Stakeholder views on the uptake of sustainable and responsible nickel mining and processing supply chains for electric vehicles in Indonesia

by

Rameen Hayat Malik

Bachelor of Chemical and Biomolecular Engineering (Honours), 2018
Bachelor of Laws (LLB), 2020
University of Sydney

Submitted to the Institute of Data, Systems, and Society in partial fulfillment of the requirements for the degree(s) of

MASTER OF SCIENCE IN TECHNOLOGY AND POLICY

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 2024

Authored by: Rameen Hayat Malik
Institute of Data, Systems and Society
May 10, 2024

Certified by: Dr. Robert James Stoner
Interim Director, MIT Energy Initiative
Thesis Supervisor

Accepted by: Dr. Frank R. Field III
Interim Director, Technology and Policy Program
Senior Research Engineer, Sociotechnical Systems Research Center

Stakeholder views on the uptake of sustainable and responsible nickel mining and processing supply chains for electric vehicles in Indonesia

by
Rameen Hayat Malik

Submitted to the Institute for Data, Systems and Society

on May 10, 2024, in Partial Fulfillment of the
Requirements for the Degree of

Master of Science in Technology and Policy

ABSTRACT

This thesis explores the evolution and contemporary challenges of Indonesia's nickel industry within the context of the electric vehicle (EV) supply chain. It critically examines the sustainability and ethical considerations as Indonesia positions itself as a key player in the global transition to clean energy. The study provides a comprehensive analysis of Indonesia's strategic moves to enhance the value derived from its extensive nickel reserves, underscored by the implementation of policies such as the raw export ban aimed at fostering local processing industries. Central to this examination is the dual role of nickel as both a critical and contentious resource, reflecting on its classification as a critical mineral by multiple countries due to its indispensability in EV battery production and the substantial environmental and social challenges associated with its extraction and processing. Employing a policy mobility framework, this thesis navigates the trans-local dynamics of policy making in Indonesia, juxtaposing these with global economy wide pursuits of transportation decarbonization via the EV industry. Through a mixed-methods approach, combining literature review, stakeholder interviews, and field observations, the research unveils the multifaceted perspectives of various stakeholders including industrial entities, government bodies, and civil society organizations. The findings highlight the significant influence of international investment, mainly Chinese investment in shaping Indonesia's nickel processing capabilities, while also noting the ethical dilemmas and environmental hazards posed by the industry's expansion. Indonesia's strategy to escalate value addition locally is critically assessed, revealing both progress and persistent ethical and environmental challenges. Strategies are proposed to leverage the myriad of resources, influence and authority of actors along the EV supply chain to spur the growth of sustainable and responsible supply of Indonesian nickel. The thesis contributes to the discourse on sustainable mineral supply chains by proposing policy recommendations aimed at reconciling economic ambitions with environmental and social imperatives. These recommendations advocate for enhanced governance structures, transparent supply chains, and international collaboration to achieve ethical sourcing practices. The research underscores the need for a balanced approach that not only caters to the economic aspirations of resource-rich nations but also adheres to global sustainability standards.

Thesis supervisor: Dr. Robert Stoner

Title: Interim Director, MIT Energy Initiative

Acknowledgements

In the Name of God, the Most Merciful, the Most Gracious. I am grateful to you for the health, ability and privilege to be getting this education.

Firstly, a massive thank you to my advisor Rob. Thank you for placing your trust in me to pursue a topic that aligns with my interests and values. You have given me the freedom and constant support (often times no questions asked!) to travel to Indonesia and pursue this research through the lens of people, place and storytelling. To Liz, Elsa and Janelle – thank you for reminding me of the value of my work and being there to bounce ideas off in times that I have felt directionless.

Thank you to my Indonesian hosts, the World Resources Institute and SunCable Indonesia, for generously sharing your expertise and networks with me. I especially want to thank Tim, Vina, Wini and Nabila for your investment in helping my research succeed and making Jakarta feel like home. To all the interviewees that contributed to this work, thank you for the invaluable knowledge and stories that you have shared with me, I hope I have done them justice. To Serena, thank you for being my partner in crime through our Indonesian adventures on cars, trains, motorbikes, planes and boats – your ability to stay calm, laugh and keep eating in the most stressful of situations is awe inspiring.

To my besties from da Area – Raya, Michelle and Yasmin – thanks for being there with me for every step of this crazy adventure and for never making Lakemba feel that far away. To my brothers, thanks for holding down the fort while I have been away and for always being available to jump on a call and make me laugh. To Deepika and Layla, you have been my home, my sisters, my confidants – I don't know how I would've made it to this point without you here at 54 Ellery. To all the friends that have filled our dinner table, thank you for the meals, conversations (mainly putting up with my tirades on America) and joy that you have brought to our home. I am honoured to have spent the final weeks of my degree at the SAGE encampment, the community we created exemplifies what bravery, solidarity, mutual care and conviction looks like – I hope to keep on fighting for liberation and justice with you.

Finally, to my parents, you have taught us to never take knowledge for granted and to always wield it in the pursuit of what is right and just, and I am indebted to you for that lesson. Despite the distance you will always be my moral compass, my backbone – this degree and my achievements to now are built on your unconditional love, faith and belief in me.

All the universities in Gaza have been destroyed[1].

For Hind Rajab and all the children of Gaza whose dreams of becoming poets, teachers, doctors, engineers were stolen away.

"If I must die,

you must live

to tell my story

...

If I must die

let it bring hope,

let it be a story."

Dr. Refaat Alareer

(23 September 1979 – 6 December 2023)

[1] as of 18 April 2024 at least 5,479 students, 261 teachers and 95 university professors have been killed (United Nations Human Rights Office of the High Commissioner, 2024)

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AMDAL	Analisis Mengenai Dampak Lingkungan (Environmental Impact Assessment)
BKPM	Badan Koordinasi Penanaman Modal (Indonesia Investment Coordinating Board)
CATL	Contemporary Amperex Technology Co. Limited
CoW	Contract of Work
CSR	Corporate Social Responsibility
DRC	Democratic Republic of Congo
EV	Electric Vehicle
FeNi	Ferronickel
FID	Final Investment Decision
HPAL	High Pressure Acid Leaching
IBC	Indonesia Battery Corporation
IEA	International Energy Agency
IMIP	Indonesia Morowali Industrial Park
IWIP	Indonesia Weda Bay Industrial Park
JV	Joint Venture
MEMR	Ministry of Energy and Mineral Resources
MHP	Mixed Hydroxide Precipitate
MIND ID	Mining Industry Indonesia
NCMA	Nickel Cobalt Manganese Aluminum
NPI	Nickel Pig Iron
OESBF	Oxygen Enriched Side Blown Furnace
RKEF	Rotary Kiln Electric Furnace
UNDP	United Nations Development Programme

1 Introduction

"The global south is paying the price in servicing [the transition of] the global north."

As the global economy works towards creating and adopting technologies to facilitate the clean energy transition, it is well established that the majority of essential minerals needed for this transition are located in reserves in developing countries across Africa, Southeast Asia and Latin America otherwise also referred to as the "Global South" (United Nations Conference on Trade and Development, 2022). To date, resource-rich developing countries that have been relied on for such minerals – such as Cobalt in the Democratic Republic Congo (DRC) for electric vehicle supply (EV) chains – have been exploited only to be abandoned by consumers in the global north due to supply chain risks owed to ethical and sustainability concerns. In the aftermath, communities are left with unfulfilled promises of economic growth and development and an aftermath of environmental destruction.

The EV industry exemplifies this shift in strategic resource management, as companies and governments demand more sustainable and ethical supply chain practices. In response, EV manufacturers are reconsidering their battery chemistries to rely less on materials deemed 'risky' due to socio-economic and environmental implications, a trend currently evident in the shifting focus from cobalt to nickel.

Since 2021, over 23 nations including key global players like the United States, the European Union, China, and Japan have classified nickel as a critical mineral, recognizing its essential role in their strategic economic frameworks (IRENA, 2023; McNulty & Jowitt, 2021).The criteria for a critical mineral, while lacking universal consensus, commonly includes economic importance, irreplaceability, and a myriad of supply risks—ranging from extraction difficulties to geopolitical tensions (Critical Minerals Association UK, 2021; IRENA, 2023; McNulty & Jowitt, 2021; E. Olivetti et al., 2015). Nickel, crucial for both the construction and

transportation sectors, represents about 75% of stainless steel production and is a dominant element in the most mature and prevalent EV battery chemistries.

However, the nickel supply chain is not without its challenges. Declining ore grades and the lack of new high-quality reserves are shifting production towards lower-quality nickel reserves, primarily concentrated in Southeast Asia (Mudd & Jowitt, 2022). This transition necessitates the use of novel processing technologies to produce high-quality nickel derivatives for the EV industry, which are more energy intense, capital expensive and less sustainable. Moreover, recent events in the nickel industry including Indonesia's raw export ban on nickel and the suspension of nickel trading on the London Metal Exchange due to prices spikes partly associated with risks of Russian nickel supply disruption during Russia's invasion of Ukraine (The Economist, 2022), have added layers of complexity and risk to global nickel markets.

Indonesia, as the world's largest holder of nickel reserves (McRae, 2023), has become a focal point in these discussions. The Indonesian government's initiatives aimed at adding value locally likely in a bid to avoid the fate that many resource-rich developing countries in Africa have faced, are juxtaposed against persistent sustainability challenges and ethical concerns. These concerns have garnered significant international media attention (Emont, 2023; Goodman, 2023; Hidayat et al., 2022; Tan, 2023) and have prompted decisions from major industry players to reconsider establishing operations in the region. As the Indonesian nickel industry faces a crossroads with this heightened attention, the situation prompts a critical examination of how stakeholders within the EV and mining sectors can collaborate to foster a sustainable, ethical, and responsible supply chain for EVs, centering on Indonesia and its people's long-term economic and sustainable development goals.

2 Literature Review

2.1 Nickel Industry: Towards Electric Vehicles (EVs)

As our global system works towards achieving net zero emissions in line with the Paris Agreement's long-term temperature goals, the rapid and widespread adoption of clean energy technologies will be key towards realizing this outcome. This transition to a clean energy system will require significant minerals and metals inputs, shifting away from traditional fossil fuel supply. The International Energy Agency (IEA) predicts that six times more mineral inputs would be required by 2040 than today to hit net zero globally by 2050 (International Energy Agency, 2022c).

With transportation contributing 15% of global greenhouse gas emissions (Intergovernmental Panel on Climate Change, 2023), transport electrification is seen as the dominant decarbonization pathway for this sector (Cano et al., 2018). In the last 5 years, EV sales have jumped from 1 million to over 10 million units per year, with a market share of 14% of total car sales (BloombergNEF, 2023; International Energy Agency, 2023b). It is expected that in order for global climate goals to be achieved, this share needs to grow to 40% (International Energy Agency, 2022c) and this mass adoption is anticipated to be driven by policy incentives (including subsidies, policies to grow EV infrastructure, emission standards and electrification targets), technological advancements leading to lower costs and wider availability of supply, and shifting social/consumer perceptions (Haddadian et al., 2015; Jones et al., 2020). With increasing sales, the demand for EV batteries and associated minerals and metals required for battery production has been amplified at a dramatic rate.

Lithium-ion batteries (Li-Bs) are the most widely used battery technology for EVs (Cheng et al., 2024). Common cathode chemistries for Li-Bs include NCA (lithium nickel cobalt

aluminum oxide), NMC (lithium nickel manganese cobalt oxide), and LFP (lithium iron phosphate) (Cheng et al., 2024). The metals composition of these various Li-B cathodes chemistries includes lithium, manganese, cobalt and nickel amongst other materials (E. A. Olivetti et al., 2017). With the cathode contributing more than half of the cost of a battery cell, the selection of cathode materials is of particular interest (Cheng et al., 2024). This choice of cathode materials is influenced by a multitude of factors including the contribution of the cathode to the battery's performance, levels of material reserves available, supply chain risks including sustainability, geopolitical risk, risk of demand increase due to other uses of the material, concentration risk of a material in one country or company and the technological and commercial maturity of battery production using the given material composition (Helbig et al., 2018). In 2022, NMC battery chemistries held a market share of 60% with higher nickel ratio chemistries of NMC811, NMC622 and NMC532 increasing in popularity (Figure 1).

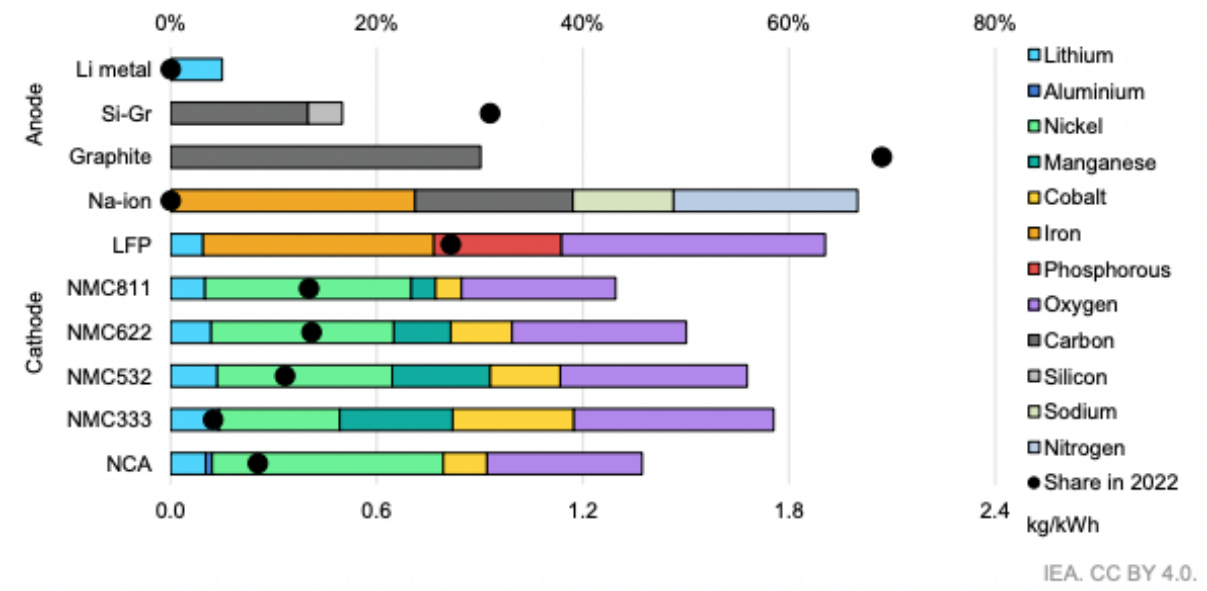

Figure 1: *Material compositions of different anode and cathode battery cell chemistries and market share in 2022*

(International Energy Agency, 2023b)

These high nickel, low cobalt battery chemistries are gaining more market share due to the supply chain risks associated with cobalt supply including scarcity and high extraction costs due to the material primarily being extracted as a low concentration co-product from copper

mining (Gourley et al., 2020). In addition, cobalt supply is concentrated in the Democratic Republic of Congo (DRC) which supplies more than 60% of global cobalt, where political instability and unethical labor practices including modern slavery and child labor are prominent (Murdock et al., 2021; Van Den Brink et al., 2020). Additionally, the higher energy density and lower cost of nickel-rich battery chemistries have prompted several major EV manufacturers and battery makers to invest in further commercializing these chemistries (Houache et al., 2022; International Energy Agency, 2022c; E. A. Olivetti et al., 2017).

It should be noted, that just as cobalt supply chain risks have prompted the shifted to nickel rich battery chemistries, emerging concerns about nickel supply particularly around the environmental impacts of nickel mining and down streaming and the risk of significant price fluctuations for nickel may contribute to the growth of more low cobalt and low nickel battery chemistries (Mauler et al., 2022; Murdock et al., 2021). Despite their lower energy density and driving range, LFP battery chemistries reached their highest market share of 30% in 2022 (International Energy Agency, 2023b). With LFP offering lower production costs, better safety performance and avoiding nickel and cobalt entirely, LFP battery chemistries have the potential to become more widespread for low-range commercial applications such as in buses and in China and other emerging economies that are experiencing increasing demand for low-cost passenger vehicles (Xu et al., 2020). More broadly, although more sustainable alternatives to Li-Bs are beginning to enter the market on a commercial scale including sodium ion batteries and newer solid state battery technologies are being developed, NMC battery chemistries are the most mature and best suited for high energy density applications (Murdock et al., 2021).

2.2 Nickel Industry Overview

Over the last decade, nickel demand has been steadily growing at an average annual growth rate of 6%, the main driver of which has been the stainless-steel industry as driven by the

construction boom in China (Fraser et al., 2021). However, since 2017 nickel demand for batteries has grown from only 6% of total demand, to 17% of total nickel demand (International Energy Agency, 2023a). As it stands, stainless steel accounts for 65% of primary nickel demand, followed by batteries (17%) and other uses including specialty alloys (9%) and plating (5%) (Nickel Institute, 2022). In 2023, global nickel demand reached 3.195 megatons per year, growing by 8% since 2022 owed to the increased demand for LiB precursor materials and production ramp up for these materials (International Nickel Study Group, 2023). It is expected that by 2040 global nickel demand will almost double (Figure 2), with the battery sector being the most significant driver of this demand and that the battery sector will account for more than 35% demand share by 2050 (Fraser et al., 2021; International Energy Agency, 2022c).

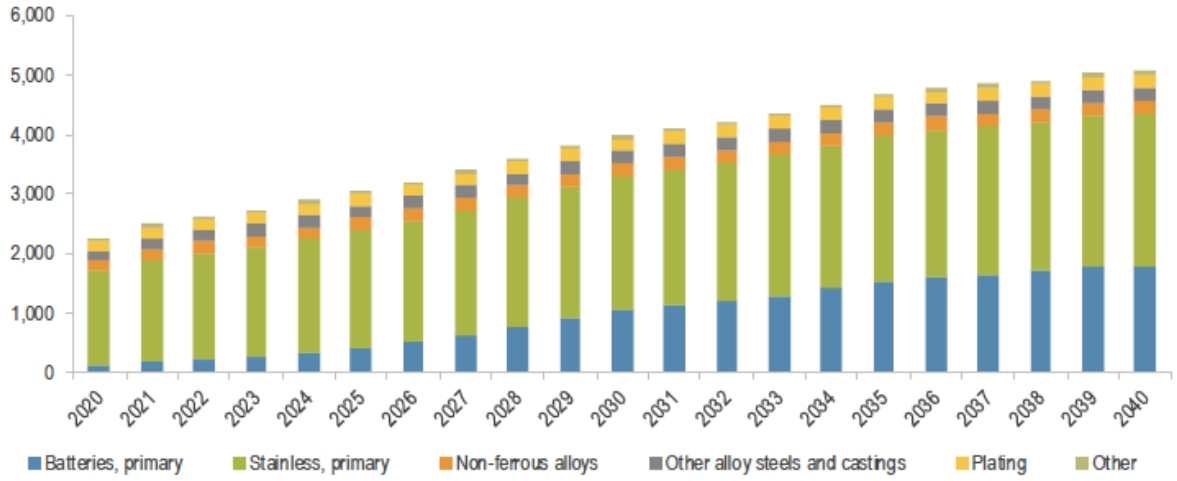

Figure 2: *Primary nickel demand by first use sector 2020-2040* (Fraser et al., 2021)

Nickel Products

Typically, nickel containing Li-Bs will require nickel to be contained in high purity nickel sulphate hexahydrate, a chemical compound to be use in producing precursor material for the cathode (Fraser et al., 2021). Nickel sulphate can be produced from a variety of nickel products. Generally, the nickel market is split into two product types, Class 1 and Class 2 nickel. Class 1 nickel contains more than 99% nickel and can take the form of pellets, briquettes, powder,

carbonyl nickel and electrolytic nickel (Schmidt et al., 2016). Due to its high quality, Class 1 nickel can be used for all of nickel's first use sectors including stainless steel, nickel alloys, plating and high purity compounds including nickel sulphate for battery production (Fraser et al., 2021; Schmidt et al., 2016). Class 2 nickel contains less than 99% nickel and can take the form of nickel oxide sinter (75-80% Ni), ferronickel (15-45% Ni) and nickel pig iron (NPI) (2-17% Ni) (Schmidt et al., 2016). Historically, these products have been exclusively used for stainless steel production, with Class 2 nickel typically not seen as suitable for batteries (Fraser et al., 2021; Schmidt et al., 2016). There is also a rising 'third' class of emerging intermediate products including Mixed Hydroxide Precipitate (MHP) and nickel matte which are used as feedstock to produce battery grade nickel sulphate (McRae, 2023).

Nickel Mining & Processing

Global nickel reserves are contained in approximately 627 deposits with more than 350.2 megatons of contained nickel (McRae, 2023; Mudd & Jowitt, 2022). These deposits are classified as either nickel sulfide or laterite ore deposits. Nickel sulfide makes up 40% of global reserves and 60% of global nickel supply (Dilshara et al., 2024). It is formed by the intrusion of molten magma into the earth's crust or is found in discrete sulfide containing ore bodies that are formed by hydrothermal leaching and precipitation (Crundwell et al., 2011a). Sulfide ores typically contained 1.5-3% nickel and generally occur in less tropical regions such as Canada, Russia and Australia (Crundwell et al., 2011a; International Nickel Study Group, 2021). Given sulfides occur in deeper subterrestrial layers, they are usually mined using underground mining techniques (Mudd & Jowitt, 2022). Typically, sulfides are more expensive to mine than laterites given the deeper nature of the ore body, but due to the higher nickel content of the ore, are usually cheaper and less energy intense to process and are used to produce Class 1 nickel products (discussed later) (Schmidt et al., 2016).

After mining, the ore is crushed, concentrated to 15% nickel using froth flotation, the concentrate is then smelted to nickel-iron sulfide which contains 40% nickel, this is further oxidized to produce low iron nickel sulfide matte containing 60-70% nickel (Crundwell et al., 2011a). This intermediate nickel matte can be further refined to produce Class 1 nickel using pyrometallurgical techniques (Schmidt et al., 2016) or more recently processed to produced nickel sulphate (Andayani et al., 2020).

Nickel laterite makes up 60% of global reserves and 40% global nickel supply (Dilshara et al., 2024). Nickel laterites form via the weathering of the ocean floor over millions of years mainly in tropical and subtropical regions which causes natural leaching of nickel resulting in the formation of various identifiable nickel bearing soil levels (Crundwell et al., 2011a). The main two subtypes of laterite deposits are limonite which occurs near the soil surface and contains 0.8-1.5% nickel and saprolite which occurs in deeper soil levels and contains 1.5-2.5% nickel (Crundwell et al., 2011a; International Nickel Study Group, 2021). Most deposits of laterites occur in tropical soils in Indonesia, Philippines and New Caledonia. As laterites occur near the surface, they are easier to access and thereby cheaper to mine using surface mining methods including open pit mining (Mudd & Jowitt, 2022).

Nickel laterites are usually a lot more energy intensive to process due to their lower nickel concentration and higher moisture content, contributing to the higher processing costs they face which is exacerbated by the rise of novel processing technologies and the often less-accessible location of laterite ores (Crundwell et al., 2011a; Norgate & Jahanshahi, 2011; Schmidt et al., 2016). The higher iron content of limonite ores does not make them well suited to smelting, instead their lower magnesium content has them better suited to hydrometallurgical processing including high pressure acid leaching (HPAL) to produce various nickel containing mixed hydroxide or sulfide precipitates (55% nickel content) which can be further refined to produce

nickel sulphate or Class 1 nickel (Crundwell et al., 2011a; Mudd & Jowitt, 2022; Schmidt et al., 2016). On the other hand, the lower iron content and higher magnesium content of saprolite ores has them better suited to pyrometallurgical processing via a blast furnace, electric arc furnace or rotary kiln electric furnace (RKEF) to produce Class 2 nickel products – ferronickel (15-45% nickel content) and nickel pig iron (NPI) (2-17% nickel content). These products are usually further refined to produce stainless steel, however there are emerging process allowing for the sulfidation of NPI to produce nickel matte (which can be subsequently refined to produce Class 1 nickel or nickel sulphate) (Schmidt et al., 2016; Seok et al., 2021).

While demand for Class 1 nickel has been growing rapidly due to the growing battery industry, Class 1 nickel has been facing supply shortages and high prices due to rapidly dwindling sulfide reserves, declining ore quality, lack of investment in building out existing reserves and in exploring new reserves and recently supply disruption due to the Russia-Ukraine war (Snowdon et al., 2022; Young et al., 2021). Only four new nickel sulfide discoveries have been made in the past decade, accounting for only 3% of total nickel discovered since 1990 (S&P Global Market Intelligence, 2022). As such the demand for more low-cost nickel supply is growing, with Class 2 nickel as derived from laterites helping to relieve stainless steel demand for Class 1 nickel and mitigate the impacts of dwindling sulfide supply. Additionally, given that both sulfide and laterite operation are producing declining ore grades as higher-grade reserves are depleted (Mudd & Jowitt, 2022), there has also a pronounced need to build out processing expertise and scale for low quality ores in a manner that is both efficient and sustainable. As such, this has provided Indonesia a unique opportunity to establish itself as a leading player in the nickel supply chain, both in relation to mining and processing.

2.3 Indonesia's Nickel Industry

Indonesia is a central player in the global nickel industry, owed both to its naturally occurring reserves and developments in Indonesia's industrial policy that have allowed it to ramp up both mine production of raw nickel and nickel products. Indonesia holds the largest nickel reserves in the world, accounting for 42% global supply at an estimated 55 megatons and is also the largest producer of nickel in the world, accounting for 50% of global mine production at an estimated 1.8 megatons in 2023 (McRae, 2024) (Figure 3).

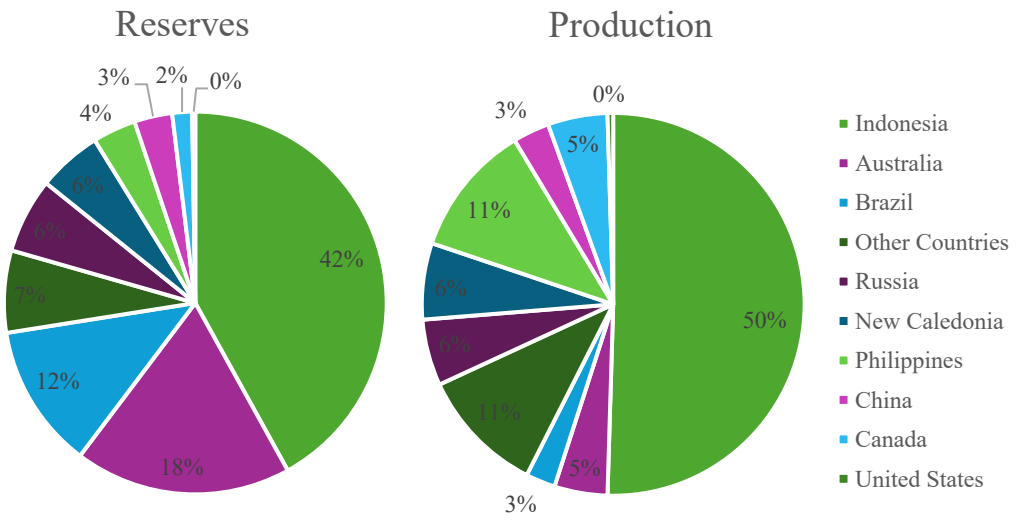

Figure 3: *Global nickel reserves and mine production 2023 (McRae,2024)*

Nickel Mining and Deposits

Indonesia's nickel resources are exclusively found in near-surface nickel laterite deposits which are high in bulk but are lower grade (Heijlen & Duhayon, 2024. These laterite deposits (Figure 4) typically consist of a top ferruginous cap layer (0.2 – 1m deep) which is low in nickel but enriched with cobalt, a low-grade limonite layer (2 – 18m deep), a 'transition' layer and a higher grade saprolite layer (0.3 – 24 m deep) (Fu et al., 2014; Soh Tamehe et al., 2024).

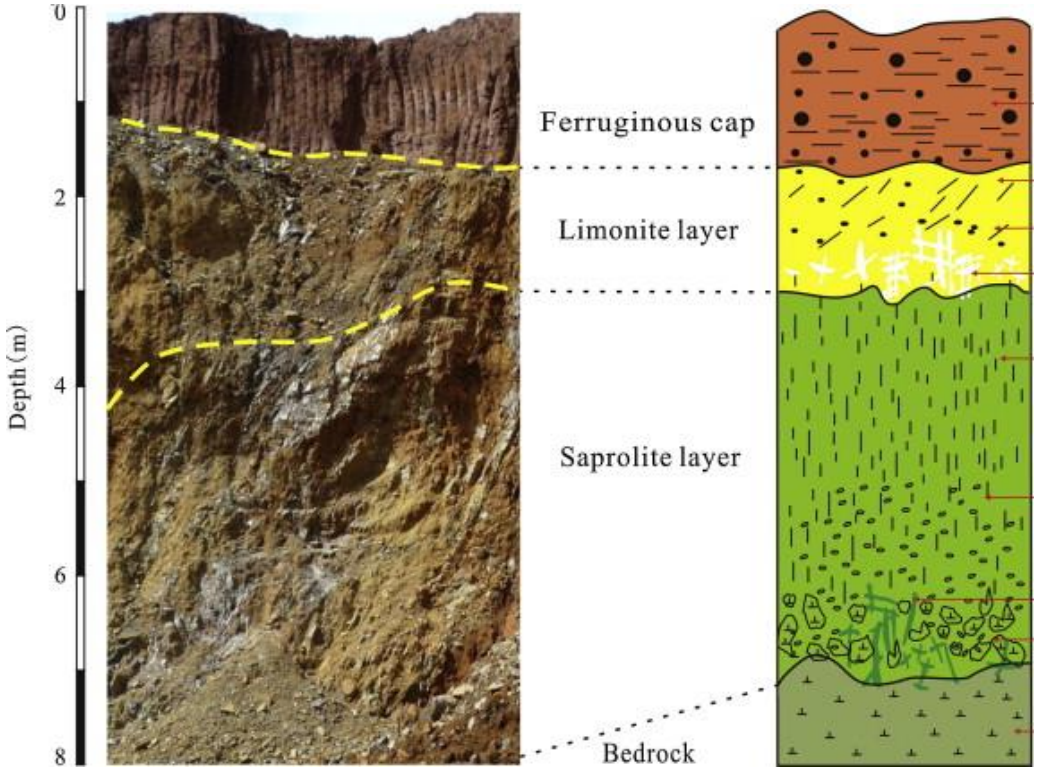

***Figure 4**: Typical geological profile of Indonesian nickel laterite from Sulawesi* (Fu et al., 2014)

Indonesia's nickel deposits are primarily located in the Sulawesi and North Maluku region (consisting of Halmahera Island, Obi Island and Gebe Island) (Heijlen & Duhayon, 2024a).

