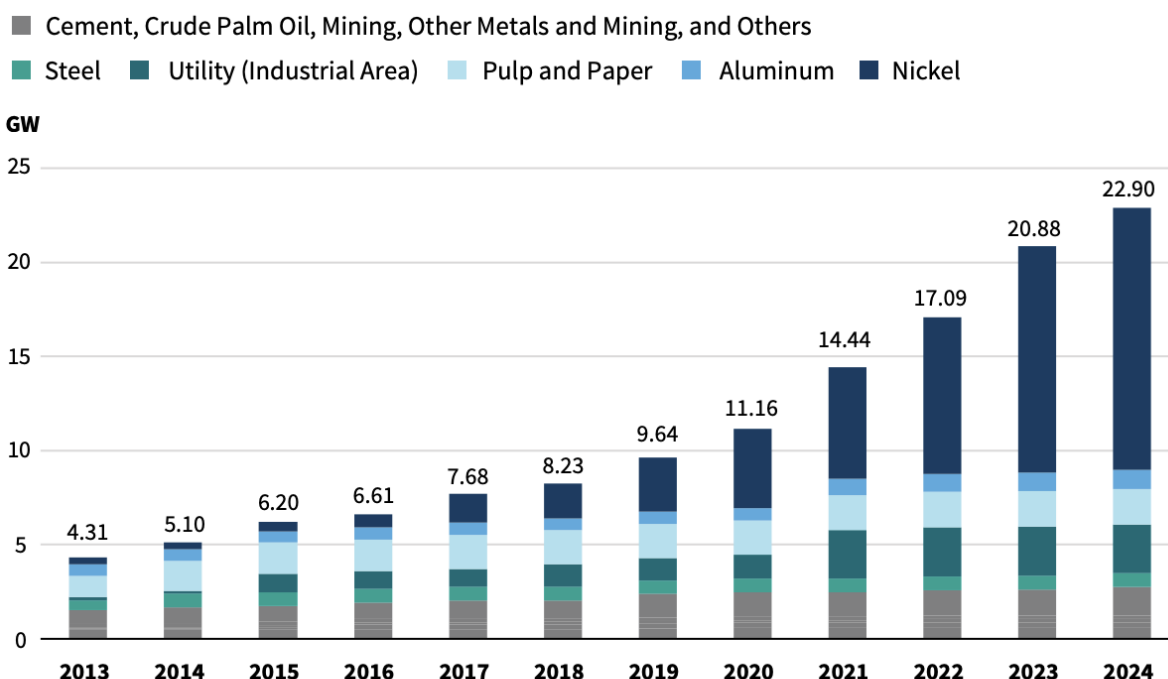
The country imposes a local content requirement for investments and imported commodities, which is regulated by each specific sector.⁶⁴ In August 2024, the ESDM and the Ministry of Industry eliminated local content requirements for the development of electricity infrastructure.⁶⁵

1.2.3 Challenges

Indonesia's implementation of its renewable energy deployment goals has faced numerous challenges over the last few years. The country's 2025 National Energy Plan (RUKN) is less ambitious than the previous iteration, with a share of fossil-fired power that is 10% higher,⁶⁶ and the renewables target reduced from 20.9 GW to 17 GW by 2030.⁶⁷

The key hurdles faced by the country are fossil dependency and the unequal energy distribution across the regions. The RUKN projects that coal generation will peak at 494 TWh in 2037, much higher and later than the 435 TWh by 2030 estimated in the Low-Carbon Compatible with Paris Agreement (LCCP) scenario.⁶⁸ The RUKN also elaborates on the plan to increase total coal capacity to 26.8 GW by 2032, of which 20 GW is attributed to captive coal. With increased demand from the growing mining and mineral processing industry, captive coal usage has increased nearly fivefold within a decade, from 2.3 GW in 2014 to 11.2 GW in 2023 (Figure 9).⁶⁹ These plants can only operate until 2050 and must reduce emissions by at least 35% within 10 years of operation.⁷⁰

Captive coal bears significant costs and long-term exposure to financing burden and price volatility due to inefficient capacity allocation, and exemption from regulated coal and energy sectors and grid benefits; captive coal faces higher long-term costs.⁷¹ In addition, captive coal plants are not eligible for the capped coal price, requiring producers to purchase coal at market prices, which could further increase generation costs.



Note: The grey area in the graph is shaded to indicate its classification as a distinct category. “Other Metals and Mining” includes gold, copper, etc. “Others” includes sugar, chemicals, fertilizer, petroleum and refining, textiles, utilities, and agriculture industries.

RMI Graphic. Sources: Publicly available information from Global Energy Monitor (2025), RUKN (2025), and stakeholder focus group discussions

Figure 9. Captive power plant capacity by industrial sector, Indonesia, 2013–2024

Source: RMI (2025).⁷²

Many countries rely on Indonesia’s coal production, as the country is the highest global exporter in 2023 with over 30%⁷³ and the industry accounts for nearly 4% of the country’s GDP.^{74,75} This economic dependency ensures revenue exposure and is used for political leverage in favor of the coal industry. The government prioritizes national coal security, and domestic market obligations (DMOs) of 25% total coal production are heavily enforced for Indonesian coal mining companies.⁷⁶ In 2022, Indonesia faced a low supply of coal inventory. In response, the government imposed a coal export ban for one month, leading to a global price surge. This phenomenon illustrates the country’s reliance on coal to avoid power outages.

The government provides many financial incentives to the coal industry. The DMOs from coal producers are sold to PLN below market price, helping lower electricity costs for lower-income households. This price cap on the DMO locks in coal reliance.⁷⁷

1.3 Grid Interconnection

Nearly 10% of the country is not connected to main grids due to remoteness.⁷⁸ In these locations, consumption does not justify the capital and operation and maintenance fees of grid connection, and instead depends on diesel generators or mobile gensets.⁷⁹ However, this creates reliance on fuel supply, which can limit electricity availability. Transportation over a long travel distance also increases the total generation costs, for both fuel and regular maintenance with parts replacement.⁸⁰ Also, to minimize the environmental impact posed by these technologies, renewable energy microgrids have been considered.

The U.S. Department of Energy developed an initiative in 2016 with PLN and ESDM, called the Sustainable Energy for Remote Indonesian Grids (SERIG) project.⁸¹ With a budget of USD 1.2 million, three pilot studies were conducted: in Lamandau District of Central Kalimantan with a biogas technology, and Sabu and Sumba Islands of East Nusa Tenggara, with a solar photovoltaic (PV) and wind source, respectively. This project was in tandem with ESDM's Bright Indonesia program to improve conditions of over 12,600 villages that lack on-demand access (worth USD 7.5B). After the feasibility study, the project provided recommendations for development, including a set of strategies to replicate the technologies on a larger scale. Nonetheless, the limitations for each solution are as follows: the Lamandau biogas needs effluent from palm oil (POME), so replication could only be done within palm oil mills; while both solar PV and wind technologies need a robust storage system.

Similarly, the Green Prosperity Project by the Millennium Challenge Corporation (MCC), in partnership with the Government of Indonesia, invested USD 56.4 million in a portfolio of 23 community-based off-grid (CBOG) RE grants back in 2018.⁸² The Ministry of National Development Planning (*Badan Perencanaan Pembangunan Nasional*, BAPPENAS) conducted the process of site and grantee selection, who are then supposed to coordinate with PLN as the national grid operator to ensure the plans are not contradicting. A combination of hydropower, solar, and biogas technologies made up the portfolio, and PLN set the tariffs. Unfortunately, 19 were not operating anymore or having substantial issues after only four years. The results were attributed to incoherent project design and accompanying business models, and suggested that commercial demand be thoroughly assessed as its productivity acts as the anchor to these electricity sources.⁸³

1.4 Shared Use of Power Infrastructure

Due to their high energy needs, mines and mineral processing facilities generally develop captive power generation. This ensures a reliable and stable supply of production, especially in countries that have underdeveloped power infrastructure. While the biggest portion of PLN sales is to residential users (Table 6 above), the biggest share of energy use is in industry (Table 1 above), suggesting that industry players in Indonesia also follow this scheme. This captive power generation is mainly powered by coal.⁸⁴ Aside from PLN, the DMOs for coal also supply IPPs and other buyers, including smelters.

Captive power requires high capital for both generation and distribution. From a policy standpoint, the independence for the mining and processing companies means less leverage from governing bodies. Effects on external communities are less controlled, and it is more difficult for sustainable development at large.

In Indonesia's case, a shared-use arrangement—connecting mining and processing facilities' captive power to other energy users⁸⁵—could provide mutual benefits. Energy demand from mineral value chains can push the generation infrastructure to be further developed. This continuous improvement can, for example, ignite rural electrification and transmission infrastructure development, and help mitigate frequent issues of blackouts in Indonesia.

Industry players would not need the high capital and operational costs. In tandem, various schemes can be provided by the national power provider (PLN), such as priority access to power, emergency generation capacity, or a premium rate to pay.⁸⁶ Industry players themselves can sell the extra power capacity as another revenue stream.

