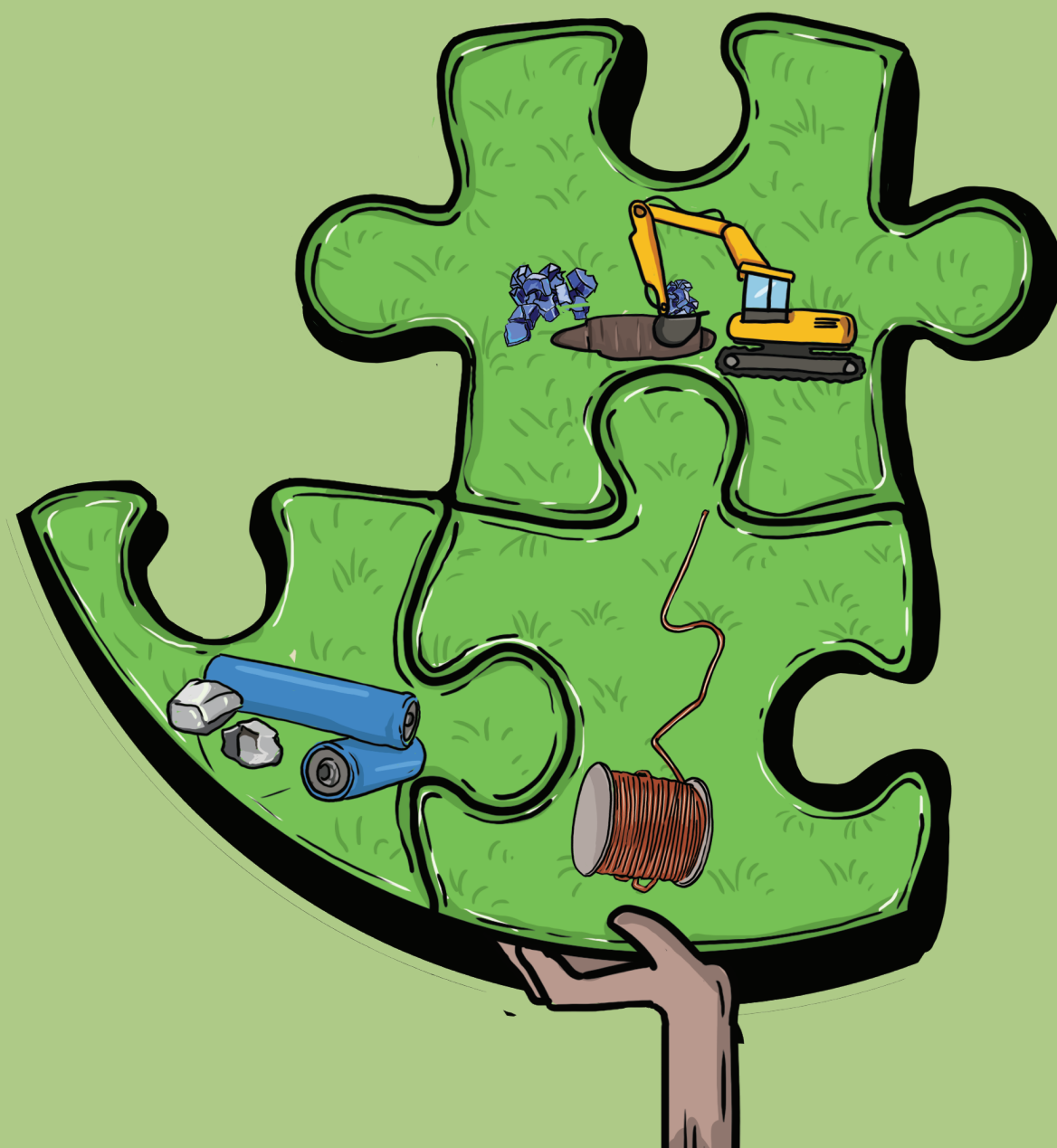




TOWARDS A NEW GREEN WORLD

CRITICAL MINERALS

Moving up the value chain





CRITICAL MINERALS

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Acknowledgement: We thank Dr Clovis Freire, Chief, Extractive Commodities Section at UNCTAD for his expertise and important perspectives that were shared as part of the peer review process.

The Centre for Science and Environment is grateful to the Swedish International Development Cooperation Agency (Sida) for their institutional support



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Material from this publication can be used, but with acknowledgement.

Maps in this report are indicative and not to scale.

Citation: Sehr Raheja and Rudrath Avinashi 2025, *Towards a New Green World: Critical minerals—Moving up the value chain*, Centre for Science and Environment, New Delhi

Published by

Centre for Science and Environment

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New Delhi 110 062

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Executive summary

This paper examines the intersection of climate action, trade and development through the lens of critical minerals—the metals and elements essential to low-carbon technologies such as electric vehicles, wind turbines and solar photovoltaics. As the global energy transition accelerates, the study highlights how resource-rich developing countries remain peripheral in value capture, continuing to export unprocessed ores while higher-income countries dominate refining and manufacturing. It argues that capturing value in the critical minerals economy will depend not on resource abundance alone, but on technological access, capital and institutional depth that enable countries to move up the value chain.

1. The geography of critical minerals and value capture

Global trade data for copper, lithium, nickel and rare earth elements reveal a stark asymmetry between where minerals are extracted and where value is realized.

- Chile contributes around 30 per cent of global raw copper exports but just 12 per cent of processed copper.
- Australia supplies 76 per cent of raw lithium, yet China captures nearly 23 per cent of processed lithium export revenues.
- Indonesia produces over 60 per cent of mined nickel but China and Japan control 75 per cent of refining, while China alone handles 90 per cent of REE processing.

This uneven geography underlines that processing concentration, not ore scarcity, determines who captures value. The analysis of Chile's current account shows that dependence on mineral exports creates macroeconomic volatility—in 2004, a copper price surge increased its current account by nearly twenty-fold; in 2021, a 35 per cent price rise quadrupled it again. Such boom-and-bust cycles expose developing economies to external risks and weaken diversification prospects.

2. Emerging alliances and global power shifts

The report reviews major international initiatives attempting to rebalance critical-minerals trade.

- The US-led Minerals Security Partnership (MSP) and the EU Critical Raw Materials Act seek to diversify supply chains away from China while advancing high ESG standards.
- Simultaneously, Latin American and African cooperation efforts are gaining momentum: the Argentina–Chile Binational Lithium Working Group, the Zambia–DRC Battery Council, and the African Green Minerals Strategy aim to promote local beneficiation and regional industrialization.

These shifts reflect an intensifying contest between resource security and developmental equity, underscoring the need for just, transparent and rights-based mineral governance, as echoed by the UN Secretary-General's Panel on Critical Energy Transition Minerals.

3. Lessons from resource-rich countries

The comparative analysis of Democratic Republic of Congo (DRC), Indonesia and Chile illustrates diverse pathways and pitfalls in domestic mineral policy.

- DRC, supplying two-thirds of the world's cobalt, refines almost none of it; 79 per cent of refined cobalt output comes from China, despite DRC's export bans and local content rules.
- Indonesia's nickel-ore export ban, coupled with industrial-park incentives and Chinese investment, catalysed over US \$20 billion in downstream projects, transforming it into the world's largest refined-nickel producer.
- Chile, though a pioneer in copper bioleaching and possessing the world's richest lithium brines, remains locked in low-value extraction due to regulatory rigidity and environmental conflicts in the Atacama Desert.