These islands form part of the Wallacea region which has the highest proportion of endemic flora and fauna species in the world and is often known as a 'living laboratory' for studying evolution and biodiversity (Struebig et al., 2022). These deposits are primarily located underneath rainforest areas which are often cleared to access surface deposits of laterite using strip mining or open pit mining methods (Heijlen & Duhayon, 2024a; Mudd & Jowitt, 2022). Deforestation to access nickel resources has resulted in soil erosion and contamination and biodiversity loss, not only the loss of endemic plant species, but the loss of habitat for endemic primates and bird species especially in the Sulawesi region (Supriatna et al., 2020).

In addition, given the tectonic instability in the region, increasing rainfall levels and natural disasters, the risk of tailings and loose soil run off due to the lack of adequate tailings storage and soil rehabilitation/remediation has been exacerbated. As such, there have been major

impacts to the health of the surrounding aquatic environment which forms part of the Coral Triangle, the most diverse and biologically marine ecosystem in the world – including coral degradation, run-off bioaccumulation in fish, reduced water quality, damaged reefs and loss of endemic fish species (Struebig et al., 2022).

Further, a majority of these deposits are located on indigenous lands and are surrounded by local rural communities that are amongst the poorest in Indonesia (Struebig et al., 2022). These communities are reliant on the surrounding natural environment for their livelihoods, engaging in dry-land farming and artisanal fishing as their major source of income (Nancy, 2022). Not only have these smaller scale agricultural activities suffered due to the environmental risks associated with nickel mining, but many indigenous communities have faced indigenous rights violations in relation to loss of land titles, lack of benefit sharing and social conflict with incoming mining communities (McCarthy & Robinson, 2016; Nancy, 2022). As such, it can be seen that the unique geography of these deposits brings about a myriad of interwoven and interdependent issues that must be grappled with at a regional level as Indonesia seeks to meet broader economic goals in utilizing these previously underutilized deposits in the global nickel market.

2.4 Gap Analysis and Research Questions

Indonesia's efforts to create nickel for EV supply chains domestically have attracted significant international attention as EV companies look to secure supply chains for battery materials. Both of the largest EV manufacturers and battery makers, BYD and CATL have made investments in Indonesia (International Energy Agency, 2023d). In particular, Chinese investment is dominant in all aspects of Indonesia's nickel and processing supply chain. China is the largest importer of Indonesian nickel products and the largest source of foreign direct investment in Indonesia's minerals sectors, with significant investments in nickel mining and processing in

Indonesia (Rosada et al., 2023). Chinese investment has driven the technological development and commercialization of a number of novel processing routes for the production of EV battery materials from laterite ores have out of including hydrometallurgical processing of nickel laterite using HPAL to produce MHP and the sulfidation of NPI to produce nickel matte which can be used as a feedstock to produce nickel sulphate (Foss & Koelsch, 2022; Heijlen & Duhayon, 2024a). The high energy intensity and production of toxic waste tailings from these processes have further exacerbated the community, land use, emissions and pollution impacts that have long been associated with nickel mining in Indonesia. As non-Chinese EV companies demand sustainable, transparent and responsible supply chains for their materials supply, while hesitating to make direct investments to build Indonesia's nickel infrastructure, there is an inherent gap between the nature of supply coming out of Indonesia and the ambitious ESG commitments made by these EV companies.

More broadly, within the context of Indonesia's broader development, mining is a significant contributor to Indonesia's economy, contributing 9% to its GDP in 2022 (Rayos, 2023). Indonesia is the fourth fastest growing large economy in the world, with its rapid growth to date owed to its exports of coal and natural gas. Indonesia is also one of the most coal dependent regions in the world and the largest coal exporter, while also being a leading producer of minerals needed for the clean energy transition including nickel (International Energy Agency, 2022a). The country also seeks to achieve net zero status by 2060, while also reaching developed country status by 2045 (International Energy Agency, 2022a). While on face value, these minerals policy changes have driven the diversification of Indonesia's mineral industry away from coal and facilitated increased economic growth and investment, it is unclear what the consequences of this rapid growth will have not only on the global EV market and decarbonization efforts but also on Indonesia's long-term development. As such the development of a long term, coordinated industrial strategy that seeks to align these

international and domestic goals in a manner that is ethically, economically and environmentally sustainable is essential. This first requires an understanding the current nature of nickel supply coming out of Indonesia and the drivers of this supply before seeking to provide recommendations for future policy development.

While previous peer reviewed literature has sought to map and consolidate Indonesia's nickel industry (Heijlen & Duhayon, 2024a; Mudd & Jowitt, 2022) and others have sought to map and analyze global nickel to EV supply chains and processing methods (Bradley & Sprecher, 2021; Dilshara et al., 2024; Schmidt et al., 2016), the emerging and rapidly changing nickel to EV ecosystem in Indonesia lacks a similar in depth analysis and no studies have looked at ownership data of these sites or have proposed strategies for sustainable nickel development that considers cultural, ecological and economic factors. Previous studies on Indonesia's EV ecosystem have focused more on uptake of EV usage domestically in Indonesia and opportunities for Indonesia to leverage shifts in battery chemistry demands (Maghfiroh et al., 2021; Pandyaswargo et al., 2021). Given the nickel to EV ecosystem in Indonesia has only recently begun since 2021, there is a need to consolidate processing routes, ownership and location of these facilities, as a first step in understanding the EV supply chain vulnerabilities of nickel coming out of Indonesia as done in Chapter 4.

While EV companies seek to capitalize on the demand from consumers for eco-friendly and green products, consumer feedback especially in the global north is pushing companies to detail and verify how beyond direct emissions (Scope 1 and 2), their EVs are being sourced (Scope 3 emissions). As a result, on the supply side nickel producers are being asked to comply to internationally set industry regulations and standards (Cao et al., 2021). The unique context in which Indonesia's nickel industry operates within an emerging economy and the policy constraints it has placed on international involvement in its supply chain poses unique

challenges. These challenges sit between mineral rich developed countries like Australia and Canada with more well-established technological innovation and regulatory frameworks for sustainable mineral supply (IRENA, 2023) and to mineral rich developing countries like the DRC that are dominated by artisanal mining amongst a political climate with high levels of instability and poverty (Sovacool, 2019). As such, placing focus on Indonesian stakeholders in the supply chain with the most proximate knowledge and experience to these country specific challenges is what this study aims to do.

In identifying these challenges through the lens of how stakeholders perceive them, there is an opportunity to understand how various stakeholders across the value chain can work together to realize sustainable and responsible nickel to EV supply chains coming out of Indonesia. Many previous studies utilizing stakeholder views in relation to the mining sector have focused on theoretical frameworks centered around corporate social responsibility (CSR), thereby placing the locus of control heavily on the internal policies adopted by mining companies themselves (Ansu-Mensah et al., 2021; Mbirigenda, 2017; Rodrigues et al., 2022; Viveros, 2016; Yakovleva & Vazquez-Brust, 2012). This approach also places the responsibility of stakeholder engagement in the mining sector predominately on mining companies, with less attention on how other actors involved in policy making for this sector engage with other stakeholders, especially vulnerable communities whose concerns are often sidelined in the CSR engagement process. This thesis seeks adopt a policy lens to ask the question of how nickel to EV supply chains in Indonesia can work towards being more sustainable and responsible. The theoretical framework of policy mobility that guide further chapters and methodologies adopted to understand stakeholder views are detailed in Chapter 3.

In seeking to understand and articulate the emerging and complex environmental and social challenges associated with the nickel to EV ecosystem in Indonesia, I will employ narrative

storytelling in Chapter 6 onwards making use of literature review, stakeholder interviews (Chapter 5) and regulatory analysis as has been applied to other mineral resources in resource-rich developing economies (Mavhunga, 2023; Mudd et al., 2020; Sovacool, 2019). In Chapter 9, I am seeking to propose strategies that can help translate broader EV industry decarbonization goals towards building capacity in Indonesia for building sustainable nickel to EV supply chains.

3 Theoretical Framework & Methodology

3.1 Theoretical Framework

I ground this thesis within the framework of policy mobility and assemblage theory to ask the question of how more responsible and ethical nickel to EV supply chains can be built in Indonesia considering the local economy, community and environment. In studying the processes through which policies spread, policy mobility seeks to understand how policies morph across space and context in an increasingly globalized world (Prince, 2017). Policy mobility offers an analytical lens to investigate the translocal dynamics of policy making and emphasizes that policies are not merely transferred but go through a process of translation and reconstruction in and through the national, regional and local situations they encounter (Peck & Theodore, 2010; Siakwah & Lawer, 2024). We can apply this to Indonesia's nickel industry, to understand how policy narratives have prompted its shift towards nickel to EV supply chains, what practices and forces continue to drive the future of this industry in Indonesia and how national and local policies in relation to this industry and as a result of it, can be understood as a mix of local and global forces that contend with each other (Vasstrøm & Lysgård, 2021). These policy narratives can include global efforts towards net zero, country level policy incentives for EV adoption, varying regional strategies to secure critical minerals supply for EV batteries or even research funding towards developing new EV battery chemistries.

The focus of policy mobility is also on how these policies affect the places they spread to (Haupt, 2023; Peck & Theodore, 2010). Policies adapt to these different contexts while also influencing governance, social life and practices (Peck & Theodore, 2012). Policy mobility recognizes the power imbalances between those who implement policy and those who are impacted by it. As such, policy mobility research draws more emphasis on the roles of non-state actors including multinational corporations, NGOs, civilians and local municipalities and

how they interact with and influence policy makers (Haupt, 2023). It asserts that the actions of policy makers are defined by these networks of knowledge, expertise and landscapes they cover (Peck & Theodore, 2012). Assemblage theory as an analytical technique often complements policy mobility to ensure that the study of policy doesn't fall into a strict global-local binary (Vasstrøm & Lysgård, 2021). Assemblage theory views complex systems such as policy to be made up of heterogenous elements – including human and non-human elements such technologies, organizations, materials, the natural environment and its resources – all of which have some level of agency in the system.

Many scholars have applied a policy mobility and assemblage theory in Indonesia as they have found it well suited to be able to unfurl the ways in which complex social relationships and patronage networks complicate the ways in which state and non-state actors are distinguishable and separate business versus public interests (Anderson, 2016; Phelps et al., 2014). Phelps notes that international actors, especially from the global north, including NGOs, donor agencies and other national governments have long been strong external influences on national and local policy making in Indonesia (Phelps et al., 2014). Further, following the fall of the centralized Suharto regime in 1999 and the rise of far-reaching power and capacity decentralization, Indonesia's policy making has been highly experimental and fast paced (Phelps et al., 2014).

In addition, policy mobility and assemblage theory has been applied increasingly in the realms of energy and climate policy, including resource extraction (Haupt, 2023; Siakwah & Lawer, 2024; Vasstrøm & Lysgård, 2021). Both policy mobility and assemblage theory see policy making as a fluid, fast moving, unpredictable and negotiated practice when applying global policies to localized contexts (Peck & Theodore, 2012; Prince, 2017). These approaches were considered appropriate and relevant to the rapidly changing nature of Indonesia's industrial

policy since it's raw nickel export ban of 2019 in response to the demands of the EV sector globally. Methodologically, policy mobility and assemblage theory invites us to "follow the policy" to be able to consider how policy develops through different time and space, the power mechanisms that legitimize policies and the process of territorialization/deterritorialization in translating global policy to a local context (Peck & Theodore, 2012; Prince, 2017; Savage, 2020). We ask the following questions: What kinds of policies are argued? How are policies produced? Who are the producers of policy? The first question asks us to identify which knowledge regimes and ideologies are influencing Indonesia's nickel and EV policies. The second question asks us to understand how these policies are 'naturalized' or 'institutionalized' in both the national and local Indonesian context. The third question asks us to observe how different actors perform and practice the policy by invention, intervention and implementation (Vasstrøm & Lysgård, 2021).

3.2 **Methodology**

The following chapters relied on mixed qualitative research methods including semi-structured interviews, academic and non-academic (e.g. company annual reports, news articles, industry reports and briefings) literature review, and legal research (e.g. key legislation, regulations and legal precedent) in order to understand Indonesia's nickel to EV supply landscape (Sovacool, 2019). Given the biases and data gaps that could emerge from employing these methods individually especially given the sparsity of peer reviewed literature on this topic, between-method triangulation and data triangulation was used not only as a verification strategy but as a means of adding depth to the analysis at hand (Flick, 2004).

A grounded theory approach was used in data collection and analysis. This approach instead of seeking to test an existing hypothesis, allows patterns to emerge from the data collected in order

to develop a theory of the phenomenon (in this case Indonesia's nickel to EV supply chain) grounded in the data collected (Flick, 2022; Knox-Hayes et al., 2021).

3.2.1 Literature Review

Given the rapidly evolving landscape of the nickel mining and processing sector in Indonesia, an inventory of operational and in development nickel projects in relation to the EV sector and their ownership structure was compiled. In addition, process mapping of commercially used to nickel to EV processing methods and pathways in Indonesia was also developed.

An extensive literature search was conducted using web-based search tools with a focus on publications post Indonesia's 2019 raw export ban (with the exclusion of data gathered for process mapping and project data for nickel mine operations). In addition, during stakeholder interviews, interviewees also provided their expert insights identifying key projects, processes and stakeholders which were verified using the literature collected. They also directed me to further sources of literature to consult. The types of literature consulted included academic journals, grey literature including reports by nickel industry groups and Indonesian mining industry association, investigative reports by NGOs involved in climate and mining advocacy, online information including news articles, market research databases and reports by the Indonesian Government's Ministry of Energy and Mineral Resources. Literature sources that were considered salient for developing these overviews including those frequently consulted or those considered foundational are listed in Table 1. Data gathered from the above sources was verified against the relevant owner company's annual reports, stock exchange filings and press releases which are detailed in Appendix 11.2

Table 1: *Literature sources for mapping Indonesia's nickel to EV supply chain (style adapted from Schmidt et al., 2016)*

	Type of Data		
Literature Type	**Process Mapping**	**Project Data**	**Ownership Data/Stakeholder Identification**
Journal Articles	(Crundwell et al., 2011a; Norgate & Jahanshahi, 2011; Schmidt et al., 2016)	(Heijlen & Duhayon, 2024b; Mudd & Jowitt, 2014, 2022)	
Databases		S&P Capital IQ Pro – Metals and Mining (S&P Global Market Intelligence, 2024)	
Industry Wide Reports	(BIZTEK Industry & Commodity, 2023; Fraser et al., 2021; International Nickel Study Group, 2021; Petromindo, 2023)	(BIZTEK Industry & Commodity, 2023; Petromindo, 2023)	
Government Databases and Sources		ESDM One Map (Ministry of Energy and Mineral Resources (ESDM), 2024) Minerba One Data Indonesia (Ministry of Energy and Mineral Resources (ESDM), 2023)	
NGO and Think Tank Reports	(Climate Rights International, 2024; Myllvirta et al., 2024; Sangadji et al., 2023; Tritto, 2023)		
News Articles and Investigations	(Silva, 2023; Singgih & Salam, 2024; Wicaksono, 2022)		

3.2.2 Legal & Regulatory Research

A central part of this thesis is understanding the current nature of the nickel to EV industry in Indonesia in order to understand how to make it more responsible and ethical. As such, the legal and policy mechanisms that currently regulate and drive the development of this industry needed to be understood.

The policy mobility framework asks us to consider how policy changes through time and space. The socio-legal method of legal research was pursued. This method seeks to view the law as a social institution and as such beyond documenting the black letter law, it seeks to explore the effects of law, legal institutions and processes and the influence of external factors on the law (Angammana, 2023). As such, the sources consulted in this exercise included primary sources of Indonesian Law including Presidential Decrees, Laws, Government Regulations, Ministerial Regulations and General Regulations (Hamzah et al., 2021). Secondary sources including reports, legal journals and stakeholder interviews were used to both identify relevant sources of law and further understand their effects and how they have been implemented in practice. The scope of this research was on Indonesian laws that either directly or indirectly regulate nickel mining and processing including mine and facility approvals, environmental regulations, export regulations and broader industrial policies focused on nickel industry growth. In addition, regulations and standards adopted in international contexts in relation to the mining sector were also explored to inform recommendations.

3.2.3 Stakeholder Interviews and Field Observation

I sought to develop relationships with stakeholders beyond the dominant actors at the international level (primarily EV companies and international governments) to understand how actors in Indonesia involved in the policy making process both directly and indirectly perceive and influence the development of Indonesian's nickel industry and policy landscape (Anderson, 2016). I travelled to Indonesia for a period of 6 weeks and was hosted by two organisations active in Indonesia's energy and climate ecosystem, including an international climate and energy think tank with an office in Indonesia and a renewable energy company working across the Asia Pacific region. Relevant stakeholders were identified through the aforementioned literature review and guidance from my host organisations (Knox-Hayes et al., 2021).

Given the relationship driven business culture within Indonesia and the politically charged nature of the subject matter at hand which had attracted heightened international media attention at the time (Emont, 2023; Goodman, 2023; Hidayat et al., 2022; Tan, 2023), there was a general unwillingness amongst relevant stakeholders to engage with initial cold contact. Leveraging relationships built within my host organisations, I was put in touch with a variety of stakeholders both specific to the nickel mining and processing Industry and more broadly in the energy, climate and development space. It should be noted that for those stakeholders where pre-existing relationships had not been established, I was unable to secure interviews – a majority of these stakeholders were Chinese nickel mining and processing companies.

I was based primarily in Jakarta, the administrative and business capital of Indonesia and conducted meetings and interviews with "expert stakeholders". The interviewees had gained knowledge on the topics of nickel mining and processing in Indonesia based on their professional, personal and educational experiences (Schmidt et al., 2016). These interviewees (n = 15) included representatives from government departments, state owned enterprises, policy think tanks, development agencies, multilateral development banks, mining companies and NGOs. As participants opted to remain anonymous, their identities and affiliations to particular organisations is not provided here.

Although it would have been preferred to speak directly with impacted communities, given time constraints, Indonesia's complex research permitting process, additional financial and administrative requirements for conducting research with vulnerable communities (including interpreters and an Indonesian university research collaborator) (Wahyono, 2022), it was decided that interviews with expert stakeholders in the form of NGOs that have worked directly with impacted communities could be used as a proxy voice for these communities. Overall, 15 semi-structured exploratory interviews and meetings were conducted with the stakeholders

mentioned above, with 5 of those stakeholders being NGOs representing affected communities. In order to create a confidential atmosphere so they could express their opinions and share insights beyond the framing of the institution they were part of, the experts' identities and organisations are not provided (Schmidt et al., 2016; Yin, 2011). An interview guide with open ended questions was tailored to each interviewee's expertise and stakeholder class (e.g. NGO, government, company) (Knox-Hayes et al., 2021). A sample interview guide for an NGO stakeholder is provided in Appendix 11.1. The interviews range between 30 minutes to 2 hours, with some stakeholders preferring a conversational format while others followed a more prescriptive question and answer format.

I also undertook a field visit to an Industrial Park in Sulawesi, where a majority of Indonesia's nickel mining and processing industry is located (Heijlen & Duhayon, 2024a). This field visit took place in the middle of the interviewing period and as such allowed for direct observation of the dynamics and impacts of the industry relayed by stakeholders while also allowing for further explanation and validation of the observations by the remaining stakeholder interviews (Flick, 2004).

Analysis of interview data using grounded theory approaches involves a two-step coding process, open coding to identify themes arising within interview data and a second step of focused coding to identify common themes within the data (Charmaz & Belgrave, 2012). Qualitative data analysis software NVivo was used to code interview transcripts (Chun Tie et al., 2019). I initially engaged in open coding, tracking in the raw interview data to identify high level themes. I then engaged in focused coding, identifying which themes were mentioned more frequently and which themes could be clustered and consolidated to develop overarching themes.

4 Indonesian Nickel to EV Supply Chain

4.1 History of Indonesia's Nickel Industry

Nickel has been commercially mined in Indonesia since the mid 20th century. Under the Suharto Government, Indonesia's mining policies sought to move away from nationalism towards a legal architecture that encouraged foreign investment in Indonesia's mineral resources. These Contract of Work (CoW) arrangements held 30-year terms and provided large tax incentives and guarantees of no nationalization (McCarthy & Robinson, 2016). By the end of the 20th century, Indonesia was one of the world's leading nickel, tin and copper producers but was still primarily exporting raw ore resources (Devi & Prayogo, 2013). Around this time, with a new government, Indonesia moved towards decentralization, shifting the responsibility of mineral resources towards district governments in response to growing critique that the benefits of these foreign investment projects should be flowing to Indonesia rather than abroad (McCarthy & Robinson, 2016).

In 2009, the government introduced the Law 4/2009 on Mineral and Coal Mining, moving towards a system of license for foreign investors and removed tax stability as was provided in the Contract of Work arrangements (Devi & Prayogo, 2013; McCarthy & Robinson, 2016). Under this law, local governments were allowed to issue mining business permits, resulting in the issuance of hundreds of nickel permits across Indonesia. This triggered a dramatic increase in Indonesian nickel ore mining and exports, with Indonesia's nickel exports peaking in 2013 and Indonesia became the largest supplier of nickel ore to Indonesia, accounting for 50% of Indonesia's supply (Sangadji et al., 2023).

The 2009 mining law also introduced domestic processing requirements requiring companies to process minerals domestically before exporting. A raw export ban on nickel ore was

instituted in 2014, with the ban being relaxed in 2017, allowing for the export of ore with <1.7% contained nickel, before a total raw ore export ban in 2019 (World Trade Organization, 2022). These recent policy changes have been part of the Indonesian government's broader efforts to extract more value from its nickel resources by developing domestic capability in downstream operations including processing and refining to produce more high value nickel products for export (Maghfiroh et al., 2021).

The first governmental regulation issued regarding Indonesia's EV industry was the *Presidential Decree No.55 of 219 on Accelerating Programs of Battery Electric Vehicles for Road Transportation,* which aims to accelerate the country's domestic EV production and deployment (Presidential Regulation (Perpres) Number 55 of 2019 Concerning the Acceleration of Battery Electric Vehicle Program for Road Transportation, 2019). The regulation included local content requirements for EV manufacturers in Indonesia, allowing battery component exports for a certain period after establishing an EV manufacturing plant and fiscal and non-fiscal incentives including tax exemptions for companies in the EV industry (Huber, 2022).

To have a more strategic role in the management of Indonesia's mineral resources, the Indonesian government established MIND ID in 2019, a state-owned holding company with stakes in Indonesia's major mining companies involved in the mining and processing of key commodities including coal, bauxite, copper, nickel ore, bauxite, aluminum, gold and ferronickel (MIND ID, 2024). In March 2021, the Indonesian government along with four of Indonesia's major energy and mining state owned enterprises signed an agreement to form the Indonesia Battery Corporation (IBC), with aim of supporting Indonesia to become a global EV battery producer. In a similar vein to the export ban, the IBC is seeking to maximize value from Indonesia's nickel resources by creating integrated upstream and downstream supply chains

that will begin producing feedstock materials for battery precursor material production with the ambition of building domestic capability for products including EV battery packs and 2-wheeler electric motorcycle manufacturing for the Indonesian market (Indonesia Battery Company, 2024).

In 2022, global mined nickel production grew by 20%, almost exclusively due to increased nickel production in Indonesia owed to the rise of integrated NPI and stainless-steel processing projects in Indonesia (McRae, 2023). Prior to the first raw export ban in 2014, Indonesia had only two nickel processing sites in operation, both pyrometallurgical nickel smelters producing 25 kilotons of refined nickel products (Huber, 2022). Since then, Indonesia's refined nickel production has grown dramatically to over 1,200 kilotons with a focus on the production of nickel products for stainless steel production, with 33 nickel smelters in operation at the end of 2022 (Ministry of Energy and Mineral Resources (ESDM), 2023). It is estimated that the value of Indonesia's nickel products exports grew to over $20 billion in 2022, from $1 billion in 2015 (Reuters, 2023b). Further, in an attempt to shift further investment into producing higher quality and more value-added nickel products particularly in the EV supply chain, the government is considering limiting the construction on new NPI and ferronickel smelters for stainless steel and cutting tax incentives for NPI projects (Nangoy & Sulaiman, 2023; Reuters, 2023a).

4.2 Nickel Processing Projects for EV Supply Chains

Indonesia's nickel to EV ecosystem has only recently ramped up since the 2019 raw export ban and EV industry presidential decree, with several processing facilities along the EV supply chain being developed (Huber, 2022). These facilities are also utilizing several novel processing techniques that have only been widely commercialized since their introduction in Indonesia. Table 2 details out the sites, their ownership structure, production status, capacity,

processing method, energy and ore source and customers (where they have been made publicly available). It should be noted that this table contains projects that are either operational or under development. With regards to projects under development, only those that have at minimum had investment in a joint venture were included. Projects with non-binding agreements in place such as a memorandum of understanding or memorandum of agreement were not included. While other studies have sought to collect data on nickel smelting projects in Indonesia, they do not differentiate between projects intended for the stainless-steel industry or EV industry (Heijlen & Duhayon, 2024a; Petromindo, 2023). Given that pyrometallurgical nickel products including NPI, ferronickel and nickel matte have predominately been used in stainless steel production (Schmidt et al., 2016), projects that specifically directed supply towards the EV supply chain were included and these projects were those that as a minimum were producing nickel matte as a final product.