2. Critical Mineral Value Chains

2.1 Critical Minerals Overview

Gold, bauxite (aluminum), copper, and coal have played major roles in Indonesia's mining sector and export economy, but nickel has risen to the top of mineral production with a 16-fold increase in domestic production since 2015.⁸⁷ In 2024, Indonesia was the largest exporter of nickel intermediates, vastly outpacing the Philippines.⁸⁸ While early nickel production largely went to raw ore exports, Indonesia has increasingly been undertaking downstreaming measures through export restrictions on raw nickel ores since 2014, making it the largest producer of nickel intermediates across all sectors in 2024 (Figure 10).⁸⁹

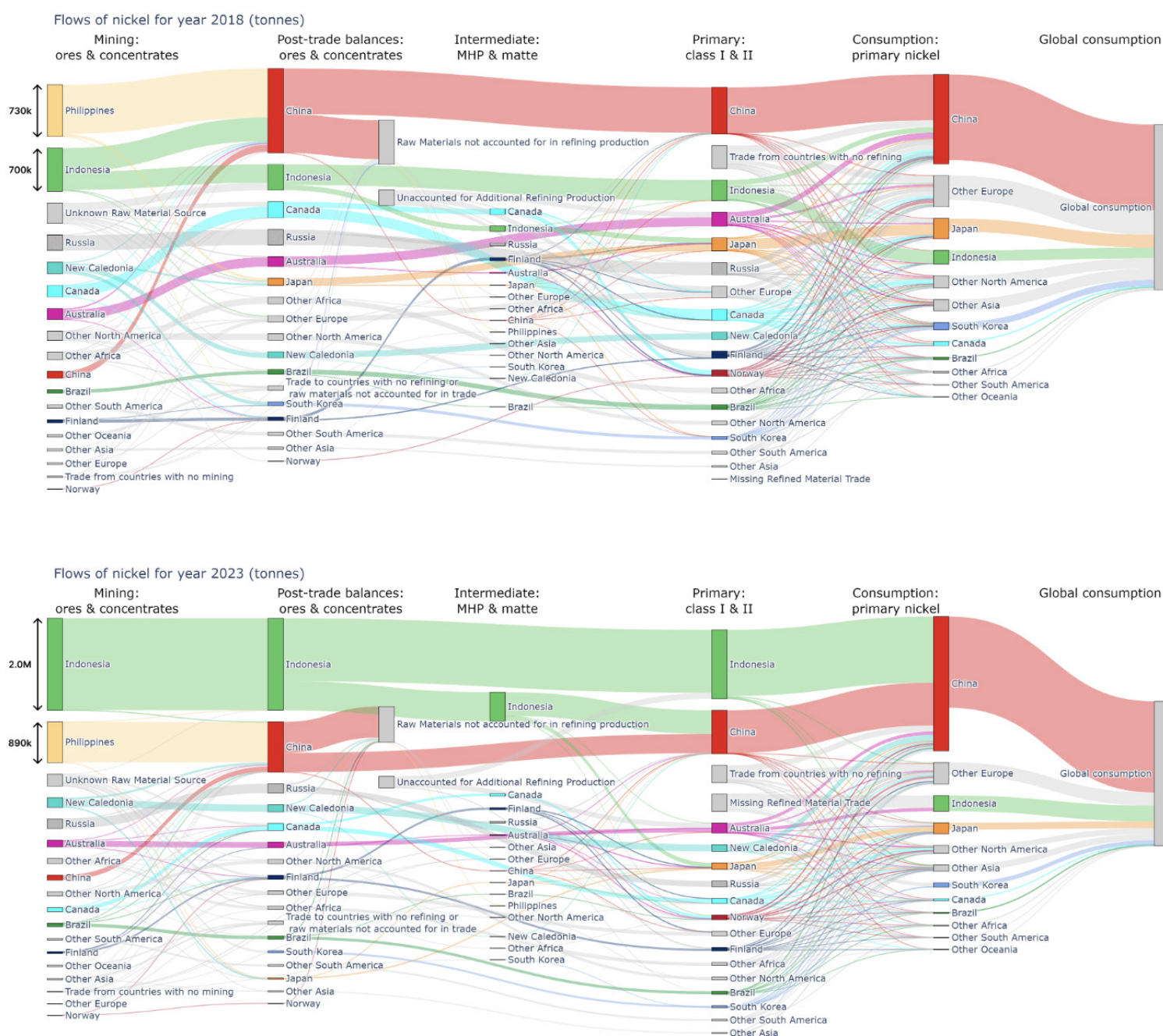


Figure 10. Flows of nickel for 2018 and 2023, in metric tons

Source: Zieleniewski (2024).⁹⁰

In 2024, Indonesia produced nickel intermediates in the form of nickel pig iron (NPI) (9.96 million tons), ferronickel (9.66 million tons), mixed hydroxide precipitate (MHP) (1.56 million tons), and nickel matte (304,800 tons) (Figure 11; see also Table 11).⁹¹ While the majority of final-stage refinement for final Class I nickel product occurs outside of Indonesia, most notably in China, Indonesia still produced 5.89 million metric tons of stainless steel and 163,100 tons of nickel hexasulphate (Ni-HSP) in 2024; nickel hexasulphate is a battery feedstock.

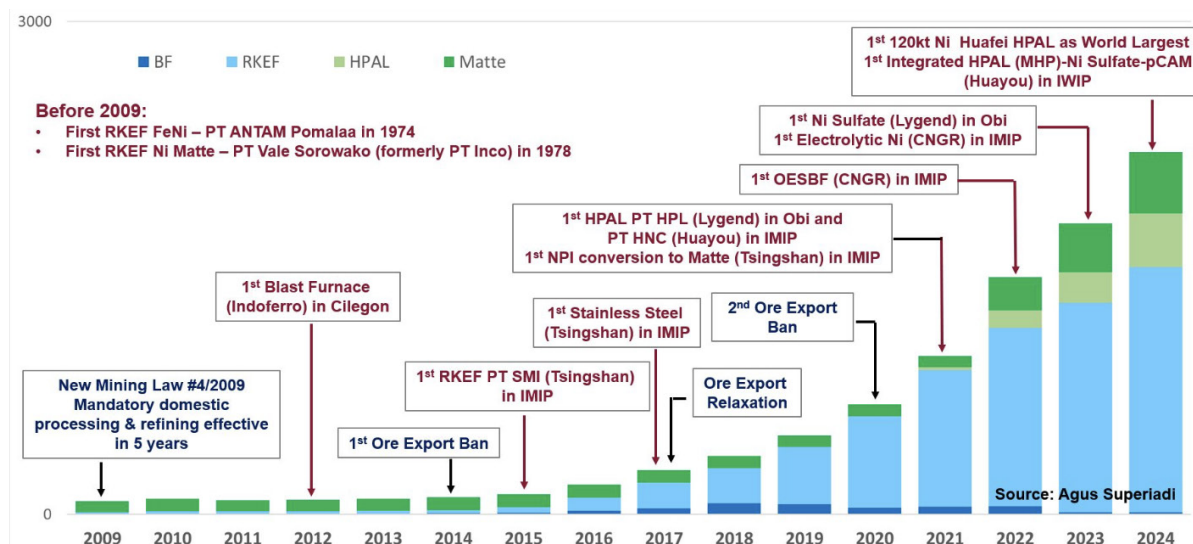


Figure 11. Nickel production growth and milestones, Indonesia, 2009–2024, in kt Ni

Source: Agus Superiadi (2025).⁹²

Table 11. Production of nickel intermediates, Indonesia, 2019–2023

Commodity (metric tons)	2019	2020	2021	2022	2023
Mine, laterite ore	853,000	767,000	1,069,000	1,579,000	2,030,000
Mixed Hydroxide Precipitate (MHP)	--	--	--	90,000	180,000
Smelter, matte	71,025	72,237	100,000	210,000	265,000
Ferronickel – gross weight	129,000	130,000	129,000	122,000	110,000
Ferronickel – Ni content	25,713	25,970	25,818	24,334	21,473
Nickel pig iron (NPI) – gross weight	3,200,000	4,300,000	6,100,000	8,100,000	9,900,000
Nickel pig iron (NPI) – Ni content	--	600,000	850,000	1,100,000	1,390,000

Notes: Blue – HPAL-processed products. Orange – RKEF-processed products.

Source: Prepared by authors based on Chung (2025).⁹³

While not the focus of this report, cobalt is a potential secondary metal relevant to nickel mining value chains. Due to the nature of geological deposits, cobalt is often found alongside copper and nickel, and is often harvested as a byproduct of copper and nickel processing. Today, Indonesia is the second-largest producer of cobalt, at 12% of global supply.⁹⁴ Indonesia first produced domestically refined cobalt in 2024.⁹⁵ Given the high co-deposits of cobalt alongside nickel, Indonesia stands to assume a larger role in the global market for cobalt in coming years.