Together, these cases show that policy design, rather than mere endowment, determines whether resource nationalism translates into economic resilience or lost opportunity.

4. Key findings and the way forward

Critical minerals should not reproduce fossil-fuel patterns of extraction. Policies must integrate human-rights safeguards, community participation and environmental protection, linking resource governance to industrial growth.

This paper identifies four strategic pillars for developing countries to advance in the critical-minerals landscape, including:

a. Sufficiency alongside efficiency

Technological efficiency alone cannot decouple growth from resource use. Without limits on total extraction, rebound effects shift mining pressure to new frontiers. The report underscores the need for sufficiency policies—reducing total material demand through smaller, repairable products, recycling and shifting consumption patterns—especially in high-income economies of the Global North.

b. Recycling and circularity

Recycling is framed as a strategic pillar of resilience. While it cannot replace mining, it provides secondary supply and enhances supply security. Studies show

42 developing and 31 developed countries could recover more critical minerals from waste than they currently import if equipped with advanced recovery technologies. The International Energy Agency estimates major financial gains from scaling recycling. India's National Critical Minerals Mission, with Rs 1,500 crore allocated for e-waste and battery recycling under Extended Producer Responsibility, demonstrates early policy action in this direction.

c. Regional cooperation

No single developing country has all the reserves, finance or technology required for end-to-end value chains. Continental and regional mechanisms—such as AfCFTA in Africa and Latin America's nascent lithium alliances—need to be improved to utilize the potential for creating market scale, attracting investment and harmonizing standards.

d. Diversification

Economic diversification across sectors (logistics, manufacturing, services) is essential to build economic resilience and absorb price shocks.

In conclusion, the global race for critical minerals will shape not just the pace of decarbonization but also the future geography of development. For the Global South, the opportunity lies in turning resource wealth into industrial capability, through beneficiation, circularity and cooperation, to ensure that the countries driving the world's green transition also underpin their own economic transformation.

Introduction

Critical minerals are a subset of minerals that are key for technological advancements of industries such as artificial intelligence (AI), defence and clean energy technologies. For example, copper is used in a range of consumer electronics such as air conditioners, heating and refrigeration systems as well as to provide high-speed data-transmission speeds in data centres. Lithium, another critical mineral, also produces light and high-performance batteries that are used in unmanned aircrafts and satellites, apart from its use in batteries of numerous consumer electronics.¹

With regard to clean energy technologies, copper is used widely for coils in wind turbine generators and in the wiring of turbines to transport electricity from generators to sub-stations to grid, while lithium is a primary component in batteries that is used to store energy in solar photovoltaics (PVs) and electric vehicles (EVs).

Critical minerals continue to dominate in the applications of AI and defence by being an integral component in the production of chips, robotics, drone manufacturing and modern aircrafts despite the rapid acceleration of their applications in clean energy technologies. It is precisely in this context that understanding of criticality has been dynamic and is determined by its economic importance for new technologies and the potential supply chain disruptions. These risks can arise from physical scarcity or a high concentration of market control. A major risk factor is the concentration of processing, with over 40 per cent of global smelting and refining capacity for minerals like copper, lithium, rare earth elements and cobalt located in China.²

The significance of critical minerals has grown with the acceleration of green transition in the context of climate change, as technologies like wind farms and electric vehicles require a greater variety and quantity of minerals. For instance, constructing a wind farm requires nine times more minerals than a natural gas plant. Similarly, manufacturing an electric car would need six times more minerals than internal combustion engine cars.³

1

CONTEXTUALIZING THE 'CRITICALITY' OF MINERALS

There is growing interest in critical minerals around the world, as they are crucial for a variety of applications ranging from defence and information technology to automobiles and consumer electronics. This paper focuses on their climate action applications.

Four minerals, namely copper, lithium, nickel and rare earth elements (REEs) are explored. Clean energy and/or other climate-related-use cases comprise the bulk of their projected demand in the coming decades.

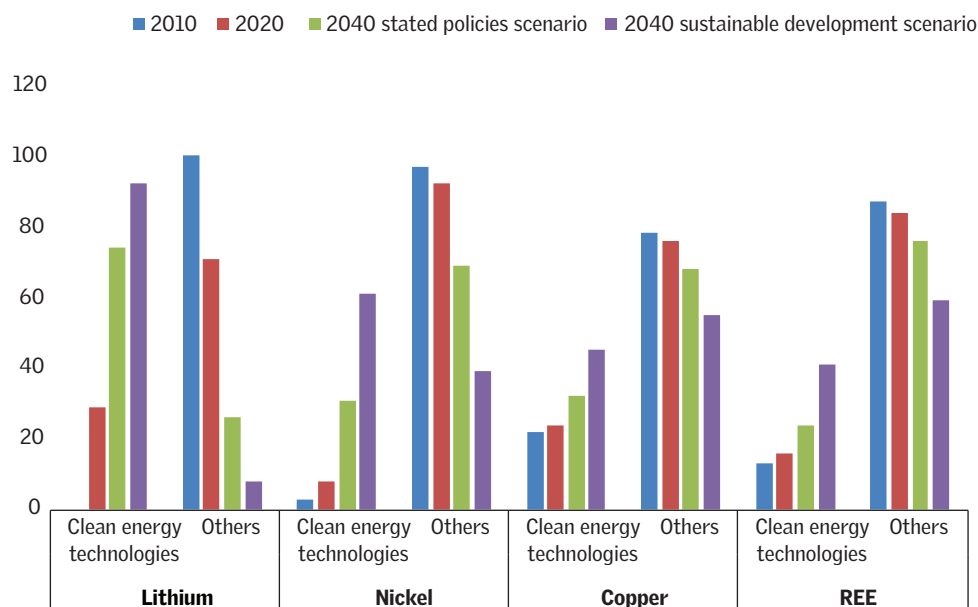
The global distribution of critical minerals is uneven. While developing countries hold the majority of reserves, refining and processing is typically concentrated outside of them, particularly in China, or select developed countries.

1.1 Critical minerals in the context of climate action

Governments have typically analysed the criticality of minerals from the standpoint of their use in the military, infotech and communication technology, and other strategic industries.⁴

But recent years have seen heightened discourse surrounding critical minerals through the lens of climate action.⁵ This refers to the minerals that are essential for the transition away from fossil fuels. These include but are not limited to minerals used for non-fossil power generation, primarily wind and solar; for the upgrading of power grids and transmission infrastructure to carry the power generated; batteries and engines required in electric vehicles and so on. This paper explores critical minerals as required inputs in low-carbon technology from an economic and geopolitical standpoint, and sheds light on the broader nexus between climate, development and trade.

Graph 1: Share of clean energy technologies in total demand for selected minerals by scenario, 2010–40 (in per cent)



Source: IEA

The specific criticality of a mineral depends on the local contexts so applied. For instance, the European Union's list of critical raw materials differs (despite some overlaps) from India's latest list.^{6, 7}

1.2 Deep dive: Four essential transition-critical minerals

This paper sets two boundaries to explore the critical minerals debate for developing countries. First, as mentioned, the focus narrows down to critical minerals that are key for climate action. Second, the geopolitical context within which these minerals are held, mined and refined is examined.

