TRENDS IN SOUTHEAST ASIA

ENHANCING ASEAN'S ROLE IN CRITICAL MINERAL SUPPLY CHAINS

Sharon Seah and Mirza Sadaqat Huda

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FOREWORD

The economic, political, strategic and cultural dynamism in Southeast Asia has gained added relevance in recent years with the spectacular rise of giant economies in East and South Asia. This has drawn greater attention to the region and to the enhanced role it now plays in international relations and global economics.

The sustained effort made by Southeast Asian nations since 1967 towards a peaceful and gradual integration of their economies has had indubitable success, and perhaps as a consequence of this, most of these countries are undergoing deep political and social changes domestically and are constructing innovative solutions to meet new international challenges. Big Power tensions continue to be played out in the neighbourhood despite the tradition of neutrality exercised by the Association of Southeast Asian Nations (ASEAN).

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Enhancing ASEAN's Role in Critical Mineral Supply Chains

By Sharon Seah and Mirza Sadaqat Huda

EXECUTIVE SUMMARY

- The clean energy transition momentum is gathering pace globally, and in Southeast Asia as well. The transition is dependent on an uninterrupted supply of critical minerals and metals that are essential for the production of low-carbon technologies.
- The supply of critical minerals is impeded by several constraints. First is the dominance of a handful of countries in both the upstream and downstream parts of the supply chain. Second is the current geopolitical race to secure supplies leading to greater protectionist behaviours, exhibited through export bans and trade impediments.
- This study focuses on four selected critical minerals which are important to the region. Two criteria are used in determining a mineral having high significance: (1) There are significant deposits of it which can be tapped on to bolster Southeast Asia's strategic position in the supply chains; and (2) It is an essential input in industries and sectors of importance in Southeast Asia. The four critical minerals examined in this study are: copper, nickel, bauxite (alumina), and rare earth elements (REEs).
- The study makes three recommendations to enhance ASEAN's role in the critical minerals supply chains. The first addresses the insufficiency of investments in early-stage exploration and exploitation of critical minerals and, in the process, calls for an embracing of circular economy principles. The second appeals for investments at all stages, including in technology to tap into downstream activities beyond refining and purification, and in the manufacturing of component parts such as battery cell storage and permanent magnets. The third calls for improvements in sustainability management in the mining sector, which is generally extremely environmentally and socially damaging to communities.

Enhancing ASEAN's Role in Critical Mineral Supply Chains

By Sharon Seah and Mirza Sadaqat Huda[1]

INTRODUCTION

An energy transition is underway in Southeast Asia. This process is dependent on an uninterrupted supply of the minerals and metals that are essential to produce low-carbon technologies. These raw materials are termed "critical minerals" (CMs), owing to three broad features: their necessity as inputs in low-carbon technology, the lack of viable substitutes, and significant supply constraints.[2] The demand for CMs such as lithium, nickel, cobalt, rare earth elements (REEs), copper, and silicon[3] is expected to increase exponentially in the coming decades. To meet the global net zero target by 2050, mineral inputs will need

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[1] Sharon Seah is concurrent Coordinator of the ASEAN Studies Centre and the Climate Change in Southeast Asia Programme at the ISEAS – Yusof Ishak Institute, Singapore, and Mirza Sadaqat Huda is Lead Researcher (Energy/Climate) of the Climate Change in Southeast Asia Programme at the ISEAS – Yusof Ishak Institute, Singapore. The authors would like to express their appreciation to Ms Qiu Jiahui for her excellent research assistance for this paper, and to Professor Tham Siew Yean for her constructive comments.

[2] Indra Overland, "The Geopolitics of Renewable Energy: Debunking Four Emerging Myths", *Energy Research and Social Science* 49 (March 2019): 36–40 https://www.sciencedirect.com/science/article/pii/S2214629618308636 (accessed 16 January 2024).

[3] Kirsten Hund et al., "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition" (Washington, DC: World Bank, 2020), https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

to increase sixfold by 2040, compared to current levels. According to scenarios developed by the International Energy Agency (IEA), the demand for minerals used in electric vehicles (EVs) will increase thirty times compared to current levels, while mineral requirements for low-carbon energy generation will triple by 2040.[4]

The development of CMs is impeded by several supply constraints. Currently, a handful of countries dominate the CMs market, with China playing an outsized role in both the upstream and downstream parts of the supply chain. For example, China currently extracts 65 per cent and processes 85 per cent of the world's REEs.[5] The largest amount of copper, nickel and cobalt are extracted in Chile, Indonesia, and the Democratic Republic of Congo (DRC), respectively. Yet, as shown in Figure 1, China dominates the processing of all three minerals, as well as alumina and lithium.[6]

There is growing academic and policy consensus on the need to develop sustainable and reliable supply chains for CMs, which is of great relevance to Southeast Asia.[7] On the one hand, the region can become a major supplier of critical minerals, due to the existence of substantial deposits of bauxite, nickel, tin, REEs, cobalt, manganese and graphite.[8] On the other hand, Southeast Asia is likely to become a

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[4] International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions" (Paris, 2022), https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

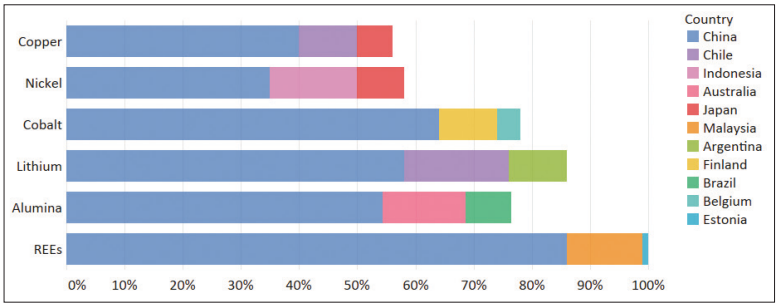
[5] Duncan Wood et al., "The Mosaic Approach: A Multidimensional Strategy for Strengthening America's Critical Minerals Supply Chain" (Washington, DC: Wilson Center, 2021), https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/critical_minerals_supply_report.pdf

[6] World Energy Outlook Special Report, "The Role of Critical Minerals in Clean Energy Transitions", IEA (Paris, 2021), https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary

[7] Shiquan Dou et al., "Critical Mineral Sustainable Supply: Challenges and Governance", *Futures* 146 (February 2023): 103101, https://doi.org/10.1016/j.futures.2023.103101

[8] International Energy Agency, "Southeast Asia Energy Outlook 2022" (Paris, 2022), https://www.iea.org/reports/southeast-asia-energy-outlook-2022

Figure 1: Share of Top Three Countries in Global Production of Each Processed Mineral in 2019 (Selected Minerals)



Notes: The values for copper and alumina are for refining operations.
Sources: International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions" (Paris, 2022), https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions; US Geological Survey, "Mineral Commodity Summaries 2020" (Reston, Virginia, 2020), https://pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf

significant consumer of critical minerals, owing to the region's growing solar photovoltaic (PV) and electric vehicle industries. Malaysia and Vietnam are the world's second and third-largest solar PV manufacturers and accounted for one-fifth of global shipments in 2020.[9] Thailand has become the region's leading producer of EVs, while the Philippines and Indonesia have undertaken initial steps to develop integrated battery and EV supply chains.[10]

Much of the discourse from the United States, Australia and Europe present China's dominance of CMs as a threat to their national security with some academics and observers referring to the threat

[9] Ibid.