2.2 Nickel Market Segments: Upstream, Midstream, and Downstream

2.2.1 Nickel Deposits

Nickel ores exist in two geological forms: sulfide nickel deposits and lateritic nickel deposits. Historic mining and production of nickel have taken place in North America and Europe due to the high prevalence of sulfidic nickel orebodies.⁹⁶ Unlike laterite ores, sulfidic ores can undergo beneficiation processes that increase the efficiency of recovering nickel intermediates before smelting. This process advantage, coupled with the potential for higher nickel percentage in sulfide ores, makes the economics of sulfidic nickel recovery advantageous.⁹⁷ However, depleting supplies of sulfide deposits, as well as the maturation of new processing methods for laterite ores in recent decades, have shifted market dynamics towards the recovery of nickel from lower quality lateritic deposits. This shift in production capacity and expanded access to different geological deposits has altered the global nickel landscape, with particular implications for Indonesia.

Indonesia holds 55 million tons of lateritic nickel ore reserves, making it the dominant player in the future of global nickel supply. Indonesia is by far the largest producer of nickel globally, and is set to reach 70% of total global nickel supply by 2040.⁹⁸ Indonesia does not maintain sulfidic ore-based operations.

Laterite nickel deposits subdivide further into two types: saprolites and limonites. As of 2024, Indonesia holds roughly 3.5 billion tons of saprolite and 1.5 billion tons of limonite reserves, processing 210 Mt of saprolite and 23 Mt of limonite ores each year.⁹⁹ Saprolitic ores contain between 1.5–2.5% nickel and are characterized by higher concentrations of magnesium and lower iron content. Limonites contain 0.9–1.6% nickel, while having higher iron content and lower magnesium concentrations present in the orebodies. These orebody sub-distinctions are important, as the relative concentration of iron and magnesium in the mined orebody informs the processing pathway and final product created; lower magnesium-containing limonites feed battery manufacturing while saprolites have fed Indonesia's intermediates used in stainless steel production.¹⁰⁰

2.2.2 Nickel Demand Trends and Macroeconomic Drivers

Prior to 2015, global steel demand had largely driven demand for Indonesian nickel production, but new drivers have emerged.¹⁰¹ China has been the primary offtaker for Indonesian nickel, first with raw ores, and then through further investment in downstreaming operations within Indonesia. Recent growth in nickel demand is largely attributed to battery production, with the rising manufacturing of electric vehicles (EVs). The global demand trend projects Indonesian chemical nickel intermediates (MHP, HSP) to grow 3.5-fold by 2040.¹⁰²

Long-term uncertainties in global nickel markets exist due to factors including shifts in global demand and the looming depletion of nickel deposits. Recent shifts in the cost of lithium-iron-phosphate chemistry batteries, as well as continued production increases in Indonesia, have led to nickel oversupply.¹⁰³ Nickel, which once traded at a price of \$28,500/metric ton in 2023, traded at less than \$15,000/metric ton in 2025, a sharp contrast from previous years (Figure 12).¹⁰⁴ In November of 2025, Government Regulation No. 28/2025 (PP 28/2025) came into effect, restricting permitting for new nickel smelters, largely in an effort to address oversupply concerns.¹⁰⁵



Figure 12. Nickel trading price, 2021–2025, in USD/ton

Source: Trading Economics (2026).¹⁰⁶

Nickel reserve depletion remains a rising uncertainty for nickel supply. Representatives of Indonesia’s ESDM have said that Indonesia’s saprolite reserves have roughly 13 years of production remaining, given today’s technology; limonites maintain roughly 33 years of reserve capacity.¹⁰⁷ Furthermore, Indonesia has announced a moratorium on Rotary Kiln Electric Furnaces (RKEF) mineral processes to slow the extraction of nickel deposits in light of looming reserve depletion.¹⁰⁸

2.2.3 Nickel Production Processes

With the laterite ore deposits in Indonesia, nickel mining and processing largely breaks down into two processes, each with different levels of energy intensity, emissions profiles, and other environmental risks. Rotary Kiln Electric Furnaces (RKEF) and High-Pressure Acid Leaching (HPAL) are the two primary processing methods in commercial production (Figure 13).

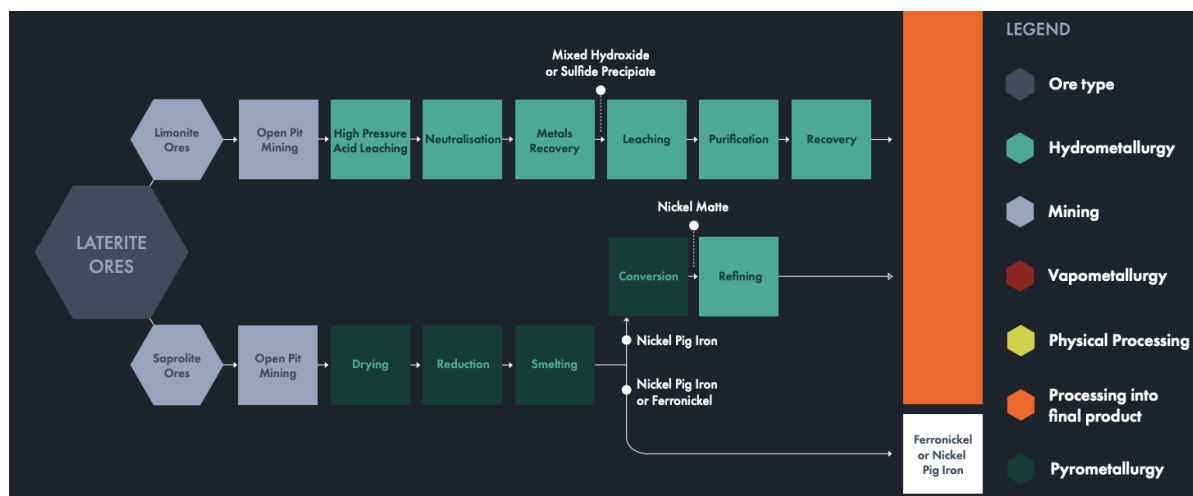


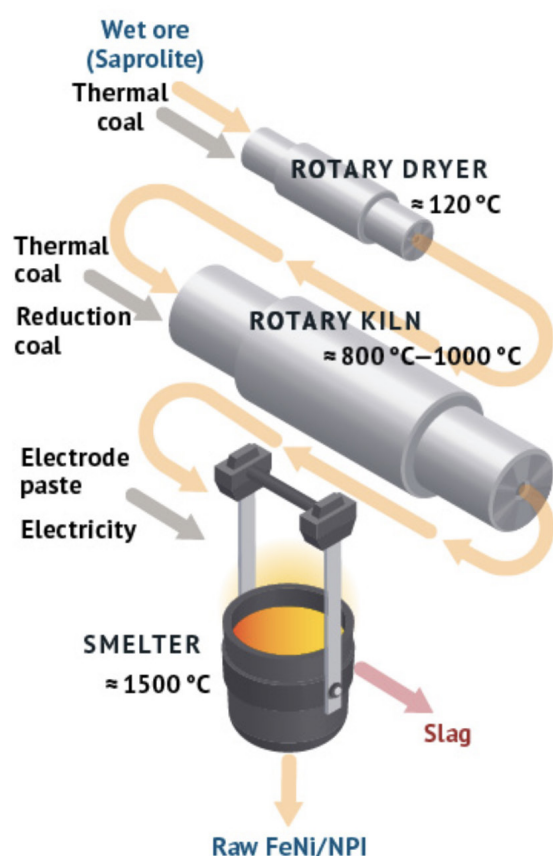
Figure 13. Complexity of major nickel production routes and processing technology options to produce battery-grade nickel sulfate hexahydrate

Source: Tijsseling and Whattoff (2023).¹⁰⁹

2.2.4 Rotary Kiln Electric Furnace Processing (RKEF) Nickel Processing

RKEF involves four main stages of processing (Figure 14):¹¹⁰

1. **Mined ore preparation:** ores are crushed and sifted to form a consistent wet mixture of mined deposits.
2. **Drying:** water is removed from the wet mixture.
3. **Reduction and calcination:** the dried mixture undergoes high heat treatment in a rotary kiln; high-carbon coal (coking coal) is introduced as part of the reduction process of converting nickel oxide and other oxides into a mixture of nickel, iron, and additional impurities.
4. **Smelting:** The reduced metals mixture enters an electric arc furnace; metals are melted, slag is separated, and silicates and impurities are removed to produce ferronickel (a blend of iron and nickel).



Rotary dryers are typically 3–5 m in diameter by 30–50 m long, while rotary kilns can be well over 100 m long.

Figure 14. Simplified RKEF process

Source: Trytten (2024).¹¹¹

The resulting ferronickel is a feedstock for stainless steel production, or can be further refined into Class I nickel for battery production. Indonesian ferronickel and NPI serve dual purposes: significant volumes are exported to China for stainless steel production there, while substantial amounts are also consumed domestically at integrated stainless steel facilities such as Indonesia's nickel industrial parks. Indonesia exported 2.39 million metric tons of finished stainless steel products in January–September 2025, including 760,000 metric tons to China.¹¹² Regarding intermediates, Indonesia also exported 9.694 million metric tons of ferronickel and NPI in the first ten months of 2025, with 9.299 million metric tons (95.9%) shipped to China for stainless steel production.¹¹³

An increasing amount of nickel production is moving towards Class I nickel production due to the rising demand from battery manufacturing. Even existing pyrometallurgical processes have seen a shift in production and further refinement from intermediates such as Nickel Pig Iron into nickel matte and pure nickel. Industrial processing advancements out of China have improved the commercial viability of converting laterite ores from pyrometallurgical processes into battery-grade nickel feedstock.