Demand for critical minerals is expected to grow rapidly, with the largest source of growth being the clean energy sector. Out of the many minerals critical to the climate transition, we focus here on those whose projected demand is driven most by clean energy technologies, making them among the ‘most needed’ in the years ahead. While demand for other minerals is also projected to increase, these four—which are listed below—also represent cases where refining is highly concentrated, and each highlights different stressors/chokepoints in the system.⁸ (Refining concentration is also acute for other minerals such as graphite; we exclude them here for scope, not because risks are lower.)

Copper (Cu): Copper is considered the best conductor of electricity, and forms the backbone of electricity transmission applications across industries. As a transition-critical mineral too, its applications span across various components in wind turbines, solar photovoltaics and energy storage systems.⁹ The International Energy Agency (IEA) notes that clean energy will comprise up to 45 per cent of the total demand for copper in 2040.¹⁰

Lithium (Li): Lithium is presently an indispensable element of the global clean energy transition. Its use in batteries for electric vehicles (EVs), solar PVs, as well as in smart grids underscores its significance. IEA projects that clean energy will form up to 92 per cent of its demand in 2040.¹¹

Nickel (Ni): Nickel is essential for high-performing alloys used in wind turbines, as well as a raw material for the cathode in Nickel Manganese Cobalt (NMC) batteries. IEA predicts that clean energy technologies will form the bulk of increased demand for nickel in 2040, going from 8 per cent in 2020 to 61 per cent in 2040, under the Sustainable Development Scenario (wherein best pro-transition policies are in place).¹²

Rare earth elements (REE): Rare earth elements (REEs) are a group of 17 elements with similar chemical properties. These are known for their use in the ‘permanent magnets’ in wind turbines, and also in the motors of electric vehicles. The IEA projects an increased demand for REEs, driven by clean energy

technologies to the tune of 41 per cent of total demand in 2040 (again, in the Sustainable Development Scenario).¹³

As per the International Energy Agency and a few other modelling estimates, the demand for critical minerals for clean energy technologies is projected to increase enormously,¹⁴ but the projections need to be viewed in the context of changing sociopolitical environments as well as technological advancements.

1.3 Supply and demand projections are riddled with uncertainties

Many models estimate the demand based on future energy needs, including that which will be generated from renewable energy, based on factors such as population growth or specific policy goals. These models also make assumptions about the mix of renewable energy sources, such as solar, wind and nuclear power, and the technologies and infrastructure needed for mainstreaming electric vehicles (EVs).¹⁵

It is also important to note that different technologies require different critical minerals. For example, a lithium iron phosphate (LFP) battery and a nickel manganese cobalt (NMC) battery will require different kinds of minerals in its cathode and the demand of such batteries will depend on factors such as energy density, security and service life.¹⁶

On the other hand, supply forecasts are generally for shorter periods and don't vary as much. They are often based on existing mines and planned projects, but some don't account for future mine expansions or resource availability. Assumptions are also made about mining and recycling technologies, and that projects will proceed as planned. Various factors can, however, disrupt mining operations, including the availability of water and energy, weather, licensing, environmental standards, political stability and community relations.¹⁷

Building on the applications and projections, we further explore the trade dynamics of the aforementioned minerals by understanding which country earns the most through the exports of the minerals in their raw and processed form, thereby highlighting the geopolitical divide that is central in shaping the energy transition.

1.4 Relevance and implications of mineral dependency for countries

This section summarizes the geography of critical minerals through a typology of who mines, who refines, and who holds reserves (resource endowed). While much

COPPER: BACKBONE OF ELECTRIFICATION AND GLOBAL TRADE IN THE ENERGY TRANSITION

Copper is essential for renewable energy systems due to its high conductivity. Used in solar PV (bus bars, wiring, inverters), wind turbines (generator windings, grounding systems), EVs and charging infrastructure (motor coils, cabling), battery connectors, and power grids (distribution and transmission lines).¹ Apart from its utility in clean energy technologies, it is vital in electrical and electronic systems, energy transmission, industrial machinery, HVAC and automotive systems and data/communication cables. It is also used in electronic interconnections and thermal management.^{2, 3}

Graph 2: Countries with the highest revenue from export of raw copper in 2020–24



Source: CSE Analysis, UN Comtrade

HS codes: 260300

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

Graph 3: Countries with the highest revenue from export of processed copper in 2020–24



Source: CSE Analysis, UN Comtrade

HS codes: 7403, 7404, 7406, 7407, 7408, 7409, 7411, 7413

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

Chile dominates global exports of both raw and processed copper. It accounts for about 30.6 per cent of raw copper exports and 11.7 per cent of processed copper exports, making it the leading supplier across the value chain. In contrast, Peru and Indonesia play major roles primarily in raw copper exports, while Germany, USA and China lead in processed copper exports. The category of 'Others' collectively contributes the largest share, reflecting a wide global distribution of copper trade beyond the top exporters.

With regard to the recyclability of copper, it is infinitely recyclable without loss of conductivity or durability; recycling uses much less energy than mining new copper.⁴ It has low substitutability, with aluminium occasionally used in high-voltage transmission. Refining of mined copper is highly toxic, making recycling preferable.

Sources:

1. How Copper Is Used for Renewable Energy Applications; <https://www.belmontmetals.com/how-copper-is-used-for-renewable-energy-applications/?srsltid=AfmBOopNwxsIyVrLQBail-g0EKqlhInfFJlJwzszSyc9W-mcDjsyVjw>; as accessed on September 23, 2025.

2. Copper Applications; <https://copper.org/applications/>; as accessed on September 23, 2025.

3. Copper Applications Technology Roadmap; https://internationalcopper.org/wp-content/uploads/2021/08/ICA_TechRoadmap-201806-Web.pdf; as accessed on September 23, 2025.

4. Copper Recycling, International Copper Association; <https://internationalcopper.org/resource/copper-recycling/>; as accessed on September 23, 2025.

LITHIUM'S GLOBAL TRADE AND CRITICALITY IN THE ENERGY TRANSITION

Lithium is central to lithium-ion batteries for EVs, energy storage and renewable integration (solar, wind, smart grids). It is also used in hydrogen production. Additionally, it is found in consumer electronics, telecom infrastructure, aerospace and defence (drones, satellites, Li-Al alloys), glass and ceramics, lubricants and psychiatric medicine.^{1, 2}

Graph 4: Countries with the highest revenue from export of raw lithium in 2020–24



Source: CSE Analysis, UN Comtrade

HS code: 253090

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

Graph 5: Countries with the highest revenue from export of processed lithium in 2020–24



Source: CSE Analysis, UN Comtrade

HS codes: 282520, 282739, 282690, 282619, 284169, 284290, 382499

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

Australia overwhelmingly dominates raw lithium exports, accounting for 76.2 per cent of global trade, far ahead of other producers like Brazil and Zimbabwe. In contrast, processed lithium exports are led by China, which holds 22.8 per cent of global exports, followed by Germany and USA, with roughly equal shares. This reflects a clear geopolitical divide in which the Global South does not reap any benefits from their reserves of lithium while most of the value-added processing is concentrated in the industrialized economies.

On the recycling front, the process remains technologically difficult and energy-intensive; lithium mining is highly polluting. Sodium-ion batteries are emerging as a potential, less costly and environmentally safer alternative.³

Sources:

1. Top 10 Applications of Lithium-Ion Batteries in 2025: From EVs to Energy Storage; <https://www.shizenenergy.in/lithium-ion-battery-application/>; as accessed on September 23, 2025.