[10] Ibid.

of weaponization in a Cold War analogy.[11] Some studies attribute the volatility of critical mineral markets to China's manipulation of prices.[12] In such contexts, the objective of diversifying supply chains with like-minded partners comes to be driven by geopolitical imperatives.[13] More extreme interpretations propose a "decoupling" of the American and Chinese economies, which implies a cessation of trade in CMs between the two countries and their partners.[14] The Minerals Security Partnership, which is an outcome of the United States' friend-shoring policy, attempts to reduce dependency on Russia and China for critical minerals by developing alternate supply chains with like-minded partners.[15] Within more nuanced perceptions of CMs, diversification is contextualized as one policy mechanism, which along with sustainable resource extraction, technological innovation, greater price transparency in CM markets and strong international cooperation, can facilitate resilient supply chains.[16]

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[11] Yu-Hsuan Wu and Phung Quoc Huy, "Geopolitics of Critical Minerals", NBR Special Report (National Bureau of Asian Research, 2022), https://www.researchgate.net/publication/367463970_Geopolitics_of_Critical_Minerals; Zongyuan Zoe Liu, "Critical Minerals and the New Cold War", *The Diplomat*, 1 October 2023, https://thediplomat.com/2023/09/critical-minerals-and-the-new-cold-war/; Wood et al., "The Mosaic Approach: A Multidimensional Strategy for Strengthening America's Critical Minerals Supply Chain".

[12] Vlado Vivoda, "Friend-Shoring and Critical Minerals: Exploring the Role of the Minerals Security Partnership", *Energy Research & Social Science* 100 (2023): 103085.

[13] Overland, "The Geopolitics of Renewable Energy".

[14] Sophia Kalantzakos, ed., *Critical Minerals, the Climate Crisis and the Tech Imperium*, *Archimedes*, vol. 65 (Cham, Switzerland: Springer, 2023).

[15] Vivoda, "Friend-Shoring and Critical Minerals".

[16] Saleem H. Ali et al., "Mineral Supply for Sustainable Development Requires Resource Governance", *Nature* 543, no. 7645 (March 2017): 367–72, https://doi.org/10.1038/nature21359; Benjamin K. Sovacool et al., "Sustainable Minerals and Metals for a Low-Carbon Future", *Science* 367, no. 6473 (2020): 30–33, https://doi.org/10.1126/science.aaz6003

This study provides an analysis of the role of selected Southeast Asian countries and the position of ASEAN as a collective in the global supply chains of CMs. It first provides an overview of energy transition and climate goals in Southeast Asia, followed by a detailed overview of the extraction, processing, and use of CMs in the region and an examination of ASEAN's cooperative framework in the minerals sector. The study concludes with policy recommendations on how ASEAN can play a constructive role in the critical minerals supply chain.

ENERGY TRANSITION IN SOUTHEAST ASIA

Southeast Asia is expected to become the world's fourth-largest economy with a population of 717 million by 2030; this will have important implications for energy security and climate change.[17] Energy demand has increased about 3 per cent per year for the past two decades and is expected to continue up to 2030.[18] In business-as-usual scenarios, three-quarters of the increase in energy demand to 2030 will be met by fossil fuels, leading to a 35 per cent increase in emissions.[19]

The twin challenges of addressing rising energy demand to meet economic development goals and addressing increasingly intense and frequent climate hazards have generated political momentum for a successful energy transition.[20] Southeast Asian governments have been

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[17] Jiahui Qiu, Sharon Seah, and Melinda Martinus, "Examining Climate Ambition Enhancement in ASEAN Countries' Nationally Determined Contributions", *Environmental Development* 49 (2024): 10094.

[18] International Energy Agency, "Southeast Asia Energy Outlook 2022".

[19] Ibid.

[20] Mirza Sadaqat Huda, Sharon Seah and Jiahui Qiu, "Accelerating the ASEAN Power Grid 2.0: Lessons from the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP)" (Singapore: ISEAS – Yusof Ishak Institute, 2023), https://www.iseas.edu.sg/wp-content/uploads/2023/11/2023-LTMS-PIP-Policy-Report-FA-V2-Online.pdf

incorporating renewable energy sources into their total primary energy supply since the 2000s. There is a long way to go though. The current proportion of renewable energy (excluding biomass) in Southeast Asia's total primary energy mix is only 15 per cent.[21] But although the region may be dependent on fossil fuels for almost 80 per cent of its power generation today, policy interventions should be able to increase the share of renewables in electricity generation to as much as 60 per cent by 2050.[22] The region surpassed its aspirational target of achieving 21 per cent of energy intensity reduction and 13.9 per cent renewable energy share in total primary energy supply in 2018.[23] At the ASEAN level, several key documents have articulated the region's green transition plans, such as the ASEAN Carbon Neutrality Roadmap, the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 and the annual ASEAN Energy Outlook reports. But regional ambition does not align with greater international ambition as evidenced in the Global Renewable and Energy Efficiency Pledge where 123 governments undertook to triple installed renewable energy generation to at least 11,000 GW at COP28 in December 2023. Among ASEAN members, only Brunei, Malaysia, Singapore and Thailand made the pledge.[24]

On a broader scale, Southeast Asian governments have set out in their Nationally Determined Contributions (NDCs) to cut down the use of fossil fuels to meet the world's target of limiting temperature increases to

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[21] International Energy Agency, "Southeast Asia Energy Outlook 2019" (Paris, 2019), https://www.iea.org/reports/southeast-asia-energy-outlook-2019

[22] ASEAN Centre for Energy and GIZ, *The 7th ASEAN Energy Outlook 2020–2050 (AEO7)* (Jakarta: ASEAN Centre for Energy, 2022).