Table 2: *Operating and in development nickel processing projects for the EV industry in Indonesia.*
References: *Table 1 and Appendix* ***Error! Reference source not found.***
Abbreviations: *RKEF = Rotary Kiln Electric Furnace, Inco RKEF = Sulfidation occurs at RKEF stage, OESBF = Oxygen Enriched Side Blown Furnace, NPI = Nickel Pig Iron, HPAL = High Pressure Acid Leaching, MHP = Mixed Hydroxide Precipitate, FeNi = Ferronickel, $NiSO_4$ = Nickel Sulphate, $CoSO_4$ = Cobalt Sulphate, IMIP = Indonesia Morowali Industrial Park, IWIP = Indonesia Weda Bay Industrial Park (IWIP), FID = Final Investment Decision, JV = Joint Venture*

Site	Region	Status	Year Operational	Company Ownership & Country of Origin	Capacity ('000 metric tonnes)	Energy Source	Process	Final Product	Ore Source	In Industrial Park?	Customers
Sorowako	East Luwu Regency South Sulawesi	Operational	1978	PT Vale Indonesia (100%) - Indonesia, Canada, Japan	**75**	Hydropower + Diesel Generator	Inco RKEF	Nickel Matte	Sorowako Mine (Saprolite)	No	Vale Canada Sumitomo Metal Mining Co. Ltd
PT Youshan Nickel Indonesia	Halmahera Island North Maluku	Operational	2020	Chengtun Mining Group (35.8%) - China Tsingshan Group (35%) - China Zheijan Huayou Cobalt (29.3%) - China	43	Coal	RKEF (NPI) + Sulfidation	Nickel Matte	Weda Bay Nickel Mine (Saprolite)	IWIP	Not Public
Halmahera Persada Lygend	Obi Island North Maluku	Operational	2021	Harita Nickel (45,1%) - Indonesia, China Lygend Resources Technology. (36.9%) - China Kang Xuan (18%) - China	120	Coal	HPAL + Secondary Refining	MHP $NiSO_4$ $CoSO_4$	Weda Bay Nickel Mine (Limonite)	IWIP	GEM China CATL
Smelter Nikel Indonesia	Banten Java	Operational	2021	PT Smelter Nikel Indonesia (100%) - Indonesia	76	Coal	HPAL	MHP	PT. Total Prima Indonesia (Limonite)	No	Unknown
PT Huaye Nickel Cobalt	Morowali South Sulawesi	Operational	2021	Zheijan Huayou Cobalt (57%) - China CMOC (30%) - China Nickel Industries (10%) - Australia Others (3%) - China	60	Coal + Planned Solar	HPAL	MHP	Hengjaya Mine (Limonite)	IMIP	Not Public
PT Huake	Halmahera Island North Maluku	Operational	2022	Zheijan Huayou Cobalt (70%) Tsingshan Group (30%)	45	Coal	RKEF (FeNi) + Sulfidation	Nickel Matte	Weda Bay Nickel Mine (Saprolite)	IWIP	Not Public
PT QMB New Energy Materials	Morowali Regency Central Sulawesi	Operational	2022	GEM (63%) - China Tsingshan Group (10%) - China Brunp (member of CATL, 10%) - China ECOPRO (9%) - South Korea Hanwa (8%) - China	50	Coal	HPAL	MHP	Hengjaya Mine (Limonite)	IMIP	Not Public
Hengjaya Nickel	Morowali Regency Central Sulawesi	Operational	2022	Nickel Industries (80%) - Australia Tsingshan Group (20%) - China	20	Coal + Planned Solar	Inco RKEF	Nickel Matte	Hengjaya Mine (Saprolite)	IMIP	Glencore
Huafei Project	Halmahera Island North Maluku	Operational	2024	Tsingshan Group (31%) - China Zheijan Huayou Cobalt (20%) - China EVE Energy (17%) - China Glaucous International (30%) - Singapore Lindo Investment (2%) - Singapore	120	Coal	HPAL	MHP	Weda Bay Nickel Mine (Saprolite)	IWIP	Not Public
CNGR Weda Bay	Halmahera Island North Maluku	Operational	2024	CNGR Advanced Material (70%) - China Rigqueza International (30%) - Singapore	40	Coal	OESBF	Nickel Matte	Weda Bay Nickel Mine (Limonite)	IWIP	Tesla
PT Bumi Mineral Sulawesi	Luwu Regency South Sulawesi	Construction (2022)	2024	Kalla Group (100%) - Indonesia	22	Hydropower	RKEF (FeNi) + Sulfidation	$NiSO_4$	PT Mitra Karya Agung Lestari (Saprolite)	Kalla Green Industrial Park	POSCO Holdings

Site	Region	Status	Year Operational	Company Ownership & Country of Origin	Capacity ('000 metric tonnes)	Energy Source	Process	Final Product	Ore Source	In Industrial Park?	Customers
PT HLI Green Power	Karawang West Java	Pre-Production	2024	Hyundai (47.5%) - South Korea LG Energy Solutions (47.5%) - South Korea IBC (5%, plan to expand to 40%) - Indonesia	10 GWh (+20GWh expansion)	Grid Sourced	Unknown	NCMA Battery Cell	Planned Feni Haltim Industrual Park (East Halmahera)	Kawarang International Industrial City	Hyundai Motor Group LG Energy Solutions
Angel Nickel Project	Halmahera Island North Maluku	Pre-Production	2024	Nickel Industries (80%) - Australia Shanghai Decent (20%) - China	24	Coal	Inco RKEF	Nickel Matte	Hengjaya Mine (Saprolite)	IWIP	Golden Harbour International Pte. Ltd Tsingshan Group
PT Ceria Nugraha Indotama	Kolaka Regency South East Sulawesi	Construction (2023)	2024	Ceria Group (100%) - Indonesia	75	Grid Sourced	RKEF (FeNi) + Sulfidation	Nickel Matte	CERIA Lapao-Pao Block Mine (Saprolite)	No	Unknown
PT Nicole Metal Industry	Halmahera Island North Maluku	JV (2023)	2025	POSCO Holdings (49%) - South Korea IBC (51%) - Indonesia	55	Unknown	RKEF	Nickel Matte	Weda Bay Nickel Mine (Limonite)	IWIP	POSCO Holdings
PT Kolaka Nickel Indonesia	Kolaka RegencySouth East Sulawesi	Construction (2022)	2025	Zheijan Huayou Cobalt (53%) - China PT Vale Indonesia (30%) - Indonesia, Canada, Japan Ford (17%) - United States	120	Natural Gas	HPAL	MHP	Pomalaa Mine (Saprolite)	No	Huaqi Singapore Ford PT Vale Indonesia
PT Pomalaa New Energy Material	Kolaka Regency South East Sulawesi	JV (2023)	2025	CNGR Advanced Material (70%) - China ANTAM (30%) - Indonesia	80	Natural Gas + Coal	OESBF	Nickel Matte	Pomalaa Mine (Limonite)	No	Unknown
Excelsior Nickel Cobalt Project	Morowali Regency Central Sulawesi	FID (2023)	2025	Nickel Industries (55%) - Australia Shanghai Decent (45%) - China	72	Coal + Planned Solar	HPAL + Secondary Refining	MHP $NiSO_4$	Hengjaya Mine (Limonite)	IMIP	Unknown
Sonic Bay	Halmahera Island North Maluku	FID (Q2 2024)	2026	Eramet - France BASF - China	67	Coal + Planned Solar	HPAL	MHP	Weda Bay Nickel Mine (Saprolite)	IWIP	Unknown
Huaxiang Refining Indonesia	Halmahera Island North Maluku	JV (2023)	2026	Zheijan Huayou Cobalt (49%) - China Strive Investmebt Capital (49%) - Singapore Lindo Investment PTE (2%) - Singapore	50	Unknown	HPAL + Secondary Refining	$NiSO_4$	Weda Bay Nickel Mine (Saprolite)	IWIP	Not Public
PT Ceria Nugraha Indotama HPAL	Kolaka Regency South East Sulawesi	FID (2023)	2026	Ceria Group (100%) - Indonesia	120	Grid Sourced	HPAL	MHP	CERIA Lapao-Pao Block Mine (Limonite)	No	Unknown
PT Huali Nickel Project	East Luwu Regency South Sulawesi	Construction (2023)	2027	Zheijan Huayou Cobalt - China PT Vale Indonesia - Indonesia, Canada, Japan	60	Natural Gas	HPAL	MHP	Sorowako Mine (Saprolite)	No	Unknown

Currently, there are 10 nickel EV processing projects that are operational and 12 projects under different stages of development. These projects are mainly producing two intermediate materials in the EV supply chain – MHP (54% capacity) and nickel matte (46% capacity) which are primarily exported to be further refined into battery grade nickel sulphate. Nickel matte projects utilize saprolite ore, whereas MHP projects utilize limonite ore. However, there are projects beginning to develop secondary refining capability to produce nickel sulphate in Indonesia. This includes the already operational Halmahera Persada Lygend and projects under development including Excelsior Nickel Cobalt, Huaxiang Refining Indonesia and PT Bumi Mineral Sulawesi. These sulphate projects (except for PT Bumi) all have some level of investment from Tsingshan Holding Group, the world's largest nickel company which first commercialized both NPI and MHP production from laterite ores in Indonesia (Foss & Koelsch, 2022). There is also one battery cell plant in development, PT HLI Green Power, developed by Hyundai, LG Energy Solutions and Indonesia Battery Corporation which will begin production of NCMA (Nickel Cobalt Manganese Aluminum) battery cells by mid-2024 (LG Energy Solution, 2023).

As shown in Figure 5, most projects are located on Sulawesi and Halmahera Island where a majority of Indonesia's laterite nickel reserves are located. In addition to the broader regional environmental risks mentioned in Section 2.3, these provinces were specifically identified by the UN Institute for Environment and Human Security as having the highest overall risk in Indonesia (Sett et al., 2022). The levels of climate-related and natural-disaster induced hazards were found to be amongst the highest in these regions, owed to the primarily rural landscape of the region and underdevelopment of infrastructure (Sett et al., 2022). Risk of future drought to due to decreases in rainfall levels and existing water scarcity as well and geophysical hazards are particularly expected to be heightened (Climate Rights International, 2024; Sett et al., 2022; Supriatna et al., 2020). In addition, Sulawesi is characterized by high levels of inequality, with

marginal groups in rural areas (where a majority of these sites are located) already facing disproportionate access to assistance and health services which will be further exacerbated due to such hazards (Sett et al., 2022). Maluku is characterized by high levels of overall economic vulnerability as many people rely on food and goods markets for income and as such as particularly vulnerable to extreme income loss when faced with livelihood shocks on agricultural land and livestock (Sett et al., 2022).

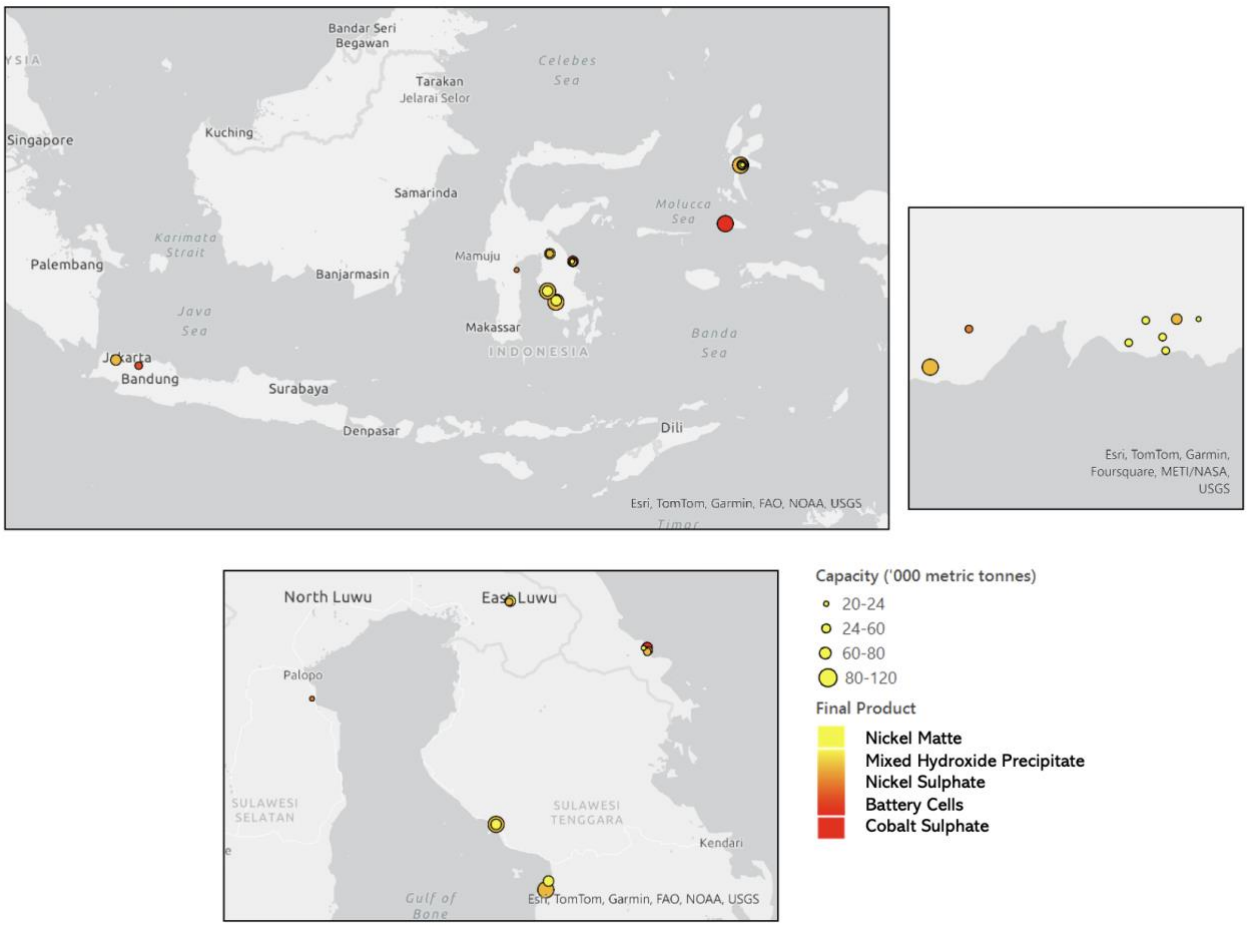

Figure 5: *Map of Indonesia's nickel processing sites for the EV supply chain, including capacity and products made*

In addition, these islands also host Indonesia's two largest industrial parks, Indonesia Morowali Industrial Park (IMIP) and Indonesia Weda Bay Industrial Park (IWIP) (Tritto, 2023). Many of the facilities lease blocks in these industrial parks to allow them to access the industrial park's centrally managed energy sources, ore reserves, port facilities and tailings management (Tritto, 2023). Facilities with majority Chinese ownership are powered by captive coal fired power

stations, while those with ownership by companies from the West including PT Vale, Nickel Industries, Eramet, BASF and Ford are planning to diversify their energy sources to include Natural Gas or Solar. As Indonesia's state owned mining holding company MIND ID (MIND ID, 2024) seeks to reach net zero emissions by 2060 and Indonesian companies seek to court non-Chinese markets for their products (Tempo English, 2023), it can be observed that projects with investment from Indonesian sources also follow this trend or are seeking to be grid connected with the aim of capitalizing from the increasing renewable capacity they expect to come online (Myllvirta et al., 2024). These grid connected projects are located on Java Island where majority of the state owned utility, PLN's transmission infrastructure and generation capacity are located (Parapat & Hasan, 2023). There also projects with intended grid connection under development in Sulawesi, where PLN is seeking to improve transmission infrastructure across the island and seeking to provide renewable energy certificates to processing facilities seeking renewable energy supply (PT PLN Persero, 2022).

4.3 Key Stakeholders

4.3.1 Industrial Stakeholders

Industrial Stakeholders in this case includes mining companies, companies specializing in nickel processing, battery cell companies, Industrial Parks and EV manufacturing companies. Currently, Tsinsghan has the highest proportion of direct ownership in currently operational nickel processing projects, accounting for 12% of current capacity. Tsingshan is also majority owner of both of Indonesia's two largest industrial parks, Indonesia Morowali Industrial Park and Indonesia Weda Bay Industrial Park (Tritto, 2023). (Sangadji et al., 2023). Zheijan Huayou Cobalt, one of the largest producers of cobalt products (Sangadji et al., 2023) is expected to overtake Tsingshan if their projects in the pipeline reach completion, with Zheijan accounting for 16% of total capacity.

Further, many companies that have historically had nickel mining operations in Indonesia including ANTAM, PT Vale Indonesia and Nickel Industries have also established processing facilities, vertically integrating ore supply into their processing facilities. It should also be noted that the majority of investment into these nickel facilities is by Chinese owned companies. These investments are from Chinese players along the nickel and EV supply chains, such as major stainless-steel producer Tsingshan, pre-cursor material companies such as Zheijan and CNGR Advanced Materials, to CATL, the world's largest battery manufacturer (Foss & Koelsch, 2022; Sangadji et al., 2023). Major non-Chinese EV and battery companies which are also some of the world's top producers are making direct investments in the Indonesian nickel processing industry, including investments from Hyundai, LG Energy Solutions and Ford (International Energy Agency, 2023d). An overview of companies involved in each step of the Indonesian nickel to EV supply chain are shown in Figure 6.

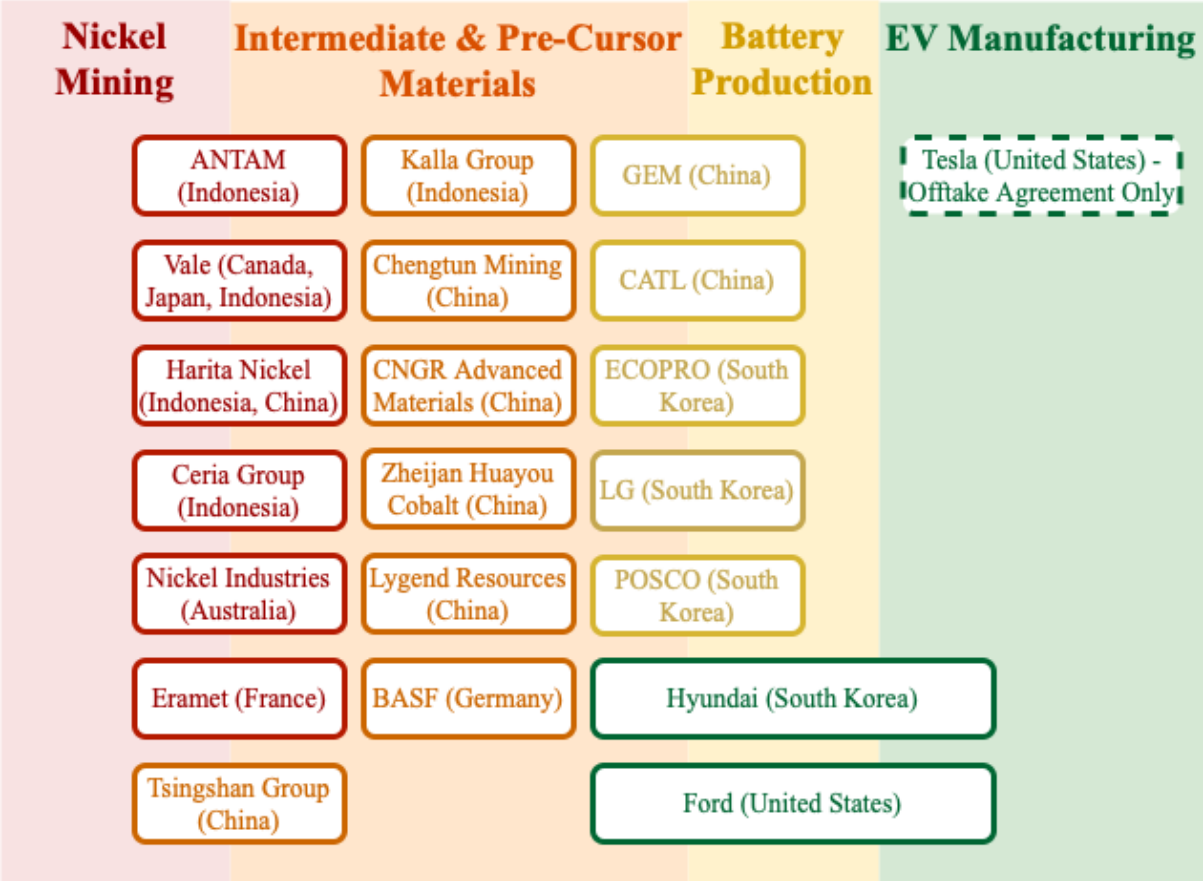

Figure 6: *Major industrial players with direct stakes in Indonesia's nickel to EV supply chain**

**The color of the company name corresponding with the process in which they typically participate with. Companies positioned between multiple processes denotes which aspects of the supply chain they have direct ownership of assets in (e.g. ANTAM which typically specializes in mining has direct ownership in both nickel mining and processing facilities in Indonesia).*

It should be noted that Tesla does not have direct ownership in Indonesian nickel but does have an offtake agreement with CNGR Advanced Materials for nickel precursor material from their Indonesian operations. While other major EV companies do not have direct offtake agreement or ownership in Indonesian assets, many have agreements with battery companies that own Indonesian nickel processing assets. For example, CATL's customers include Tesla, Toyota, Honda and BMW (Brown & Harris, 2024; Sangadji et al., 2023). ECOPRO's customer is Samsung which produces battery cells that are then sold to Volvo, Volkswagen and BMW while LG Energy Solution's (which is a customer of Huayou Nickel Cobalt and Posco) customers include Volvo, Tesla, Volkswagen, Audi, Hyundai, Ford, Kia and General Motors (Brown & Harris, 2024; Sangadji et al., 2023). As such, it can be observed that major international companies involved in the EV supply chain have built strategic relationships to secure battery

materials for their products, this has taken the form of direct ownership, offtake agreements or other supply contracts, with most major players having some sort of reliance on Indonesian nickel and its subsequent products (International Energy Agency, 2022b).

4.3.2 Government & State-Owned Enterprises

Several government bodies are involved in driving the development of Indonesia's nickel to EV industry, ranging from perspectives of international trade and investment, management of natural resources reserves, environmental standards, special permitting on and near small islands, forests and oceans and employment. As such some of the key ministries involved include:

- **Coordinating Ministry of Maritime and Investment Affairs (MARVES):** was established in 2019 under the *Presidential Regulation (Perpres) Number 92 of 2019 concerning the Coordinating Ministry for Maritime Affairs and Investment* and is responsible for 'coordinating, synchronizing and controlling the affairs of the Ministry is administering government functions in the maritime and investment sector (Presidential Regulation (Perpres) Number 92 of 2019 Concerning the Coordinating Ministry for Maritime Affairs and Investment, 2019). The following ministries fall under MARVES:
    - **Ministry of Energy and Mineral Resources (MEMR):** Under the *Presidential Regulation of the Republic of Indonesia No. 68 of 2015 concerning the Ministry of Energy and Mineral Resources* and the *Regulation of the Minister of Energy and Mineral Resources No. 15 of 2021 concerning the Organization and Work Procedure of the Ministry of Energy and Mineral Resources*, the duties of MEMR includes 'organizing government affairs in the field of energy and mineral resources' with functions including policy formulation and

implementation, technical guidance and research and development in energy, mineral resources, geology and electricity (Ministry of Energy and Mineral Resources, 2024). Within MEMER there are the Directorate General of mineral and Coal and Human Resources Development Agency of Energy and Mineral Resources which are primarily focused on activities regarding minerals including nickel.

  - **Ministry of Environment and Forestry**: Under the *Presidential Regulation Number 92 of 202on the Ministry of Environment and Forestry,* it is responsible for the conservation and management of Indonesia's forests and administers permits for forest use in Indonesia as well as developing policies and regulations on pollution, hazardous and toxic waste materials and forest rehabilitation (Ministry of Environment and Forestry, 2022). It also administers, AMDAL – the Environmental Impact Assessment procedure required for business activities in Indonesia.

- **Ministry of Investment/Indonesia Investment Coordinating Board (BKPM):** was established in 2021, upgrading from bureaucratic agency status into a Ministry with the mandate of boosting domestic and foreign direct investments and introducing reforms to enhance the ease of doing business in the country (UN Trade and Development, 2021).

In addition to ministries, Indonesia has established state owned enterprises focused on increasing Indonesian ownership and involvement in the nickel and EV industries. These include:

- **MIND ID:** established in 2019, MIND ID is a state-owned holding company with stakes in Indonesia's major mining companies including a 65% ownership stakes in

ANTAM, Indonesia's main nickel mining company, 65% ownership in Bukit Asam, one of Indonesia's main coal mining, processing and power plant companies (MIND ID, 2024) and it has also sought to recently acquire a 14% share in PT Vale Indonesia (Nangoy & Christina, 2024).

- **Indonesia Battery Corporation:** was formed in 2021 with the aim of supporting Indonesia to become a global EV battery producer. It is a consortium of four state-owned enterprises, including Oil and Gas company Pertamina, Indonesia's electricity utility PLN, MIND ID and ANTAM. As seen in Table 2 it has made strategic investments along the nickel to EV supply chain in Indonesia, forming joint ventures with international battery and EV companies including LG Energy Solutions and CATL. The company seeks to create domestic integrated upstream and downstream nickel to EV supply chains through direct investment, capability and knowledge building (Indonesia Battery Company, 2024).

4.3.3 Civil Society Organisations

International multinational development banks like the World Bank and Asian Development Bank are yet to make investments in sustainable development on Indonesia's nickel industry but have been involved in driving investment towards Indonesia's natural resources and energy and driving decarbonization efforts by supporting initiatives such as the Just Energy Transition Partnership along with the UN Development Program. The UNDP has previously looked at the mining industry and its impacts on the community and environment including the impacts of artisanal mining (UNDP Indonesia, 2019). Their institutional knowledge in facilitating international climate and energy finance to the region is nevertheless valuable in driving the future of this industry.

Several Indonesian environmental NGOs have been involved in conducting in depth investigations, campaigns and advocacy around Indonesia's nickel industry. With networks and offices in the regions that are directly impacted by many of these nickel mining and process operations, they work closely with indigenous communities, local communities, mining workers and have conducted detailed assessments of these operations. Some NGOs active in nickel include:

- **WALHI (Indonesian Forum for Living Environment):** Indonesia's largest and oldest environmental advocacy NGO. WALHI lead the campaign to deliver an open letter to Tesla to not invest in Indonesia's nickel industry (WALHI, 2023).
- **JATAM (Mining Advocacy Network):** working on issues relating to human rights, the environment, indigenous people and social justice in relation to the mining, oil and gas sectors (JATAM, 2023).
- **AEER (Action for People Ecology and Emancipation):** focusing on emissions reduction in the energy sector in Indonesia with a focus on coal retirement, climate and energy finance, energy democracy, transition minerals and public transport (AEER, 2023).
- **Trend Asia:** conducts research and advocacy campaigns with a focus on the just energy transition, community welfare and intergenerational justice (Trend Asia, 2023).
- **Greenpeace Indonesia:** with a historical focus on deforestation, biodiversity protection, indigenous communities and fisheries, Greenpeace has also begun research and advocacy work into nickel (Greenpeace Indonesia, 2023).

4.4 Processing Routes and Products

Based on the data collected in Table 2, the nickel products exported from Indonesia for use in the EV supply chain include intermediate products such as MHP and Nickel Matte, Class 1

nickel product nickel sulphate and battery cells. As shown in Figure 7, saprolite ores are processed using various pyrometallurgical techniques while limonite is processed using hydrometallurgical processing technique HPAL. Intermediate products have begun to also undergo further refining in Indonesia and Indonesia's first battery cell plant is also set to begin production this year.

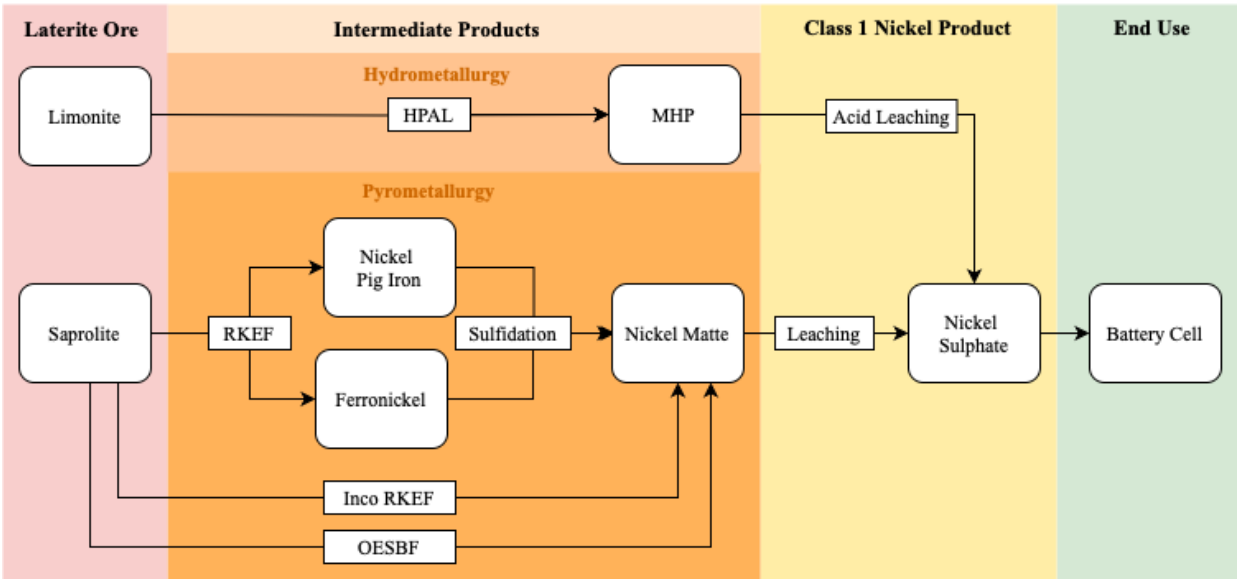

***Figure** 7: Overview of nickel processing routes and products for Indonesia's EV supply chain*

4.4.1 Nickel Matte Production: Pyrometallurgical Techniques

Saprolite ore has been pyrometallurgically processed in Indonesia since the 1970s, typically having been processed to the NPI or ferronickel stage before being exported for stainless steel production (Eckelman et al., 2012; Suherman & Saleh, 2018). Rotary Kiln Electric Furnace (RKEF) technology is typically used to produce NPI and ferronickel products (Norgate & Jahanshahi, 2011). As demand for battery products has grown, Indonesia has sought to ramp up its production of nickel matte, which is a precursor material for producing battery grade nickel sulphate (Foss & Koelsch, 2022). This has taken on two routes, direct production of nickel matte or 'flexible' production of nickel matte from typical class 2 nickel products of NPI and ferronickel.

The direct production of nickel matte through modifications to the typical RKEF process which involves sulphidation at the beginning of the process, to make low grade intermediate nickel matte which is then further refined using different converter technologies to produce finished high grade nickel matte (Crundwell et al., 2011a). The 'flexible' production method involves the production of NPI or ferronickel through RKEF as an intermediate product, which is then converted into nickel matte via sulphidation. The second process potentially allows nickel producers who are seeking to sell both to the stainless steel and EV customers to be more responsive and adaptive to fluctuations in product demand and prices for both industries (Campagnol et al., 2021).

RKEF and Sulphidation: Nickel Matte production from NPI/ferronickel

While RKEF production of NPI and ferronickel is well established, the further step of 'converting' these products into nickel matte, first developed by Société Le Nickel, New Caledonia, has been modified and made more commercially available by Tsingshan since it started producing nickel matte at its Indonesian facilities in 2021 (Foss & Koelsch, 2022). The additional step involves adding elemental Sulphur to NPI or ferronickel in a converter where it is blown with air to produce high grade nickel matte (Racanelli, 2021). The full process is detailed in Figure 8.

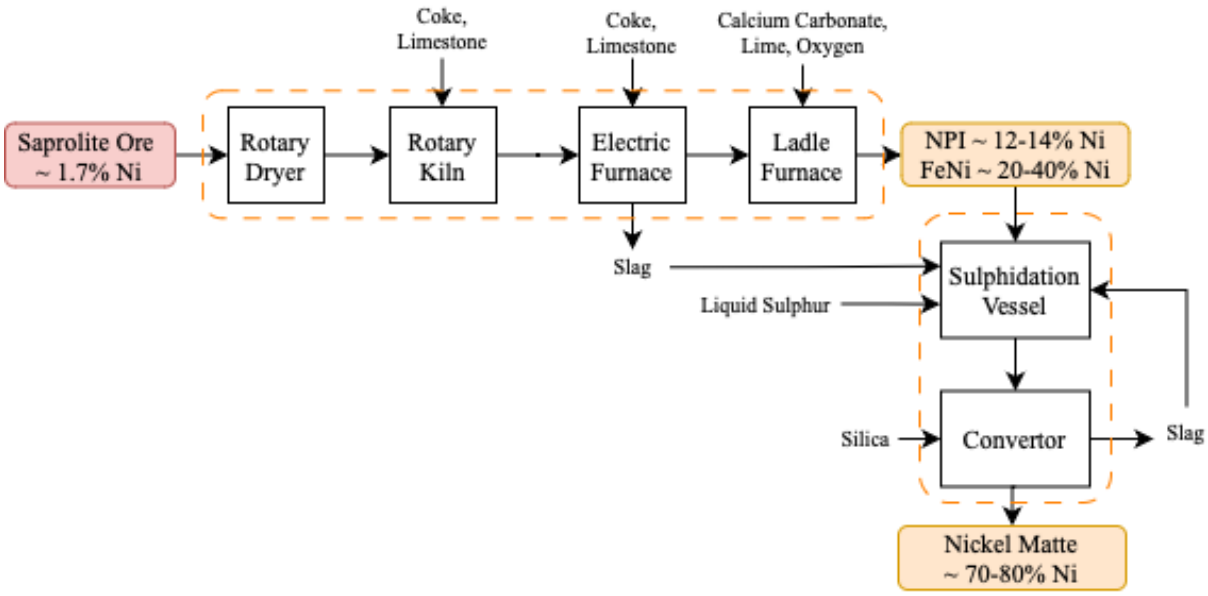

Figure 8: *Rotary kiln electric furnace production of NPI and ferronickel + sulfidation for nickel matte production*

The steps include (Bodley et al., 2023; Crundwell et al., 2011d, 2011c; Haziq Uddin, 2020; Racanelli, 2021):

- **Ore Preparation:** A rotary dryer reduces moisture content in the ore from 35% to 20-23% and removes volatile impurities.
- **Rotary Kiln Reduction:** The prepared ore is heated to 300°C to remove residual water in the ore, then to 600°C where it undergoes calcination to remove crystal water and finally it is heated to 750-900°C along with coke and limestone for pre-reduction to produce calcine.
- **Electric Furnace Smelting:** Calcine is heated with coke and limestone to 1600°C which causes the nickel and iron in the calcine to be further reduced and separated from slag. The resulting product is molten crude ferronickel or NPI.
- **Ladle Furnace Refining:** These crude ferronickel or NPI products are further refined by the addition of calcium carbonate, lime and oxygen, removing excess impurities including phosphorus, carbon, silicon and Sulphur.