2. Electricity storage and hydrogen generation system using the electrochemical reaction of lithium and water; <https://www.sciencedirect.com/science/article/abs/pii/S0360319924053138>; as accessed on September 23, 2025.

3. We rely heavily on lithium batteries—but there's a growing array of alternatives; <https://www.bbc.com/future/article/20240319-the-most-sustainable-alternatives-to-lithium-batteries>; as accessed on September 23, 2025.

NICKEL'S CENTRAL ROLE IN THE ENERGY TRANSITION AMIDST SHIFTING GLOBAL TRADE DYNAMICS

Nickel is used in key components in EV battery cathodes (improving range and performance), high-performance alloys for wind and solar systems, and catalysts for green hydrogen production.¹ Nickel also dominates consumer electronics and healthcare as it is used extensively in stainless steel for cookware, construction, and medical devices (angioplasty wires, surgical equipment).²

Graph 6: Countries with the highest revenue from export of raw nickel in 2020–24



Source: CSE Analysis, UN Comtrade

HS codes: 260400

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

Graph 7: Countries with the highest revenue from export of processed nickel in 2020–24



Source: CSE Analysis, UN Comtrade

HS codes: 283324, 7505, 7506, 7507, 750800, 750810, 750890, 7501, 7502, 750300, 7504

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

In global nickel trade, Indonesia leads in processed nickel exports, accounting for 14.2 per cent of global exports, followed by Canada and USA. In contrast, raw nickel exports are dominated by the Philippines, with 33.3 per cent share of global exports, and Zimbabwe emerging as a significant supplier at 21.8 per cent. A shift towards downstream processes in Southeast Asia, especially in Indonesia, has transpired in the last five years, but North American countries such as Canada and USA continue to earn from value-added nickel products.

The nature of nickel's recyclability emerges primarily from stainless steel and battery scrap. LFP (lithium iron phosphate) batteries are emerging as lower-cost, safer alternatives to nickel–manganese–cobalt (NMC) batteries, though with lower energy density.³

Sources:

1. International Energy Forum. 2024. Nickel – a mineral with a challenging role in clean tech;

<https://www.ief.org/news/nickel-a-mineral-with-a-challenging-role-in-clean-tech>; as accessed on September 23, 2025.

2. Nickel Institute. About Nickel; <https://nickelinstitute.org/en/nickel-applications/>; as accessed on September 23, 2025.

3. Elcan Industries. Lithium Iron Phosphate vs Lithium Ion Batteries. <https://elcanindustries.com/toll-processing/lithium-iron-phosphate-batteries-vs-lithium-ion-batteries/>; as accessed on September 23, 2025.

RARE EARTH ELEMENTS: STRATEGIC ENABLERS OF CLEAN ENERGY AND HIGH-TECH INDUSTRIES

Rare earth elements are crucial in wind turbine permanent magnets and EV motors (Pr, Nd, Tb, Dy improve power and efficiency). They also enable lightweight, compact, high-efficiency designs in clean tech. Furthermore, they are widely used in defence systems (radar, missile guidance), medical lasers and radiotherapy, and consumer electronics (speakers, LEDs, displays).

Graph 8: Countries with the highest revenue from export of raw REE in 2020–24



Source: CSE Analysis, UN Comtrade

HS code: 284690

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

Graph 9: Countries with the highest revenue from export of processed REE in 2020–24



Source: CSE Analysis, UN Comtrade

HS codes: 280530

Note: Values are the sum total of figures for 2020–24. Countries are selected only if the data is available for all five years.

In the exports of raw REEs, China leads slightly with 27.8 per cent of global exports, followed closely by Malaysia and USA, showing a relatively balanced distribution among major exporters. However, in processed REE exports, China dominates overwhelmingly, accounting for more than 60 per cent of global exports, while Thailand follows at 29 per cent. Japan and rest of the world together account for less than 10 per cent, underscoring China's strong control over the value-added stage of the REE supply chain.

On the recycling front, end-of-life products yield higher-value REEs and avoid radioactive waste from the process. Recycling is environmentally preferable but economically challenging; it requires assessment of lifecycle impacts and scalability.⁵

Sources:

- Charlie Hoffs. 2022. *Just and Sustainable Solutions for the Mining and Recycling of Rare Earth Elements in Wind Turbines*. The Equation. <https://blog.ucs.org/charlie-hoffs/just-and-sustainable-solutions-for-the-mining-and-recycling-of-rare-earth-elements-in-wind-turbines/>; as accessed on October 17, 2025.
- Victory Metals. Rare Earth Metals in Electric Vehicles. <https://www.victorymetalsaustralia.com/rare-earth-metals-electric-vehicles/>; as accessed on October 17, 2025.
- Commodities Hub. 2025. Understanding Rare Earth Elements and Their Uses. <https://commoditieshub.ch/en/2025/02/11/understanding-rare-earth-elements-and-their-uses/>; as accessed on 17 October 2025.
- Yoshiko Fujita et al. 2022. Recycling rare earths: Perspectives and recent advances. *MRS Bulletin*. <https://link.springer.com/article/10.1557/s43577-022-00301-w#Sec4>; as accessed on October 17, 2025.
- Abdulhammed K. Hamzat. 2025. *Rare earth element recycling: a review on sustainable solutions and impacts on semiconductor and chip industries*. *Journal of Material Cycles and Waste Management*. <https://link.springer.com/article/10.1007/s10163-025-02276-7#Sec18>; as accessed on October 17, 2025.

of the mineral wealth lies in the Global South, especially across Africa and Latin America, the higher-value stages of refining and processing are concentrated elsewhere, most notably in China. The result is a persistent gap between where resources are found and where economic value is captured.

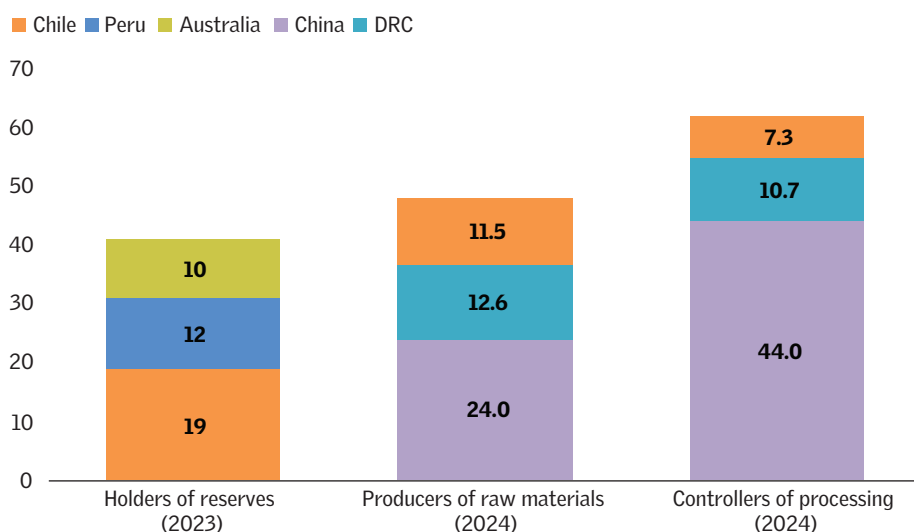
1.4.1 How do different countries stack up in the supply chain of various transition-critical minerals?