RKEF processes are both highly intensive in energy use and greenhouse gas emissions. As of 2024, 85% of Indonesia's nickel production has gone to stainless steel intermediaries through RKEF processes (Figure 15).¹¹⁴ In the production of battery-grade nickel hexasulfate through RKEF processing of saprolitic nickel ore, carbon intensity reaches around 98 kg of CO₂e per kg of nickel product. While significant emissions come from the use of coal for chemical reduction, roughly 40% of the emissions profile is attributed to energy production to power RKEF refining processes (Figure 16).¹¹⁵

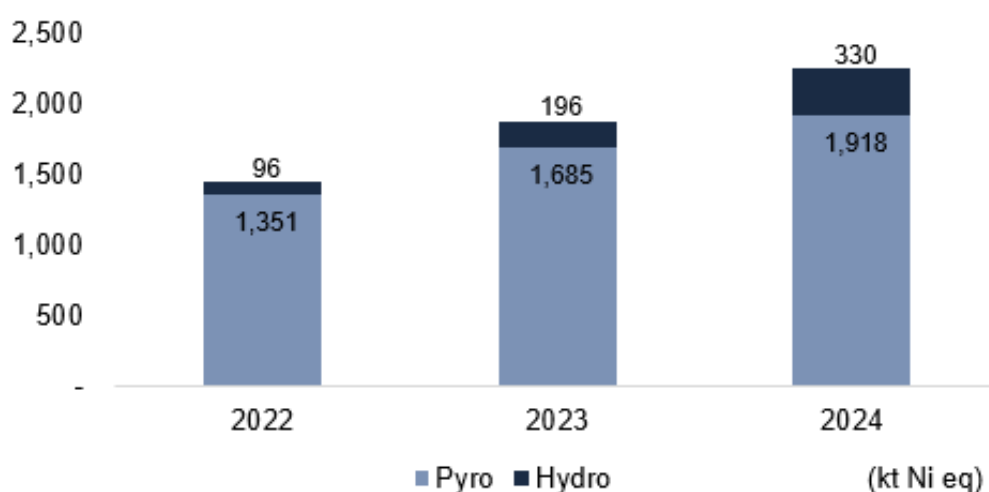


Figure 15: Nickel production by processing route, Indonesia, 2022–2024, in kt

Source: Lee et al. (2025).¹¹⁶

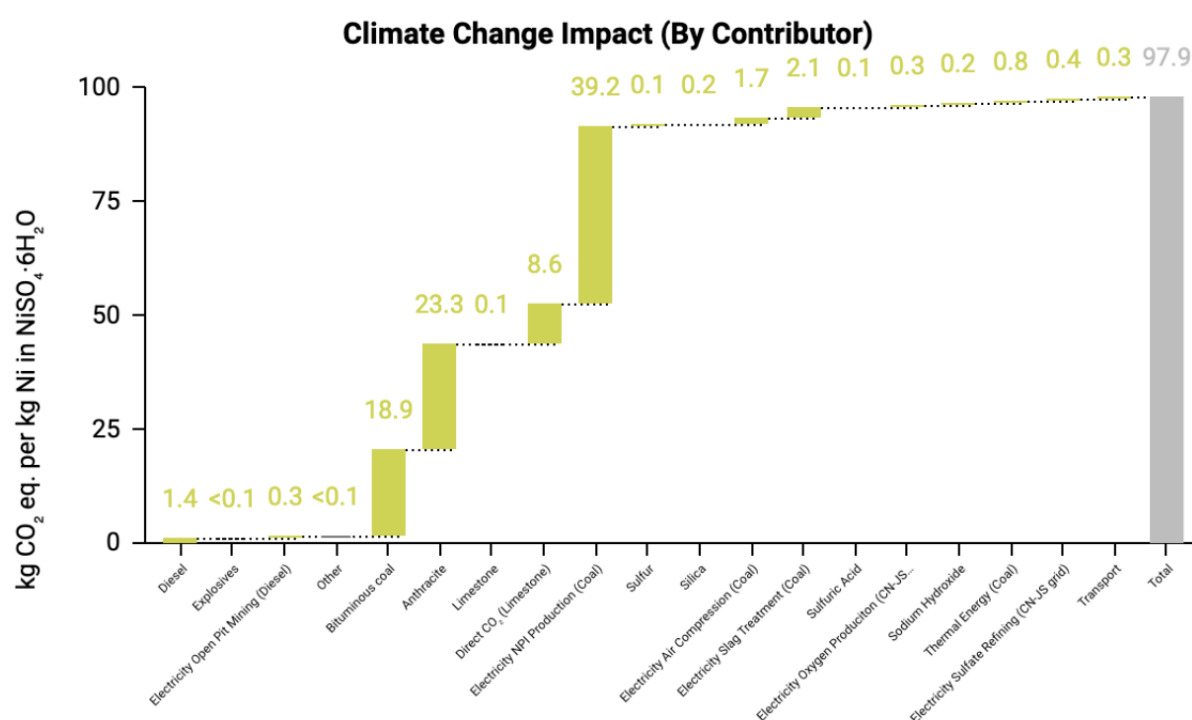


Figure 16: Breakdown of emissions from RKEF, Indonesia

Source: Tijsseling and Whattoff (2023).¹¹⁷

Given that the most energy- and emissions-intensive portion of the RKEF process is already an electrified process through the use of the electric arc furnace (EAF), it remains challenging to decarbonize RKEF processes.¹¹⁸ Additionally, the use of coal as a reducing agent in the nickel separation process also makes it unlikely that RKEF will become a fully decarbonized process.¹¹⁹ Considering the intractability of fully decarbonizing the RKEF process, it is worthwhile to explore new techniques and technologies to process high-magnesium lateritic nickel deposits.

2.2.5 High-Pressure Acid Leaching (HPAL) Nickel Processing

High-Pressure Acid Leaching (HPAL) is an alternative processing pathway for nickel intermediate production. A hydrometallurgical process, HPAL uses chemical processes to separate nickel from its oxide and raw ore state. HPAL produces mixed hydroxide precipitate (MHP), which is a combination of nickel and cobalt hydroxides. This intermediate can be stored or shipped as a slurry or dehydrated cake or powder, and then further refined directly into battery-grade nickel.

In commercial production, HPAL uses sulphuric acid to chemically separate nickel ions from their oxygen bonds to produce intermediate nickel precipitates (Figure 17). Nickel ore slurries are placed in an autoclave with sulphuric acid and undergo high pressure and temperatures of roughly 250° Celsius to produce a separated mixture. Limestone is added to neutralize the acid solution, and the subsequent tailings undergo several stages of counter-current decanting (CCD) to recover the desired minerals. Following several stages of the CCD process, nearly 97% of valuable materials can be recovered.¹²⁰

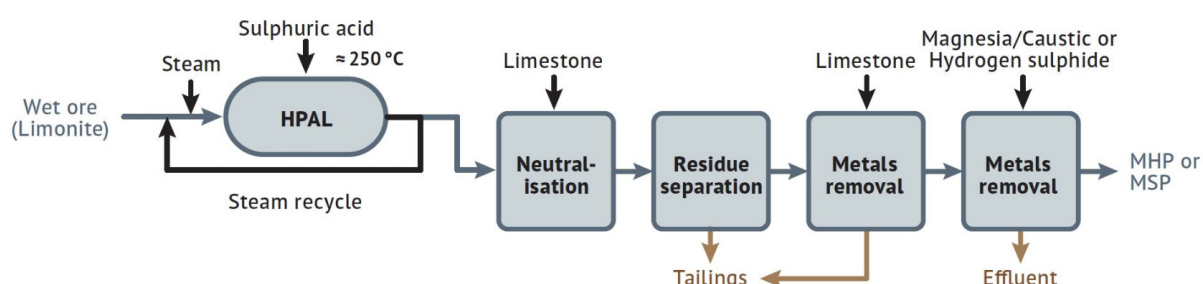


Figure 17. HPAL process

Source: Trytten (2025).¹²¹

2.2.6 Energy, Carbon Intensity, and Risks of HPAL

Per metric ton of nickel produced, the HPAL process requires approximately 39 times less energy (1.8 MWh) than RKEF (71 MWh). The autoclave operation in HPAL, which is the stage with the largest energy requirements, has significantly lower energy requirements than the energy-intensive EAF in the RKEF process. Furthermore, sulfuric acid is often produced on site for HPAL processing, which generates heat; this process heat is captured and used for autoclave heating. This combination of reduced energy consumption for lower thermal requirements and the availability of cogenerated heat lends to a significantly lower energy intensity for HPAL processes (Table 12).