[23] Sharon Seah et al., "Planning Southeast Asia's Decarbonisation Pathways: Insights for Policy-Making" (Singapore: ISEAS – Yusof Ishak Institute, 2023), https://www.iseas.edu.sg/wp-content/uploads/2025/07/Energy-workshop-report_6-final.pdf

[24] "COP28: Global Renewables And Energy Efficiency Pledge" (accessed 16 January 2024), https://www.cop28.com/en/global-renewables-and-energy-efficiency-pledge

under 1.5 degrees. Research has found a significant regionwide ambition gap, even if all of the ASEAN countries' conditional NDCs are met.[25] Only four Southeast Asian countries (Cambodia, Indonesia, Singapore and Vietnam) have published long-term low emissions strategies to transition to a low-carbon economy. The regionwide ambition could be met if ASEAN considers adopting a collective climate mitigation target to meet domestic energy demands sustainably. Energy security is a primary goal for governments in the region, particularly after the energy disruptions caused by the Russia-Ukraine war which led to volatile and unpredictable fossil fuel prices. Other potentially disruptive events including the Red Sea Houthi attacks pose additional risks. Yet, these events also highlight the vulnerability of critical mineral supply chains to geopolitical conflicts, an issue of increasing importance to Southeast Asia.

EXTRACTION AND PROCESSING OF CRITICAL MINERALS IN SOUTHEAST ASIA

According to the IEA, nine critical minerals are of increasing importance in the contemporary context of energy transition: copper, cobalt, nickel, lithium, REEs, chromium, zinc, PGMs[26] and aluminium. As conducting research on every CM is beyond the scope of this paper, the study focuses on the minerals that are of particular importance to ASEAN's energy transition plans and the organization's role in critical mineral supply chains.

The authors propose that a CM is particularly important to ASEAN if it meets two conditions: (i) There are significant deposits in the region, which can therefore be tapped on and in addition, could serve ASEAN's

[25] Seah et al., "Planning Southeast Asia's Decarbonisation Pathways: Insights for Policy-Making".

[26] PGMs are platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), osmium (Os) and iridium (Ir).

strategic interest in bolstering its position in the supply chains to create a competitive advantage; and (ii) It is an essential input in solar PVs, EVs, batteries and grid infrastructures, which are industries and sectors of growing importance in Southeast Asia. Malaysia and Vietnam are among the world's largest producers of solar PV, while Thailand is the region's biggest EV manufacturer. Indonesia has ambitions to become a leader in battery manufacturing.[27] As shown in Figures 2 and 3, the four CMs that meet this criterion are: copper, nickel, bauxite (alumina) and REEs. The extraction and processing of these minerals in Southeast Asia are described below:

Copper

Indonesia has the highest copper reserves in the region and was the ninth-largest copper producer in the world in 2022.[28] Collectively, Indonesia, Myanmar, and the Philippines account for about 4 per cent of global copper production.[29] Copper is a key component in many electrical and electronic technologies and is used in wiring to circuit boards to batteries and renewable energy technologies such as solar panels and wind turbines. Millions of feet of copper are required to develop complex electricity grids and to transfer renewable energy from decentralized power plants.[30]

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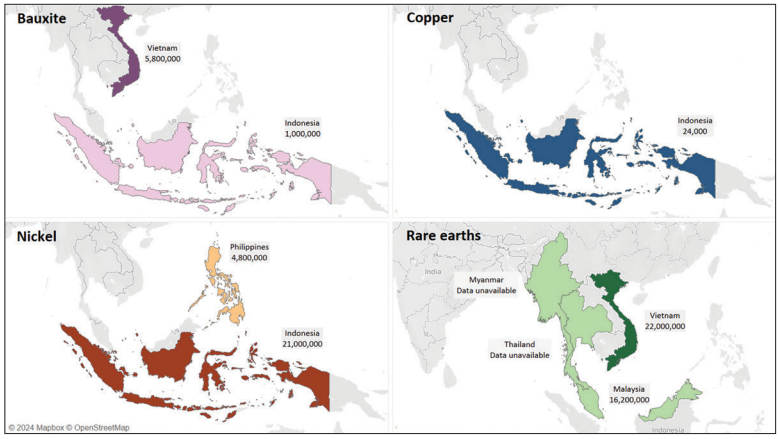
[27] International Energy Agency, "Southeast Asia Energy Outlook 2022" (Paris, 2022).

[28] World Economic Forum, "Which Countries Produce the Most Copper?", 12 December 2022, https://www.weforum.org/agenda/2022/12/which-countries-produce-the-most-copper/

[29] International Energy Agency, "Southeast Asia Energy Outlook 2022", p. 130.

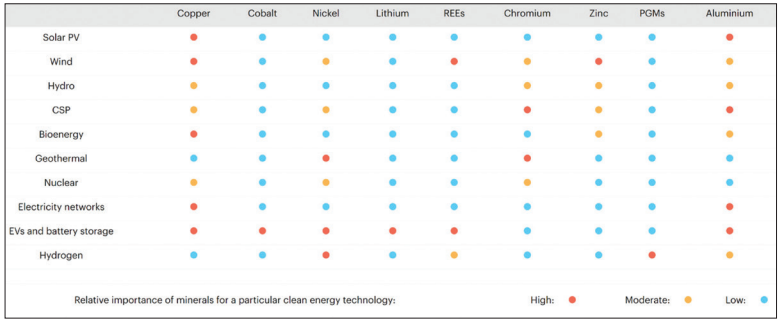
[30] James Attwood, "How Lack of Copper Could Slow the Energy Transition", *Washington Post*, 13 February 2023, https://www.washingtonpost.com/business/energy/how-lack-of-copper-could-slow-the-energy-transition/2023/02/13/d064a970-ab98-11ed-b0ba-9f4244c6e5da_story.html

Figure 2: Significant Critical Mineral Reserves in Southeast Asia (Metric Tonnes)



Notes: While data on reserves of rare earths in Myanmar and Thailand are unavailable, both countries are included in this map due to their significant production volumes. Data for Malaysia refers to non-radioactive rare earth elements.
Sources: Map developed by ISEAS based on data from the US Geological Survey, "Mineral Commodity Summaries 2023" (Reston, Virginia, 2023), https://pubs.usgs.gov/periodicals/mcs2023/mcs2023.pdf; Rashvinjeet S. Bedi, "'High-Growth, High-Value': Malaysia's Rare Earths Industry Getting a Push, but Splitting Public Opinion Too", *CNA*, 2023, https://www.channelnewsasia.com/asia/malaysia-rare-earth-elements-mining-perak-sustainability-3799736

Figure 3: Critical Mineral Needs for Clean Energy Technology



Source: International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions" (Paris, 2022), https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

As seen in Table 1, currently there are five copper refineries in operation in the region. In Vietnam, the state-run mining company Vinacomin is the sole owner of the copper refinery in Bao Thang District (northeast Vietnam) which has a capacity of 16,000t. Indonesia's refinery in East Java is the largest in the region, with a capacity of 270,000t, followed by the facility in Leyte Province of the Philippines, which produces approximately 215,000t of refined copper annually. The majority shareholders of the copper refineries in Laos, the Philippines and Indonesia, are companies based in China, Switzerland and Japan, respectively. In Myanmar, the largest shareholder of the Monywa solvent extraction electrowinning plant is the state-owned No. 1 Mining Enterprise, followed by the Chinese company Wanbao Mining and the Union of Myanmar Economic Holding Ltd.