For our analysis, countries are mapped and selected as per their composition in the global reserves, processing and end-use demand for minerals such as Li, Cu, Ni and REE; classified as critical in Section 1.2.

Copper's global supply chain

In the upstream segment, the top three holders of reserves in 2023 were Chile, Peru and Australia, collectively accounting for 41 per cent of global reserves. In 2024, the leading countries for production of mined copper or the raw material were China, the Democratic Republic of Congo (DRC) and Chile with these three countries making up 48.1 per cent of the global output. Similarly, in the downstream processing stage, the top three controllers were China, the DRC, and Chile. In this stage, they control a greater share of processing, accounting for 62 per cent of the global total, with China holding 44 per cent of it.

Graph 10: Top countries influencing the different elements of supply chains of copper



Source: Our World in Data, IEA

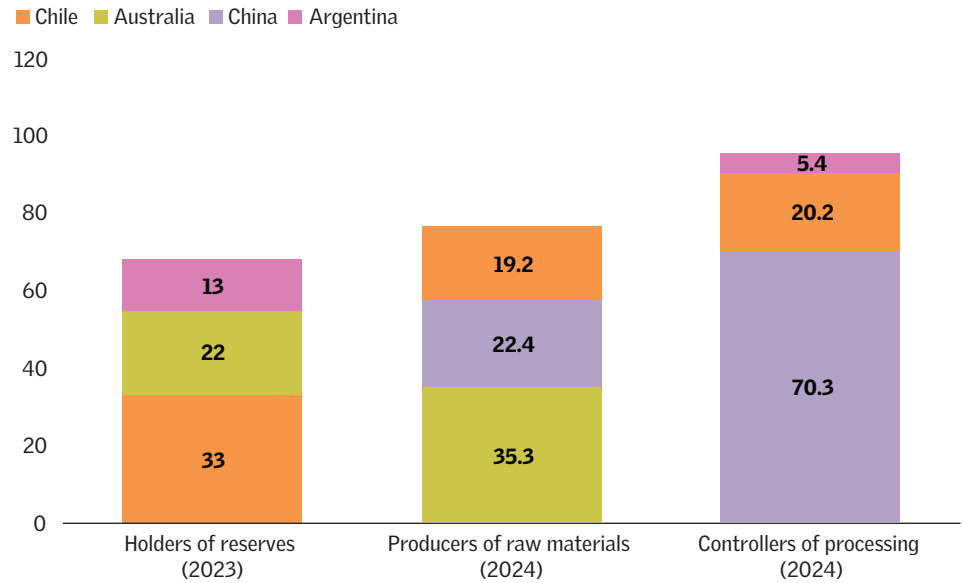
Note: Values are in percentages

Lithium’s global supply chain

The global lithium supply chain is characterized by increasing geographical concentration as the material moves from extraction to processing. With regard to who holds the reserves, the top three countries—Chile, Australia and Argentina—collectively account for 68 per cent of the world’s known lithium reserves. This strong concentration continues as countries who are producers of raw lithium such as Australia, China and Chile are responsible for a combined total of approximately 77 per cent of global mined lithium.

However, the most critical bottleneck is found in the processing stage of lithium’s supply chain where China alone controls around 70 per cent of the entire stage. This structure means that resource-rich nations are primarily exporters of raw materials, while China maintains a near-monopoly on the most critical steps of the supply chain, thereby creating a major point of geopolitical concentration and supply-side vulnerability for the manufacturing of EVs and clean energy technologies.

Graph 11: Top countries influencing the different elements of supply chains of lithium

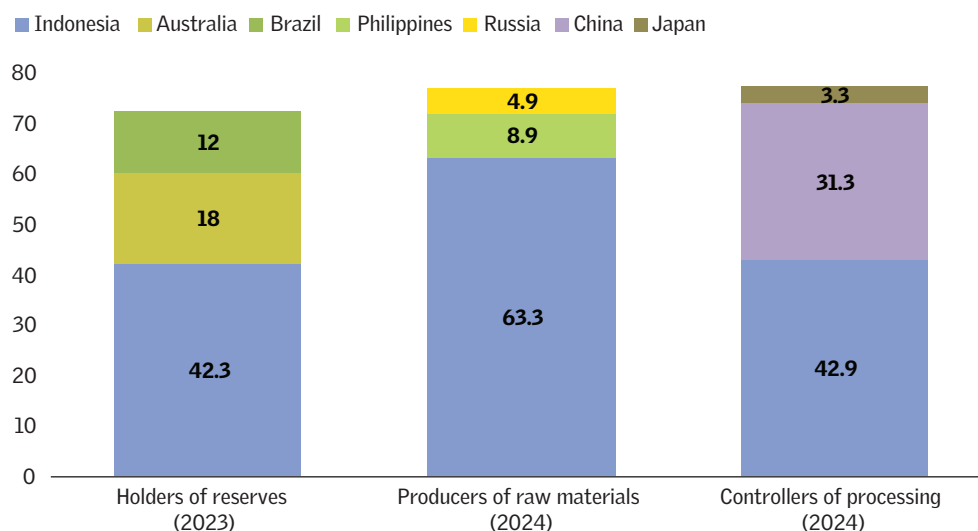


Source: Our World in Data, IEA
Note: Values are in percentages

Nickel’s global supply chain

Indonesia dominates the upstream segment of nickel’s global value chain, holding 42.3 per cent of global reserves in 2023 and producing 63.3 per cent of mined nickel in 2024. The top three reserve holders (Indonesia, Australia, Brazil) account for 72.3 per cent of reserves, while the top three raw material producers (Indonesia, Philippines, Russia) account for 77 per cent of production. However, control of

Graph 12: Top countries influencing the different elements of supply chains of nickel



Source: Our World in Data, IEA

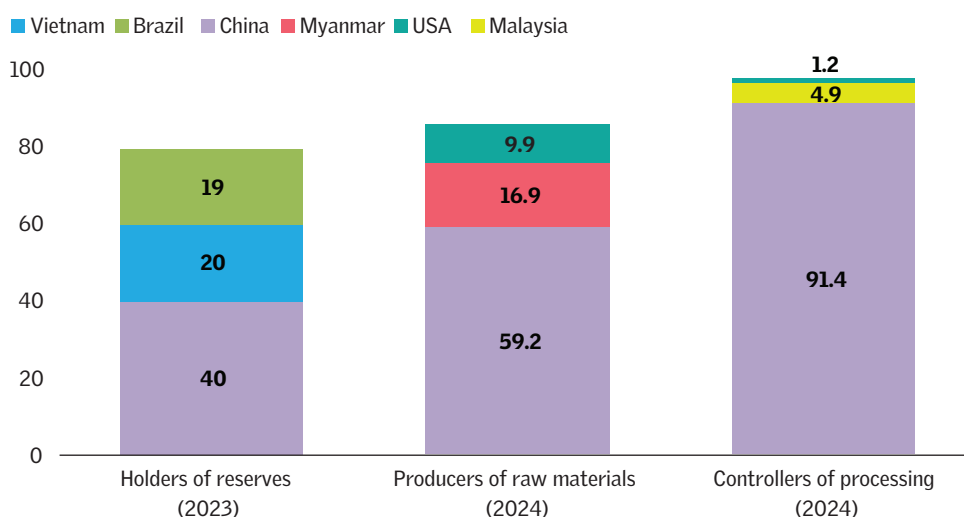
Note: Values are in percentages

downstream processing and refining shifts to East Asian countries, where China and Japan are the key actors, with the top three countries generating 77.4 per cent of the global output.