Table 12. Energy consumption of circuits processing limonite, by process and fuel type, in MWh per metric ton of Ni processed

Circuit	HPAL	Caron	Goro	RKEF
Electricity	1.8	0.2	1.9	37
Natural gas	-	86	0.5	34

Source: Dry and Harris (2012).¹²²

HPAL generates 20 metric tons of CO₂e, compared to 54 metric tons of CO₂e produced through the RKEF process (Table 13).¹²³ Electricity generation and heat production, which in Indonesia largely rely on captive coal-fired power, account for a significant share of these emissions. Even so, the overall emissions intensity of HPAL is lower than that of RKEF (Figure 18).

Table 13. Nickel processing routes and relevant decarbonization pathways

Processing Route	Ore	Nickel Product	GHG Emissions per tonne of Ni in products	End Use	Market Trends	Decarbonization Pathway example includes
Pyrometallurgical RKEF	Saprolite High-grade and scarcity anticipated	Class 2 15-45% Ni	54 tonnes of CO ₂ equivalent	Stainless steel	Stable growth, demand and supplied balanced	Solar PV, batteries pumped hydroelectric storage, Biochar
Hydrometallurgical HPAL	Limonite underutilized	Class 1 > 99.8% Ni	20 tonnes of CO ₂ equivalent	Batteries	Demand will increase and shortage supply expected	Efficiency improvement, biomass, solar PV, batteries, geothermal, mitigating process emissions

Source: Hazarabedian, O'Neill, and Witto (2023).¹²⁴

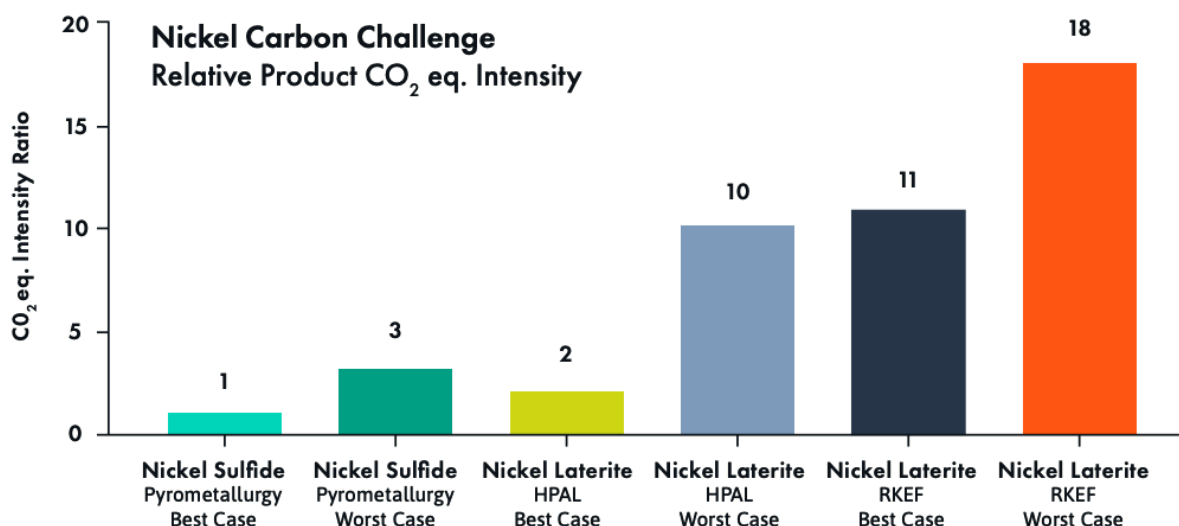


Figure 18. Climate change impact results for best- and worst-case nickel sulfate hexahydrate production routes, by technology

Note: Results are presented as ratio of lowest climate change impact route.

Source: Tijsseling et al. (2023).¹²⁵

Despite its lower emissions intensity, HPAL poses other environmental risks. Due to the significant acid neutralization and washing requirements of HPAL, the process results in high water consumption, with potential environmental exposure from mine tailings disposal. In 2021, Indonesia prohibited the practice of deep-sea mine tailings disposal; mining and processing waste was previously disposed of at the bottom of the ocean.¹²⁶ In terms of water consumption, sulfuric acid-based HPAL processing consumes roughly 91 kg of water per kg of nickel produced.¹²⁷

2.2.7 RKEF vs. HPAL: Where Will Decarbonization Be More Relevant and Accessible?

Regardless of input efficiency, the nature of the underlying ore deposit determines the suitability of HPAL or RKEF as the nickel processing route (Figure 19). As it stands, RKEF processing is better suited for the processing of saprolite ores, while HPAL lends well to the characteristics of limonite orebodies. This distinction is largely due to the high magnesium content found in saprolitic laterite nickel ore deposits; excess magnesium consumes sulfuric acid to such an extent that it makes HPAL processing economically prohibitive.¹²⁸ Additionally, the complexity and specific manufacturing requirements of HPAL autoclaves present higher up-front costs, bespoke materials, and specialized skills, which may require additional support during the construction phase. This higher construction cost may make HPAL production investments more sensitive to the price of nickel in the global marketplace.¹²⁹

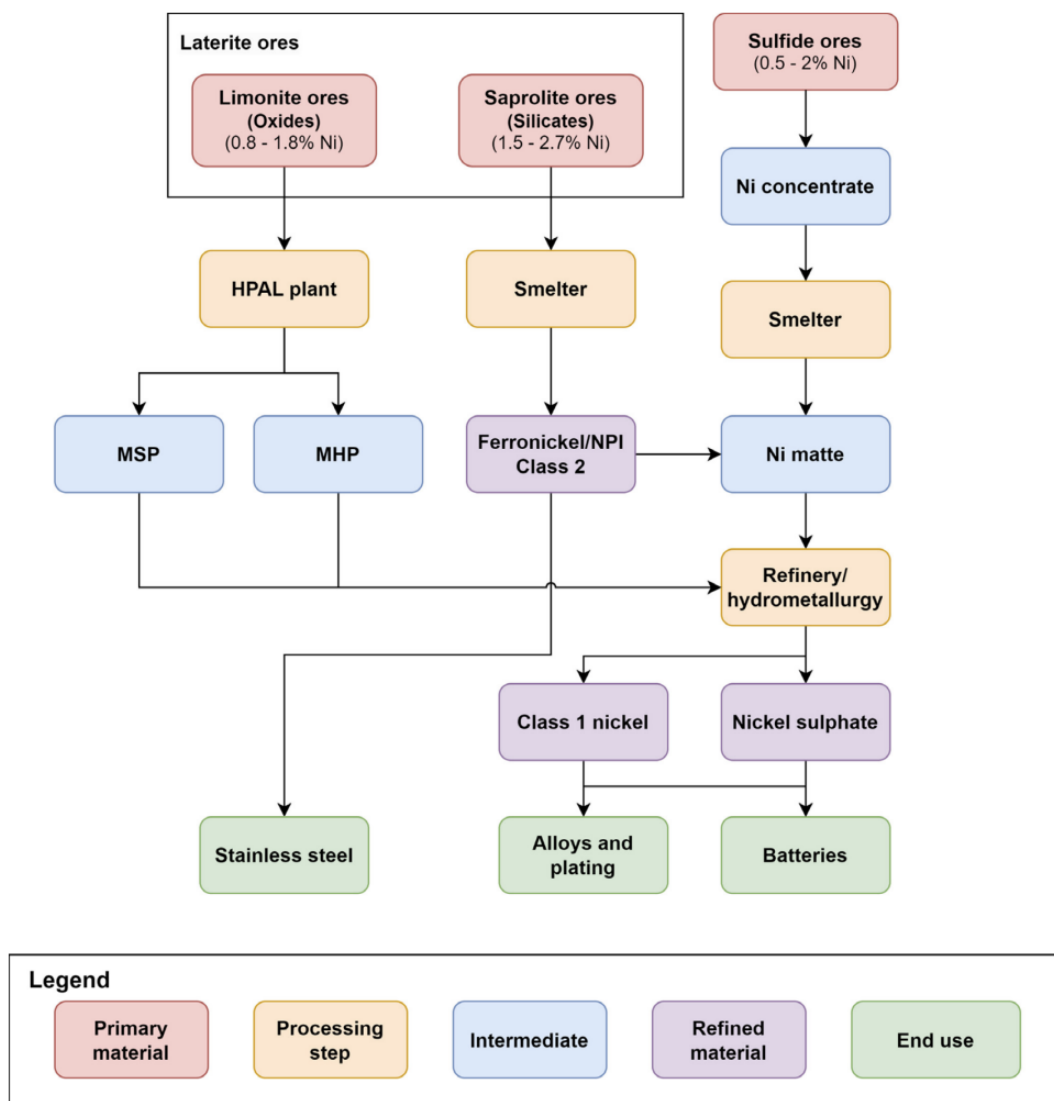


Figure 19. Nickel supply chain

Source: IEA (2024).¹³⁰

2.2.8 Emissions Sources of Nickel Production in Indonesia

Nickel production in Indonesia is highly emissions-intensive because it relies on energy-intensive industrial processing powered by captive coal, which has expanded to support the nickel industry. RKEF smelters account for approximately 14 GW, 61% of captive capacity.¹³¹ In 2023, RKEF was the dominant production pathway, accounting for almost 90% of nickel output and driving an estimated 150 Mt CO₂e of emissions.¹³²