    - After this stage, if the products are not being directed towards matte production, they can be cast into ingots or granulated. This is also the stage at which the RKEF process can be decoupled from the sulfidation process, allowing for the use of solid NPI/ferronickel products from other sites or from stockpiles.
- **Sulphidation Vessel:** Liquid NPI/ferronickel is tapped into a sulphidation vessel where liquid Sulphur is injected alongside air. Here, Iron is further oxidized and removed, with the extent of oxidation depending on the incoming composition of the feed material. Typically, NPI will require more iron and impurities to be removed compared to ferronickel.
- **Finishing Vessel/Convertor:** Oxygen is blown in to oxidize any remaining iron and silica flux is added to flux the oxidized iron which is then slagged away.

The RKEF process using saprolite ores is highly energy intensive, with Tsingshan's RKEF NPI process requiring more than 500kWh of energy per ton of feed (Racanelli, 2021). The emissions intensity of processing laterite ores in this way amounts to almost 60 t CO_2 per ton of nickel (International Energy Agency, 2022c), triple the emissions intensity of the MHP process. In addition, the process generates high levels of Sulphur dioxide and particulate matter emissions and extra capital costs to install a Sulphuric acid plant to reduce these emissions would be required (Racanelli, 2021). S&P Global estimates that the operating cost of producing nickel matte sits at around $7,300/t for NPI production using RKEF and between $1,000 and $4000/t for NPI to matte conversion, resulting in an average operating cost of $9,800/t for producing nickel matte from saprolite ore using this process (Sappor, 2021).

PT Inco Process: Sulphidation at RKEF

This process was developed by Vale and has been commercially producing nickel matte since 1978 (PT Vale Indonesia, 2023). What makes it different from the above process is that

sulphidation occurs at the RKEF process, as such producing an intermediate furnace matte product instead NPI or ferronickel (Crundwell et al., 2011c). The furnace matte is then blown with air in a converter to oxidize and separate iron to produce high grade nickel matte. This process has been adopted by PT Vale's Sorowako Smelter and has been adopted by Nickel Industries at their existing RKEF smelters which have undergone modifications for this process (Nickel Industries, 2023a; PT Vale Indonesia, 2023). The full process is detailed in Figure 9.

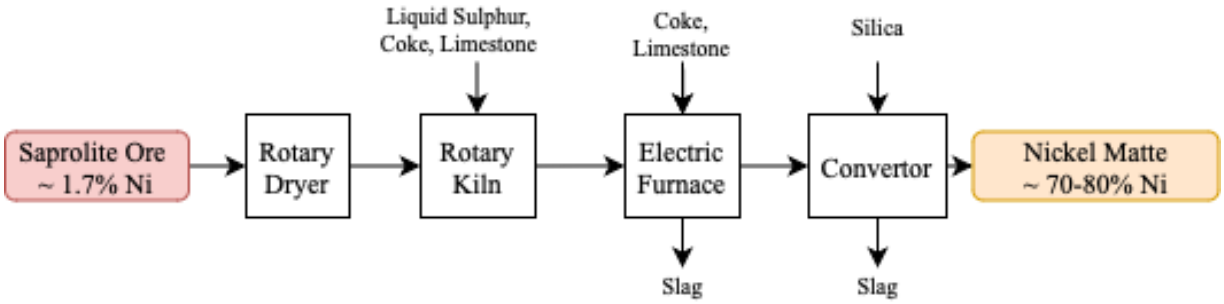

Figure 9: *PT Inco process for nickel matte production*

The steps include (Bodley et al., 2023; Crundwell et al., 2011d, 2011c; Haziq Uddin, 2020; Nickel Industries, 2023a; PT Vale Indonesia, 2023; Racanelli, 2021):

- **Ore Preparation:** A rotary dryer reduces moisture content in the ore from 35% to 20-% and removes volatile impurities.
- **Rotary Kiln Reduction:** The dried ore is progressively heated as detailed in the RKEF process above, however at the final pre-reduction stage liquid Sulphur is injected, whereby the Sulphur combines with iron and nickel to form iron nickel sulphide.
- **Electric Furnace:** The resulting calcine is heated to 1,500 ºC, slag is skimmed from the furnace and disposed, while furnace matte (25-28% Ni) is tapped as required by the convertor.
- **Pierce-Smith Convertor:** is used to remove iron. Molten furnace matte has oxygen blown in to oxidize any remaining iron. Silica is added to flux the oxidized iron which

is slagged away. The final product is liquid Bessemer matte (78% Ni) which can then be solidified to produce nickel matte granules.

This process is a more efficient way of producing nickel matte as it is less energy intensive and allows for the use of lower quality coal (high in Sulphur) as a reductant in the RKEF process (Racanelli, 2021). However, product flexibility is reduced as the RKEF line needs to undergo modification and the matte is produced directly from the RKEF line (Nickel Industries, 2023a). The capital cost to modify an existing RKEF line as reported by Nickel Industries is about $1 million per line and the addition of the convertor process is around $100 million (Nickel Industries, 2023c) resulting in an additional operating cash cost of $2,000/ton (Nickel Industries, 2023a). The company also reported a margin of $5,950/ton of nickel matte sold (Nickel Industries, 2023a).

Oxygen Enriched Side Blown Furnace

This process of producing nickel matte from saprolite ores has only recently been used commercially, with the first operational facility being open in Indonesia by CNGR Advanced Materials in 2023 (CNGR Advanced Material Co. Ltd., 2023). It should be noted that there is a lack of academic literature outlining the process, probably due to the fact that this technology is currently only being used by CNGR and is in its early stages of commercialization. Based on the patent filing by Hunan Brunp Recycling Technology Co., Ltd, another major battery precursor company with operations in Indonesia, the process diagram in Figure 10 was developed, along with production steps (Ruan et al., 2024):

- **Ore Preparation:** Ore is dried, crushed and granulate to form laterite ore pellets.
- **Reduction, Vulcanization and Smelting:** Prepared ore is fed into a side blowing furnace top with anthracite, a sulphurization agent and flux agent and then fed further

to an oxygen-enriched side blowing smelting furnace at a temperature of 1490 ºC to produce cobalt poor low nickel matte. This matte is subject to water quenching.

    - **Settling Electric Furnace:** The slag from the reduction process can be fed into a settling electric furnace and is subject to further separation. The low quality nickel matte from this process is also fed into the convertor.

- **Bottom Blowing Furnace/Convertor:** The cobalt poor low nickel matte is mixed with a second flux of quartz stone and enters a blowing process at a temperature of about 1450 ºC to obtain cobalt-rich nickel matte and blowing slag.

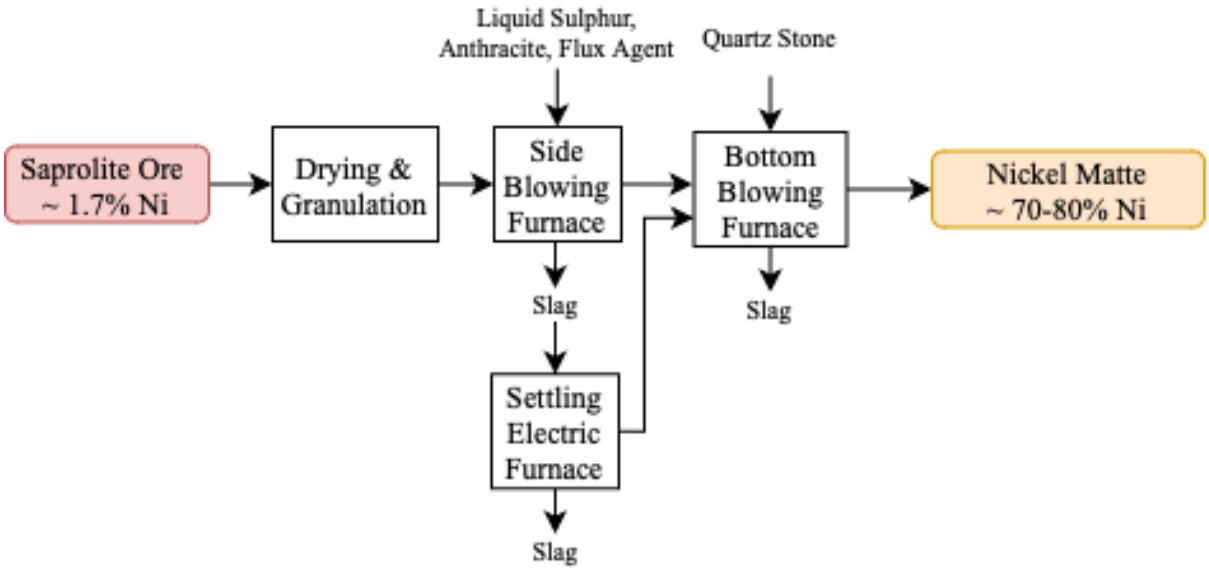

Figure 10: *OESBF process for nickel matte production*

Indonesia's Coordinating Ministry of Maritime and Investment reported that the energy intensity of this process is significantly lower than RKEF due to the fact that latent heat of the smelting slag and blowing slag can be fully utilized (IndoPremier, 2024).

4.4.2 MHP Production: High Pressure Acid Leaching

Traditionally, mining companies have directed lower quality limonite ore into waste piles as the limonite layer in laterite ore needs to be cleared in order to access the deeper saprolite layer. However, as high quality saprolite ores being to dwindle, laterite ores have been looked to

provide battery grade nickel precursor material (Mudd & Jowitt, 2022). However, the higher iron content of limonite ore does not make them suitable for smelting, instead making them suited to hydrometallurgical processing (Crundwell et al., 2011a; Mudd & Jowitt, 2022; Schmidt et al., 2016). The most common hydrometallurgical technique used to process limonite ores in Indonesia is high pressure acid leaching (HPAL). The full process is detailed in Figure 11 (Meshram et al., 2019; Schmidt et al., 2016).

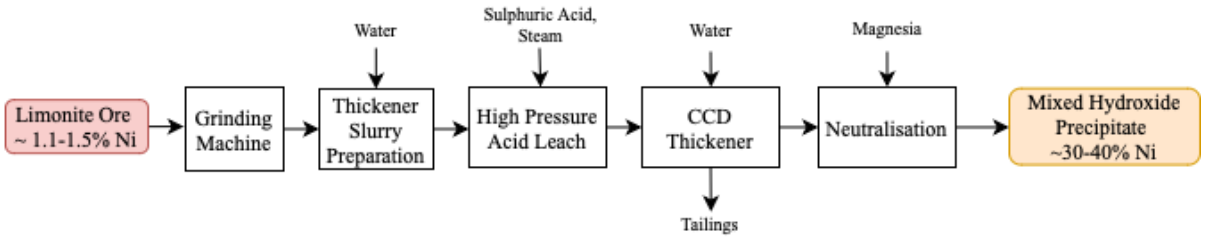

Figure 11: *HPAL process for mixed hydroxide precipitate production*

The steps include (Lygend Resources & Technology Pty Ltd, 2022; Meshram et al., 2019; Norgate & Jahanshahi, 2011; Schmidt et al., 2016):

- **Slurry preparation:** ore is crushed and mixed with water and thickened to produce a slurry of 45% solids.
- **High Pressure Acid Leaching:** Slurry is heated to 70-80 ºC and fed into a high-pressure steam heated autoclave which is at 250 ºC and concentrated sulfuric acid is injected to allow for the selective leaching of cobalt and nickel in leach liquor which extracts around 95% Ni.
- **Neutralization and Impurity Removal:** The liquor undergoes further neutralization and reduction to remove iron, aluminum, silicon and other impurities.
- **Precipitation:** Nickel and cobalt are selectively precipitated using magnesia as mixed hydroxide precipitate.

HPAL has been the preferred technology for limonite processing due to its high nickel recovery rate compared to traditional hydrometallurgical processing (Lygend Resources & Technology Pty Ltd, 2022; Meshram et al., 2019) as well as its lower energy intensity and emissions intensity at 19t CO_2 per ton of nickel (International Energy Agency, 2022c). However, the capital investment required for building HPAL facilities range between 2 to 5 times the investment required for RKEF (Brown & Harris, 2024). There are however concerns about increasing overreliance on HPAL in Indonesia for the production of battery grade nickel materials given many HPAL projects have had a track record of delays and cost overruns(International Energy Agency, 2022c). Given the still relatively novel nature of this processing method, there are risks of failure due to technical grounds including choice of leaching chemical and ore compositions that are leading to such cost overruns (Brown & Harris, 2024). Given the use of concentrated sulphuric acid in HPAL, the tailings of this process are highly toxic and companies are faced with logistical challenges in disposing these tailings in a safe manner given the lack of dry, tectonically stable land for such tailings (Brown & Harris, 2024).

4.4.3 Nickel Sulphate Production

While majority of the projects in Table 2 export their products for further processing into nickel sulphate, four projects have also begun to conduct further processing in Indonesia to export Class 1 nickel sulphate. Process overviews of nickel sulphate refining from MHP and matte are shown in Figure 12.

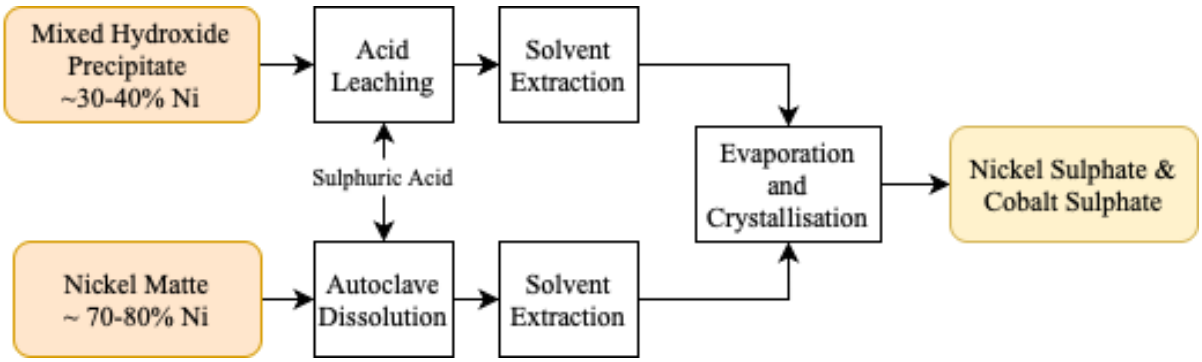

Figure 12: *Secondary refining of nickel matte and MHP to produce nickel sulphate*

In order to produce nickel sulphate from MHP, the MHP is refined by further sulphuric acid leaching, iron and aluminum removal, followed by solvent extraction to separate cobalt and nickel sulphate from any remaining impurities (Dry et al., 2019). The nickel and cobalt sulphate undergo crystallization as a final step. However, the sulphuric acid leaching and further solvent extraction of nickel matte to produce nickel sulphate is more complicated and expensive due to the presence of copper and other impurities in the incoming matte (Crundwell et al., 2011b). The increasing incidence of secondary processing to produce nickel sulphate is in a bid to integrate the battery material supply chain further vertically in Indonesia, with companies benefitting from process improvements allowing them to recycle and reprocess spent materials such as sulphuric acid from the MHP process or from the RKEF sulphidation process (Fraser et al., 2021).

5 Stakeholder Views on Indonesia's Nickel to EV Supply Chain

After the two-step coding process, from 111 initial low-level codes, 17 high level themes which represent common patterns observed in the interview data were formulated as shown in Table 3. Most commonly referenced themes were policies and regulations, investment sources for the nickel industry, environmental impacts and recommendations.

***Table 3**: Interview themes obtained from high level coding*

Theme	Description	Illustrative Quote
Downstream Nickel Processing	Explores government rationale, policies and incentives to drive the growth of nickel processing as well as factors impacting the choice around specific technologies (e.g. HPAL, RKEF, nickel matte production)	*"The mandate from the Indonesian government is to produce high value nickel products. We are looking to make sure we can produce for both stainless steel and EV industries by adopting multiple processing technologies"*
Employment	Explores employment practices by nickel facilities including worker safety, training and hiring practices around local communities, job quality and the impacts of bringing in foreign workers. Job displacement due to the mining industry is also explored.	*"There is an increase in unstable, short term and unskilled jobs that are happening because local communities don't have the skills for the long term employment opportunities at these sites."*
Energy Sources	Explores the range of energy sources used at nickel mining and processing facilities including captive coal, diesel	*"The upstream side is more coal dominated, but downstream can be renewable as the location of these plants does not need to be*

Theme	Description	Illustrative Quote
	generation, natural gas and the factors influencing renewable energy uptake and grid connection.	*on remote islands that are not as well connected to the grid."*
Environmental Impacts	Explores the environmental impacts associated with nickel facilities including biodiversity loss, deforestation, mangrove destruction, air quality impacts, carbon emissions and loss of carbon sinks, exacerbation of the impacts of natural disasters and impacts on water sources including pollution and water mismanagement.	*"As we said, there is more than 1 million hectares of nickel mining concession given by the government and 700,00 of this is in the forest area. If this is all cleared that means more than 18 million tons of carbon dioxide sink capacity is lost."*
Illegal & Artisanal Mining	Explores the rise of illegal and artisanal nickel mining including its impacts and how they interact with major mining companies.	*"Nickel ore is more complex than coal to extract and as such needs more resources to exploit, so there is less illegal mining of it. However big and small holdings blame each other for the environmental destruction of the region due to mining."*
Indigenous Communities	Explores how indigenous communities are engaged with by nickel companies, issues around formal recognition of indigenous groups and the impacts of nickel operations on indigenous communities.	*"Mining concessions are often operating inside indigenous territory but the issue is that also the government is not recognizing indigenous people at all. They are neglected because the land is classified as government controlled area and as such it is*

Theme	Description	Illustrative Quote
		within the government's power to give forest permits."
Investment Sources for Nickel Industry	Explores the impacts of different types of investment on nickel mining and processing operations including the impacts of Chinese and non-Chinese investment, impacts of different ownership structures including stock exchange listing, joint ventures, state owned entities and industrial parks.	*"There are three scenarios we should be looking at in terms of how companies are carrying out their operations: Chinese companies, international companies and domestic companies. Are they doing things differently?"*
Local Communities	Explores the impacts of nickel facilities on surrounding local communities including impacts on farming and fishing industries, land compensation and land grabbing, forced displacement and relocation and criminalization of local communities that oppose mining operations.	*"Local communities don't have enough capital to be part of the value chain of this industry, they don't have capital to build guest houses or other infrastructure to support these industries. These communities are forced to sell their fishing boats because they cannot afford the increased cost of fishing anymore. The only thing they have left is their land and now they don't even have that because they end up selling it."*
Mine Reclamation & Remediation	Explore mine reclamation and remediation practices by companies and its interaction with permitting processes.	*"Rehabilitation programs depend on the status of the area. We need to plant specific trees (local) and make the area dense if it is a protected area. For non-protected area, it is more simple and need to make sure the land is green*

Theme	Description	Illustrative Quote
		again or convert it to housing estate or public facility required by the community."
Monitoring & Compliance	Explores issues around monitoring and compliance of nickel facilities both in terms of company behaviors in relation to complying to standards and issues around governments conducting monitoring and compliance activities including capacity issues, corruption, political influences and coordination with other ministries.	*"In relation to enforcement of environmental standards, this is very difficult. It should be noted that a majority of Indonesia's nickel resources and processing facilities are located in remote areas in provinces that are difficult to access from Java Island.*
Nickel Market Dynamics	Explores the dynamics between stainless steel and battery industry demand for nickel and nickel prices on decisions around nickel processing pathways.	*"Looking at the supply and demand curves for nickel demand, smelting and stainless steel needs for nickel are growing faster than batteries right now. However, demand for batteries is getting bigger and nickel sulphate demand is growing. As such, certain amounts of nickel products originally intended for the stainless steel industry will be converted to battery materials."*
Nickel Sourcing by EV Companies	Explores nickel sourcing strategies by EV companies and their potential impacts on nickel processing operations in Indonesia.	*"The objective of the EV industry is to reduce emissions for example in transportation, but then on the other hand it is increasing emissions in Indonesia*

Theme	Description	Illustrative Quote
		because the mining industry that is servicing this EV industry is polluting."
Sustainability, Justice and Development	Overall views on how different actors view definitions of sustainability, justice and development.	*"The global south is paying the price in servicing the global north with all this mining, Better policy should not be considering business interests of economic growth but also climate justice."*
Policies and Regulations	Explores policies and regulations in relation to the nickel industry in Indonesia including permitting regulation, environmental standards, industrial policy, Indonesian Mining Law, Omnibus Law and Raw Export Ban.	*"The government and the federal ministries are proud of this technology developing in Indonesia. Smelters to date have had a lot of incentive to date, but now the government is looking to shift to HPAL and pyrometallurgy and actively providing more incentive to produce materials for EV batteries."*
Recommendations	Includes recommendations on the role of different actors in improving Indonesia's nickel industry including uptake of international standards, EV company driven accountability, environmental monitoring, needs of industrial players and civil society actors.	*"This growth in Indonesia's nickel will happen regardless of how it is governed. Therefore, combined efforts from several ministries including holistic management and integrated planning covering ESF and infrastructure needs in required."*
Small Island Impacts	Explores the laws and impacts of nickel operations specifically on small islands including West Papua and Obi Island.	*"Our main objectives of our advocacy is to protect the landscape especially on coastal areas and small islands. This is*

Theme	Description	Illustrative Quote
		because nickel mining and processing is not only occurring on forest area in the mainland but many of these smelting activities are located on coastal areas and much of the pollution is ending up in the ocean."
Tailings Management	Explores issues around tailings management policy and practices including tailings disposal in the ocean, land based tailings disposal and hazardous waste disposal.	*"There have been complaints on the mining operations not only dumping tailings but also sand and wastewater to the sea. This is because it is easier to get permits for dumping wastewater, whereas tailings need to be disposed as dry brick. But however during the wet season, large amounts of rain is causing it to run off into the ocean and so even if they are not actually disposing directly, it is ending up in water ways."*

A hierarchy chat visualizing the above high-level themes and popular low-level codes in them are shown in Figure 13. The size of each of the boxes in the hierarchy chart is proportional to the number of times that theme or code was reference by stakeholders.

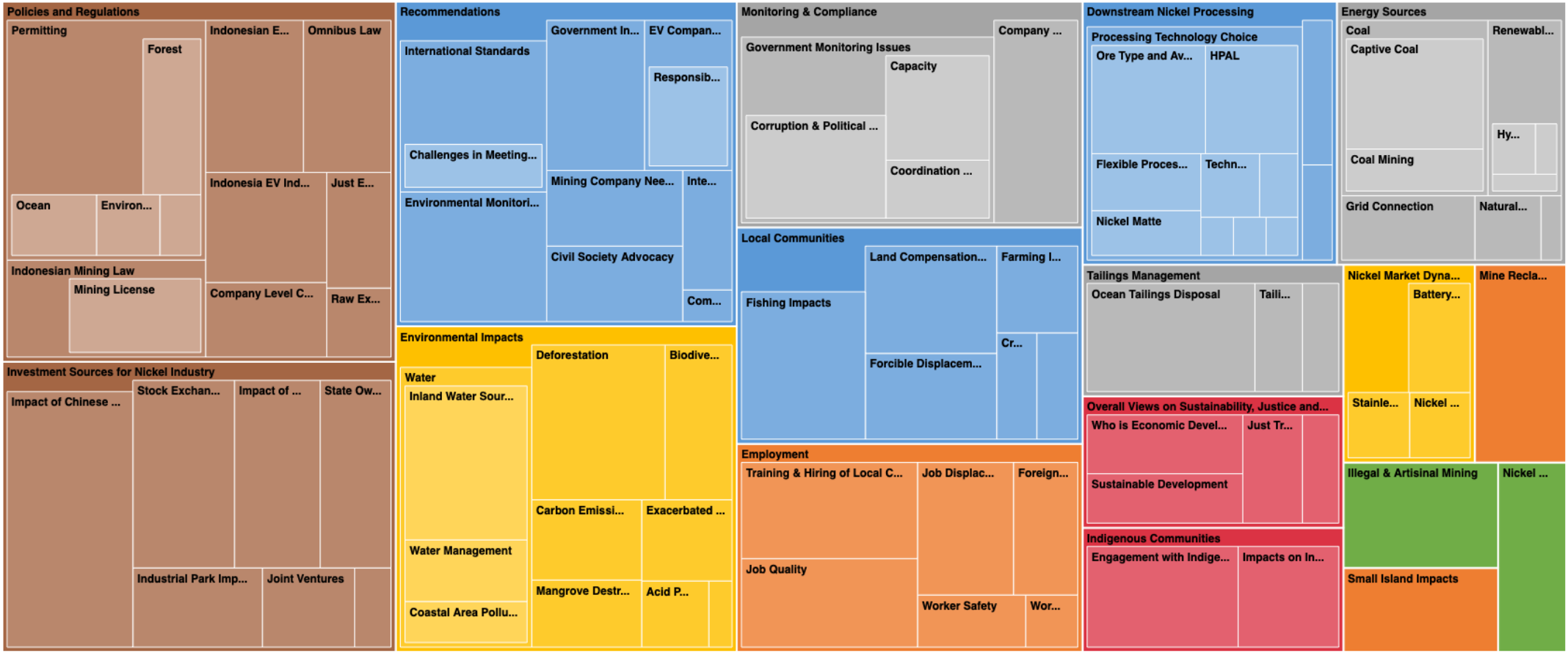

Figure 13: *Hierarchy chart generated by NVivo of high-level themes and select low-level codes*

Based off the above interview data analysis into subsequent themes, analysis done in Chapter 4 and further legal research, I utilize narrative storytelling to understand Indonesia's policy landscape and its impacts in relation to its nickel to EV industry, summarized visually in Figure 14.

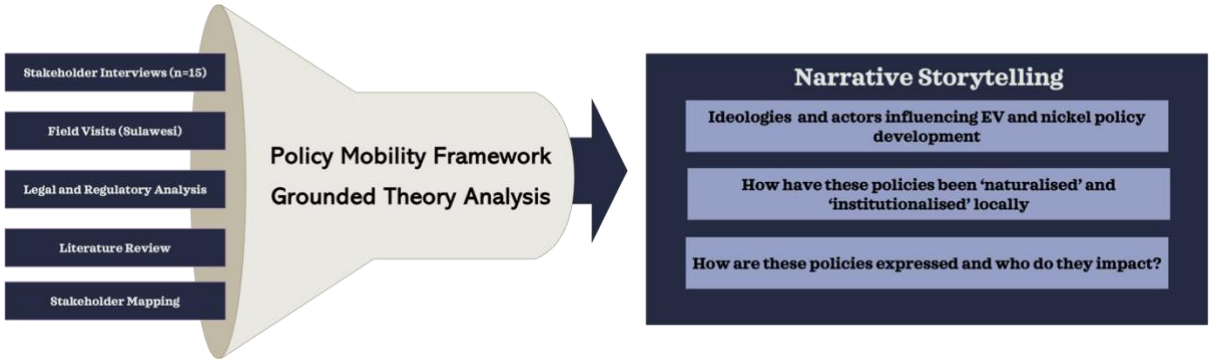

Figure 14: *Sources and analytical frameworks used to tell the story of Indonesia's nickel to EV industry policy landscape.*

I address the following questions as applied from the policy mobility framework (1) What ideologies and actors are influencing nickel to EV industry policy development in Indonesia? (2) How have these policies been 'naturalized' and 'institutionalized' locally? (3) How are these policies expressed in practice, who/what do they impact and how?

6 Influences on Indonesia's Nickel to EV Industry

"Why should Indonesia export 98% dirt and 2% nickel? Indonesia is looking to fulfill two main goals, to become a more industrialized nation and to capture value of our mineral resources by adding value domestically."