The number and capacities of copper refineries in Southeast Asia are very low compared to the region's substantial reserves. Currently, all regional countries are involved in low-value upstream activities with ores being exported overseas for refining. In January 2023, the Indonesian government announced a potential ban on the export of copper ores to encourage investment in downstream activities,[31] and Indonesian companies have engaged in several joint ventures to enhance copper refining facilities. In 2021, PT Amman Mineral Industri (AMIN) signed an agreement with China Non-Ferrous Metal Industry's Foreign Engineering and Construction as well as PT Pengembangan Industri Logam to build a copper refinery in West Sumbawa Regency.[32] In 2022, PT Smelting, a joint venture between the Japan-based Mitsubishi Materials and Freeport Indonesia started a copper smelting facility in East

[31] Gusty da Costa, "Government's Plan to Ban Copper Exports May Cause 40,000 Jobless", *Indonesia Business Post*, 27 January 2023, https://indonesiabusinesspost.com/insider/governments-plan-to-ban-copper-exports-may-cause-40000-jobless/

[32] "China Consortium to Develop Amman's EPC Smelter", *D-Insights*, 2021, https://dinsights.katadata.co.id/read/2021/07/27/china-consortium-to-develop-ammans-epc-smelter

Java which will increase production of copper cathodes from 300,000t to 342,000t.[33] Indonesia has also been trying to seek more control over the critical minerals sector. For example, the government agreed to extend PT Freeport Indonesia's contract in exchange for a 10 per cent increase in shareholdings in the company.[34]

Nickel

Indonesia and the Philippines are two of the largest nickel producers in the world and are projected to produce 70 per cent of the world's nickel by 2025.[35] According to the US Geological Survey (USGS), Indonesia holds 21 million tonnes and the Philippines' 4.8 million tonnes of nickel reserves as of 2022.[36] Nickel is a critical input in lithium-ion battery cells used in EVs and is important in technologies for generating geothermal energy and hydrogen. Nickel is also used in battery storage systems to store excess electricity from intermittent renewable sources such as solar and wind. Nickel can be an alternative to cobalt in batteries; in turn, nickel can be replaced with manganese.[37] The role of nickel in the energy transition is dependent on technological innovations as well as the increasing concern over social and environmental impacts in Indonesia and the Philippines.

As shown in Table 1, there are three nickel refineries in Indonesia—two in South Sulawesi (Pomalaa and Sorowako) and one in North Maluku—

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[33] Archana Rani, "PT Smelting Begins Construction of Copper Smelter Expansion in Indonesia", *Mining Technology* (blog), 21 February 2022, https://www.mining-technology.com/news/pt-smelting-copper-indonesia/

[34] "Indonesia Finalizes Contract Extension, Eyes Bigger Stake in Freeport", *Jakarta Post*, 15 November 2023, https://www.thejakartapost.com/business/2023/11/15/indonesia-finalizes-contract-extension-eyes-bigger-stake-in-freeport.html

[35] International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions".

[36] US Geological Survey, "Mineral Commodity Summaries 2023" (Reston, Virginia, 2023), https://pubs.usgs.gov/periodicals/mcs2023/mcs2023.pdf

[37] International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions".

Table 1: Critical Mineral Refineries in Southeast Asia

Country	Commodity	Major Operating Companies	Major Equity Owners	Location of Main Facilities	Annual Capacity (thousand metric tons)
Vietnam	Copper (refined)	Lao Cai Copper Smelting Enterprise	VINACOMIN – Minerals Holding Corp. (VIMICO), 100%	Tang Loong Industrial Park, Bao Thang District, Lao Cai Province	16
Vietnam	REEs (processing)	Shin-Etsu Magnetic Minerals Vietnam Co., Ltd.	Unavailable	Dinh Vu Industrial Park, Hai Phong City	2
Vietnam	REEs (processing)	Vietnam Rare Earth Co. (VERX)	Shenghe Resources (Singapore), 90%; Seidou, 10%	Bac Ninh Industrial Zone, Bac Ninh Province	0.7
Vietnam	REEs (processing)	Vietnam Rare Earth Joint Stock Co. (VTRE)	Unavailable	Lao Cau, Phu Ly City, Ha Nam Province	4

Vietnam	Zinc (refined)	Thai Nguyen Nonferrous Metal Joint Stock Co.	VINACOMIN – Minerals Holding Corp. (VIMICO), 51%; others unavailable	Zinc electrolytic plant, Thai Nguyen Song Cong Industrial Park, Thai Nguyen Province	10
Vietnam	Zinc (refined)	Ta Pan Zinc-Lead Plant	A Chinese private firm, 70.2%; Ha Giang Mineral Exploiting and Engineering Co., 29.8%	Lung Vay, Bac Me District, Ha Giang Province	6
Vietnam	Alumina	Dak Nong Aluminum Co.	Vietnam National Coal and Mineral Industries Group (VINACOMIN), 100%	Nhan Co Aluminium Plant, Dak Nong Province	630
Vietnam	Alumina	Lam Dong Aluminum Co.	Vietnam National Coal and Mineral Industries Group (VINACOMIN), 100%	Lam Dong Province	650

continued on next page

Table 1 — cont'd

Country	Commodity	Major Operating Companies	Major Equity Owners	Location of Main Facilities	Annual Capacity (thousand metric tons)
Laos	Copper (refined)	Lane Xang Minerals Ltd.	Chifeng Jilong Gold Mining Co. Ltd., 90%, Government, 10%	Sepon Mine, Vilabouly District, Savannakhet Province	93
Philippines	Copper (refined)	Philippine Associated Smelting and Refining Corp. (PASAR)	Glencore International plc.,78.2%, others unavailable	Refinery and smelter at Leyte Industrial Development Estate, Isabel, Leyte Province	215
Philippines	Nickel (intermediate)	Coral Bay Nickel Corp.	Sumitomo Metal Mining Co. Ltd., 54%; Sojitz Philippines Corp., 18%; Nickel Asia Corp., 10%; Rio Nickel Mining Corp., 10%; Tuba Nickel Mining Corp., 10%	Coral Bay nickel high-pressure acid-leach (HPLA) plant, Rio Tuba, Bataraza Coral Bay nickel high-pressure acid-leach	24