2.3 Industrial Parks Involving Nickel Processing

Industrial parks in Indonesia are an essential part of the country's manufacturing capabilities. Starting from the 1970s, they were used to secure foreign direct investment and promote domestic manufacturing and processing of key commodities.¹³³ Ever since the late 1990s, the Indonesian government has helped with provisions of infrastructure and supporting facilities, but the area itself is developed and operated by a licensed industrial estate company.¹³⁴

Large-scale production of nickel largely takes place in industrial parks that cater to nickel mining and metal processing. Located close to nickel reserves, industrial parks serve as primary centers of processing and manufacturing for nickel-based products. As of 2024, there are 140 licensed industrial parks in Indonesia, with 16 parks specifically dedicated to nickel and metal mining and processing.¹³⁵ All of the nickel-producing parks are located on Sulawesi or the Maluku islands.¹³⁶ Nickel production within Indonesia is further concentrated; three industrial parks—Morowali Industrial Park (IMIP) (Box 1), Weda Bay Industrial Park (IWIP) (Box 2), and Obi Island Industrial Park—produce 83% of the total tonnage of nickel metal equivalent processed from raw ores (Figure 20).¹³⁷

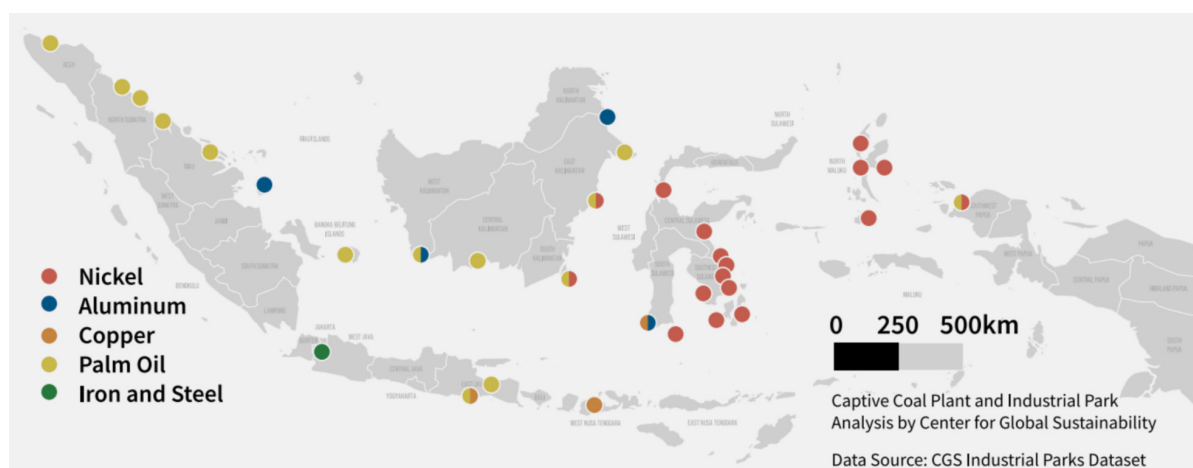


Figure 20. Industrial parks with key commodity production, Indonesia, 2024

Source: Schreier et al. (2024).¹³⁸

Industrial parks represent a key pillar in Indonesia's nickel downstreaming strategy. Often designated as Special Economic Zones (*Kawasan Ekonomi Khusus*, KEK) and Projects of National Interest (*Proyek Strategis Nasional*, PSN), industrial parks access policy concessions that allow for greater capital flows and project development. KEKs confer several exemptions, ranging from income, corporate, and luxury tax exemptions; customs duty reductions; and fewer restrictions on immigration and expatriate labor.¹³⁹ PSNs similarly provide benefits to businesses, including expedited permit processing, dedicated organizational support from the state government, and fiscal incentives.¹⁴⁰ Such policy concessions have not only fueled the rise of nickel production in Indonesia, but also accelerated drivers of emissions and other environmental concerns (Figure 21).

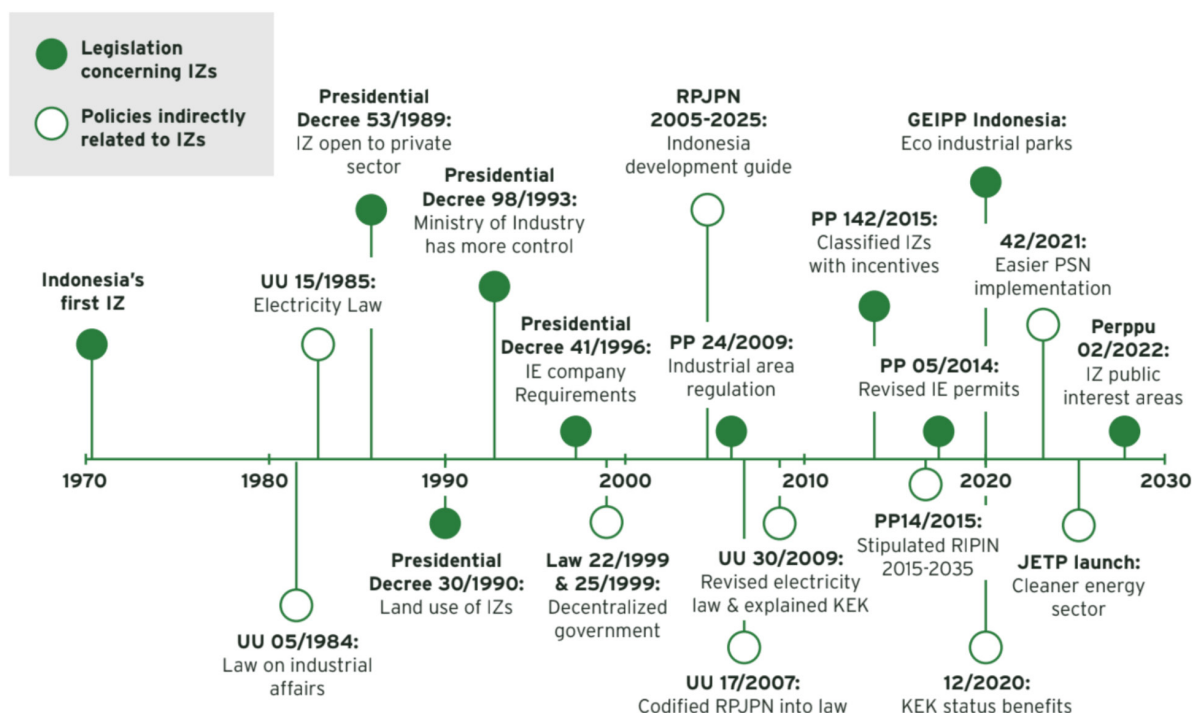


Figure 21. Timeline of the evolution of industrial park-related policies, Indonesia

Source: Schreier et al. (2024).¹⁴¹

While many industrial parks are connected to the grid, nickel mining industrial parks are overwhelmingly powered by captive coal-fired power plants (Figure 22). As of 2024, only two operational nickel industrial parks are grid-connected, with neither of them being major producing parks. The power capacity of grid-connected industrial parks stood at roughly 405 MW, a small fraction (approx. 3.7%) of the 10.9 GW of energy capacity present across all nickel-related parks.¹⁴² Renewable energy on industrial parks remains limited as well; three industrial parks report use of solar generation.¹⁴³ As of 2025, no smelters use solar generation, and hydropower only accounts for 365 MW out of the 16.7 GW (approx. 2.2%) of power capacity allotted to nickel smelters across all industrial parks.¹⁴⁴ As PSNs, nickel industrial parks are also most notably exempt from the Presidential Regulation No. 112 of 2022 on renewable energy development that otherwise prohibits the development of new captive coal generation.¹⁴⁵