For many stakeholders, the growth of Indonesia's EV industry is a continuation of Indonesia's long standing economic development goals that have manifested in the growth of industrialization and furthering the exploitation of its natural resources. In particular, also ensuring the value of Indonesia's mineral resources is captured in Indonesia and that value is being fed back into the Indonesian economy. However, there is an inherent disconnect that exists between who this value capture is meant to serve and who it is serving. With a stakeholder from the nickel industry articulating this concern in relation to foreign investment as:

> *"The government needs to be seeing this as an opportunity for the whole country rather than for a select few people. There is need for a balance between nationalism and diversity of players in the market. If you open too much, then you are vulnerable to those seeking to extract from the country without leaving anything behind."*

Given the export driven nature of this value addition ambition, much of the direction in which Indonesia's nickel to EV industry goes is influenced also by who the customers of Indonesian nickel are and the end use industries for it. Many stakeholders across government and industry noted that as it stands, the biggest industry for Indonesian nickel is stainless steel and that government assumptions about future growth of the battery industry have driven diversification of processing towards battery materials more so than immediate price signals observed in global nickel markets. One civil society stakeholder put forward the fast turnover of battery

technologies as a reason for this preparedness strategy towards building EV supply chains that is happening in Indonesia:

> *"With the way in which battery technologies are progressing at the pace they are, nickel may not be needed anymore and so I think that government is looking to exploit nickel as fast as they can and Chinese investors are willing to build smelters really fast, like within a year."*

With Chinese investment acting as a central enabling condition for the fast build out of Indonesia's nickel to EV supply chains, many stakeholders spoke to both the benefits and drawbacks of this investment in Indonesia. Government and industry stakeholders mentioned that it is not by design that they are actively seeking Chinese investment but that the finance they are providing is cost effective, time efficient and that they are willing to take the risk on Indonesian nickel and the rise of nickel-based battery chemistries. They are also brining technology transfer, skills transfer and intellectual property transfer on key processing technologies for the nickel grades found in Indonesia. As one stakeholder put it, in the absence of investment sources otherwise, Chinese investment would be welcomed:

> *"Indonesia is also entitled to leverage its natural resources to drive its development and unless countries are willing to invest in helping Indonesia do this sustainably, Indonesia will continue with the capability it has and will work with those that are investing in Indonesia."*

The fact that Indonesian nickel is being diverted to the EV industry also brought up tensions around the sustainability driven motives for the growth in EV demand and the fact that this demand is not being translated into the way in which nickel is being extracted and processed for this industry.

"Raising awareness around the clean energy transition and motivating people to purchase their product is the basis of the business of EV companies. It is hypocritical because the very foundation of your product is contributing to global emissions because of the energy being used for mining, processing, using coal and areas being cleared out for mining and processing."

In addition, many stakeholders from civil society that have worked on other energy justice campaigns in relation to resources such as coal exports and having observed past example of critical minerals supply from the global south such as the cobalt supply from the DRC, noted the broader trend of resource imperialism at play:

"Countries that are demanding more sustainable energy supply out of Indonesia including the US, Australia and EU are countries that have also made their wealth and reached their developed status from the extraction of fossil fuels. Indonesia is also entitled to leverage its natural resources for its development."

"The global south is paying the price in servicing the global north with all of this mining."

In addition, in speaking to the role of EV companies in influencing how Indonesia's industry develops, while it was acknowledged that major non-Chinese EV companies had taken the step to not invest in Indonesia's nickel industry directly due to sustainability concerns, it was stressed that these companies were still utilizing Indonesian nickel by virtue of their supply agreements and other arrangements with Chinese companies:

"NGOs including us have sent letters to Tesla to withdraw investment from Indonesia until such standards are met. While this worked and they drew direct investment away from Indonesia, they are just now choosing to directly buy from China – that's what is

actually happening with Tesla and Ford. They just blindfold it. The whole supply chain finds its way back to Chinese companies. The supply chain inevitably traces back to Indonesia."

With Chinese investment dominating Indonesia's nickel to EV supply chain, the direction of the industry is inevitably driven towards rapid growth and development rather than sustainable development. On the other hand, non-Chinese investors are demanding sustainable supply chains but then not investing in building them out and creating the capability to realize these outcomes and still purchasing nickel products from the same Chinese companies. This has led for there to be no real political will or incentive to build out sustainable nickel to EV supply chains in Indonesia in the absence of financial resources and knowledge transfer to do so.

"Political vision drives the uptake of mining standards and mining companies are driving the political will."

As such, short term growth seeking to capitalize on the anticipated demands from the EV industry is happening at the expense of long-term sustainable growth, broader decarbonization goals and the most vulnerable communities in Indonesia.

"Why are they giving permits for open pit mining in coastal areas knowing the impact it will have on mangroves when they are at the same time pushing for mangroves as being one of the largest sources of blue carbon in the world."

"In Indonesia, our policy is not focused for the needs of individual communities, policy is made by politicians in Java Island who have no relation or lived experience in these communities, they are not born indigenous to these lands."

7 Systems of Governance, Regulation and Monitoring

In seeking to explain how the broader ambitions mentioned above in regards to Indonesia's nickel to EV industry have been naturalized and institutionalized, stakeholders spoke on their perceptions of key policies, regulations and systems of monitoring and compliance enabling this. These mechanisms were spoken to at both a national and local level. Their insights are also woven in with additional legal and regulatory analysis of policies mentioned and grounding of them in the country's broader policy history.

7.1 Raw Export Ban

A major driving force in the development of Indonesia's nickel to EV industry has been the raw export ban. In December 2022, the World Trade Organization (WTO) ruled that Indonesia's nickel raw export ban and domestic processing requirements violated WTO rules disallowing export prohibitions and restrictions. It also ruled that Indonesia did not fall within the exemption category allowing such policies to prevent the "imminent critical shortage of a product essential to Indonesia" (World Trade Organization, 2022). Indonesia has since launched an appeal with the WTO and continues to grow its down streaming capabilities.

While the WTO has begun the process to consult on the possible use of its in Enforcement Regulation to oblige other WTO members to comply with countermeasures (e.g. imposition of duties or import/export restriction), there has been no movement on this since mid-2023 (European Commission Directorate General for Trade, 2023). It should be noted that the WTO ruling will not have legal force until Indonesia's appeal has been heard and given the US has vetoed the appointment of judges to the WTO's appellate body, it is expected that it will be several years before Indonesia's appeal is heard given the WTO's backlog of 29 cases, allowing

for the ban to be operational in the meantime (Widitatedja, 2023). This as such allows Indonesia to proceed with potentially expanding this ban further to other materials.

While for some stakeholders the export ban is an assertion that Indonesia's natural resources are not simply up for exploitation by international consumers with little to no benefits being shared with Indonesia, while for others, these dynamics are merely being mirrored within Indonesia itself – that the political elite and those on Java Island are benefitting from this industrialization as the expense of local communities that are most proximate and vulnerable to these nickel facilities. For them, the externalization of these impacts on local communities is a cost that the government regards acceptable as evidenced by the government's response to the World Trade Organization case:

> *"When we look at the WTO case and the president's response to this, he is not concerned about this. He is looking to expand these raw export bans to bauxite and other materials. He wants everything processed in country, but when we look at what is happening on the ground, it is not only destroying the environment, it is also affecting people's livelihood."*

7.2 Omnibus Law and Associated Reforms

Most stakeholders in expressing the ways in which the raw export ban has been institutionalized at the national level pointed to the Omnibus Law and revisions to the Mineral and Coal Mining Law. These reforms have been part of a broader shift under President Joko Widodo's government to shift government responsibility back towards centralization. This has been driven by some of the aforementioned government commitments to invest in physical infrastructure to simulate economic investment and in turn reduce poverty (Nugroho & Sujarwoto, 2021).

The *2020 Mining Law*'s revisions to the *2009 Mineral and Coal Mining Law* were the first tranche of legal instruments centralizing the regulation of mining activity in order to align with the government's down streaming agenda (Central Government of Indonesia, 2023; Nugroho & Sujarwoto, 2021). These revisions have shifted the responsibility of issuing mining permits to the central government and took away the authority of local and regional government in approving, denying and managing mining activities. Other key amendments have included provisions new provisions around reclamation and post mining activities, requiring reclamation to begin during mine operations rather than after and requiring foreign-owned mining companies to divest a 51% share of their business to Indonesian entities, the first instance of this has been PT Vale Indonesia divesting a further 14% of its shares to state-owned MIND ID (Nangoy & Christina, 2024).

The *Law of the Republic of Indonesia No. 11 of 2020 on Job Creation,* otherwise known as the Omnibus Law, was enacted with the central goal of making it easier to do business in Indonesia, create new jobs, stimulate economic growth by simplifying licensing processes and harmonizing more than 75 current laws and introducing more than 30 regulations to implement the Omnibus Law (UNCTAD Investment Policy Hub, 2021).

With regards to the impacts of the Omnibus Law on nickel mining and processing, many pointed to its central goal of making it easier to do business in Indonesia and the impacts of provisions regarding special project designation, permitting and labor law.

> *"Currently Indonesia has very protective labor laws and an onerous permitting process. The Omnibus Law seeks to streamline the permitting process and make it easier to invest in Indonesia. In seeking to do this, the government is acquiring more land for public use and so it can make determinations which projects it believes will help Indonesia meet its long-term goals."*

The designation of many nickel projects as national strategic projects has allowed the national government under the implementing regulation of the Omnibus Law, *Government Regulation No. 42 of 2021 regarding ease for national strategic project (PP 42/2021)* (Government Regulation (PP) Number 42 of 2021 Concerning the Ease of National Strategic Projects, 2021) to step in and undertake land procurement for these projects, streamline the permitting process by making determination on the need for particular environmental studies during different stages of project development and accelerating the procurement of goods and services for these projects. Stakeholders have noted that in practice this has meant that for example many nickel projects are given permission to build captive coal fired power plants because the designation of these facilities as strategic projects has meant that these coal plants are exempt from the presidential decree for coal power plant retirement (Indonesia Just Energy Transition Partnership, 2023).

Given the discretionary nature of these determinations, industry stakeholders observed that many of these projects have been Chinese funded projects which have benefitted from streamlined permitting in being able to set up facilities in record time. In addition, environmental impact studies in practice can be submitted at the operations stage of these projects rather than being submitted at the project scoping level as previously mandated (Aji & Khudi, 2021). The belief is also that these decisions are more so politically driven, with the increasing emergence of Chinese lobbying at the national government level. As a result, non-Chinese projects are unable to keep up with the speed of these Chinese projects, because despite having such designations, as they are required by internal company procedures or other international investment safeguards to follow particular due processes regarding environmental planning.

For many, the Omnibus Law has undermined the integrity of Indonesia's legislative process, with the Omnibus Law providing greater freedoms to the central government to overturn regional environmental decisions and allows law changes to be triggered by the needs of national strategic project rather than the regular periodic review processes that existed prior.

> *"The Omnibus Law is essentially in the name of economic growth, but it is giving up a lot of the environmental standards that exist now that could be used for the better."*

A recent review of climate litigation in Indonesian courts revealed how Indonesia's Supreme Court have increasingly begun overturning environmental decisions following the passing of *Government Regulation no. 21 of 2021 on implementation of Spatial Planning (PP21/2021)* under the Omnibus Law. In the first instance, the construction of a national strategic designated coal fired power station was blocked because it had violated local planning regulation which banned the proposed location for construction. However, on appeal, the defendant in relying on amendment by Article 114 of PP21/2021 was able to argue that despite a national strategic project not being approved for use under regional planning regulation, the proposed site of the project could still be utilized if approved by the national government (Wardana, 2022).

Another key promise of the Omnibus Law has been job creation, some stakeholders expressed that Indonesia's existing labor laws in relation to hiring international workers and subcontractors were especially onerous in requiring particular processes to employ locally first and then applying for permits for these workforces (Pratikto et al., 2021). Many expressed that there was a lack of skilled local forces and as such facilitating the hiring of international workers and subcontractors allows for accelerated skills transfer and training of local workers. Others however felt that these provisions paired with provisions that make it easier to fire workers has meant that local workers have often been relegated to low skill, short term jobs such as construction and such local communities are not experiencing the promised benefits of

employment growth associated with these strategic mining and processing projects. As one industry stakeholder mentioned:

> *"The conditions for this law to work effectively towards its stated intention are not there. There needs to be more consultation with affected people to make this law applicable to its purpose."*

7.3 Permitting Regulations

Indonesia's permitting process for mining projects involves the granting of a mining business license followed by approval of these licenses by relevant environmental agencies depending on whether the relevant mining license is on forest areas, coastal areas or small islands etc. (Devi & Prayogo, 2013). Several stakeholders noted that until the introduction of the Omnibus Law, all mining activities were prohibited in protected forests. With the Omnibus Law, under *Government Regulation 23/2021 on the Implementation of Forestry (GR 23/2021)* mining companies are allowed to apply for forest borrowing permits which allow mining activities subject to obligations such as reclamation and paying official fees.

Many civil society stakeholders interviewed expressed concerns about the jurisdictional powers shared by both the Ministry of Forestry and Environment and the Ministry of Energy and Mining leading to coordination issues around how such licenses are granted and monitored.

> *"These areas (forest zone) are under two authorities, under the Ministry of Forestry and Environment as forest zones but then under the Ministry of Energy and Mining because they are mining concessions. In Indonesia we have the law enforcement directorate general of Forestry but they have made no comment on this. These two authorities have a lack of coordination and are not speaking to each other."*

At an administrative level, this has meant that there has often been overlapping between mining areas and protected non-mining forests (Devi & Prayogo, 2013). While the government has been working to consolidate forestry and mining permit data and streamline mapping procedures so they are centralized, stakeholders also stressed that political tensions between these ministries could hinder efforts to stop mining on protected forests.

> *"There is also a political element to this as well because the Ministry of Mining and Energy have precedence over the Ministry of Forestry. The directorate general of law enforcement of the Ministry of Forestry doesn't want conflict with another Ministry. There are also different parties running these different ministries. Everybody has their own agenda they want to enforce."*

With the Omnibus Law repealing regulation requiring 30% of forest area to be conversed for each watershed area or island and replacing it with *Regulation of the Minister of Environment and Forestry Number 8 of 2021 on Forest Management And Preparation Of Forest Management Plans as well as Forest Utilization In Protected Forests And Production Forests* (Regulation of the Minister of Environment and Forestry Number 8 of 2021 Concerning Forest Management and Preparation of Forest Management Plans, as Well as the Utilization of Forests in Protected Forests and Production Forests, 2021), the Central Government through the Ministry of Forestry and Environment have authority to make determinations on which areas are to be considered protected forest areas (including prospective sites of National Strategic Projects under PP21/2021), leaving open the influence of ministries such as MARVES on such determinations (Herbert Smith Freehills, 2020).

In relation to permitting on Small Islands, stakeholders noted that the ways in which strict environmental standards with regards to commercial activities on these lands can be

circumvented often, for example with the government looking to grant forest permits instead on small islands to allow for mining exploration:

> *"In Indonesia, there are very strict laws on small island protection, especially that these islands are not for mining. This is the Law No. 27 of 2007 on the Management of Coastal Zones and Small Islands. Historically, this law has been successful for advocating for these small islands. These small islands have limited infrastructure and not much resources or forest areas. That's why there is a lot of focus on protecting these small islands, because relatively small destruction on these islands can be devastating. However, now that it is easier to get forest permits, the Ministry of Forestry and Environment will grant permits to utilize forest areas on these small islands and so companies can now do mining exploration here. Since 2020, it is very easy for big companies who want to extract these resources to access the lands for exploration."*

Others also noted how the government has utilized its zoning power to consolidate and divide regional provinces in order to streamline mining project approvals. In the case of West Papua, where despite the growth of mining projects, there has been no movement on poverty alleviation (Underrepresented Nations and Peoples Organisation, 2020), the recent decision by the government to add 3 new provinces was seen as a move to dilute West Papua's regional autonomy and make it easier for nickel extraction to grow:

> *"They are also planning to bring more industrial parks in West Papua. Papua has been changed from having 2 provinces to 5 provinces to help relieve the regulatory burdens in building new facilities. There is an economic incentive behind this."*

Machielsen goes further to assert that the expansion of nickel mining and processing in West Papua is an inherent form 'green colonialism', further reinforcing the ongoing colonization of West Papua through resource control which has been used as a tool to further silence and

oppress Indigenous Papuan voices, subjecting them to human rights violations, denial of procedural justice and environmental degradation of their ancestral lands (Machielsen, 2022).

7.4 Monitoring and Compliance

Both government, industry and civil society stakeholders expressed that increasing centralization through the Omnibus Law and 2020 Mining Law has further exacerbated the capacity constraints of the federal government to monitor and prosecute violations of environmental standards and other laws in relation to mining.

> *"In relation to enforcement of environmental standards, this is very difficult. It should be noted that a majority of Indonesia's nickel resources and processing facilities are located in remote areas in provinces that are difficult to access from Java Island. The Indonesian government does not have the manpower and administrative capacity to conduct the level of enforcement and regular monitoring required."*

Under *Article 88 of the Omnibus Law* removal of a strict liability regime in relation to environmental pollution by industrial activities dealing with hazardous materials of waste, has meant that it has become harder to charge companies for environmental violations now that proof of wrongdoing must also be established (Faizal, 2021).

As mentioned earlier, coordination between government bodies has also been cited as a major barrier towards enforcement of environmental standards in Indonesia in relation to nickel mining and processing. Given the industry is regulated by several different ministries, where there are policy incongruencies, ministries such as the Ministry of Energy and Mining benefit in bureaucratic seniority, from their priority and proximity to the overarching Coordinating Ministry of Maritime and Investment Affairs (Datta et al., 2011). In addition, given the

ministries are run by ministers from different political parties, the agendas of these parties has also exacerbated the coordination issue:

> *"Ministry of Oceans and Fisheries do not want to give the license and want no disposal of tailings at all, but then MARVES is giving the licenses and they are not talking to each other. This may also be because of the different agendas of these ministries."*

These dynamics also are mirrored between local and federal governments in Indonesia and have been further exacerbated by the increased centralization via the Omnibus Law which has created conflict and uncertainty around which bodies have responsibility for monitoring and enforcement. It should however be noted that the *2020 Mining Law, Article 35(4)* provides the central government with the authority to delegate licensing and permitting matters to regional governments (Central Government of Indonesia, 2023).

Stakeholders also noted the increasing influence of political lobbying, corruption and agenda setting on law enforcement activities. One stakeholder noted that Indonesia's corruption index ratings are getting worse every year and this being the case across a variety of sectors.

> *"Currently with the political climate and the granting of mining permits with such ease right now, it would also be a political embarrassment to withdraw these permits. The same government is being politically funded by these corporations."*

> *"The most important thing is political will. Political enforcement is necessary to translate these responsible mining standards towards local regulation changes. Currently, mining companies are driving the political will."*

8 Policy Implementation and Impacts

Finally, in understanding how different actors in the value chain perform and practice the policies mentioned in the section above, interviewees focused on three sets of actors:

- **Investment sources** for the nickel industry and the impacts of such investment on technology deployment and operating standards at nickel sites
- **Nickel mining and processing companies** and their practices during different project phases including construction and operation
- **Local and indigenous communities and the natural environment** facing the impacts of these projects

8.1 Impacts of Investment Sources on Nickel Site Operations

"There are three scenarios we should be looking at in terms of how mining companies are carrying out their operations: Chinese companies, international companies and domestic companies. Are they doing things differently?"

8.1.1 Chinese Investment

As mentioned earlier, many stakeholders spoke to the influence of Chinese investment on the rapid development of Indonesia's Nickel to EV industry. The localized impacts of such investment can be understood by observing trends in how sites with such investment are operating. As noted in Chapter 4, many stakeholders emphasized that the increase in HPAL and nickel matte sites has been driven by Chinese companies, both in terms of technological expertise and project economics that allow these technologies to be deployed at lower cost than has been possible from non-Chinese investment. Another aspect of aspect of this lower cost proposed by some stakeholders was the lower standards for waste and tailings treatment and management these facilities operate with.

Example – Industrial Parks: In addition, many of these facilities are located in industrial parks that can help streamline many operational costs in establishing new nickel processing facilities.

> *"In Weda Bay, there is a trend of industrial parks introduced by Chinese investors and these are a new invention under the Jokowi government. The park will have several tenants, one tenant is responsible for mining and will send it to the industrial park, one tenant may do processing of raw materials, one tenant will be responsible for waste training, another tenant will produce nickel products for EVs and another tenant will centrally manage all the tailings. These parks are a lot more complex and hire people from overseas to run these operations."*

In addition, the industrial park business structure allows tenants to circumvent and simplify environmental planning and permitting procedures, with these processes being centrally managed by park management that make determinations on prospective tenancies and self-report park wide environmental performance.

> *"The permitting process is very complex and is known as the AMDAL process. This is usually subcontracted out [to the industrial park]. The industrial parks is responsible for doing the environmental impact and social assessments for the whole area. Each tenant needs to apply for permits and submit an environmental management and monitoring plan to the park. The industrial park will access these plans and make sure it is line with AMDAL and submit a larger document to the government for approval. In reality they will also expand with new smelters which are not covered by the original documents and will again ask for approval."*

Many stakeholders expressed concern that this streamlining and cost efficiency introduced through the introduction of Industrial Parks will lead to monopolization and industry standard

setting by the owners of these parks, leaving even less opportunity for nickel facilities that do seek to operate differently to compete with these parks.

8.1.2 Other Sources of Investment

With international EV companies such as Ford, Hyundai and LG beginning to enter the Indonesian nickel to EV industry via direct investment typically through joint venture agreements, stakeholders were asked about their views on how such investments may impact the future development and operation of nickel projects in Indonesia for EVs. Industry stakeholders involved in these joint venture agreements spoke to how pressure from these partners has made them adopt higher environmental standards and operating practices.

Domestic company stakeholders spoke to efforts that they are taking to get accreditation from international bodies including The Initiative for Responsible Mining Assurance (IRMA) and working towards membership with the International Council on Mining and Metals (ICMM) in a bid to maintain partnerships with their existing international partners and to court more diverse international investment. Given the increased international media attention on perceptions around the sustainability of Indonesian nickel and the diversion of some international players away from investment in Indonesian nickel, they emphasized the role that Indonesian owned companies played in ensuring the longevity of the industry by attracting diverse sources of investment outside of China.

Many stakeholders noted that companies with investment from international lending institution or companies that were publicly listed on foreign stock exchanges could also leverage their reporting obligations to shareholder and lenders to further incentivize the uptake of international standards and practices. An Indonesian company spoke about the rationale behind their dual listing on the Indonesian Stock Exchange (ISX) and Australian Stock Exchange (ASX) and how it has prompted them to be more transparent in their environmental reporting:

"Our trading activity of our shares is not that liquid on the ASX. We are listed there to have our ESG and standard of openness and transparency at an international level. In the ASX there are also some standards in relation to mine and research disclosure statements that we need to comply with. I see the dual listing as more to bring our company to the international level by complying with ASX rules rather than listing on the ASX being a profitable venture."

Another company in reference to a recent joint venture they established with companies from three different countries, mentioned how their project needed to meet International Finance Corporation (IFC) performance standards to ensure that one of their partners could apply for loans from international banks for this project. Civil society stakeholders spoke to how shareholder activism on their part is pushing compliance towards standards set by these financial institutions forward:

"Companies that are listed on stock exchanges are more concerned about public pressure on changing their day-to-day operations, because they know that we can send letters directly to the stock exchange they are listed on and to investors about the environmental and social impacts of their operations."

Example – Energy Sources: One major shift is that most of these international players have stipulated clean energy requirements for the facilities they are co-investing in. A major constraint to realizing these goals has been the large costs involved in overcoming the geographical, technical and capacity constraints in building out such resources. One Indonesian industry stakeholder also emphasized the expectation that these costs be shouldered by the Indonesian Government or Indonesian industry partners when they are being brought in specifically by these international investors:

"Indonesia is the largest archipelago of Islands in the world. Given Indonesia's geographic complexity, the needs and capacity of the country across all of the islands is very different. We cannot simply build renewable energy resources, there is a lack of available land for these resources to meet energy needs for individual islands and the task of building inter-island transmission when there is none is also a massive and very expensive task that requires a large amount of capital and technical capability which international investors are not willing to provide"

As shown in Table 2 and confirmed by stakeholders, these clean energy requirements have translated into a variety of approaches being adopted.

"The upstream side is more coal dominated, but the downstream can be renewable as the location of these plants does not need to be on remote islands that are not as well connected to the grid."

This includes the building and co-location of renewable energy facilities including solar power and hydropower sites at processing sites where possible, purchasing of renewable energy certificates (it was noted that PLN, the state-owned electricity utility is also currently unable to meet these renewable energy demands in addition to replacing existing coal capacity) or relocation of downstream processes that do not necessarily need to be located in close proximity to mineral resources onto Java Island so they can be grid connected.

Civil society stakeholders, especially those within international development organisations that have been active in the implementation of Indonesia's Just Energy Transition Partnership (JETP) spoke to the existing challenges in phasing out coal fired power stations. They expressed concerns that in seeking to build the EV industry at the rate desired with the energy capacity constraints at hand, this would also further undermine broader decarbonization efforts

"I think right now it is hard to execute the scale of nickel expansion expected in Indonesia without fossil fuels. Although the JETP is in place, the majority of sites are relying on captive coal to power their sites."

With attention being diverted to these broader JETP efforts, civil society stakeholders also raised concerns that there would be even less oversight of captive coal fired power stations in these industrial areas, observing increases in illegal coal mining and less oversight over waste disposal of fly ash, bottom ash and other hazardous materials from these plants.

Many pointed towards government policy that excludes captive coal from the scope of JETP and Indonesia's coal phase out targets and emphasized the pressures from the highly influential coal industry and its lobbying efforts in the announcement of this policy. They asserted that the government's plans for coal phase out while trying to build an EV industry were cancelling each other out in effect.

"In addition, captive coal on these sites is out of JETP. Just before the JETP was signed, the president signed a regulation on energy transition acceleration [Presidential Regulation No. 112 of 2022 on Acceleration of Development of Renewable Energy for Electricity Provision (PR 112)] and did not include captive coal. It doesn't allow new coal plants under PLN, but smelters have an exception to run with captive coal until 2050. It is essentially channeling the influence of the coal industry and its lobby to a new industry."

Since then, the *JETP Comprehensive Investment and Policy Plan* has confirmed this, allowing for the building of coal fired power station where the plant is built in support of an industrial estate listed as a national strategic project or an industrial estate dedicated to enhancing the value of add of natural resources (including nickel) or where such plant had been planned before the government's PR 112 (Indonesia Just Energy Transition Partnership, 2023).

8.2 Social and Environmental Impacts

In addition to overarching planning decision made by nickel companies in relation to technology choices, environmental standards or energy sources, many stakeholders also drew attention to operational practices around employment, land acquisition, land reclamation and tailings disposal that have impacts local communities and their environment demonstrably.

8.2.1 Employment

As mentioned earlier, with the Omnibus Law resulting in significant changes to Indonesian labor law, specifically in the hiring of international workers and making it easier to dismiss workers, these impacts have been felt by local workforces near these sites. Companies that have been operating in Indonesia for a while noted that historically they have had difficulties in meeting local workforce requirements in relation to skilled labor and as such saw the opportunity to bring in international workforces as an opportunity to also bring along opportunities for training and skills transfer locally. However, clashes between international and local workforces have also been on the rise:

> *"There has been lots of conflict between Chinese and Indonesian workers. There are concerns that jobs that should be going to Indonesians are going to Chinese workers. There is also a stereotype around these local communities, about them being lazy and so it being better to bring international workers and not local workers"*

Another major observation has been the increased levels of job displacement of local communities that live near these sites. With many of these islands being home to large fishing and farming communities, the environmental impacts of these operations have severely impacted the profitably of these industries due to lack of viable farming land and fish populations. For farming communities, the loss of clean water supply and soil contamination

have several decreased crop output, forcing many to look to the mining industry for employment:

> *"This is a general phenomenon where a group or community is surrounded by an industrial site. There is a very narrow beach for fishermen but they are surrounded by big ships, by coal or gas plants, so it is quite difficult for them to go out to the open sea and fish. They eventually have to change their jobs, what can you do when you are unskilled, you end up with low skills jobs and jobs that involve manual labor."*

As mentioned above, the quality of jobs on offer for local communities has been unstable, short term and unskilled jobs as these communities with existing levels of little to no formal education are not equipped to take on skilled jobs with long term employment prospects. The training provided to local communities under company CSR funds have been programs around farm and fishing training rather than training for site employment, which many stakeholders regarded ironic given these industries have been depleted from mining. Companies that have had a presence on these islands for a while have technical schools with 1-2 year training programs but have noted that they are in the minority and given they have been operational for several years, do not have the capacity to absorb all of these skilled workers.

Many locals with property near these sites may rent out their homes for worker guesthouses, however also do not have sufficient capital to bear the cost of operating these guesthouses and such cannot make adequate incomes from them or may also be forced to sell their properties instead. As one stakeholder observed:

> *"In the example of Weda Bay, farming practices there have a legacy of Dutch colonial interest in cloves, spices, banana trees and nutmeg, Farmers are offered money for their land at around 9000 Rupiah per square metre. Companies will also box in unwilling farms. Some farmers may be forced to convert their homes into guesthouses for workers*

and are making less money from guesthouses than farming but they have no choice as farming is becoming more and more difficult as mining companies use up water supplies."

8.2.2 Land Acquisition & Forcible Displacement

Given the financial circumstances these communities confront, many are subject to instances of land grabbing and inadequate compensation for their lands. Some locals reported being promised jobs in exchange for land, but then finding out that these jobs have a limited timespan which usually is only during the construction phase of these projects. Others have noted deceptive land grabbing practices by companies including intentionally boxing in farm land and diverting water supply away, while others have sought to capitalize on internal community conflict to acquire land.

"What mining companies will try to do is create horizontal conflict between community members. Mining companies will give payments to certain community members to lobby on behalf of the mining company to people to allow companies to access their lands. In some communities where they are solid, they are stronger."

In addition, 2020 revisions to Indonesia's Mining Law introduced Article 162 which states that "anyone who hinders or disturbs mining activities by permit holders who have met the requirements … may be punished with a maximum prison term of one year and maximum fines of 100 million rupiah." (Central Government of Indonesia, 2023). It was reported that this law has been used to criminalize local communities fighting against forced land acquisition by companies that have been granted mining licenses over their land.