Rare earth elements' global supply chain

China exhibits dominance across all stages of the value chain, holding 40 per cent of reserves in 2023 and accounting for 59.1 per cent of mined REE production

Graph 13: Top countries influencing the different elements of supply chains of REE



Source: IEA, Our World in Data

Note: Values are in percentages

in 2024. The most significant concentration is in the downstream, where China controls an overwhelming 91.3 per cent of the global processing. In total, the share of the top three countries in reserves, raw material production and processing is 79 per cent, 85.9 per cent and 97.5 per cent respectively and they manage the vast majority of the REE market.

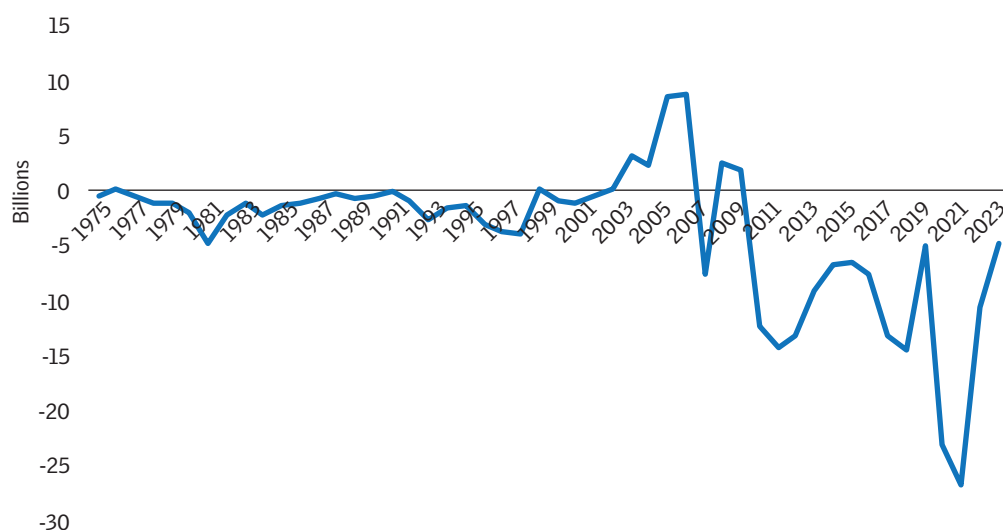
1.4.2 The paradox of raw mineral exports and the current account

The export of raw minerals exerts a complex and often contradictory influence on a country's current account (CA), specifically within the Balance of Payments (BoP) framework.¹⁸ To elaborate, the CA records the flow of goods, services and income, reflecting the net flow of money resulting from international trade, and is a critical indicator of resource flow for open economies.¹⁹

The large export revenues from raw minerals can improve the trade balance and current account of a country when commodity prices are high. However, they can also make the CA volatile due to external commodity price shocks. This high elasticity means that the terms of trade (the ratio of export prices to import prices) can fluctuate rapidly and violently.²⁰

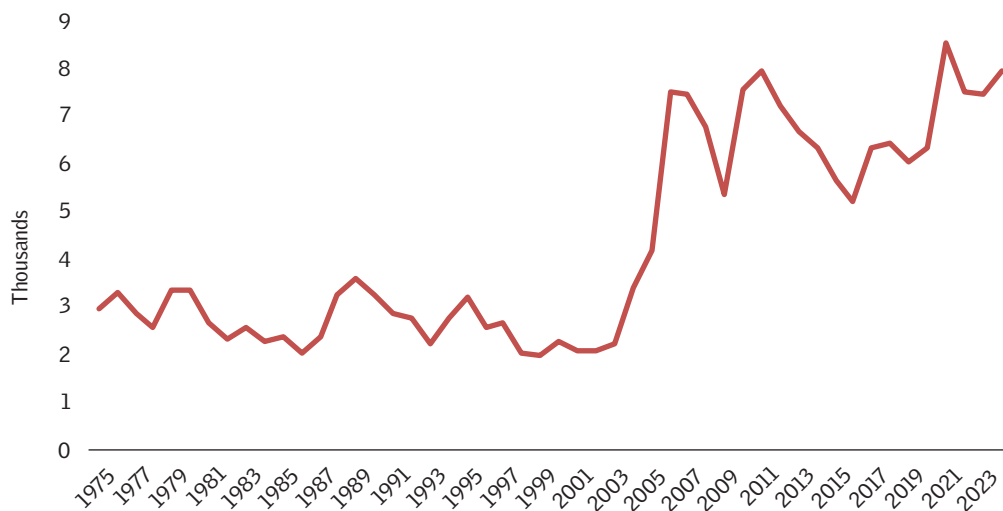
Furthermore, commodity price volatility creates major macroeconomic consequences, especially for economies who are commodity-dependent. For example, in copper-dependent economies, exchange rates show a strong correlation with copper price fluctuations, as higher prices imply greater returns

Graph 14: Chile's current account over the last 50 years



Source: World Bank 2025

Graph 15: Prices of copper (adjusted for inflation) globally over the last 50 years



Source: World Bank 2025

from export volumes. This instability complicates government planning and long-term investment decisions.²¹

The correlation between the current account and commodity prices for a mineral-dependent country such as Chile is evident from *Graph 15*. For instance, in 2004, Chile's CA increased by almost 20 times as compared to the previous year, reflecting the 50 per cent rise in 2004 in the global price of copper, after adjusting for inflation from 2003 levels. Furthermore, as per IMF's Staff report for the 2005 Article IV consultation, the country's CA registered a surplus of 1.5 per cent in 2004 boosted by improved terms of trade, especially with China that absorbs more than one-third of Chile's total exports and its demand for copper helped in increasing the mineral's price. A similar pattern can be observed in 2021 where the country's CA increased by more than four times from 2020 after the price increase of copper by 35 per cent since 2020 owing to strong demand and tight supply.²²

Harnessing one's own natural endowment to spur economic growth has been a dominant model of export-oriented development followed by many countries but one of the main repercussions of being dependent on the exports of natural resources (including raw minerals) is the negative impact it can have on the non-resource-based industries. It could further hamper the price competitiveness of exports of a country's manufactured goods, thereby increasing the risks of Dutch disease.²³ A phenomenon that facilitates a rise in the value of a country's currency by virtue of its newly discovered endowments but this can also weaken

the competitiveness of its manufacturing sector; thereby creating weak linkages to the rest of the economy and making economic diversification difficult.

Resource abundance alone does not guarantee sustained economic growth.²⁴ To counteract the limits and instability inherent in the raw export model, producer countries must maximize the value-added from extracted minerals. This involves processing, milling and refining minerals domestically before export, a process known as mineral beneficiation. Additionally, the gains from mining are not automatic; they depend heavily on policies, regulatory frameworks and institutional strength.²⁵

1.4.3 Producer strongholds vary across stages of the critical minerals supply chain

As demonstrated by the geographical mapping and listing of minerals above, critical minerals supply chains reveal a persistent imbalance between resource endowments and value capture by countries. Many developing countries, such as the DRC and Chile, dominate mining but carry out little refining, while China has positioned itself as the world's refinery across copper, lithium, nickel, cobalt and rare earth elements.