Philippines	Nickel (intermediate)	Taganito HPAL Nickel Corp.	Sumitomo Metal Mining Co. Ltd., 75%; Mitsui Co. Ltd., 15%; Nickel Asia Corp., 10%	Nickel high-pressure acid-leach (HPAL) plant, Surigao del Norte Province, Mindanao Island	36
Indonesia	Alumina	PT Indonesia Chemical Alumina	PT Antam Tbk, 100%	Tayan CGA plant, West Kalimantan	300
Indonesia	Copper (metal)	PT Smelting Co.	Mitsubishi Materials Corp., 60.5%; PT Freeport Indonesia Co., 25%; others, 14.5%	Gresik, East Java	270
Indonesia	Nickel (ferronickel)	PT Antam Tbk	PT Inalum, 65%; the public, 35%	Pomalaa, South Sulawesi	27
Indonesia	Nickel (ferronickel)	PT Megah Surya Pertiwi	Harita Group, 60%; Xinxing Ductile Iron Pipes Co. Ltd, 40%	South Halmahera, North Maluku	N.A.

continued on next page

Table 1 — cont'd

Country	Commodity	Major Operating Companies	Major Equity Owners	Location of Main Facilities	Annual Capacity (thousand metric tons)
Indonesia	Nickel (matte)	PT Vale Indonesia Tbk	Vale Canada Ltd., 58.73%; Sumitomo Metal Mining Co. Ltd, 20%; others 21.27%	Sorowako, South Sulawesi	80
Malaysia	Primary aluminium	Press Metal Sarawak Sdn. Bhd.	Press Metal Berhad, 80%, and Sumitomo Corp., 20%	Mukah, Sarawak smelter	120
Malaysia	Primary aluminium	Press Metal Sarawak Sdn. Bhd.	Press Metal Berhad, 80%, and Sumitomo Corp., 20%	Two smelters in Similaijau, Sarawak	640
Malaysia	REEs (oxide equivalent)	Lynas Malaysia Sdn. Bhd.	Lynas Corp. Ltd., 100%	Kuantan, Pahang	22

Myanmar	Copper (cathode)	Myanmar Wanbao Mining Copper Ltd. (operator), and Myanmar Yang Tse Copper Ltd.	No. 1 Mining Enterprise, 51%; Wanbao Mining Ltd., 30%; Union of Myanmar Economic Holding Ltd. (UMEH), 19%	Sabetaung and Kyisintaung copper mine and Monywa solvent extraction electrowinning plant, Monywa, Sagaing Division	50
Myanmar	REEs (concentrates, oxide equivalent)	Myanmar Ye Huang Mining Corp.	Unavailable	Mine in Kokang, Langkho, Shan State	20

Source: Collected and compiled by ISEAS using data from the USGS.

with a combined capacity of more than 107,000t.[38] The two refineries in Rio Tuba and Surigao del Norte of the Philippines collectively process around 60,000t of nickel annually. In Indonesia, there is some variety in the ownership structure of the nickel refineries. The majority shareholder of the Pomalaa refinery operated by PT Antam Tbk is the state company PT Indonesia Asahan Aluminium. The Indonesian conglomerate Harita Group owns 60 per cent of the North Maluku refinery, while Vale Canada is the majority shareholder of the Sorowako refinery operated by PT Vale Indonesia Tbk. In the Philippines, Japan-based Sumitomo Metal Mining is the majority shareholder of the two refineries.

In recent years Indonesia has undertaken steps to move up the supply chain of nickel. Between 2009 and 2019, the government has undertaken successive policies to progressively ban the export of nickel ore.[39] This has led to increased investments in the domestic nickel processing industry. From 2014 to 2020, over US$6.5 billion was invested in downstream processing activities in the country's nickel-rich Morowali Regency.[40] In 2022, a consortium led by Korea's LG Energy Solution agreed to invest US$9 billion in developing battery supply chains in Indonesia, which will include smelting and refining of nickel, manufacturing precursors, cathode materials and cells, and assembling finished products.[41] In the same year, the Indonesian government expressed interest in forming an OPEC-style cartel for nickel to enable greater control over supply and price. The Philippines is currently considering replicating Indonesia's

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[38] The capacity of the refinery in North Maluku run by PT Megah Surya Pertiwi is not known.

[39] International Energy Agency, "Prohibition of the Export of Nickel Ore", Policies, 12 December 2023, https://www.iea.org/policies/16084-prohibition-of-the-export-of-nickel-ore

[40] "Indonesia Plays Hardball with Its Nickel", *East Asia Forum*, 30 March 2021, https://www.eastasiaforum.org/2021/03/30/indonesia-plays-hardball-with-its-nickel/

[41] Hyung-Kyu Kim, "LG Energy-Led Group to Set up $9 Bn Indonesia Battery Value Chain", *KED Global*, 18 April 2022, https://www.kedglobal.com/batteries/newsView/ked202204180014

policies by taxing the export of nickel ores.[42] These export controls aim to enhance refinery capabilities and also encourage companies to manufacture EV batteries and battery storage systems in Southeast Asia.[43]

Bauxite (Alumina)

Vietnam and Indonesia have the world's fourth- and sixth-largest bauxite deposits, which collectively account for 12 per cent of global reserves.[44] In 2022, Indonesia produced as much as 21,000t of bauxite and 1,100t of alumina. Despite having almost five times more bauxite deposits than Indonesia, Vietnam only produced around 3,800t of bauxite and 1,500t of alumina in the same period,[45] due to critical environmental constraints.[46] Alumina is a potential replacement for copper in electricity grids and is a key input in 85 per cent of solar PV technologies.[47] Alumina can become an important input in EV batteries and battery storage systems if technological advancements enable

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[42] Manolo Serapio Jr. and Andreo Calonzo, "Philippines May Tax Nickel Exports to Follow Indonesia's Success", *Bloomberg*, 30 January 2023, https://www.bloomberg.com/news/articles/2023-01-30/philippines-may-tax-nickel-exports-to-follow-indonesia-s-success

[43] James Guild, "Indonesia Pushing for OPEC-Style Nickel Cartel", *Asia Times*, 26 January 2023, http://asiatimes.com/2023/01/indonesia-pushing-for-opec-style-nickel-cartel/

[44] "Bauxite", *Geoscience Australia*, 19 December 2023, https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/australian-resource-reviews/bauxite

[45] U.S. Geological Survey, "Mineral Commodity Summaries 2023", 2023, https://doi.org/10.3133/mcs2023

[46] Truong Ha and Khanh Huong, "Vietnam Province at Risk of Losing Forest to Bauxite Mining", *VnExpress International*, 3 March 2023, https://e.vnexpress.net/news/news/environment/vietnam-province-at-risk-of-losing-forest-to-bauxite-mining-4577096.html

[47] World Bank, "Competitiveness of Global Aluminium Supply Chains Under Carbon Pricing Scenarios for Solar PV", 13 March 2023, https://www.worldbank.org/en/topic/extractiveindustries/publication/competitiveness-of-global-aluminum-supply-chains-under-carbon-pricing-scenarios-for-solar-pv

the replacement of the lithium-ion model with the more economical aluminium-sulphur formulation.[48]