Another stakeholder noted that as a last resort, people have been forced to become ecological refugees in their own country, with the land destruction around them exacerbating the effect of

natural disasters on their properties such that they are forced to move. The loss of freshwater sources due to diversion from mining has had these communities facing already longer dry seasons without safe drinking water supplies. The loss of natural flood banks in the form of forests and mangroves have made the impacts of avalanches and flooding a lot more severe, while for communities on Wawonii Island near Sulawesi, the loss of hills due to land clearing for mining has left them with no protection from increasingly higher tidal waves and tsunamis. This in addition to coastal villages across North Maluku that have been lost due to sea level rises over the last decade.

8.2.3 Indigenous Community Engagement

Both industry and civil society stakeholders noted that it is often difficult to begin the process of engagement with indigenous communities due to the lack of consolidated data collection and mapping of indigenous communities by the government and the government's lack of willingness to make official declarations on whether communities are indigenous and thus entitled to specific legal protections. One stakeholder noted that while geographically isolated indigenous communities have gotten such recognition, self-identifying indigenous groups struggle to be recognized (Siringoringo & Mambor, 2021) .

> *"Mining concessions are often operating inside indigenous territory but the issue is that also the government is not recognizing indigenous people at all. They are neglected because the land is classified as government controlled area and as such it is within the government's power to give forest permits."*

> *"If we tell the mining companies there are indigenous people, they will refuse this and try to create a caveat by saying that people migrated from nearby islands, so therefore the preferred term for them is "local communities."*

Even where communities have been recognized, NGOs note that they are not involved in consultation by companies being afforded little to no procedural fairness and are deprived of free, informed and prior consent as evidenced by multiple instances on land grabbing and forced relocation:

> *"These indigenous peoples are asked to show land certificates so they can be compensated for their land when mining companies take over, but because there is no system of land certificates in these indigenous communities, they do not get paid. The company hires locals that can speak the Indigenous languages who manipulate them into giving up their lands."*

> *"The Kawasi village is the oldest settlement on Obi Island and because they are located directly between the infrastructure of the mining industry, even though they're not directly being threatened to move, they're being boxed in. They refuse to move and are still fighting with the government and corporations pushing the agenda. However, many others end up moving."*

This forced displacement has been due to indigenous communities being unable to sustain indigenous practices and self-sustaining lifestyles that have made them stewards of many protected lands and natural resources.

8.2.4 Deforestation & Land Reclamation

Although the Omnibus Law, through *Government Regulation no. 22 of 2021 on Environmental Protection, Organisation and Management* (Government Regulation (PP) Number 22 of 2021 Concerning the Implementation of Environmental Protection and Management, 2021), has formalized obligations for companies to pay into an environmental restoration guarantee fund

in order to obtain a mining license, it was observed that many companies were able to keep operating with incomplete reclamation or no reclamation at all.

As one stakeholder explained:

> *"Corporations need to pay the government a guarantee for the reclamation. The amount they deposit is not close to the amount needed to carry out reclamation and they are happy to forfeit that money and assume the government can carry out the reclamation using this money. But for the government the idea is that if they conduct the reclamation, the government will give back the money. So it is cheaper for the companies to give that money up. This is a common practice and the government is not really bothered by it. The money is also not being redirected for government driven reclamation either."*

Many stakeholders asserted that any reclamation activity by mining companies on deforested land that was previously protected primary forest would not be able to address the loss of endemic animal and plant species in these areas. One stakeholder noted that 25% of mining concessions in Central Sulawesi are over biodiverse rich areas, which are home to several endemic species including the Maleo bird that are under threat of extinction due to habitat loss. In addition, they noted that given the surface level exposition of nickel laterite resources, loss of fertile top soil would only hinder strategies to replant local species. Some companies in conducting incomplete reclamation activities have instead introduced invasive species that are further exacerbating the threats on endemic plant species in these areas.

> *"Top soil is the most fertile soil and when you do mining, this soil structure is upside down and as such the least fertile soil is left on top. Trying to replant on this less fertile soil is difficult and so these companies will plant acacias which are invasive species*

and will risk overtaking virgin forests too. It becomes a monoculture and its only acacia that can grow on such harsh soils."

Given companies are required to hand in yearly progress reports with regards to land rehabilitation, it was noted that governments were still approving mining licenses year by year in the absence of companies handing in their progress reports (Jong, 2020). As these deposits are held for a period of 10 years before release, companies are not incentivized to ensure immediate land remediation after open pit mining. As such, NGO stakeholders based off their on the ground investigations and groundwater testing found that during Indonesia's wet season, these pits fill up with rainwater and become highly toxic acid ponds containing the compound Hexavalent Chromium, a common post-nickel mining pollutant near mining operations in East Halmahera (Christita, 2018). They reported several cases of drownings in these ponds and increased incidences of acute respiratory infection in local communities due to groundwater leaching into water catchment areas.

"In addition, with these mining pits being left open, when it rains, these pits fill up with rainwater and become a big poisonous lake. It is dangerous to the community, because this body of water can affect surrounding water systems that are being used by the community. There are lots of cases in East Kalimantan where a lot of children that are dying in these poisonous lakes, around 45 children and counting. These acid ponds are directly affecting the surrounding environment and biodiversity."

8.2.5 Tailings Disposal & Impacts on Waterways

Impacts on both inland water bodies and surrounding oceans have been exacerbated by the increasing tailings waste from nickel processing facilities, especially from HPAL. While the government has for now banned deep sea tailings disposal due to pressures from NGO

campaigning, given Indonesia's wet climate, many have observed that these tailings are finding their way into both inland water supplies and the ocean.

Industry stakeholders noted that the most common method of HPAL tailings disposal and treatment is dry stacking, whereby tailings are neutralized and filter pressed to remove water. Given existing issues around land availability, many companies need to wait for areas to be mined out before the land is available for tailings management. In the interim, it has been observed that these dry tailings sit in large mounds, for many facilities which are already located close to the coast due to availability of port infrastructure, during the wet season, many of these tailing stacks end up running off into the ocean and into ground water. Where post mining land has been available, these pits are lined with ferronickel slag before they are filled with these tailings, but concerns have been raised about the lack of adequate seepage and draining controls in preventing run off.

Many NGO stakeholders also drew attention to the fact in 2021, amendments to the Indonesian government's hazardous waste regulation were made under the Omnibus Law, such that under the *Government Regulation no. 22 of 2021 on Environmental Protection, Organisation and Management* (Government Regulation (PP) Number 22 of 2021 Concerning the Implementation of Environmental Protection and Management, 2021) , both fly ash and bottom ash from coal fired power station and nickel slag have been exempt from meeting strict waste management regulations for hazardous materials (known as B3 materials) under previous hazardous materials legislation. They noted that air quality near nickel facilities with captive coal plants had demonstrably deteriorated due to high levels of particulate matter which have exacerbated levels of respiratory issues in surrounding communities. For nickel slag, while this has meant that nickel slag from smelting can be reprocessed into building and road materials, thereby freeing up land for storage of HPAL tailings, there are concerns about the leaching of

chromium from slag used to line HPAL storage pits (Christita, 2018) and the unknown impacts of both HPAL tailings and nickel slag interactions. In addition, cases of tailings accumulation in mangrove areas has also been observed:

> *"Mangroves are also being destroyed by pollution from mining activity and by the land clearing. In Wawonii Island near South East Sulawesi, when we went there in 2019, there is 20 hectares of mangrove area that is gone because the tailings are accumulating in the mangroves. By these mangroves being destroyed we are losing a source of blue carbon and a natural flood bank as well."*

In addition, due to tailings run off, the unique marine ecosystems off the small islands of North Maluku have been especially impacted (Struebig et al., 2022). One NGO stakeholder that had just conducted field studies on the impacts of nickel operations off these islands shared that protected yellow fin tuna populations had observably gone down near Maluku's Islands. This was due not only because of pollution of catch areas but the changing migration patterns of these fish. They hypothesized that this has been due to water temperature changes observed near the coasts of Maluku because of the disposal of warm wastewater from captive coals plants at these sites. As a result, this has meant that fishing communities have needed to travel further out into the open sea to be able to fish, facing both rough sea conditions to which their existing equipment is not suited and incurring extra costs due to fuel use. Higher temperatures and tailings pollution has also contributed towards the destruction of coral reefs in these areas.

9 Recommendations

In providing recommendations as to what would be needed for sustainable and ethical nickel supplies to be realized from Indonesia, stakeholders spoke to the role of international customers in simulating this demand, the need to build capacity within Indonesia to be able to provide such nickel and shifting domestic law and regulations to place the benefit of such supply within the hands of local communities and refocusing the need to ensure the long term sustainability of Indonesia beyond mining. In this chapter, I further explore these stakeholder recommendations – this include areas of improvement which stakeholders spoke of, but also success stories which they felt could be applied more broadly. As I weave in examples and cases from other contexts and geographies, I seek to further flesh out and strengthen these recommendations with best practice, specifically narrowing in on examples with relevance to the economic, cultural and political climate of Indonesia.

9.1 Increasing the Role of International Investment in Strengthening Demand

As international EV companies increasingly enter Indonesia's nickel market, many stakeholders spoke to the role that they should be playing in translating their publicly stated goals for sustainable nickel into their sourcing strategies. While the decision by companies like Tesla to not make direct investment in Indonesian nickel due to sustainability concerns has been welcomed by civil society actors, this has only increased the incidence of indirect supply of Indonesian nickel to these companies and the substitution of this demand by Chinese consumers less concerned with sustainable nickel. As such, the role of EV companies and investors should be creating demand signals for sustainable nickel supply by clearly defining what "clean" nickel supply means, actively incentivizing "clean" nickel supplies in offering price premiums for such products and investing in building out such supply chains.

Defining 'clean/green/responsible' supply requirements: Recently as nickel companies from Australia and Canada called on the London Metal Exchange (LME) to establish differential pricing for "green" nickel products, the LME opted not to do so, citing a lack of a universal definition of what this meant and that currently such a sub-segment of the market was too narrow to be viable (London Metal Exchange, 2024). They acknowledged that any such incentives would need to be gradual to ensure broad market participation, noting that increasing term supply agreements by major automakers with ESG compliance woven in would help naturally build such a market (Lazenby, 2024).

While Tesla requires its suppliers of conflict minerals to only source from smelters or refineries validated as responsible by the Responsible Minerals Initiative (RMI), Responsible Minerals Assurance process or others such as the Initiative for Responsible Mining Assurance (IRMA), International Council for Minerals and Mining (ICMM) or CopperMark Standards (Tesla, 2023). Tesla also publishes a yearly list of eligible processing facilities to which any facility can submit for assessment and inclusion (or be provided feedback to be eligible) (Tesla, 2023). This list is an industry wide initiative that leverages members of the RMI and their expectations of what eligibility should be to produce this database. Currently, this process does not extend to nickel, with Tesla instead relying on self-reporting from suppliers after they have already signed supply contracts (Tesla, 2022).

Such an initiative could be extended to nickel supply chain by EV industry members who are committed to sustainable and ethical nickel supplies and could leverage organization such as the Nickel Institute and IRMA who have a presence in the Indonesian nickel industry already to coordinate the formation of such a database. A transparent and publicly available reporting mechanism and database clearly signals to companies interesting in courting such customers what is required of them. It also signals that there is a large market segment of EV companies

for such products to further incentivize prospective suppliers to engage in this process of certification.

Developing inclusive and context specific standards: Given a majority of sustainability certification schemes are global in their coverage, relying on best practice standard setting often by companies in developed contexts, making it difficult for new entrants and those from developing economies to participate (Mori Junior et al., 2015). As such, in acknowledging Indonesia's dominant share of global nickel supply such standards need to be framed around the context of such an operating environment, similar to cobalt standards and their applicability to the DRC (Mancini et al., 2020) – both in terms of accessibility of such standards to those seeking certification and the setting of standards specific to the salient environmental and social issues currently surrounding Indonesian nickel mining and processing.

One industry stakeholder who had recently formed a joint venture with a large EV company that required compliance with ICMM standards, spoke to the fact that it was difficult to ascertain what the exact requirements of these standards required in terms of indicators/metrics of compliance and guidance on how such gaps could be met. As such, the company has had to incur considerable cost and time to engage external consultants to interpret the standard, conduct an audit of the company's operations and assess the gaps between Indonesian environmental standards the company follows and ICMM standards. Accessibility can be strengthened by introducing specifiable and measurable metrics (especially in relation to environmental standards), defining minimum standards for compliance, involvement of a variety of stakeholders (civil society organisations, government representatives especially those developing policies and standards for minerals, industry representatives beyond mining companies including processing companies) and more practice driven guidance on improving compliance (Mori Junior et al., 2015).

In developing standards specific to Indonesia and its nickel industry, many stakeholders called for attention to be paid to metrics beyond carbon emissions in developing environmental criteria. As the impacts of downstream nickel processing are realized, environmental criteria specific to the risks from these processes can developed. Given the risk of toxic and heavy metal leaching associated from nickel slag and HPAL tailings and Sulphur dioxide emissions from smelting, specified pollutant limits could be included. While measurable and established ecological criteria around deforestation in Indonesia developed in relation to other industries such as palm oil can be leveraged (Carlson et al., 2018), less quantifiable and well-defined ecological impacts specific to the geography of these islands can leverage local knowledge systems in assessing them (Agusdinata et al., 2023). An example of this in this case has been how local fishing communities on the Maluku Islands observations on blue fin tuna populations and their migration patterns has been employed to speak to the impacts of tailings disposal on the surrounding delicate ocean ecosystem. Focusing on how such impacts are perceived and experienced by those affected not only allows for them to be accounted for in such standards, but also provides those affected with an avenue for having their voices meaningfully engaged (Franks et al., 2014) in defining what "green" nickel looks like in the broader global economy.

Encouraging supply chain wide transparency: Often one of the challenges cited in the monitoring and enforcement of minerals sourcing standards in the EV industry where such is difficulties in following the complex processing supply chains where companies are not directly purchasing minerals but other downstream materials (Mancini et al., 2020; Tesla, 2023). Transparency around the whole of product supply chain, starting from EV companies and throughout to include disclosure from downstream players such as battery cell and precursor material manufacturers allows for a true understanding of how expectations from the EV industry translate to how they are being mined and processed in Indonesia. In addition, stronger institutional scrutiny of EV companies as actors with high levels of influence and

resources in supply chain behaviour could be impactful in distributing the onus of building sustainable and responsible supply beyond just Indonesia as an actor at the tail end of this supply chain. This can be through EV company involvement in initiatives such as the Battery Passport scheme by the Global Battery Alliance (Global Battery Alliance, 2023) or requirements by governments where they are retailing their products, such as the European Council's Corporate Sustainability Due Diligence Directive (European Commission, 2022). Such initiatives can work towards strengthening demand for sustainable supply at all stages of the supply chain, with Indonesia being one part of broader supply chain goals where all actors are working towards a common and broader goal of a sustainable EV industry.

Leveraging the role stock exchange listing and stakeholder activism in ESG compliance:

The impact of Indonesian nickel mining and processing companies being publicly listed was discussed by several interviewees, with domestic industry stakeholders emphasizing how listing on foreign stock exchanges such as the Australian Stock Exchange (ASX) has meant that it has had to improve its ESG monitoring, data collection and reporting in line with the disclosure practices maintained by other resources companies listed on the ASX (Miklos & Evans, 2021). For many NGO stakeholders interviewed, they see value in using shareholder activism to increasing transparency and accountability on sustainability and human rights violations in the Indonesian nickel sector by large international companies and influencing large institutional investors to apply pressure on the nickel companies they invest in (Yang et al., 2018). For example, some of Indonesia's largest environmental NGOs sent letters to the Financial Services Authority, Indonesian Stock Exchange, prospective investors and underwriters regarding Harita Nickel's right practices before its IPO (Business & Human Rights Resource Centre, 2023). Others have been successful in directly targeting international banking institutions to withhold finance from mineral processing companies in Indonesia that use captive coal plants (Ruehl, 2023).

9.2 Building Capability and Capacity for Sustainable Nickel Production in Indonesia

Increasing capital investment in Indonesian nickel mining and processing: For Indonesia's nickel to EV industry to meet such international standards listed above, there is a considerable capacity gap that requires capital investment including from those demanding such standards. Direct international investment such as long term supply agreements with Indonesian partners, joint ownership of processing and mining facilities with major international companies across the supply chain (e.g. Vale, Ford and Huayou's Kolaka Project), public-private partnerships (e.g. IBC, Hyundai and LG's PT HLI Green Power) or vertical integration into processing by long standing international nickel mining companies in Indonesia (e.g. Nickel Industries, Eramet) are beginning to emerge in Indonesia.

In addition to bringing long-term, stable investment towards building sustainable supply, these international investments and supply agreements can also bring institutional knowledge, capacity and best practice with them. In long-standing international mining companies building out their supply chain capability or partnering with new entrants, there is an opportunity to leverage the reputation, expertise and institutional knowledge they bring. Companies such as Vale have been able to leverage their experience across multiple geographies and best practices developed at other sites into Indonesia. For example, Vale's Sorowako and Pomalaa sites will be one of the first HPAL sites in Indonesia to introduce dry stack tailings (Silva, 2023), expertise which Vale has invested in and developed at its site in Brazil dry stack tailings expertise developed in Brazil (Vale, 2023). In addition, these long-standing companies in partnering with new entrants are able to also leverage their institutional knowledge of Indonesia's systems, policies and environment in translating broader company-wide corporate sustainability goals that new entrants may bring with them (e.g. net zero goals) within an Indonesian content.

Increasing research and development (R&D) on sustainable nickel processing: Given Indonesia is home to the largest number of HPAL facilities in the world and many of the first commercially viable smelting facilities for battery grade nickel, Indonesia is uniquely placed to facilitate novel industry-based research and development in making these processes more sustainable. This could include working towards better energy recovery rates, alternative uses for mining and processing waste, tailings management and circular hydrometallurgy practices (Binnemans & Jones, 2023). There is opportunity to leverage existing state-owned industry bodies like MIND ID, IBC and the Indonesia's National Battery Institute to develop bilateral research collaborations with other regional with strong mining and processing R&D capabilities. For example, Australia which contains the second largest nickel reserves in the world has signed critical minerals partnerships with partners in the Asia Pacific region such as India, Korea and Japan, sharing expertise on mining technologies, education and training partnerships and best practice on mining governance (Australian Government, 2023). Other initiatives for collaboration include the Global Research Consortium on Tailings based at the University of Queensland (University of Queensland, 2023) or the Commonwealth Scientific and Industrial Research Organisation's research program on efficient and sustainable processing of nickel laterite (CSIRO, 2023).

While critical minerals supply in other developing contexts are split into larger operations and small and artisanal mining operations requiring standard setting to ensure participation of both segments (similar to the case of palm oil standards in Indonesia), the reality is that given the capital and technological expertise needs in processing Indonesian nickel, Indonesia's industry consists primarily of large operations run by international companies. With companies willing to adapt to Indonesia's raw export ban once in the past, Indonesia is well placed to apply similar pressures on these players to move towards building sustainable production. Creating Indonesian intellectual property through joint ventures and technology transfers of smelting

and HPAL technologies is a practice that has begun to be adopted by IBC and as such could be extended towards sustainability centered R&D partnerships with international companies operating in Indonesia (Tundang, 2023).

With stakeholders from international development organisations citing the high risk nature of Indonesia's nickel industry as one of the reasons behind the lack of financial involvement from multi-national development banks such as the Asian Development Bank and World Bank, there are opportunities for Indonesia to benefit from some of the capability building programs and initiatives by these institutions for resource rich developing nations. This includes the UN Framework on Just Transitions for Critical Energy Transition Metals (CETM) and the World Bank's Climate-Smart Mining Initiative which seek to work with governments and local industry to de-risk investment in minerals in these regions by leveraging financial and risk products offered by the World Bank, offering advice on strengthening governance and legal frameworks and utilizing institutional knowledge and tools on just transitions to create more opportunities for local communities to benefit share from extractive industries (The World Bank, 2023; UN Secretary General's Working Group on Transforming The Extractive Industries for Sustainable Development, 2024).

Improving local employment and skills development and worker welfare: All stakeholders spoke to the need to increase domestic employment and improve access skill development for the sectors. This was both as a means of meeting the demands of companies who are seeking to hire locally but confront a lack of a skilled workforce and as means of realizing the economic development goals expressed by the government in relation to Indonesia's nickel processing and mining facilities. Other countries with local content requirements for their mineral resources have also integrated employment requirements (both in hiring local communities or national citizen) and investment into skills development (Ramdoo, 2018). In South Africa, the

government require companies to submit skills development plans and annual training reports along with requiring companies to invest 5% of annual leviable payrolls in internal skills development programs and 1% into a national training fund (Ramdoo, 2018). In India, the government has signed MoUs with several companies in the mining industry to digitally enable low skilled workforces and pilot digital and STEM education in schools (Ramdoo, 2018).

Stressing the need for stable, high quality jobs for local communities, civil society stakeholders have been concerned about the impact of the Omnibus Law on labor law. Indonesian workers have been pushing for the government to repeal key provisions around temporary contracts for workers and the ease at which businesses are now able to lay off employees and hire foreign workers as well as calling for the introduction of worker safety provisions (Izzati, 2023). Additionally, as Indonesia's 250,000 people workforce face unemployment as Indonesia's energy sector transitions (Christian et al., 2022), there is also an opportunity to leverage the existing skills of this workforce and roll out training programs specifically aimed at transitioning them into Indonesia's energy transition mineral industry as part of a broader just transition framework .

9.3 Strengthening Domestic Monitoring Tools, Legal and Regulatory Instruments

Improving collection and harmonization of relevant data for monitoring and compliance:

With the recent centralization of Indonesia's mining licensing and environmental permitting processes (Chapter 7.4), there is a need to audit existing mining licenses and forest permits in a centralized database that is accessible and harmonized across different ministries. This both allows for any environmental monitoring data collected to be attributable to specific sites and companies and streamline future permitting processes to ensure that mining license are not granted on non-eligible protected forests.

Similar to the recommendations on international standard development, collecting emissions data beyond scope 1 and 2 is essential to truly understand just the CO_2 emissions impact of nickel mining and processing in Indonesia given the incidence of diverse naturally existing carbon sinks on these islands including peatlands, forest, mangroves and seagrass amongst others (Murdiyarso et al., 2024). Stakeholders emphasized the need to develop methodologies to assess and quantify the loss of valuable carbon stock which can be done using a combination of geospatial data and developing Indonesia specific emission factors for these sinks (Murdiyarso et al., 2023). In addition, monitoring of other pollutants from captive coal plants at these processing facilities and high-risk chemical effluents associated with these technologies was also considered as key data collection for environmental monitoring of nickel mining and processing. Stakeholders called on the Indonesian government to work with the international scientific community to define any such limits in line with international practice. In measuring and monitoring social impacts, one stakeholder suggested leveraging Indonesia's existing Inarisk platform developed by the UNDP that reports on various risk vulnerability metrics at a village level and has been used in determining locations for dispersal of JETP funds in line with the energy justice goals of the fund (United Nations Development Programme Indonesia, 2024).

Coordinating government priorities and processes to strengthen monitoring and compliance: Across government consultation is needed to align long term goals between the Ministry of Ministry of Energy Mineral Resources (who administer mining permits) and Ministry of Forestry and Environment (administering forest permits) in order to ensure the integrity of the permitting process and establish commitments for the preservation of key forested areas. In addition, as mentioned in Chapter 7.2, given the powers provided to MARVES in assisting national strategic projects, sustainability requirements and priorities could be included within designation criteria and there should also be back stop criteria that

trigger the loss of such designation in violation of minimum environmental compliance criteria. This is especially important given the amount of processing sites being built on Industrial Parks which have such designation and benefit from relaxed environmental standards while also managing and self-reporting on the environmental performance of all their tenants. In addition, the restriction of all mining activity on protected forest should also be reinstated and the *2007 Law on Small Islands* updated to disallow the granting of any forest permits for mining activities.

There is also a need to balance impacts of re-centralization with Indonesia's history of institutional decentralization. A strategy to address the capacity issue cited by federal government in impacting its monitoring ability, a clear designation of roles between the federal government and regional government could assist in relieving these capacity restraints, while also leveraging the on the ground knowledge of those from the communities where these nickel sites are located. Further, the federal government could increase investment and capability building of local communities to contribute to the monitoring and compliance efforts of these regional government. Such a designation is permitted under Article 35(4) of the *2020 Mining Law,* allowing the central government the authority to delegate licensing and permitting matters to regional government (Central Government of Indonesia, 2023).

Strengthening domestic environmental regulations: In working towards greater environmental protection, the Indonesian Government should reverse recent changes to its hazardous legislation under *Government Regulation no. 22 of 2021 on Environmental Protection, Organisation and Management* (Government Regulation (PP) Number 22 of 2021 Concerning the Implementation of Environmental Protection and Management, 2021), putting nickel slag and fly ash and bottom ash from coal fired power plants back on its hazardous waste lists, mandating minimal treatment for these waste materials. In addition, given that many

nickel processing sites are located on Industrial Parks where tailings management and disposal are centrally managed, individual companies have less control over how their tailings are processed. As such, a pre-condition for maintaining national strategic project designation these Industrial Parks should be the adoption of minimum treatment methodologies for HPAL waste, a standard which should be set by the government in line with international best practice, this could include compliance with the Global Industry Standard on Tailings Management as developed the UN Environmental Programme, IRMA and ICMM.

There is also the need to adopt policies and monitoring practices that can build capacity to protect and manage key biodiversity areas where these facilities are seeking to be located or already are. In the Philippines, which hosts similar nickel deposits as Indonesia and has similar biodiversity, environmental and climate risks as a developing economy in South-East Asia (Soh Tamehe et al., 2024), the government introduced an administrative order integrating biodiversity conversation measures into all laws applicable to mining, This includes data collection on critical ecosystems and species to establish biodiversity baselines, setting aside 5% of the total mining concession area as a reference ecosystem, mandating the hiring of full-time personnel with biodiversity expertise and encouraging the establishment of participatory governance by local communities of biodiversity near these sites (International Energy Agency, 2023c).

Developing policies to facilitate renewable energy development and uptake: When speaking to the role of government in facilitating the decarbonization of nickel mining and processing in Indonesia, all industry stakeholders called for the government to facilitate the availability of renewable energy capacity and supporting infrastructure. Calls have been made to expand the availability of JETP financing to assist in the transition of captive power plants towards renewable energy capacity and making JETP financing available in building out

transmission capacity to support inter-island connection to Indonesia's power grid (Parapat & Hasan, 2023). More broadly there have been calls for the government to align its economic and industrial strategies with its long-term climate and sustainability commitments in order to help reduce investment risk for Indonesia's clean mineral and renewable energy industries (Zhu et al., 2022). In addition, given that more than 70% of captive coal plants are funded by Chinese investment and that many Chinese companies in the nickel industry have already brought technology transfer with regards to hydrometallurgy and pyrometallurgy with them in joint venture agreements with entities like an IBC, there is an opportunity to leverage Chinese expertise and technology transfer in terms of renewable energy, building of eco-industrial parks and industrial energy efficiency (Zhu et al., 2022).

9.4 Building Social License to Operate from Local and Indigenous Communities

Protecting the roles of NGO, civil society and local community advocacy: The introduction of the omnibus law and 2020 Mining Law has significantly curbed the role of NGOs, environmental expert, indigenous groups in engaging with permitting process for nickel sites (Herbert Smith Freehills, 2020) as well as criminalizing those who interfere with mining projects ." (Central Government of Indonesia, 2023). – an act which has disproportionately target local communities and worker unions. As such, there is an urgent need not only to repeal such provision but create avenues and governance frameworks that actively involve such actors in permitting processes and providing avenues for community grievances and procedural justice.

Given the impacts of the Omnibus Law reach beyond the mining industry and more broadly in infrastructure development, lessons can be learnt from Peru, where the government has increased the role of its financial services sector in creating incentives for managing social

conflict by mining, energy and forestry companies. Peru's Superintendence of Banks, Insurers and Private Pension Funds seeks to use regulatory measures by the banking sectors encourage including frameworks for evaluating the quality of company-community relationships and assisting in improving engagement and consultation processes for these companies (Franks et al., 2014). In Chile's National Action Plan, the Ministry of Energy has been made responsible for creating and promoting conflict resolution mechanisms between local communities and energy-related projects (Schönsteiner & Contardo, 2020).

Establishing free, prior and informed consent from indigenous communities: For indigenous communities in Indonesia, recognition is an essential first step in asserting their indigenous personhood and rights over the lands and resources of which they already outside of formal legal systems have stewardship over. NGOs have played a key role in empowering indigenous communities to establish and petition for indigenous status as well as leading participatory mapping efforts of indigenous lands (Rye & Kurniawan, 2017). However, there is also a need to strengthen recognition of self-identified indigenous people and communities and including rights of ancestral domain over land to have them classified as customary land (Fay & Denduangrudee, 2016). The government also plays a role in increasing efforts to monitor and prosecute illegal land grabbing of existing customary forest lands on which mining is prohibited yet often ignored (McCarthy & Robinson, 2016). In addition with the Omnibus Law leaving open the potential for the government to expropriate customary land for national strategic projects, there is need to introduce backstop mechanism in the Omnibus Law that prevent this from occurring as well as mandating indigenous engagement as a part of the AMDAL process (International Work Group for Indigenous Affairs, 2024). The presence of the UN's Principle of Free, Informed and Prior Consent in Indonesia's mining law is also a crucial step in asserting the jurisdiction of these communities over lands used for nickel mining and processing (MacInnes et al., 2017).

While ICMM and IRMA have standards and best practice on indigenous engagement and obtaining Free, Informed and Prior Consent, it has been found that many multinational corporations that are members of either have been found to be in violation of such standards without consequence (MacInnes et al., 2017). As such in the absence of government driven enforcement of such standards, the international EV industry has a role to play in both monitoring and encouraging the enforcement of such standards by suppliers (MacInnes et al., 2017).