Even Australia, despite being a high-income country with vast reserves and nearly half of global lithium output, refines relatively little. This mismatch between reserves, production and refining is stark: Bolivia holds large lithium reserves but hardly produces; DRC has over half of global cobalt reserves but refines little; and countries like Vietnam and Brazil mine far less than their rare earth potential, leaving China's integrated dominance largely intact.

This paper argues that processing concentration, and not ore scarcity, in conjunction with a country's political economy determines who captures the most revenue from copper, lithium, nickel and rare earth element's value chains. Additionally, when mineral-rich countries intervene through a set of policies (such as export bans, local content requirements, creation of industrial parks, diversified supply- and demand-side contracts and agreements etc.) that prioritizes resource sovereignty, it can lead to a shift in outcomes, as evidenced by the DRC, Indonesia and Chile.

2

STATUS OF PARTNERSHIPS TO BREAK THIS STRONGHOLD

As an overwhelming majority of critical mineral refining and processing is currently concentrated in China, countries around the world are attempting to reconcile with this.

While the industrialized nations of the Global North are conceiving critical mineral policies to secure their supply chains and address Chinese dominance, some developing country partnerships are seeking to maximize value capture and leverage their natural resource endowments.

At the multilateral level, the UN Secretary General's Panel on Critical Energy Transition Minerals is pushing for embedding ethics, equity and justice at the core of the critical mineral value chains.

While the dominance of certain countries at various points in the global supply chain of critical minerals is noted, as with the trade of any critical commodities, attempts at forging new relationships to tip the balance of power are underway. Countries all over the world are already competing in the rush for a ‘new green economy’.

2.1 Mineral Security Partnership, USA

- The US-led Minerals Security Partnership (MSP) aims to accelerate the development of diverse, secure and responsible critical-minerals supply chains, with a heavy emphasis on high ESG standards and reducing over-concentration risk. In other words, this is the US’s policy move directly aimed at breaking the stronghold of China over critical mineral supply chains.²⁶
- Its financing arm is the MSP Finance Network, which links public and private financiers to share information and co-finance projects, providing capital to crowd in investment.²⁷
- MSP convenes regular principals/ministerial meetings and launched the MSP Forum to formalize engagement with mineral-producing countries; recent sessions highlighted pipeline projects and coordination among Development Finance Institutions (DFIs) and Export Credit Agencies (ECAs).²⁸
- Current partners cover a broad set of countries, including the European Union, Australia, Canada, Japan, India, Germany, France, Italy, the UK, Republic of Korea, Sweden, Norway, Finland and Estonia, with additional MSP Forum members from producer countries, including Argentina, DRC, Namibia, Peru, Kazakhstan, Mexico, Uzbekistan and others.
- The Minerals Security Partnership has announced progress across 32 projects so far, spanning upstream mining (19), midstream processing (15), and recycling (3), with mineral coverage including rare earths, graphite, cobalt, nickel, copper, lithium, aluminum, gallium, germanium and manganese.²⁹
- Seven projects have reportedly reached key milestones: a US \$2 billion copper development in Zambia; a Gécamines–Umicore germanium offtake and processing deal in the DRC; POSCO International’s investment in Tanzania’s Mahenge graphite mine; U.S. and Canadian financing for Electra’s cobalt sulfate refinery in Ontario; EXIM Bank’s \$50 million financing for iron flow battery lines in Oregon; EXIM’s letter of interest for \$600 million to Australian Strategic Materials’ Dubbo rare earths project; and multi-level financing for Queensland Pacific Metals’ nickel and cobalt hub in Australia.³⁰ These illustrate how MSP is engaging with African, American, and Asia-Pacific partners to expand supply security and diversify beyond China across key minerals essential to the energy transition.

2.2 European Critical Raw Materials Act

- The EU Critical Raw Material Act's stated objective is to secure a stable and sustainable supply of critical raw materials for European industry, while reducing the bloc's reliance on any single external supplier. It aims to strengthen the EU's position across the value chain.³¹
- By 2030, the Act sets benchmarks for meeting EU demand: 10 per cent through domestic extraction, 40 per cent through processing, and 25 per cent through recycling, with no more than 65 per cent of any material at any processing stage sourced from a single third country.
- In line with the European Union's Global Gateway strategy, it also aims to secure 'mutually beneficial partnerships' with emerging economies and developing countries.³²
- The Act has designated 60 strategic projects so far, including 47 within the EU and 13 in partner countries outside Europe. These projects span extraction, processing, recycling, and substitution, and cover lithium, nickel, cobalt, copper, graphite, manganese, rare earth elements, germanium, gallium, tungsten and magnesium.
- Within the EU, efforts include lithium extraction in Portugal and Germany, graphite and rare earth processing in France and Poland, and recycling initiatives in Italy, Spain, Sweden, and Finland. Beyond Europe, partnerships extend to Ukraine (graphite), Canada (nickel/cobalt), Zambia (cobalt processing), Brazil (nickel/cobalt), Kazakhstan (graphite), Malawi and South Africa (rare earths, manganese), and others.^{33, 34}
- Twenty-two of the projects involve lithium, 12 nickel, 11 graphite, 10 cobalt, and seven manganese, meant to improve the battery-making supply chain, with some involving more than one metal. The projects are meant to diversify supply and de-risk dependencies while building local value in partner countries.³⁵

Efforts to organize and attempt to break resource monopolies are not new. At the 15th Convention on Biological Diversity (CBD) COP in Montreal, the Sustainable Critical Minerals Alliance was formed between developed countries such as Japan, Australia, United Kingdom, the United States, Canada, France and Germany.³⁶ Most alliances of this nature foreground the need for economic security, but also emphasize (at least on paper) reducing the environmental and social footprints of surging critical minerals mining and processing. The Quad countries (India, Australia, USA and Japan) also released a joint statement on critical minerals in July 2025.³⁷ The initiative frames the critical minerals questions exclusively through the lens of national security, setting it apart from other 'climate/green steered' partnerships. But the objective to combat Chinese dominance remains.³⁸ More recently, the Group of 7 (G7) nations also released a joint statement endorsing

the G7 Critical Minerals Action Plan.³⁹ In addition to these main Western-led efforts to increase security of the critical mineral supply chain, regional and bilateral agreements/mechanisms have also emerged in recent years. Given that the majority of the resources lie in the Global South, careful consideration of emerging policies is warranted.

CHINA-US PUSH AND PULL FOR RARE EARTH ELEMENTS

On October 9 2025, China announced sweeping export controls on rare earth elements and related technologies, tightening its grip over critical minerals ahead of a planned meeting between Presidents Donald Trump and Xi Jinping, Financial Times reported.¹ The new rules require foreign companies to seek Beijing's approval to export magnets or semiconductor materials that contain even trace amounts of Chinese-sourced rare earths, or that use Chinese 'extraction methods, refining or magnet-making technology.' The measures seem to be quite similar to the United States' own export-control tools, making this among China's most direct response to USA's curbs on advanced technology trade. China has said the move aims to protect national security and prevent the misuse of Chinese materials for military purposes and other sensitive industries. It has also stated the rules will come into effect from December, and licences for military end-users will largely be denied, while exports for semiconductor manufacturing will be assessed on a case-by-case basis. Analysts see the timing as strategic, giving China leverage in trade talks. The country dominates global rare earth supply chains, holding around 70 per cent of mining, 90 per cent of processing, and 93 per cent of magnet production. The US has expressed concern since the policy could give China sweeping influence over global technology supply chains, even for products made outside China, such as US AI chips.