Vietnam currently has two aluminium refineries—in Dak Nong and Lam Dong provinces—with a combined capacity of 1,280,000t. Both are owned by the state-run Vinacomin. Indonesia has only one refinery—in Tayan, West Kalimantan, which has a capacity of 300,000t and is owned by PT Antam Tbk, a government-owned holding company. In recent years, Vietnam has attempted to develop its bauxite deposits in the Central Highlands region.[49] These plans have faced pushback from environmental groups who argue that mining results in deforestation, soil contamination and displacement of communities.[50] Similar to its policies on nickel, Indonesia sees the export of bauxite ores as a low-value activity that does not serve the country's long-term economic goals of becoming a manufacturing hub for batteries and other green technology. In 2022, the Indonesian government announced a ban on bauxite ores, with the stated goal of encouraging investment in refining and developing an ecosystem for EV industries.[51] In 2020, the Indonesian company Pembangunan Perumahan signed a US$695 million contract with China Aluminium International Engineering Corporation Limited to construct an alumina refinery in Mempawah, West Kalimantan.[52]

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[48] David L. Chandler, "A New Concept for Low-Cost Batteries", *MIT News*, Massachusetts Institute of Technology, 24 August 2022, https://news.mit.edu/2022/aluminum-sulfur-battery-0824

[49] Truong Ha and Khanh Huong, "Vietnam Province at Risk of Losing Forest to Bauxite Mining".

[50] Lại Tuấn and Ji-Whan Ahn, "Bauxite Developments in Vietnam : Opportunities and Challenges", *Journal of Energy Engineering*, 27, no. 3 (2018): 41–47, https://doi.org/10.5855/ENERGY.2018.27.3.041

[51] Qian Zhou, "Indonesia to Ban Bauxite Exports from June 2023: An Explainer", *ASEAN Briefing*, 2022, https://www.aseanbriefing.com/news/indonesia-to-ban-bauxite-export-from-june-2023/

[52] Norman Harsono, "China, Indonesia Sign $695m Deal for West Kalimantan Alumina Smelter", *Jakarta Post*, 17 January 2020, https://www.thejakartapost.com/news/2020/01/17/china-indonesia-signs-695m-deal-for-west-kalimantan-alumina-smelter.html

Rare Earth Elements (REEs)[53]

There are seventeen elements in the REE family.[54] The four REEs that are particularly important to the development of clean energy technologies are neodymium, dysprosium, praseodymium and terbium. These are required for producing permanent magnets used in EV motors and wind turbines. More than 1 kg of REEs is needed to manufacture an EV motor,[55] while as much as 1,000 kg can go into producing one wind turbine.[56] Vietnam holds 19 per cent of the world's REE deposits, or 22,000,000t, which is the largest deposit outside of China. Despite such huge reserves, Vietnam extracted only 1,000t in 2020, while Thailand's production was 2,000t in the same period.[57] Although information on Myanmar's reserves is scarce, pre-coup Myanmar was reported to have accounted for 13 per cent of global REE production, making it the third-largest producer behind China and the US. In 2020, Myanmar's REE production was 30,000t. In the same year, the country supplied half of China's rare earth concentrates.[58] Malaysia considers non-radioactive REEs to be one of five strategic critical minerals, having the highest

[53] The seventeen REEs are: scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

[54] International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions".

[55] Ibid.

[56] Brian Daigle and Samantha DeCarlo, "Rare Earths and the U.S. Electronics Sector: Supply Chain Developments and Trends", Office of Industries Working Paper, 2021, https://www.usitc.gov/publications/332/working_papers/rare_earths_and_the_electronics_sector_final_070921_2-compliant.pdf

[57] Nicholas LePan, "Rare Earth Elements: Where in the World Are They?", *Visual Capitalist*, 23 November 2021, https://www.visualcapitalist.com/rare-earth-elements-where-in-the-world-are-they/

[58] International Energy Agency, "Southeast Asia Energy Outlook 2022".

estimated deposit value of RM747.42 billion (approx. US$160 billion).[59] The non-radioactive REE industry has been identified as a new source of growth in Malaysia's National Mineral Industry Transformation Plan 2021–2030, in particular, to move from midstream and subsequently downstream activities.[60]

As seen in Table 1, Vietnam currently has three refineries for REEs with a combined capacity of 67,000t. The China-based Shenghe Resources owns 90 per cent of the equity interest of the refinery in Bac Ninh Province, with the remaining 10 per cent belonging to the Japanese company Seidou. Currently, there is only one refinery in Myanmar; this is run by Myanmar Ye Huang Mining and has a capacity of 20,000t. Malaysia hosts the single largest processing facility of REEs outside of China, with a capacity of 22,000t. The controversial Lynas Malaysia Sdn Bhd, a subsidiary of Australia's Lynas, has been embroiled in environmental and health issues since the early 2000s.[61] Lynas Malaysia's operating licence has been renewed for another three years subject to the cessation of key activities that are deemed to generate radioactive wastes.[62] Lynas Malaysia insists that its operations meet IAEA radioactivity standards but the partial closure of the plant's activities means that production

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[59] Tham Siew Yean and Neo Hui Yun Rebecca, "Malaysia's Return to Mining: Redeveloping Rare Earth Elements (REE)", *ISEAS Perspective,* no. 2023/97, 13 December 2023, https://www.iseas.edu.sg/articles-commentaries/iseas-perspective/2023-97-malaysias-return-to-mining-redeveloping-rare-earth-elements-ree-by-tham-siew-yean-and-neo-hui-yun-rebecca/

[60] Ibid.

[61] John Berthelsen, "Lynas Malaysia and the Rare Earth Controversy", *Asia Sentinel*, 2011, https://www.asiasentinel.com/p/lynas-malaysia-and-the-rare-earth-controversy

[62] Amy Chew, "Malaysia Says Lynas Rare Earths Must Stop Key Processing Activity", *Nikkei Asia,* 16 February 2023, https://asia.nikkei.com/Spotlight/Environment/Malaysia-says-Lynas-Rare-Earths-must-stop-key-processing-activity

would be affected and the downstream impact may be felt sometime in the future.[63]

ASEAN'S MINERAL SECTOR DEVELOPMENT

Collectively, ASEAN can potentially become one of the largest markets for the supply of selected critical minerals. As detailed above, Indonesia, Malaysia, Myanmar, the Philippines and Vietnam are among the biggest producers of copper, nickel, bauxite and REEs. According to a public report commissioned by the ASEAN Secretariat, the region's intra-ASEAN and extra-ASEAN trade accounted for US$249.8 billion, or 8.9 per cent, of ASEAN's total trade in 2018.[64] Approximately 21 per cent of ASEAN's trade in minerals is intra-regional trade which suggests that there are downstream activities at play in the region.[65] The region is also set to become a major market for clean energy technologies. By 2050, ASEAN's market for wind turbines, solar panels, lithium-ion batteries, electrolysers, and fuel cells will be worth over US$800 billion.[66]