Benefit sharing between companies and local communities: Benefit sharing agreements have increasingly been on the rise in the energy industry as a means of garnering social license to operate from both local and indigenous communities (Cesar & Jhony, 2021). Canada has been lauded for its Impacts Fund Agreements for between mining companies and local communities and vulnerable groups (Sovacool, 2019). One feature has been the creation of a centralized fund to compensate individual landholders for land acquisition using standardized rates, community funds and demographic specific trust funds to be administered by community members (Meerveld, 2016). Other features of IBAs have included local employment requirements, revenue sharing, cross-cultural training, independent review boards, funding of social and educational programs and the formation of dispute resolution bodies (Sovacool, 2019).

10 Conclusion

"Indonesia is in the right place at the right moment and [this industry] can make a huge difference for future generations of the country."

The story of Indonesian nickel mining and processing for the EV industry is one which on face value is quite simple: On the one hand, our global economy is putting out the call for minerals essential for the clean energy transition. On the other hand, Indonesia seeks to respond to this demand in a way which seeks to assert the sovereignty and right of mineral rich countries in the global south, leveraging on this opportunity to drive economic growth, industrialization and development. However, as we went on this journey of following the supply chain, its policies, actors and impacts, a complex story emerged of competing priorities around what types of nickel supply chains customers are willing to accept and the definition of what production of nickel for the sake of "development" should look like.

Indonesia's nickel mining and processing industry for the EV industry after the introduction of the raw export ban and presidential decree on electric vehicles has been characterized by rapid expansion, primarily driven by international investment by Chinese companies with expertise, technology and scale in processing nickel and producing battery pre-cursor materials with growing involvement from other international mining companies and EV companies. As such, this has allowed for the introduction of a variety processing pathways for battery grade nickel from nickel laterite including the production of nickel matte using various pyrometallurgy techniques and the production of MHP using the hydrometallurgical technique of HPAL. Given the low-quality input ore and novel nature of these technologies, these processes are characterized by high capital costs, high energy intensity (especially for pyrometallurgy) and hazardous waste materials and tailings. In addition, most of these processes in Indonesia are powered by captive coal fired power stations.

Driven by the voices of stakeholders operating out of Indonesia including industry, government and civil society stakeholders, I find that although international investment from China has played a significant role in developing Indonesia's downstream capabilities. It has also influenced the way in the government has developed legal and regulatory frameworks. Such frameworks prioritize attracting investment at the expense of existing environmental standards and the rights and living conditions of vulnerable populations near this industry.

Some of the key environmental and social challenges posed by the industry included deforestation, biodiversity loss, water and soil pollution and adverse impacts on local and indigenous communities including forced displacement, health implications, illegal land grabbing, loss of local fishing and farming industries and worker exploitation. The emergence of these challenges is driven by the changes in Indonesia's legal and regulatory landscape as a result of the raw export ban, a lack of political will and capacity in monitoring and enforcing existing regulations. This policy environment in turn influences company behavior and practices. Recent wide-spanning policies seeking to facilitate international investment in Indonesia's industrial growth, such as the Omnibus Law and 2020 Mining Law have also repealed and weakened existing permitting laws, environmental regulations and labor laws, lessening the influence of civil society and local communities in decision making while significantly increasing the discretionary powers of the central government.

The recommendations put forward seek to foster effective collaboration of stakeholders across the EV supply chain, ranging from international players in the EV industry, to local communities. Most importantly, in seeking to center Indonesian voices, I sought to leverage the influence of external stakeholders and international examples to support recommendations put forwards by the stakeholders interviewed.

The first set of recommendations proposed center around increasing the role of other sources of international investment, especially EV companies to strengthen demand for clean and responsible nickel. This includes developing and adopting transparent, inclusive and context specific international standards as part of responsible sourcing strategies and enhancing transparency across the whole supply chain through international industry wide initiatives such as the Battery Passport scheme. In addition to international investment playing a role in the adoption of international standards, it also has a key role in translating demand for sustainable nickel production towards building this supply in Indonesia by building capability. This can be done via direct investment, research and development on sustainable processing techniques, institutional knowledge sharing and building skilled workforces for the sector in Indonesia.

Recommendations regarding governance call for strengthening domestic monitoring, legal and regulatory instruments in line with environmental and social goals. This includes the reversal of recent legislative changes that have weakened environmental standards and the participation rights of vulnerable communities. Additional recommendations include improved data collection, across government coordination, incentives for sustainable practices and stronger environmental regulations in line with international practice.

The final set of recommendations center around companies developing the social license to operate. Proposed strategies include the recognition of indigenous communities, adoption of principles of free, prior and informed consent, introducing benefit sharing arrangements tailored to community needs and strengthening and preserving the role of grassroots advocacy in decision making processes for the sector.

This research encountered limitations, including the inability to conduct interviews with some key stakeholders, particularly Chinese companies, and time constraints coupled with the complexities of Indonesia's research permitting process. While the interviews sought to center

Indonesian voices, they could be expanded to include international stakeholders including EV companies, industry associations, and representatives from other resource-rich developed and developing countries. This could allow us to understand their motivations and priorities in securing nickel supply, leverage success stories and anticipate key challenges in building these supply chains sustainably and responsibly. The data collected on nickel processing sites could be expanded to include similar analysis of mine ownership and nickel processing for the stainless-steel industry given the shared resource use by both industries. In addition, land use data, vulnerability data on local communities, and publicly available emissions or pollution data could also be collected as well. This could be used to develop a live database of Indonesia's nickel industry and available metrics for assessing its environmental and social impacts and carrying out a life-cycle analysis of different technology pathways.

Future research could develop monitoring methods for environmental and social impacts, exploring innovative technologies for sustainable nickel processing, and assessing the effectiveness of policy implementations. Additionally, comparative studies with other mineral-rich developing countries with clean energy mineral reserves can provide valuable insights into common challenges and best practices for sustainable and responsible mining.

In conclusion, Indonesia's nickel to EV industry stands at a critical juncture, where the pursuit of economic development for a select must be balanced with the imperative of sustainability and the long-term development of the most vulnerable in Indonesia. Stakeholder collaborations that leverage international knowledge, influence and resources alongside local knowledge systems and recommendations are key in addressing many of the environmental, social, financial and governance challenges identified in this research. As such, Indonesia can position itself as a leader in sustainable and responsible nickel production, contributing to the global transition to clean energy while ensuring the well-being of its people and environment.

11 Appendix

11.1 Interview Guide Example

Project Introduction

This project is seeking to understand the environmental, climate and ethical implications of nickel mining and processing in Indonesia as it seeks to establish itself as a major global producer of battery grade nickel. This project will specifically seek to understand the emissions, land use and community impacts associated with nickel laterite mining and processing in Indonesia. My objective is to understand the prospective benefits and (social and environmental) costs of laterite mining and refining in Indonesia in the context of lithium ion battery manufacturing, and to be able to compare these costs and benefits with those associated with nickel mined elsewhere. I will explore the following issues:

- The current nature of nickel laterite mining and processing practices in Indonesia with a focus on land clearing impacts on biodiversity and local indigenous communities, as well as the greenhouse gas emissions resulting from the combination of deforestation, laterite processing, lithium ion battery manufacture, and shipping of completed batteries and battery components (i.e., cathodes containing nickel) to their respective markets.
- The scale of energy, infrastructure, skill and land needs for the expansion of Indonesia's nickel laterite industry.
- The demand for ethically and sustainably sourced nickel by the electric vehicle battery industry internationally and the geo-political dynamics of this demand.
- The "green cost premium" that would be obtained from adopting sustainable practices throughout the Indonesian lithium ion battery supply chain.

- The potential for policy interventions and incentives to drive the growth of the sustainably sourced nickel industry in Indonesia.

Meeting Agenda/Interview Questions

I will be seeking to conduct a 1 hour interview with **STAKEHOLDER** to understand the current nature of nickel mining and processing and the potential for policy interventions and incentives to drive the growth of sustainably sourced nickel in Indonesia.

All questions are optional, you can choose to decline answering any question or stop the interview at any time. Unless you give us permission to use your name, title, and/or quote you in any publications that may result from this research, the information you tell us will only be identified by stakeholder type – e.g. NGO/Advocacy Group. A full Consent to Participate form will be provided at the beginning of the interview.

1. Can you tell me about **STAKEHOLDER's** organizing and advocacy efforts in relation to Nickel mining and processing in Indonesia?
2. How have indigenous, forest dependent communities been impacted by these facilities? How are these communities approached by the mining companies during the permitting and operation phases of these mine sites?
    a. What involvement and consultation are indigenous communities seeking from companies and the government?
3. Can you tell a me a bit more about the rise of illegal nickel mining activities in Sulawesi including mining operations within protected forests?
4. The government recently introduced laws to allow companies to obtain permits to discard mineral processing waste into the ocean. What are these criteria to allow waste dumping?
    a. What environmental and biodiversity impacts have been observed after the introduction of these laws?

5. What have been the impacts on the viability of local farming and fishing communities due to land clearing, tailings disposal and air pollution associated with these nickel mining facilities?
6. Are efforts being made to employ and train in local communities where these facilities are located?
7. Beyond measuring carbon dioxide emissions associated with energy needs for nickel mining, what other emissions and sources of air pollution should be monitored?
8. Some mining companies have included reclamation and replanting strategies in their plans regarding post mining areas. What is actually being done to address the biodiversity loss, leeching and environmental impacts of these open pit mines?
9. Since the government introduced the export ban on raw nickel, many processing facilities including High Pressure Acid Leaching (HPAL) are under development. What environmental and community risks do you anticipate from these facilities?
10. What role do you think international EV companies in furthering sustainable mining practices for nickel?
11. What role should the government have in driving the uptake and enforcement of sustainable mining standards?
12. What role do you think international standards and policies like the EU carbon border adjustment will have on making nickel mining and processing sustainable in Indonesia?

11.2 **Additional References for Nickel Processing Sites (Table 2)**

Site	Reference
Sorowako	(PT Vale Indonesia, 2023)
PT Youshan Nickel Indonesia	(Zhejiang Huayou Cobalt Co. Ltd., 2023b)
Halmahera Persada Lygend	(Halmahera Persada Lygend, 2024; Lygend Resources & Technology Pty Ltd, 2022)
Smelter Nikel Indonesia	(Indonesia Government Information Portal, 2021)
PT Huaye Nickel Cobalt	(Zheijan Huayou Cobalt Co Ltd, 2023)
PT Huake	(Zheijan Huayou Cobalt Co Ltd, 2023; Zhejiang Huayou Cobalt Co. Ltd., 2023b)
PT QMB New Energy Materials	(GEM Indonesia, 2024)
Hengjaya Nickel	(Nickel Industries, 2023a)
Huafei Project	(Daly, 2021; Zhejiang Huayou Cobalt Co. Ltd., 2023b)
CNGR Weda Bay	(CNGR Advanced Material Co. Ltd., 2023; CNGR Advanced Material Co. Ltd, 2024)
PT Bumi Mineral Sulawesi	(PT. Bumi Mineral Sulawesi, 2024)
PT HLI Green Power	(Indonesia Battery Corporation, 2022; PT. HLI Green Power, 2024)
Angel Nickel Project	(Nickel Industries, 2023a, 2023c)
PT Ceria Nugraha Indotama	(Tempo English, 2023)
PT Nicole Metal Industry	(POSCO Holdings Inc., 2023)
PT Kolaka Nickel Indonesia	(Zhejiang Huayou Cobalt Co. Ltd., 2023a)
PT Pomalaa New Energy Material	(PT ANTAM Tbk, 2022)
Excelsior Nickel Cobalt Project	(Nickel Industries, 2023b)
Sonic Bay	(Eramet, 2022)
Huaxiang Refining Indonesia	(Zheijan Huayou Cobalt Co Ltd, 2023; Zhejiang Huayou Cobalt Co. Ltd., 2023b)
PT Ceria Nugraha Indotama HPAL	(PT Ceria Nugraha Indotama, 2024)
PT Huali Nickel Project	(PT Vale Indonesia, 2023)

12 Bibliography

Agusdinata, D. B., Liu, W., Sulistyo, S., LeBillon, P., & Wegner, J. (2023). Evaluating sustainability impacts of critical mineral extractions: Integration of life cycle sustainability assessment and SDGs frameworks. *Journal of Industrial Ecology*, *27*(3), 746–759. https://doi.org/10.1111/JIEC.13317

Aji, S. B., & Khudi, A. F. (2021). Indonesia's National Strategic Project, Displacement, and the New Poverty. *Journal of Southeast Asian Human Rights*, *5*(2), 136. https://doi.org/10.19184/jseahr.v5i2.23399

Andayani, S. W., Qizwini, A. M., Wibowo, H. S., & Arsyansyah, M. (2020). Preliminary Research of Synthesizing Battery Grade Nickel Sulphate from Dissolution of Nickel Matte in Dilute Sulphuric Acid. *IOP Conference Series: Materials Science and Engineering*. https://doi.org/10.1088/1757-899X/893/1/012003

Anderson, Z. R. (2016). Assembling the 'Field': Conducting Research in Indonesia's Emerging Green Economy. *Advances in Southeast Asian Studies*, *9*(1), 173–180. https://doi.org/10.14764/10.ASEAS-2016.1-11

Angammana, M. (2023). Research Methodology. In *Introducing Board Gender Diversity to Sri Lanka* (pp. 133–170). Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-99-0436-5_6

Ansu-Mensah, P., Marfo, E. O., Awuah, L. S., & Amoako, K. O. (2021). Corporate social responsibility and stakeholder engagement in Ghana's mining sector: a case study of Newmont Ahafo mines. *International Journal of Corporate Social Responsibility 2021 6:1*, *6*(1), 1–22. https://doi.org/10.1186/S40991-020-00054-2

Australian Government. (2023). *Appendix A: International Partnerships - Critical Minerals Strategy 2023–2030 | Department of Industry Science and Resources*. https://www.industry.gov.au/publications/critical-minerals-strategy-2023-2030/appendix-international-partnerships

Binnemans, K., & Jones, P. T. (2023). The Twelve Principles of Circular Hydrometallurgy. *Journal of Sustainable Metallurgy*, *9*(1), 1–25. https://doi.org/10.1007/s40831-022-00636-3

BIZTEK Industry & Commodity. (2023). *Industry and Market Prospects of Nickel Processing in Indonesia*.

BloombergNEF. (2023). *Electric Vehicle Outlook 2023*.

Bodley, M., Ko, R., Sauter, D., & Anderson, L. (2023). Ferronickel Sulfidation: A Solution to Supplying the Battery Market? *Proceedings of the 62nd Conference of Metallurgists, COM 2023*, 801–807. https://doi.org/10.1007/978-3-031-38141-6_104

Bradley, J., & Sprecher, B. (2021). *The Future of Nickel in a Transitioning World Exploratory System Dynamics Modelling and Analysis of the Global Nickel Supply Chain and its Nexus with the Energy System*.

Brown, D., & Harris, J. (2024). *From Forest to Electric Vehicles: Quantifying and Addressing the Environmental Toll of Indonesian Nickel*. https://mightyearth.org/wp-content/uploads/2024/05/FromForeststoEVs2024May.pdf

Business & Human Rights Resource Centre. (2023). *Indonesia: Communities and CSOs demand environmental and social accountability as Harita Group's nickel subsidiary goes public; incl. company responses* . https://www.business-humanrights.org/en/latest-

news/indonesia-residents-and-ngos-demand-environmental-and-social-accountability-as-harita-groups-nickel-subsidiary-goes-public/

Campagnol, N., Hoffman, K., Lala, A., & Ramsbottom, O. (2021). *The future of nickel: A class act*.

Cano, Z. P., Banham, D., Ye, S., Hintennach, A., Lu, J., Fowler, M., & Chen, Z. (2018). Batteries and fuel cells for emerging electric vehicle markets. *Nature Energy*, *3*(4), 279–289. https://doi.org/10.1038/s41560-018-0108-1

Cao, J., Chen, X., Qiu, R., & Hou, S. (2021). Electric vehicle industry sustainable development with a stakeholder engagement system. *Technology in Society*, *67*, 101771. https://doi.org/10.1016/J.TECHSOC.2021.101771

Carlson, K. M., Heilmayr, R., Gibbs, H. K., Noojipady, P., Burns, D. N., Morton, D. C., Walker, N. F., Paoli, G. D., & Kremen, C. (2018). Effect of oil palm sustainability certification on deforestation and fire in Indonesia. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(1), 121–126. https://doi.org/10.1073/PNAS.1704728114/SUPPL_FILE/PNAS.201704728SI.PDF

Central Government of Indonesia. (2023). *Law (UU) Number 3 of 2020 concerning Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining*. https://peraturan.bpk.go.id/Details/138909/uu-no-3-tahun-2020

Cesar, S., & Jhony, O. (2021). Making or breaking social license to operate in the mining industry: Factors of the main drivers of social conflict. *Journal of Cleaner Production*, *278*, 123640. https://doi.org/10.1016/J.JCLEPRO.2020.123640

Charmaz, K., & Belgrave, L. (2012). Qualitative interviewing and grounded theory analysis. In *The Sage handbook of interview research : the complexity of the craft* (Second edition.). SAGE,.

Cheng, A. L., Fuchs, E. R. H., Karplus, V. J., & Michalek, J. J. (2024). Electric vehicle battery chemistry affects supply chain disruption vulnerabilities. *Nature Communications*, *15*(1), 2143. https://doi.org/10.1038/s41467-024-46418-1

Christian, J., Ronald, A., Suryadi, J., Tumiwa, F., Wijayani, L., & Simamora, P. (2022). *Redefining Future Jobs Implication of coal phase-out to the employment sector and economic transformation in Indonesia's coal region 1 Redefining Future Jobs: Implication of coal phase-out to the employment sector and economic transformation in Indonesia's coal region* . www.climatetransparency.org.

Christita, M. (2018, September 15). *The Ability of Hexavalen Chromium (Cr6+) Reduction by Bacteria Isolated from Nickel Post Mining Soil at East Halmahera*.

Chun Tie, Y., Birks, M., & Francis, K. (2019). Grounded theory research: A design framework for novice researchers. *SAGE Open Medicine*, *7*, 1–8. https://doi.org/10.1177/2050312118822927

Climate Rights International. (2024). *Nickel Unearthed - The Human and Climate Costs of Indonesia's Nickel Industry*. https://cri.org/reports/nickel-unearthed/

CNGR Advanced Material Co. Ltd. (2023). *The world's first integrated connection. CNGR's first OESBF production line continuously and successfully produces high-nickel matte* . http://www.cngrgf.com.cn/en-US/gsxw/1135.html

CNGR Advanced Material Co. Ltd. (2024). *Another CNGR Indonesia Industrial Base Commenced Operation Successfully*. http://www.cngrgf.com.cn/en-US/gsxw/1241.html

Critical Minerals Association UK. (2021). *Defining Criticality - What Makes a Critical Mineral?* https://www.criticalmineral.org/post/defining-criticality-what-makes-a-critical-mineral

Crundwell, F. K., Moats, M. S., Ramachandran, V., Robinson, T. G., & Davenport, W. G. (2011a). Chapter 1 - Overview. In F. K. Crundwell, M. S. Moats, V. Ramachandran, T. G. Robinson, & W. G. Davenport (Eds.), *Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals* (pp. 1–18). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-08-096809-4.10001-2

Crundwell, F. K., Moats, M. S., Ramachandran, V., Robinson, T. G., & Davenport, W. G. (2011b). Leaching of Nickel Sulfide Mattes and Precipitates. In *Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals* (pp. 301–313). Elsevier. https://doi.org/10.1016/B978-0-08-096809-4.10024-3

Crundwell, F. K., Moats, M. S., Ramachandran, V., Robinson, T. G., & Davenport, W. G. (2011c). Smelting Laterite Concentrates to Sulfide Matte. In *Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals* (pp. 95–107). Elsevier. https://doi.org/10.1016/B978-0-08-096809-4.10008-5

Crundwell, F. K., Moats, M. S., Ramachandran, V., Robinson, T. G., & Davenport, W. G. (2011d). Smelting of Laterite Ores to Ferronickel. In *Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals* (pp. 67–83). Elsevier. https://doi.org/10.1016/B978-0-08-096809-4.10006-1

CSIRO. (2023). *Unlocking millions of tonnes of nickel - CSIRO*. https://www.csiro.au/en/work-with-us/industries/mining-resources/processing/direct-nickel

Daly, T. (2021). *China's Huayou invests in $2.1 bln Indonesia nickel project* . Reuters. https://www.reuters.com/business/energy/chinas-huayou-invests-21-bln-indonesia-nickel-project-2021-05-24/

Datta, A., Jones, H., Febriany, V., Harris, D., Kumala Dewi, R., Wild, L., & Young, J. (2011). *The political economy of policy-making in Indonesia Opportunities for improving the demand for and use of knowledge*. www.odi.org.uk

Devi, B., & Prayogo, D. (2013). *Mining and Development in Indonesia: An Overview of the Regulatory Framework and Policies*.

Dilshara, P., Abeysinghe, B., Premasiri, R., Dushyantha, N., Ratnayake, N., Senarath, S., Sandaruwan Ratnayake, A., & Batapola, N. (2024). The role of nickel (Ni) as a critical metal in clean energy transition: applications, global distribution and occurrences, production-demand and phytomining. *Journal of Asian Earth Sciences*, *259*, 105912. https://doi.org/10.1016/J.JSEAES.2023.105912

Dry, M., Vaughan, J., & Hawker, W. (2019). Environmental evaluation of making nickel sulphate. *Proceedings of ALTA 2019 Nickel-Cobalt-Copper Conference*, 136–153.

Eckelman, M. J., Reck, B. K., & Graedel, T. E. (2012). Exploring the Global Journey of Nickel with Markov Chain Models. *Journal of Industrial Ecology*, *16*(3), 334–342. https://doi.org/10.1111/j.1530-9290.2011.00425.x

Emont, J. (2023). *EV Makers Confront the 'Nickel Pickle.'* Wall Street Journal. https://www.wsj.com/articles/electric-vehicles-batteries-nickel-pickle-indonesia-9152b1f

Eramet. (2022). *Eramet in Indonesia: A landmark for the EV industry*.

European Commision Directorate General for Trade. (2023). *EU launches consultation on use of Enforcement Regulation on Indonesian nickel export restrictions - European Commission*. https://policy.trade.ec.europa.eu/news/eu-launches-consultation-use-enforcement-regulation-indonesian-nickel-export-restrictions-2023-07-07_en

European Commission. (2022). *Corporate sustainability due diligence*. https://commission.europa.eu/business-economy-euro/doing-business-eu/corporate-sustainability-due-diligence_en

Faizal, Z. P. (2021). Strict Liability in Environmental Dispute Responsibility Before and After the Enabling of Omnibus Law. *Administrative and Environmental Law Review*, *2*(1), 53–60. https://doi.org/10.25041/AELR.V2I1.2318

Fay, C., & Denduangrudee, H.-M. S. (2016). Emerging options for the recognition and protection of indigenous community rights in Indonesia. In *Land and Development in Indonesia: Searching for the People's Sovereignty* (pp. 91–112). ISEAS–Yusof Ishak Institute. https://www.cambridge.org/core/books/land-and-development-in-indonesia/emerging-options-for-the-recognition-and-protection-of-indigenous-community-rights-in-indonesia/84DB03A44E35578556795C2C3A6E7422

Flick, U. (2004). Triangulation in Qualitative Research. In *A companion to qualitative research* (pp. 178–194). Sage Publications,.

Flick, U. (2022). *The SAGE Handbook of Qualitative Research Design*. SAGE Publications Ltd. https://doi.org/10.4135/9781529770278

Foss, M. M., & Koelsch, J. (2022). *Need nickel? How electrifying transport and Chinese investment are playing out in the Indonesian archipelago*. https://doi.org/10.25613/30S0-Y623

Franks, D. M., Davis, R., Bebbington, A. J., Ali, S. H., Kemp, D., & Scurrah, M. (2014). Conflict translates environmental and social risk into business costs. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(21), 7576–7581. https://doi.org/10.1073/PNAS.1405135111/-/DCSUPPLEMENTAL/PNAS.1405135111.SD01.XLSX

Fraser, J., Anderson, J., Lazuen, J., Lu, Y., Heathman, O., Brewster, N., Bedder, J., Masson, O., Roskill Information Services London, & Europäische Kommission Gemeinsame Forschungsstelle. (2021). *Study on future demand and supply security of nickel for electric vehicle batteries external study performed by Roskill for the Joint Research Center*. https://doi.org/10.2760/212807

Fu, W., Yang, J., Yang, M., Pang, B., Liu, X., Niu, H., & Huang, X. (2014). Mineralogical and geochemical characteristics of a serpentinite-derived laterite profile from East Sulawesi, Indonesia: Implications for the lateritization process and Ni supergene enrichment in the tropical rainforest. *Journal of Asian Earth Sciences*, *93*, 74–88. https://doi.org/10.1016/J.JSEAES.2014.06.030

GEM Indonesia. (2024). *GEM in Indonesia*. http://en.gemindonesia.com/HAPLTechnology/index.aspx

Global Battery Alliance. (2023). *Battery Passport*. https://www.globalbattery.org/battery-passport/

Goodman, P. S. (2023). *China's Nickel Plants in Indonesia Created Needed Jobs, and Pollution*. The New York Times. https://www.nytimes.com/2023/08/18/business/indonesia-nickel-sulawesi-china.html

Gourley, S. W. D., Or, T., & Chen, Z. (2020). Breaking Free from Cobalt Reliance in Lithium-Ion Batteries. *IScience*, *23*(9), 101505. https://doi.org/10.1016/j.isci.2020.101505

Government Regulation (PP) Number 22 of 2021 Concerning the Implementation of Environmental Protection and Management (2021). https://peraturan.bpk.go.id/Details/161852/pp-no-22-tahun-2021

Government Regulation (PP) Number 42 of 2021 Concerning the Ease of National Strategic Projects (2021). https://peraturan.bpk.go.id/Details/161962/pp-no-42-tahun-2021

Greenpeace Indonesia. (2023). *About Us*. https://www.greenpeace.org/indonesia/aksi/

Haddadian, G., Khodayar, M., & Shahidehpour, M. (2015). Accelerating the Global Adoption of Electric Vehicles: Barriers and Drivers. *The Electricity Journal*, *28*(10), 53–68. https://doi.org/10.1016/j.tej.2015.11.011

Halmahera Persada Lygend. (2024). *HPAL | About Us*. https://hpalnickel.com/about-us

Hamzah, H., Narang, A. M., & Yusari, A. (2021). *Legal Systems in Indonesia: Overview*. https://elischolar.library.yale.edu/ypfs-documents/11551

Haupt, W. (2023). Policy diffusion, policy transfer, and policy mobilities revisited: A call for more interdisciplinary approaches in human geography. *Geography Compass*, 17. https://doi.org/10.1111/gec3.12688

Haziq Uddin, M. (2020). *The effect of sulfur in rotary kiln fuels on nickel laterite calcination* [University of British Columbia]. http://oatd.org/oatd/record?record=handle%5C%3A2429%5C%2F73313

Heijlen, W., & Duhayon, C. (2024a). An empirical estimate of the land footprint of nickel from laterite mining in Indonesia. *The Extractive Industries and Society*, *17*, 101421. https://doi.org/10.1016/J.EXIS.2024.101421

Heijlen, W., & Duhayon, C. (2024b). An empirical estimate of the land footprint of nickel from laterite mining in Indonesia. *The Extractive Industries and Society*, *17*, 101421.

Helbig, C., Bradshaw, A. M., Wietschel, L., Thorenz, A., & Tuma, A. (2018). Supply risks associated with lithium-ion battery materials. *Journal of Cleaner Production*, *172*, 274–286. https://doi.org/10.1016/J.JCLEPRO.2017.10.122

Herbert Smith Freehills. (2020). *Omnibus Law Insights: Guide to Impact on Indonesia's Energy, Resources and Infrastructure Sectors – Licensing, Environmental, Forestry and Construction Reforms | Indonesia notes*. https://hsfnotes.com/indonesia/2020/10/30/omnibus-law-insights-guide-to-impact-on-indonesias-energy-resources-and-infrastructure-sectors-licensing-environmental-forestry-and-construction-reforms/

Hidayat, B., Jossi, K., Chu, K., & Meers, J. (2022). *Investigating Rainforest Destruction: The Nickel Mines Clearing Indonesian Forests | .* Pulitzer Center. https://pulitzercenter.org/stories/investigating-rainforest-destruction-nickel-mines-clearing-indonesian-forests

Houache, M. S. E., Yim, C. H., Karkar, Z., & Abu-Lebdeh, Y. (2022). On the Current and Future Outlook of Battery Chemistries for Electric Vehicles—Mini Review. *Batteries 2022, Vol. 8, Page 70*, *8*(7), 70. https://doi.org/10.3390/BATTERIES8070070

Huber, I. (2022). *Indonesia's Battery Industrial Strategy*. Center for Strategic and International Studies. https://www.csis.org/analysis/indonesias-battery-industrial-strategy

Indonesia Battery Company. (2024). *About Us*. https://www.indonesiabatterycorp.com/en/future-project

Indonesia Battery Corporation. (2022). *The Framework Agreement Signing of The EV Battery Integrated Project Between Indonesia Battery Corporation, ANTAM, CBL, and LGES with an Investment Value of USD15 Billion or Equal to Rp215 Trillion*. https://www.antam.com/index.php/downloads/the-framework-agreement-signing-of-the-ev-battery-integrated-project-between-indonesia-battery-corporation--antam--cbl--and-lges-with-an-investment-value-of-usd15-billion-or-equal-to-rp215-trillion--

Indonesia Government Information Portal. (2021). *Four Smelters Will Operate This Year*. https://indonesia.go.id/kategori/editorial/2956/empat-smelter-akan-beroperasi-tahun-ini

Indonesia Just Energy Transition Partnership. (2023). *Comprehensive Investment and Policy Plan (CIPP)* . https://jetp-id.org/cipp

IndoPremier. (2024). *Metals Sector Update - Discussion KTA with Coordinating Ministry of Maritime and Investment*.