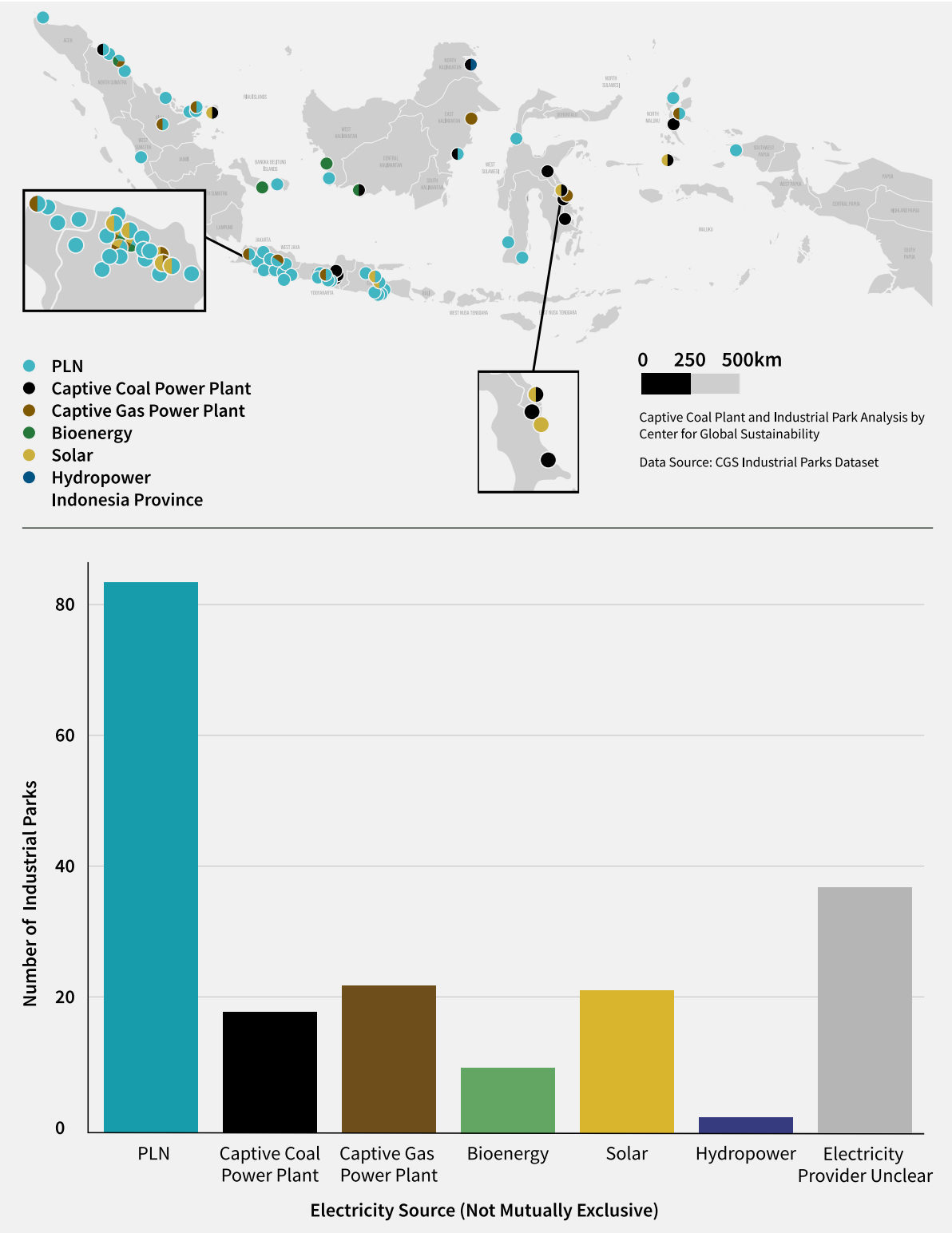


Figure 22. Electricity source of industrial parks

Source: Schreier (2024).¹⁴⁶

Box 1. Morowali Industrial Park (IMIP)

Incorporated in 2014, with its first smelter coming online in May 2015, Morowali Industrial Park (IMIP) is Indonesia's oldest nickel processing industrial park. As one of the first flagship investment projects under China's Belt and Road Initiative, IMIP took the first steps for China's entry into Indonesia's domestic nickel production sector.¹⁴⁷ IMIP supports 53 tenants across 4000+ hectares of industrial zoning, supplying key nickel downstream industries such as stainless steel, nickel intermediate exports, and battery-grade nickel material.¹⁴⁸ IMIP is home to 20 smelters and produces 347,000 metric tons of Ni-metal equivalent across all intermediates and final products, making it the second largest industrial nickel operation in Indonesia following Obi Island.¹⁴⁹

In terms of power generation, Morowali follows similarly to most nickel industrial parks. Morowali relies on captive coal power generation, with 3420 MW of coal generation powering its smelters as of 2025. However, a small solar operation is taking shape in Morowali, with 200 MW of solar generation in project development, and one tenant declaring intent to install roughly 65 MW of rooftop solar in 2024.¹⁵⁰

Box 2. Weda Bay Industrial Park (IWIP)

Established in August 2018 with its first smelters coming online in 2020, the Indonesia Weda Bay Industrial Park (IWIP) is a massive integrated mega-project located in North Maluku. Developed as a joint venture between Chinese firms Tsingshan Group, Huayou Cobalt, and Zhenshi Group, the 5,000-hectare park supports 42 tenants supplying electric vehicle (EV) battery materials like mixed hydroxide precipitate (MHP) and nickel sulphate. IWIP houses 6 major smelters and boasts an estimated production of around 400,000 metric tons of nickel equivalent annually.¹⁵¹

Weda Bay's power generation follows most Indonesian nickel industrial parks by relying heavily on captive coal. The park currently utilizes 3,400 MW of operational coal-fired capacity to power its smelters.¹⁵² However, renewable energy infrastructure is taking shape to decarbonize operations, with IWIP announcing a USD 2 billion investment for a 2 GW solar plant and 500 MW wind facility to supplement a pre-existing 5 MW wind pilot.¹⁵³

2.4 Regional and External Developments Relevant to Critical Mineral Value Chains

2.4.1 The Association of Southeast Asian Nations (ASEAN)

The Association of Southeast Asian Nations (ASEAN) has adopted a cooperation action plan specifically for minerals, with the most recent iteration for 2026 until 2030.¹⁵⁴ This plan emphasizes critical minerals and four pillars to guide action plans:

- increase attractiveness for trade and investment (both intra-ASEAN and international trade);
- sustainable minerals development by reducing the environmental footprint of mining and ensuring local communities benefit from mineral wealth;
- capacity building via strengthened human resources and institutional knowledge by training on geological survey techniques, resource assessment, and modern mining governance; and
- development of the ASEAN Minerals Information System (AMIS) for a minerals information and database that provides high-quality, transparent data and WebGIS tools to help investors make informed decisions.

The nickel industry associations of the Philippines (PNIA) and Indonesia (APNI) have established the IndoPhil nickel corridor in response to the ASEAN direction.¹⁵⁵ Previously, many Indonesian smelters have imported ores from the Philippines due to slower mining capacity, presumably as a result of the government's intention for price control.¹⁵⁶ Players of the two countries will work together in building a reliable nickel value chain that has clearer standards and accountability via policy coordination and advanced sustainable mining practices, in hopes to promote investment confidence.

2.4.2 The European Union (EU) and Other Markets

Regional pressures from the European Union (EU) and other markets call for more stringent carbon footprint reporting and traceability of minerals, affecting the long-term viability of Indonesian mineral products. The Inflation Reduction Act (IRA) in the United States heavily incentivized domestic content for eligibility of incentives, prioritizing sourcing from countries with free trade agreements, as well as excluding suppliers with over 25% of production in countries deemed as Foreign Entities of Concern (FEOC).¹⁵⁷ The U.S. regulation hampered Indonesia's ability to sell into the United States market given the absence of a free trade agreement and heavy exposure to China as an investor and offtaker. In 2025, Indonesia and the United States Trump Administration signed a bilateral trade agreement, eliminating 99% of Indonesia's tariff barriers while maintaining the United States's 19% tariff on Indonesian goods.¹⁵⁸ Such bilateral agreements carry geopolitical implications and remain a risk to Indonesia's resilient participation in global markets.

European regulations also carry long-term trade implications. The European Union Carbon Border Adjustment Mechanism (CBAM) explicitly addresses hard-to-abate sectors such as steel, leaving Indonesian steel susceptible to future exclusion—Indonesian steel produces 1.8 metric tons of CO₂e in emissions compared to 0.7 metric tons of CO₂e per metric ton of steel, as done by benchmark European producers.¹⁵⁹ CBAM impacts on Indonesia pose greater risk, as the vast majority of Indonesian nickel goes toward steel production.¹⁶⁰ In 2023, the EU passed its Battery Passport regulation, known as Regulation (EU) 2023/1542, with transparency and traceability measures becoming more stringent in 2026 and beyond.¹⁶¹ Companies beyond Indonesia, such as CATL, are developing supply chains and manufacturing capacity globally to comply with regional regulations and rules of origin mandates; as early as 2022, CATL built ten gigafactories planned worldwide, including facilities in China and Germany, to serve major European carmakers.¹⁶² Should Indonesia fail to make the necessary investments into its battery EV supply chain to incorporate a more future-forward strategy, the country may lose access to critical markets regardless of the maturity of its materials processing capacity.

3. Legal, Policy, and Regulatory Overview

Boxes 3 and 4 provide a brief overview of Indonesia's policy framework relevant to critical minerals value chains. Box 3 discusses Indonesia's overall policy environment, while Box 4 presents a more detailed assessment of policies across the key policy dimensions examined in this report. Together, they highlight how Indonesia has combined industrial, energy, investment, and innovation policies to support downstream mineral development. Additional national policies relevant to critical minerals, energy, and industrial development can be found in the International Energy Agency's Indonesia policy database.¹⁶³

Box 3. Indonesia's Overall Policy Environment for Critical Minerals Value Chains

Overall Policy Environment: Progressive amendments in Indonesia's mining laws aim to stimulate downstream industrialization and enhance sustainable resource management practices. Following Indonesia's bans on unprocessed mineral exports and regulations for domestic mineral processing and refining, the country identified critical minerals based on exposure to supply chain disruption and limited substitution availability. Indonesia has steadily advanced its midstream processing capabilities and set ambitious targets for EV battery production, aiming to rank among the top three global producers by 2027.