ASEAN's institutional cooperation in the minerals sector was established in 2005 when the grouping held its first ministerial meeting on Minerals in Sarawak, Malaysia and signed an MOU to develop

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[63] Shannon Teoh, "Malaysia to Insist Rare Earths Miner Lynas Go Radiation-Free by July", *Straits Times*, 11 February 2023, https://www.straitstimes.com/asia/se-asia/malaysia-to-insist-rare-earths-miner-lynas-go-radiation-free-by-july

[64] ASEAN Secretariat, *Development Prospects of ASEAN Minerals Cooperation (DPAMC)* (Jakarta: ASEAN Secretariat, 2022), p. 21, https://asean.org/wp-content/uploads/2022/04/Development-Prospects-of-ASEAN-Minerals-Cooperation-DPAMC.pdf

[65] ASEAN Secretariat, "ASEAN Minerals Cooperation", https://asean.org/our-communities/economic-community/asean-minerals-cooperation/ (accessed 16 January 2024).

[66] International Energy Agency, "Southeast Asia Energy Outlook 2022" (Paris, 2022).

the minerals sector as "an engine for greater economic growth and social progress", to "enhance trade and investment" and "promote environmentally sound and socially responsible mineral development practices".[67] The MOU provided a governance framework which included a biennial ministerial-level meeting (AMMin), a senior officials' level meeting (SOM), the creation of five-year ASEAN Minerals Cooperation Action Plans (AMCAPs) and a cooperation platform for ASEAN Dialogue Partners to engage in. This resulted in an ASEAN+3 Minerals Cooperation Work Plan 2016–2020 which promoted technical information exchange and best practices on information and database, geosciences R&D and sustainable development of mineral resources. In addition to cooperation with the Plus Three countries (China, Japan and ROK), the minerals sector also cooperates with Australia and the Inter-Governmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF).

ASEAN has identified four strategic areas of cooperation in the minerals sector including: (1) facilitation and enhancement of trade and investment; (2) promotion of environmentally and socially sustainable mineral development; (3) strengthening institutional and human capacities; and (4) maintenance of an ASEAN Mineral Database. These four strategic areas are supported by four respective working groups. The concrete deliverables in this sector include an ASEAN Minerals Database and Information System (AMDIS), an ASEAN Minerals Trust Fund, and improved sustainability frameworks, regional capacity-building, training and trade facilitation. The AMDIS was developed in cooperation with Japan's Geological Survey[68] but is currently being revamped to provide the most up-to-date information to promote greater investments and

[67] "Ministerial Understanding on ASEAN Cooperation in Minerals" (ASEAN, 2005), https://asean.org/wp-content/uploads/2021/08/MU_on_ASEAN_Cooperation_in_Minerals.pdf

[68] https://ui.adsabs.harvard.edu/abs/2014AGUFMPA31A4054O/abstract

to develop high-quality geological data and resource mapping.[69] The ASEAN Minerals Trust Fund was established with contributions from all AMS to strengthen ASEAN institutions and capacities in the minerals sector.[70]

In the mid-2000s, ASEAN discussions on mineral cooperation focused on the sector as an engine of economic growth for individual countries and the region. A majority of ASEAN countries had up to now been heavily dependent on the extraction of natural resources. However, discussions started to focus on the role of minerals in the growing energy transition and digital age,[71] starting in 2019. This signals a shift in ASEAN's thinking about the harnessing of minerals solely for trade, investment and economic purposes and reveals that ASEAN is cognizant of the greater macro trends of sustainability, accelerated digitalization and low-carbon transition. ASEAN also began to pay greater attention to the growing demands for sustainability by promoting information sharing among its members on social frameworks, environmental standards and legislation, and implementing a sustainability assessment framework and guidelines (AMCAP-III). An ASEAN Minerals Award was also established in 2017 to recognize sustainable development practices and associated best practices of industry players.[72]

At the same time, the patterns of global investments in securing minerals had also changed, which saw the rise of China as a major actor in

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[69] "The 8th ASEAN Ministerial Meeting on Minerals (AMMin) Joint Media Statement" (ASEAN, 2021), https://asean.org/wp-content/uploads/2021/10/JMS-of-the-8th-AMMIN_Final.pdf

[70] Ibid.

[71] "Joint Media Statement of the Seventh ASEAN Ministerial Meeting on Minerals (7th AMMIN)" (ASEAN, 2019), https://asean.org/wp-content/uploads/JMS-of-the-7th-AMMIN-final-00000002.pdf

[72] "Joint Media Statement of the Sixth ASEAN Ministerial Meeting on Minerals (6th AMMIN)" (ASEAN, 2017), https://asean.org/wp-content/uploads/2017/12/Doc-12-AMMIN6-Joint-Statement-of-the-6th-AMMin_FinalFinal-00000002.pdf

securing critical minerals for the production of clean energy technologies. At about this time, the US-China trade war which started around 2018, had led to trickle-down effects on countries adopting a greater resource nationalism stance such as in the imposition of export bans on certain minerals. This type of protectionist tit-for-tat behaviour, which has had a long history between major CM producers,[73] has continued well into this decade and has experienced a surge in high-producer regions such as Africa.[74] China's ban on gallium, germanium and graphite in October 2023 followed by another export restriction on REE in November 2023 was in response to the US' export control restrictions on advanced semiconductors.[75] More recently, China has moved to ban the export of REE technology for the production of REE magnets due to "national security concerns".[76] But China is not the only one imposing export controls and bans. Almost every significant player in the extraction, production and manufacture of CMs, from Indonesia to Zimbabwe, has imposed some form of export ban; an OECD policy paper estimates that global export restrictions on critical raw materials have increased five-fold since 2009.[77] For various reasons, countries may also decide that an

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[73] Sam Pryke, "Explaining Resource Nationalism", *Global Policy* 8, issue 4 (2017): 474–82, https://www.globalpolicyjournal.com/articles/global-commons-and-environment/explaining-resource-nationalism-0

[74] Matthew Hall, "Mapping the Rise of Resource Nationalism in Africa", *Mining Technology*, 12 July 2021, https://www.mining-technology.com/features/mapping-the-rise-of-resource-nationalism-in-africa/?cf-view

[75] Lily Kuo, "China to Restrict Graphite Exports to United States as Tech War Escalates", *Washington Post,* 29 November 2023, https://www.washingtonpost.com/world/2023/11/29/china-critical-minerals-graphite-trade-united-states/

[76] "China Bans REE Technology Exports, Cites 'National Security Concerns'" *Mining News Wire*, 11 January 2024, https://www.miningnewswire.com/china-bans-ree-technology-exports-cites-national-security-concerns/

[77] Przemyslaw Kowalski and Clarisse Legendre, "Raw Materials Critical for the Green Transition: Production, International Trade and Export Restrictions", *OECD Trade Policy Papers*, no. 269 (Paris: OECD Publishing, 2023), https://doi.org/10.1787/c6bb598b-en

export ban on upstream CM could help grow the downstream industry, create greater value-add and attract investments; however the evidence is not yet conclusive, and bans may lead to long-term trade-offs.