Intergovernmental Panel on Climate Change. (2023). *Climate Change 2022 - Mitigation of Climate Change* (Intergovernmental Panel on Climate Change (IPCC), Ed.). Cambridge University Press. https://doi.org/10.1017/9781009157926

International Energy Agency. (2022a). *An Energy Sector Roadmap to Net Zero Emissions in Indonesia*. https://www.iea.org/reports/an-energy-sector-roadmap-to-net-zero-emissions-in-indonesia

International Energy Agency. (2022b). *Global Supply Chains of EV Batteries*. www.iea.org/t&c/

International Energy Agency. (2022c). *The Role of Critical Minerals in Clean Energy Transitions*. www.iea.org/t&c/

International Energy Agency. (2023a). *Critical Minerals Market Review 2023*. www.iea.org

International Energy Agency. (2023b). Global EV Outlook 2023. In *Internatiio*. https://www.iea.org/reports/global-ev-outlook-2023/trends-in-batteries

International Energy Agency. (2023c). *Sustainable and Responsible Critical Mineral Supply Chains Guidance for policy makers*. www.iea.org

International Energy Agency. (2023d). *World Energy Outlook 2023*. https://www.iea.org/reports/world-energy-outlook-2023

International Nickel Study Group. (2021). *The World Nickel Facebook*.

International Nickel Study Group. (2023). *Nickel Market Observations for 2023 and 2024* (Press Releases). https://insg.org/wp-content/uploads/2023/10/pressrel_INSG-Press-Release-October_2023fbnub82.pdf

International Work Group for Indigenous Affairs. (2024). *The Indigenous World 2023: Indonesia*. https://www.iwgia.org/en/indonesia/5120-iw-2023-indonesia.html#_ednref10

IRENA. (2023). *Geopolitics of the Energy Transition: Critical Materials*. https://www.irena.org/Publications/2023/Jul/Geopolitics-of-the-Energy-Transition-Critical-Materials

Izzati, N. R. (2023). *Indonesia's emergency labour regulation changes spark worker anger a year out from election, but Jokowi's government is unwavering*. The Conversation. https://theconversation.com/indonesias-emergency-labour-regulation-changes-spark-worker-anger-a-year-out-from-election-but-jokowis-government-is-unwavering-197281

JATAM. (2023). *About Us*. https://www.jatam.org/en/about-us/

Jones, B., Elliott, R. J. R., & Nguyen-Tien, V. (2020). The EV revolution: The road ahead for critical raw materials demand. *Applied Energy*, *280*, 115072. https://doi.org/10.1016/j.apenergy.2020.115072

Jong, H. N. (2020). *Indonesia's miners exploit loopholes to avoid restoring mining sites*. https://news.mongabay.com/2020/04/indonesias-miners-exploit-loopholes-to-avoid-restoring-mining-sites/

Knox-Hayes, J., Chandra, S., & Chun, J. (2021). The role of values in shaping sustainable development perspectives and outcomes: A case study of Iceland. *Sustainable Development*, *29*(2), 363–377. https://doi.org/10.1002/sd.2152

Lazenby, H. (2024). *Push for ESG price premiums may reshape global critical minerals markets - MINING.COM*. https://www.mining.com/push-for-esg-price-premiums-may-reshape-global-critical-minerals-markets/

LG Energy Solution. (2023). *LG Energy Solution Company Profile 2023*. https://www.lgensol.com/assets/file/2023_company_profile_EN.pdf

Lygend Resources & Technology Pty Ltd. (2022). *Global Offering: Lygend Resources & Technology Pty Ltd*. www.lygend.com

Machielsen, A.-L. (2022). *Green colonialism: Research on colonial injustices related to nickel mining in West Papua* [TU Delft Technology]. https://repository.tudelft.nl/islandora/object/uuid%3A103675cf-31f8-4dd7-83dc-f933465514fa

MacInnes, A., Colchester, M., & Whitmore, A. (2017). Free, prior and informed consent: how to rectify the devastating consequences of harmful mining for indigenous peoples'. *Perspectives in Ecology and Conservation*, *15*(3), 152–160. https://doi.org/10.1016/J.PECON.2017.05.007

Maghfiroh, M. F. N., Pandyaswargo, A. H., & Onoda, H. (2021). Current Readiness Status of Electric Vehicles in Indonesia: Multistakeholder Perceptions. *Sustainability*, *13*(23), 13177. https://doi.org/10.3390/su132313177

Mancini, L., Eslava, N. A., Traverso, M., & Mathieux, F. (2020). Responsible and sustainable sourcing of battery raw materials. *JRC Technical Report*. https://doi.org/10.2760/562951

Mauler, L., Lou, X., Duffner, F., & Leker, J. (2022). Technological innovation vs. tightening raw material markets: falling battery costs put at risk. *Energy Advances*, *1*(3), 136–145. https://doi.org/10.1039/D1YA00052G

Mavhunga, C. C. (2023). Africa's move from raw material exports toward mineral value addition: Historical background and implications. *MRS Bulletin*, *48*(4), 395–406. https://doi.org/10.1557/s43577-023-00534-3

Mbirigenda, S. K. (2017). Stakeholders' involvement in Corporate Social Responsibility: The Mining Sector in Tanzania. *Utafiti*, *12*(1–2), 109–130. https://doi.org/10.1163/26836408-0120102007

McCarthy, J. F. (John F., & Robinson, K. M. (2016). Land & development in Indonesia : searching for the people's sovereignty. In *Land & development in Indonesia : searching for the people's sovereignty*. ISEAS-Yusof Ishak Institute.

McNulty, B. A., & Jowitt, S. M. (2021). Barriers to and uncertainties in understanding and quantifying global critical mineral and element supply. *IScience*, *24*(7), 102809. https://doi.org/10.1016/J.ISCI.2021.102809

McRae, M. E. (2023). *USGS Mineral Commodity Summary* .

McRae, M. E. (2024). *USGS Mineral Commodities Summary - Nickel*.

Meerveld, D. (2016). *Assessing Value: A Comprehensive Study of Impact Benefit Agreements on Indigenous Communities of Canada*.

Meshram, P., Abhilash, & Pandey, B. D. (2019). Advanced Review on Extraction of Nickel from Primary and Secondary Sources. *Mineral Processing and Extractive Metallurgy Review*, *40*(3), 157–193. https://doi.org/10.1080/08827508.2018.1514300

Miklosik, A., & Evans, N. (2021). *Environmental sustainability disclosures in annual reports of mining companies listed on the Australian Stock Exchange (ASX)*. https://doi.org/10.1016/j.heliyon.2021.e07505

MIND ID. (2024). *About Us*. https://mind.id/en/pages/tentang-kami

Ministry of Energy and Mineral Resources. (2024). *Duties & Functions*. https://www.esdm.go.id/en/profile/duties-functions/kementerian-esdm

Ministry of Energy and Mineral Resources (ESDM). (2023). *Minerba One Data Indonesia*. https://modi.esdm.go.id/filter?tahun=2023

Ministry of Energy and Mineral Resources (ESDM). (2024). *ESDM One Map - Exploring Energy and Mineral Resources of Indonesia*. https://geoportal.esdm.go.id/

Ministry of Environment and Forestry. (2022). *Organisation Duties*. https://www.menlhk.go.id/profile/organization/

Mori Junior, C., Franks, R. M., & Ali, D. M. (2015). *Designing Sustainability Certification for Impact: Analysis of the design characteristics of 15 sustainability standards in the mining industry. Centre for Social Responsibility in Mining*.

Mudd, G. M., & Jowitt, S. M. (2014). A Detailed Assessment of Global Nickel Resource Trends and Endowments. *Economic Geology*, *109*(7), 1813–1841. https://doi.org/10.2113/ECONGEO.109.7.1813

Mudd, G. M., & Jowitt, S. M. (2022). The New Century for Nickel Resources, Reserves, and Mining: Reassessing the Sustainability of the Devil's Metal. *Economic Geology*, *117*(8), 1961–1983. https://doi.org/10.5382/econgeo.4950

Mudd, G. M., Roche, C., Northey, S. A., Jowitt, S. M., & Gamato, G. (2020). Mining in Papua New Guinea: A complex story of trends, impacts and governance. *Science of The Total Environment*, *741*, 140375. https://doi.org/10.1016/J.SCITOTENV.2020.140375

Murdiyarso, D., Krisnawati, H., Adinugroho, W. C., & Sasmito, S. D. (2023). Deriving emission factors for mangrove blue carbon ecosystem in Indonesia. *Carbon Balance and Management*, *18*(1), 1–12. https://doi.org/10.1186/S13021-023-00233-1/FIGURES/4

Murdiyarso, D., Swails, E., Hergoualc'h, K., Bhomia, R., & Sasmito, S. D. (2024). Progress and Promise for Science in Indonesia: Refining greenhouse gas emission factors for Indonesian peatlands and mangroves to meet ambitious climate targets. *Proceedings of the National Academy of Sciences of the United States of America*, *121*(17). https://doi.org/10.1073/PNAS.2307219121

Murdock, B. E., Toghill, K. E., & Tapia-Ruiz, N. (2021). A Perspective on the Sustainability of Cathode Materials used in Lithium-Ion Batteries. *Advanced Energy Materials*, *11*(39). https://doi.org/10.1002/AENM.202102028

Myllvirta, L., Hasan, K., Kelly, J., & Parapat, J. (2024). *Debunking the value-added myth in nickel downstream industry*. https://energyandcleanair.org/publication/debunking-the-value-added-myth-in-nickel-downstream-industry/

Nancy, N. (2022). Potential Distortion of Sustainable Development in the Conflict of Interest of Nickel Mining and Indigenous Communities in Halmahera, North Maluku. *Journal of Global Environmental Dynamics*, *3*(2), 11–20.

Nangoy, F., & Christina, B. (2024). *MIND ID to acquire 14% stake in Vale Indonesia from foreign investors | Reuters*. https://www.reuters.com/markets/deals/mind-id-acquire-14-stake-vale-indonesia-foreign-investors-2024-02-26/

Nangoy, F., & Sulaiman, S. (2023). *Indonesia cuts tax breaks to discourage low-quality nickel investment, minister says*. Reuters.

https://www.reuters.com/markets/commodities/indonesia-cuts-tax-breaks-discourage-low-quality-nickel-investment-minister-2023-05-03/

Nickel Industries. (2023a). *Annual Report 2022*.

Nickel Industries. (2023b). *Positive final investment decision for ENC HPAL project, supported by Indonesian bank loans*. https://nickelindustries.com/carbon/wp-content/uploads/2023/10/2622065.pdf

Nickel Industries. (2023c). *Presentation to Investors*. https://www.listcorp.com/asx/nic/nickel-industries-limited/news/presentation-to-investors-2852457.html

Nickel Institute. (2022). *About Nickel: First Use of Nickel*. Nickel Institute. https://nickelinstitute.org/en/about-nickel-and-its-applications/#02-nickel-availability

Norgate, T., & Jahanshahi, S. (2011). Assessing the energy and greenhouse gas footprints of nickel laterite processing. *Minerals Engineering*, *24*(7), 698–707. https://doi.org/10.1016/j.mineng.2010.10.002

Nugroho, Y., & Sujarwoto. (2021). Two Decades of Decentralization and State Capacity in Indonesia. *Journal of Southeast Asian Economies*, *38*(3), 296–319. https://www.jstor.org/stable/27096080

Olivetti, E. A., Ceder, G., Gaustad, G. G., & Fu, X. (2017). Lithium-Ion Battery Supply Chain Considerations: Analysis of Potential Bottlenecks in Critical Metals. *Joule*, *1*(2), 229–243. https://doi.org/10.1016/j.joule.2017.08.019

Olivetti, E., Field, F., & Kirchain, R. (2015). Understanding dynamic availability risk of critical materials: The role and evolution of market analysis and modeling. *MRS Energy and Sustainability*, *2*(1), 1–16. https://doi.org/10.1557/MRE.2015.6/FIGURES/7

Pandyaswargo, A. H., Dwi Wibowo, A., Fitriani, M., Maghfiroh, N., Rezqita, A., & Onoda, H. (2021). *The Emerging Electric Vehicle and Battery Industry in Indonesia: Actions around the Nickel Ore Export Ban and a SWOT Analysis*. https://doi.org/10.3390/batteries7040080

Parapat, J., & Hasan, K. (2023). *Emerging captive coal power: Dark clouds on Indonesia's clean energy horizon*. www.globalenergymonitor.org.

Peck, J., & Theodore, N. (2010). Mobilizing policy: Models, methods, and mutations. *Geoforum*, *41*(2), 169–174. https://doi.org/10.1016/J.GEOFORUM.2010.01.002

Peck, J., & Theodore, N. (2012). Follow the policy: A distended case approach. *Environment and Planning A*, *44*(1), 21–30. https://doi.org/10.1068/A44179

Petromindo. (2023). *Indonesian Nickel Book 2022*. https://www.petromindo.com/products/detail?id=459

Phelps, N. A., Bunnell, T., Miller, M. A., & Taylor, J. (2014). Urban inter-referencing within and beyond a decentralized Indonesia. *Cities*, *39*, 37–49. https://doi.org/10.1016/J.CITIES.2014.02.004

POSCO Holdings Inc. (2023). *Form 6-K report of foreign private issuer pursuant to Rule 13a-16 or 15d-16 under the Securities Exchange Act of 1934*. www.secdatabase.com.

Pratikto, A., Sanyojaya, A., Phan, A. T., Arnold, B., & Darsa, M. (2021). *Changes of Employment Regulations Omnibus Employment Cluster: How might it support the investment environment? What are the potential impacts on Financial Reporting?*

Presidential Regulation (Perpres) Number 55 of 2019 Concerning the Acceleration of Battery Electric Vehicle Program for Road Transportation, The Audit Board of the Republic of Indonesia (2019). https://peraturan.bpk.go.id/Details/116973/perpres-no-55-tahun-2019

Presidential Regulation (Perpres) Number 92 of 2019 Concerning the Coordinating Ministry for Maritime Affairs and Investment (2019). https://peraturan.bpk.go.id/Details/129196/perpres-no-92-tahun-2019

Prince, R. (2017). Local or global policy? Thinking about policy mobility with assemblage and topology. *Area*, *49*(3), 335–341. https://doi.org/10.1111/AREA.12319

PT ANTAM Tbk. (2022). *CNGR and ANTAM Sign Framework Agreement for the Development of Nickel Ore Industrial Area*. https://antam.com/en/news-and-events/article/cngr-and-antam-sign-framework-agreement-for-the-development-of-nickel-ore-industrial-area

PT. Bumi Mineral Sulawesi. (2024). *Projects*. https://www.bumimineralsulawesi.com/project/

PT Ceria Nugraha Indotama. (2024). *EV Battery Ecosystem*. https://cerindocorp.com/business-battery-precusors

PT. HLI Green Power. (2024). *Home | HLI Green Power*. https://hligreenpower.com/

PT PLN Persero. (2022). *PLN is Ready to Electrifie 6 Smelters in Sulawesi as Much as 3.168 MVA*. https://web.pln.co.id/media/2022/06/pln-siap-listriki-6-smelter-di-sulawesi-sebesar-3-168-mva

PT Vale Indonesia. (2023). *PT Vale Indonesia Annual Report 2023*.

Racanelli, J. (2021). *Does Matte Matter? Is nickel pig iron the answer to EV battery demand?*

Ramdoo, I. (2018). *Skills development in the mining sector: Making more strategic use of local content strategies*.

Rayos, M. (2023). *Indonesia – Mining by the numbers, 2023*. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/research/indonesia-mining-by-the-numbers-2023

Regulation of the Minister of Environment and Forestry Number 8 of 2021 Concerning Forest Management and Preparation of Forest Management Plans, as Well as the Utilization of Forests in Protected Forests and Production Forests (2021). https://peraturan.bpk.go.id/Details/235254/permen-lhk-no-8-tahun-2021

Reuters. (2023a). *Indonesia details plans to limit development of nickel smelters*. Reuters. https://www.reuters.com/markets/commodities/indonesia-details-plans-limit-development-nickel-smelters-report-2023-01-13/

Reuters. (2023b). *Indonesia probes possible illegal nickel ore exports to China*. https://www.reuters.com/article/idUSKBN2YN0J4/

Rodrigues, M., Alves, M. C., Silva, R., & Oliveira, C. (2022). Mapping the Literature on Social Responsibility and Stakeholders' Pressures in the Mining Industry. *Journal of Risk and Financial Management 2022, Vol. 15, Page 425*, *15*(10), 425. https://doi.org/10.3390/JRFM15100425

Rosada, F., Wibisana, R. A. A., & Paksi, A. K. (2023). The Impact of Indonesia-China Nickel Cooperations on Indonesia's Economy and Environment. *Nation State: Journal of International Studies*, *6*(2), 96–116. https://doi.org/10.24076/nsjis.v6i2.1270

Ruan, D., Li, C., Yue, X., Tang, S., Liu, Y., & Chen, X. (2024). *Method for treating laterite nickel ore by means of oxygen-enriched side blowing furnace* (Patent WO2024026998). World Intellectual Property Organization. https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2024026998

Ruehl, M. (2023). *Indonesia's Adaro struggles to secure funding for $2bn aluminium project*. https://www.ft.com/content/214da7e7-c858-452c-9aff-e6dab9b805e4

Rye, S. A., & Kurniawan, N. I. (2017). Claiming indigenous rights through participatory mapping and the making of citizenship. *Political Geography*, *61*, 148–159. https://doi.org/10.1016/J.POLGEO.2017.08.008

Sangadji, A., Ngoyo, M. F., & Ginting, P. (2023). *Challenging the Sustainability of Nickel-based Production for Electric Vehicle Batteries*.

Sappor, J. (2021). *Profit margins key to Tsingshan's battery nickel supply plans* . S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/blog/profit-margins-key-to-tsingshans-battery-nickel-supply-plans#

Savage, G. C. (2020). What is policy assemblage? *Territory, Politics, Governance*, *8*(3), 319–335. https://doi.org/10.1080/21622671.2018.1559760

Schmidt, T., Buchert, M., & Schebek, L. (2016). Investigation of the primary production routes of nickel and cobalt products used for Li-ion batteries. *Resources, Conservation and Recycling*, *112*, 107–122. https://doi.org/10.1016/J.RESCONREC.2016.04.017

Schönsteiner, J., & Contardo, J. I. (2020). Chile. In C. Kessedjian & H. Cantú Rivera (Eds.), *Private International Law Aspects of Corporate Social Responsibility* (Vol. 42). Springer International Publishing. https://doi.org/10.1007/978-3-030-35187-8

Seok, C.-W., Son, W.-Y., Lee, K.-H., Park, J. G., & Kang, Y. (2021). Study on the Refining Conditions of Nickel Pig Iron for High Purity Nickel Matte Production. *SSRN Electronic Journal*. https://doi.org/10.2139/SSRN.3926649

Sett, D., Natalia Widjaja, C., Sanady, P., Greco, A., Setiadi, N., Sagala, S., Sri Rozanna, C., & Sandholz, S. (2022). *HAZARDS, EXPOSURE AND VULNERABILITY IN INDONESIA: A risk assessment across regions and provinces to inform the development of an Adaptive Social Protection Road Map*.

Siakwah, P., & Lawer, E. T. (2024). Global Pressures in Policymaking: Insights from the Extractive Industries Transparency Initiative and Ghana's Petroleum Industry. *International Series on Public Policy*, *Part F1956*, 181–199. https://doi.org/10.1007/978-3-031-33005-6_11/COVER

Silva, E. (2023). *Indonesia's nickel processing boom raises questions over tailings disposal* . S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/indonesia-s-nickel-processing-boom-raises-questions-over-tailings-disposal-75180844

Singgih, V., & Salam, F. (2024). *Cina di Hilir: Gurita Oligarki Nikel Indonesia - Project Multatuli*. Project Multatuli. https://projectmultatuli.org/cina-di-hilir-gurita-oligarki-nikel-indonesia/

Siringoringo, J., & Mambor, V. (2021). *The Indigenous World 2021: Indonesia*. https://www.iwgia.org/en/indonesia/4224-iw-2021-indonesia.html

Snowdon, N., Rai, A., Schiavon, A., Sharp, D., & Currie, J. (2022). *Green Metals Nickel's class divide*. www.gs.com/research/hedge.html.

Soh Tamehe, L., Zhao, Y., Xu, W., & Gao, J. (2024). Ni(Co) Laterite Deposits of Southeast Asia: A Review and Perspective. *Minerals*, *14*(2), 134. https://doi.org/10.3390/MIN14020134/S1

Sovacool, B. K. (2019). The precarious political economy of cobalt: Balancing prosperity, poverty, and brutality in artisanal and industrial mining in the Democratic Republic of the Congo. *The Extractive Industries and Society*, *6*(3), 915–939. https://doi.org/10.1016/J.EXIS.2019.05.018

S&P Global Market Intelligence. (2022). *Major nickel discoveries remain scarce amid looming supply deficits*. https://www.spglobal.com/marketintelligence/en/news-insights/research/major-nickel-discoveries-remain-scarce-amid-looming-supply-deficits

S&P Global Market Intelligence. (2024). *S&P Capital IQ Pro - Metals and Mining*. https://www.spglobal.com/marketintelligence/en/campaigns/metals-mining

Struebig, M. J., Aninta, S. G., Beger, M., Bani, A., Barus, H., Brace, S., Davies, Z. G., De Brauwer, M., Diele, K., Djakiman, C., Djamaluddin, R., Drinkwater, R., Dumbrell, A., Evans, D., Fusi, M., Herrera-Alsina, L., Iskandar, D. T., Jompa, J., Juliandi, B., … Supriatna, J. (2022). Safeguarding Imperiled Biodiversity and Evolutionary Processes in the Wallacea Center of Endemism. *BioScience*, *72*(11), 1118–1130. https://doi.org/10.1093/BIOSCI/BIAC085

Suherman, I., & Saleh, R. (2018). Supply chain analysis for Indonesian nickel. *Indonesian Mining Journal*, *21*(1), 59–76. https://doi.org/10.30556/imj.vol21.no1.2018.246

Supriatna, J., Shekelle, M., Fuad, H. A. H., Winarni, N. L., Dwiyahreni, A. A., Farid, M., Mariati, S., Margules, C., Prakoso, B., & Zakaria, Z. (2020). Deforestation on the

Indonesian island of Sulawesi and the loss of primate habitat. *Global Ecology and Conservation*, *24*, e01205. https://doi.org/10.1016/J.GECCO.2020.E01205

Tan, R. (2023). *To mine EV minerals, industry turns to dangerous refinery technology*. https://www.washingtonpost.com/world/interactive/2023/ev-nickel-refinery-dangers/

Tempo English. (2023). *PT Ceria Nugraha Indotama - Indonesian Owned Nickel Company* . Tempo English. https://magz.tempo.co/read/inforial/40976/indonesian-owned-nickel-company

Tesla. (2022). *2022 Tesla Impact Report*. https://www.tesla.com/ns_videos/2022-tesla-impact-report.pdf

Tesla. (2023). *Tesla Conflict Minerals Report*.

The Economist. (2022). *A nickel-trading fiasco raises three big questions*. https://www.economist.com/finance-and-economics/2022/03/19/a-nickel-trading-fiasco-raises-three-big-questions

The World Bank. (2023). *Climate-Smart Mining Framework*. https://www.worldbank.org/en/programs/climate-smart-mining/csm-framework

Trend Asia. (2023). *About Us*. https://trendasia.org/en/about-us/#

Tritto, A. (2023). *How Indonesia Used Chinese Industrial Investments to Turn Nickel into the New Gold*. https://doi.org/10.22617/FLS168388-2

Tundang, R. E. (2023). *Navigating Trade and Investment Treaties to Develop Indonesia's Sustainable Electric Vehicle Industry Through Technology Transfer – Investment Treaty News*. International Institute for Sustainable Development.

https://www.iisd.org/itn/en/2023/07/01/navigating-trade-and-investment-treaties-to-develop-indonesias-sustainable-electric-vehicle-industry-through-technology-transfer/

UN Secretary General's Working Group on Transforming The Extractive Industries for Sustainable Development. (2024). *UN Framework on Just Transitions for Critical Energy Transition Minerals*. https://www.greenpolicyplatform.org/initiatives/working-group-transforming-extractive-industries-sustainable-development/UN%20Framework%20on%20Just%20Transitions%20for%20CETM

UN Trade and Development. (2021). *Indonesia - New Investment Ministry established | Investment Policy Monitor | UNCTAD Investment Policy Hub*. https://investmentpolicy.unctad.org/investment-policy-monitor/measures/3712/new-investment-ministry-established

UNCTAD Investment Policy Hub. (2021). *Indonesia - "Omnibus Law" on job creation has been enacted | Investment Policy Monitor | .* https://investmentpolicy.unctad.org/investment-policy-monitor/measures/3567/indonesia-omnibus-law-on-job-creation-has-been-enacted

Underrepresented Nations and Peoples Organisation. (2020). *West Papua: Indonesia Continues Mining*. https://unpo.org/article/21849

UNDP Indonesia. (2019). *UNDP Indonesia, GEF, launch initiative to curb the use of harmful mercury | United Nations Development Programme*. https://www.undp.org/indonesia/press-releases/undp-indonesia-gef-launch-initiative-curb-use-harmful-mercury

United Nations Conference on Trade and Development. (2022). *Technical note on critical minerals: Supply chains, trade flows and value addition*.

United Nations Development Programme Indonesia. (2024). *Annual Report*. www.undp.org/indonesia

United Nations Human Rights Office of the High Commissioner. (2024). *UN experts deeply concerned over 'scholasticide' in Gaza | OHCHR*. https://www.ohchr.org/en/press-releases/2024/04/un-experts-deeply-concerned-over-scholasticide-gaza

University of Queensland. (2023). *Global Research Consortium on Tailings*. https://smi.uq.edu.au/Tailings-Consortium

Vale. (2023). *Vale to invest 11 billion reais in dry iron ore processing over the next five years - Vale*. https://vale.com/in/w/vale-to-invest-11-billion-reais-in-dry-iron-ore-processing-over-the-next-five-years

Van Den Brink, S., Kleijn, R., Sprecher, B., & Tukker, A. (2020). *Identifying supply risks by mapping the cobalt supply chain*. https://doi.org/10.1016/j.resconrec.2020.104743

Vasstrøm, M., & Lysgård, H. K. (2021). What shapes Norwegian wind power policy? Analysing the constructing forces of policymaking and emerging questions of energy justice. *Energy Research & Social Science*, *77*, 102089. https://doi.org/10.1016/J.ERSS.2021.102089

Viveros, H. (2016). Examining Stakeholders' Perceptions of Mining Impacts and Corporate Social Responsibility. *Corporate Social Responsibility and Environmental Management*, *23*(1), 50–64. https://doi.org/10.1002/CSR.1363

Wahyono, S. (2022). International Collaborative Research: Responsive Partnership, Value and the Missing Link in Indonesia. *KnE Social Sciences*. https://doi.org/10.18502/KSS.V7I9.10968

WALHI. (2023). *About Us*. https://www.walhi.or.id/

Wardana, A. (2022). Governing through Courts?: A Gloomy Picture of Climate Litigation in Indonesia. *Völkerrechtsblog*. https://doi.org/10.1093/LAW/9780198849155.001.0001/LAW-9780198849155-CHAPTER-17

Wicaksono, R. A. (2022). *The Face of the Nickel Industry Now*. Betahita. https://betahita.id/news/detail/7983/wajah-industri-nikel-kini.html?v=1671190601

Widitatedja, G. N. P. (2023). *Indonesia's nickel export ban: is it really in the national interest? - Indonesia at Melbourne*. Indonesia at the University of Melbourne. https://indonesiaatmelbourne.unimelb.edu.au/indonesias-nickel-export-ban-is-it-really-in-the-national-interest/

World Trade Organization. (2022). *Indonesia: Measures Relating to Raw Materials*. https://www.wto.org/english/tratop_e/dispu_e/592r_e.pdf

Xu, C., Dai, Q., Gaines, L., Hu, M., Tukker, A., & Steubing, B. (2020). Future material demand for automotive lithium-based batteries. *Communications Materials*, *1*(1), 99. https://doi.org/10.1038/s43246-020-00095-x

Yakovleva, N., & Vazquez-Brust, D. (2012). Stakeholder Perspectives on CSR of Mining MNCs in Argentina. *Journal of Business Ethics*, *106*(2), 191–211. https://doi.org/10.1007/S10551-011-0989-4/TABLES/8

Yang, A., Uysal, N., & Taylor, M. (2018). Unleashing the Power of Networks: Shareholder Activism, Sustainable Development and Corporate Environmental Policy. *Business Strategy and the Environment*, *27*(6), 712–727. https://doi.org/10.1002/bse.2026

Yin, R. K. (2011). *Qualitative research from start to finish*. Guilford Press.

Young, E., Billy, R., Petavratzi, E., & Reck, B. (2021). *Battery Nickel Bottlenecks: A material flow analysis of the impact the energy transition will have on the nickel supply system*. Norwegian University of Science and Technology.

Zheijan Huayou Cobalt Co Ltd. (2023). *Company Profile*. https://www.hannovermesse.de/apollo/hannover_messe_2023/obs/Binary/A1253699/Compro.pdf

Zhejiang Huayou Cobalt Co. Ltd. (2023a). *Announcement on the Cooperation Progress of Pomalaa Project Among Ford Motor and PTVI*.

Zhejiang Huayou Cobalt Co. Ltd. (2023b). *Annual Report*. https://www.huayou.com/Public/Uploads/uploadfile2/files/20240423/2023AnnualReportofHuayouCobalt1.pdf

Zhu, M., Lou, J., Cui, R. Y., Cheng, X., Li, S., Li, D., Arinaldo, D., Li, W., & Hultman, N. (2022). *Decarbonizing captive coal power plants in Indonesia and implications for Chinese stakeholders: Trends, challenges and opportunities*.