Policies on Technological Innovation: Indonesia's export bans on unprocessed minerals are designed to strengthen domestic midstream processing capabilities. Simultaneously, financial incentives that promote the use of local components are accelerating industrialization within the country. Local content requirements for EV development companies, which range from 40% to 70%, have recently been postponed from 2023 to 2027. Indonesia is also lagging on international partnerships to encourage investment, research and development (R&D), and collaboration in building downstream supply chains. While Indonesia does not have mineral recovery-specific policies in place, there are several waste management regulations in place.

Policies on Financial Mechanisms: Indonesia's targets and broader domestic industrialization goals are supported by a growing set of financial mechanisms, including tax incentives for R&D initiatives and lowering the cost of EVs that include a share of domestic components. Indonesia is also prioritizing the development of special economic zones to attract foreign investment and stimulate industrial activity through a series of corporate income tax allowances and exemptions.

Source: CCSI and Columbia Engineering (2024).¹⁶⁴

Box 4. Selected Indonesian Law, Policies, and Regulations Relevant to Critical Minerals Value Chains

Laws, Policies and Regulations	Detailed information
Indonesia, Mining Law No. 3 (2020), https://www.iea.org/policies/16957-mining-law-no-32020 .	Mining Law No. 3/2020 , which amends the 2009 mining law, aligns with the government's mission of stimulating downstream industrialization and strengthens policies related to environmental management in mining business activities.
Indonesia, Energy Ministry Decree regarding National Planning on Mineral and Coal 2022–2027 (2022), https://www.iea.org/policies/17994-energy-ministry-decree-regarding-national-planning-on-mineral-and-coal-2022-2027 .	Indonesia's Energy Ministry Decree regarding National Planning on Mineral and Coal 2022–2027 enhanced the Mining Law No. 3/2020 and instituted a strategic plan to serve as a guiding framework for sustainable resource management. The plan considers key factors, such as sustainability and environmental considerations, as well as technology development and economic growth.
Indonesia, Decree Regarding Classification of the Critical Minerals Lists (2023), https://www.iea.org/policies/17998-energy-ministry-decree-regarding-classification-of-the-critical-minerals-lists .	In 2023, the Energy Ministry released a Decree Regarding Classification of the Critical Minerals Lists , identifying critical minerals based on potential supply disruptions where substitution options are limited. This exercise follows Indonesia's bans on unprocessed mineral exports.
Indonesia, Government Regulation (GR) No. 4 (2009), https://pubs.usgs.gov/myb/vol3/2019/myb3-2019-indonesia.pdf .	Government Regulation (GR) No. 4 (2009) required mineral products to be processed and refined domestically. Mining companies were allowed to export ore concentrates until 2017 as long as they met commodity-specific refining requirements, paid export duties, and committed to building smelters in the country.
Indonesia, Prohibition of the Export of Nickel Ore (2020), https://www.iea.org/policies/16084-prohibition-of-the-export-of-nickel-ore .	Government Regulation (GR) No. 4 (2009), among many others, contributed to the prohibition of the export of nickel ore , requiring nickel to be processed domestically before export. Restrictions were initially set based on ore concentrations; however, all exports have been banned since January 2020. The goal of this policy is to strengthen domestic midstream processing capabilities and capture economic value from the commodity supply chain, creating jobs and economic development. There are currently several nickel processing plants in Indonesia, where three plants started trial production in 2021.
Indonesia, Statement Regarding EV Batteries During 2023 National Coordination Meeting of Regional Heads (2023), https://en.antaranews.com/news/269706/indonesia-to-become-largest-ev-battery-producer-in-2027-minister .	The electric battery and EV sectors play a significant role in developing Indonesia's mid- and downstream segments of critical minerals value chains. The country has set a goal to become a top-three global producer of EV batteries by 2027 and create a domestic EV market, as stated at the 2023 National Coordination Meeting of Regional Heads . This includes a target to produce EV batteries with a total capacity of 140 GWh annually by 2030, accounting for 4–9% of global demand.

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Laws, Policies and Regulations	Detailed information
Indonesia, Presidential Regulation No. 55 of 2019 on Electric Vehicles (2019), https://climate-laws.org/document/presidential-regulation-55-2019-on-electric-vehicles_411d. Amended by Presidential Regulation No. 79 of 2023, https://theicct.org/publication/roadmap-to-zero-policies-to-accelerate-the-electric-vehicle-transition-in-indonesia-apr26/.	Presidential Regulation No. 55 of 2019 accelerates the adoption and rollout of Indonesia's battery electric vehicles (BEVs). It sets up fiscal and non-fiscal incentives for manufacturing, minimum targets for local components, and a framework for charging infrastructure and necessary electricity supply rates. It was amended by Presidential Regulation No. 79 of 2023, which extended the framework from two- and three-wheeler BEVs to four-wheeler, truck and bus BEVs.
Indonesia, AEML Electric Vehicles Outlook (2023), https://acv.vc/wp-content/uploads/2023/07/Report-Indonesias-Electric-Vehicle-Outlook-Supercharging-Tomorrows-Mobility_NEW.pdf.	Specific production targets across various EV types have also been set. The Ministry of Industry Plan for 2020/21 set a target of 400,000 BEVs by 2025, which was later followed by a 2030 target to produce 600,000 EVs.
Indonesia, Presidential Regulation No. 55 of 2019 on the Acceleration of the Battery Electric Vehicle Program for Road Transportation (2019), https://peraturan.bpk.go.id/Details/116973/perpres-no-55-tahun-2019, as revised by Presidential Regulation No. 79 of 2023 (2023), https://peraturan.bpk.go.id/Details/273447/perpres-no-79-tahun-2023. Indonesia, Ministry of Industry Regulation No. 6 of 2022 on Specifications, Development Roadmap, and Provisions for Calculating the Domestic Component Level Value for Battery-Based Electric Motor Vehicles (2022), as amended by Ministry of Industry Regulation No. 28 of 2023, https://peraturan.bpk.go.id/Details/227541/permenperin-no-6-tahun-2022.	Indonesia's Battery Electric Vehicle Acceleration Program, established under presidential regulation and later revised, comprises a series of implementing regulations issued by the Ministry of Industry. These set out specifications, a development roadmap, and domestic component-level (TKDN, <i>Tingkat Komponen Dalam Negeri</i>) requirements for battery electric vehicles, alongside separate fiscal incentive instruments to spur investment. The program anchors Indonesia's EV industrial policy on domestic component requirements, with battery manufacturing carrying the largest single weighting in the TKDN calculation.
Indonesia, 2023 Local Content Decree (2023), https://jdih.setkab.go.id.	Production targets, and domestic industrialization goals more broadly, are enabled through financial incentive schemes, such as tax incentives to reduce the cost of electric LDVs and buses that include a share of domestic components or a five-year corporate income tax holiday for IDR 10 trillion (approx. USD 647 million) investments, among others. However, under a 2023 local content decree, Indonesia has pushed the 40% local content requirement for EV development companies to 2026, from the earlier 2023 timeframe, which also delays the local content threshold increase to 70% from 2024 to 2027.

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Laws, Policies and Regulations	Detailed information
Indonesia, Tax Incentives for Special Economic Zones (2022), https://www.aseanbriefing.com/news/tax-incentives-for-special-economic-zones-in-indonesia .	The Indonesian government has also pledged tax incentives for special economic zones (KEK) in Indonesia to attract foreign investment and bolster industrial activity. These include a series of tax exemptions and corporate income tax allowances.
Indonesia, Super Tax Deductions for R&D (2024), https://www2.deloitte.com/content/dam/Deloitte/id/Documents/tax/id-tax-info-jun2024-en.pdf .	The Ministry of Finance has been rolling out Super Tax Deductions for companies that are conducting R&D in-house or in collaboration with academic and public institutions.
Indonesia, National Research and Innovation Agency, https://www.brin.go.id/en/page/5/pengantar .	In line with this priority of R&D, the president-elect has focused Indonesia's National Research and Innovation Agency (Badan Riset dan Inovasi Nasional, BRIN) on the critical minerals sector.
Indonesia, Governmental Regulation No. 27 of 2020 on Specific Wastes Management (2020), https://setkab.go.id/en/govt-issues-regulation-on-specific-waste-management .	Indonesia's downstream activity also includes launching e-waste policies to manage and capture the value of critical minerals in waste streams. The Governmental Regulation No. 27 of 2020 on Specific Wastes Management assigns the responsibility to manage electronic waste across regional governments, electronics producers, and waste processors. Producers are also required to understand waste generation prevention measures, including technological development. Moreover, since 2021, Indonesia has banned deep-sea tailings placement and requires all high-pressure acid leach (HPAL) facilities to use tailings dams or dry stacking methods to mitigate the environmental impact of mining.

Source: Adapted from CCSI and Columbia Engineering (2024).¹⁶⁵

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