ASEAN has ambitions to develop a regional electric vehicle ecosystem. Adoption of EVs is seen as part of its collective efforts to reduce greenhouse gas (GHG) emissions, accelerate the energy transition and decarbonize its transportation sector. The goal is also to build an EV global production hub in the region by utilizing each AMS' comparative advantage. To this end, ASEAN adopted a declaration[78] to develop a regional EV ecosystem in May 2023 under Indonesia's Chairmanship. A comprehensive regional strategy with a clear sectoral lead is expected to drive ASEAN's ambition.

ASEAN'S ROLE IN THE CRITICAL MINERALS SUPPLY CHAIN

Several challenges stand in the way of ASEAN playing a greater role in the critical minerals supply chain. The first is the lack of investments in early-stage exploration and exploitation of minerals. According to a 2022 study commissioned by the ASEAN Secretariat, although there was an increase in global exploration and investments in mining, ASEAN exploration data and FDI into the mining sector showed a decline.[79] Foreign direct investments in the mining sector have seen a downward trend since 2014, albeit there has been a recovery in 2019.[80] The study

[78] "ASEAN Leaders' Declaration on Developing Regional Electric Vehicle Ecosystem" (ASEAN, 2023), https://asean.org/wp-content/uploads/2023/05/07-ASEAN-Leaders-Declaration-on-Developing-Regional-EV-Ecosystem_adopted.pdf

[79] ASEAN Secretariat, "Development Prospects of ASEAN Minerals Cooperation (DPAMC)" (Jakarta, 2022), https://asean.org/wp-content/uploads/2022/04/Development-Prospects-of-ASEAN-Minerals-Cooperation-DPAMC.pdf

[80] Ibid.

posits that this could be due to negative perceptions and governments not marketing the investment opportunities.

One of the constraints on the supply of CMs is that it can take as long as seventeen years from the time a deposit is discovered to when it is produced. Mineral exploration and exploitation require high capital outlays, infrastructural, and site development plus uncertain prospects of whether a specific mineral can be found, or even if it is relevant to technologies of the time. To bolster ASEAN's position, these barriers to entry need to be managed. However, this cannot be done simply by offering incentives and subsidies for companies to enter the market at the expense of long-term sustainable development. Rather, by deliberate policy design, governments can by stipulating certain conditions to entry, ensure that companies are committed long-term to the sustainable development of the sector. Minerals, like fossil fuels, are a finite resource that cannot be replaced. There is also the mounting problem of what to do with end-of-life products. According to one study, EV battery waste is estimated to increase by eight times more from 2030 to 2040 in the United Kingdom; it is also claimed that the recycling of 300 smartphones can provide enough cobalt to produce one EV battery.[81] One way is then to stipulate that in entering a market, companies should be committed to responsible business conduct and circular economy principles, for instance by setting up a facility to recycle used CMs.

The second is the need to invest in all stages of the minerals sector, including in technology to tap into further downstream activities beyond refining and purification, into manufacturing and production of component parts such as battery cell storage and permanent magnets, and to mainstream circular economy principles. This would be a

[81] Deloitte, "A Circular Economy for Critical Minerals Is Fundamental for Our Future", https://www2.deloitte.com/uk/en/pages/energy-and-resources/articles/circular-economy-critical-minerals-fundamental-our-future.html (accessed 23 January 2024).

more efficient way of shortening the supply chain. Besides attracting investments, ASEAN also needs to put in place a robust governance framework to govern the adoption of technology in the CM sector as this is dependent on attracting major foreign companies with requisite technological know-how and expertise. A circular economy strategy for the critical minerals sector would be crucial to improve the long-term sustainability of this sector. ASEAN adopted a Framework for Circular Economy for the ASEAN Economic Community in 2021.[82] While this framework does not specifically address the mineral sector, one of its five strategic priorities pertains to the efficient use of energy and other resources, starting with the review of existing policies that discourage circularity in operations, promotion of responsible business conduct, and enhancement of the role of the primary sectors in resources management, to name a few. The ASEAN Minerals Cooperation Action Plan 2016–2025 (AMCAP-III) briefly mentions the need for efforts to contribute to the circular economy but does not sufficiently map out strategies for doing this.[83] Hence it would be imperative to dovetail the next AMCAP-IV with the ASEAN Framework for Circular Economy.

The third challenge is improving the sustainability management of the mining sector. This sector is environmentally extremely destructive and causes habitat and biodiversity losses and water and air pollution while generating GHGs and wastes. Socially, the sector is associated with poor labour rights, community displacements, and associated health issues. A recent study on CMs uses quantitative data to predict that the extraction of platinum, manganese, and rare earths is likely to create

[82] ASEAN Secretariat, "Framework for the Circular Economy of the ASEAN Economic Community", October 2021, https://asean.org/wp-content/uploads/2021/10/Brochure-Circular-Economy-Final.pdf

[83] ASEAN Secretariat, "ASEAN Minerals Cooperation Action Plan 2016-2025 (AMCAP-III)", November 2021, https://asean.org/book/asean-minerals-cooperation-action-plan-2016-2025-amcap-iii-phase-2-2021-2025/

significant governance challenges in China, Mexico, Peru and South Africa.[84] Regional aspirations of getting companies to perform well in this sector (the ASEAN Minerals Awards is an example) are laudable, but the fact remains that the enforcement of good environmental governance and standards still resides within national borders. The AMS will need to mitigate these issues through stricter implementation of environmental regulations, enforce compliance, conduct environmental impact assessments, adopt sustainable mining practices, ensure responsible sourcing, promote community well-being, and invest in R&D.

CONCLUSION

Southeast Asian countries are faced with the complex task of increasing investments and mitigating environmental and social costs while moving up the supply chains of critical minerals. While ASEAN has developed multiple visions and plans for its mineral sector, implementation will require higher levels of international cooperation, which is now constrained by geopolitical conflicts and zero-sum competition. Some Southeast Asian countries have used protectionism to spur investment in the processing sector. While this has led to short-term growth in domestic processing, the long-term trade-offs are yet unknown. Developing electric vehicle and battery industries will require astute management of capital investments, sustainability goals and geopolitics.

Continued cooperation at the ASEAN level can facilitate a collective approach to utilizing the region's critical mineral resources for long-term sustainable development.

[84] Éléonare Lèbre et al., "The Social and Environmental Complexities of Extracting Energy Transition Metals", *Nature Communications* 11, article no. 4823 (2020), https://www.nature.com/articles/s41467-020-18661-9

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