After the leaders met in South Korea, the latest export controls on rare earths were temporarily reversed for one year, Reuters reported. But the pause does not extend to the restrictions put forth by China in April. Essentially, China's April export restrictions, per the Chinese Ministry of Commerce Announcement No. 18², required licenses for several medium and heavy rare earths; these will formally remain in place, but after the leaders' meeting, Beijing will issue broad licenses that effectively lift these restrictions for U.S. buyers, while keeping the newer October 2025 curbs on hold for a year.³

But this type of back and forth is not new. As one analyst has written, much of what the USA is doing now in terms of policy levers for gaining leverage in global supply chains includes strategies employed by China decades ago. China has built its rare earth dominance through strategic efforts over three decades: first boosting exports with tax breaks, then declaring the minerals strategic, restricting foreign access, and consolidating control through state giants and quotas. The result is near-total command over mining, processing and magnet technology. Today, the West seems to be following a similar script but in reverse by using subsidies, tariffs and onshoring laws to rebuild domestic supply chains and cut dependence on China. What Beijing did over decades to gain leverage, the US, EU and Australia are trying to compress into a few years.⁴ All of them use industrial policy and export controls as tools of power in the critical-minerals race.

Sources:

1. *Financial Times*. 2025. China unveils sweeping rare-earth export controls to protect 'national security'; <https://www.ft.com/content/c4b2c5d9-c82f-401e-b763-bc9581019cb7>; as accessed on November 3, 2025.
2. International Energy Agency. 2025. Export controls on certain medium and heavy rare earth items. <https://www.iea.org/policies/26796-export-controls-on-certain-medium-and-heavy-rare-earth-items>; as accessed on November 3, 2025.
3. Reuters. 2025. US gets rare earth reprieve from China, but not rollback. <https://www.reuters.com/sustainability/climate-energy/china-agrees-one-year-rare-earth-export-deal-issue-settled-says-trump-2025-10-30/>; as accessed on November 3, 2025.
4. Rare Earths Exchanges. 2025. Detailed Timeline: China's Rare Earth Restrictions and Strategic Moves. <https://forum.rareearthexchanges.com/threads/detailed-timeline-chinas-rare-earth-restrictions-and-strategic-moves.16/>; as accessed on September 25, 2025

2.3 Emerging cooperation in Latin America

Argentina–Chile Lithium working group: The two key players created the Binational Lithium and Salt Flats Working Group in 2023. The two governments signed a MoU to cooperate on value addition, environmental and social standards, and human-capital development.⁴⁰

Talks of ‘Lithium OPEC’: Since 2022, Chile, Argentina and Bolivia have floated the idea of forming a regional ‘lithium OPEC’ to pool bargaining power through a strategic alliance. Some sources suggest such a cartel faces major obstacles: lithium is traded more as a specialist product than a standardized commodity; Latin America’s share of global production is projected to decline; higher prices through the cartel would encourage other alternative producers, i.e. exploring lithium elsewhere may be relatively cheaper; and hard-rock deposits in Australia and China are already expanding. Added to this are political and investment risks, such as Chile’s moves toward greater nationalization, along with Bolivia’s continued lack of commercial-scale production, making the prospect of a functioning cartel unlikely.⁴¹

However, experts at UNCTAD have opined that regional cooperation frameworks, though not necessarily in this form, should be prioritized by resource-endowed countries. Their paper suggests that countries should leverage their unique advantages and come together to combine their strengths. They do also highlight that simultaneously developing economic diversification is prudent and necessary, i.e. ‘a strategic economic diversification approach at the regional level’.⁴²

2.4 Potential for cooperation in Africa

Zambia and DRC signed an agreement in 2022 to develop a joint battery value chain.⁴³ The common governance framework termed DRC–Zambia Battery Council will also cover the development of industrial zones in both countries. A key aspect of this initiative is for the countries to jointly produce nickel, manganese and cobalt (NMC) battery precursors. In 2023, the Afreximbank and the United Nations Economic Commission of Africa (UNECA) signed an agreement to provide financial and technical support to the effort of production of batteries in Special Economic Zones (SEZs) in the countries.⁴⁴ At the continental level, the African Union adopted the African Green Minerals Strategy in February 2025. Its stated aim is to take Africa from being solely a provider of green raw materials to ‘an integrated partner in the global minerals value chain’. It provides a roadmap for the needed partnerships across governments, regional cooperation, private sector and development partners.⁴⁵

2.5 UNSG Panel on Critical Energy Transition Minerals: High-level principles for embedding ethics in critical mineral value chains

The United Nations Secretary-General's Panel on Critical Energy Transition Minerals published a report in September 2024 that laid out seven high-level 'guiding principles' to premise the global mineral supply chains in justice and equity.⁴⁶

The guiding principles are:

- Protection of human rights at the core;
- Protection of ecosystems;
- Embedding justice and equity;
- Sharing benefits through local value addition and economic diversification;
- Ensure responsible finance and trade;
- Implementation through transparency and anti-corruption as pillars; and
- Multilateral and international cooperation to underpin global action, peace and security.

The panel supplements these principles with actionable recommendations as well, including but not limited to, diversified supply, community participation, circularity and fair contracts. For the Global South, the report explicitly aims to turn resource endowments into development gains via value addition, better governance and fairer financing, not just raw-ore exports.

The report underscores an issue emerging as central to the justice concern in critical mineral transition discourse—that of artisanal and small-scale miners in the extraction of the critical minerals required for the energy transition. It suggests the formalization and legalization of the labour already being carried out by these groups, and even highlights the need for ensuring intergenerational equity.

While the EU- and US-led initiatives focus openly on the need to break Chinese hegemony, other Global South countries are attempting to capture more value from the resources they are endowed with. The next section examines the question of what can and has been done at a domestic-policy level to address this need and ambition.

3

A COMPARATIVE ASSESSMENT OF MINERAL-RICH GLOBAL SOUTH COUNTRIES

The Democratic Republic of Congo, Indonesia and Chile all possess rich critical mineral wealth. Yet, each of their approaches to leveraging their natural endowments has been unique.

This section identifies the strengths, weaknesses, opportunities and threats (SWOT) for each country's critical mineral ecosystem.

The SWOT analysis reveals that while a country's strategy must be tailored to its unique national circumstances, using the present moment as an opportunity to foreground economic resilience along with climate action has the potential to significantly benefit the Global South.



DEMOCRATIC REPUBLIC OF CONGO

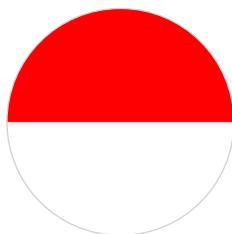
Strong and growing global demand of cobalt in clean technologies

DRC is a leading resource base of cobalt primarily and supplies a large share of the mineral to the world, making it a strategic supplier, especially in lithium-ion batteries and EV supply chains. To elaborate, cobalt's demand in the share of clean energy out of total demand of the mineral increased from 20 per cent in 2021 to 32 per cent in 2024 and is projected to increase up to 47 per cent under the stated policies scenario by IEA.⁴⁷

Exercising autonomy over its natural endowments

By the end of 2024, cobalt prices fell drastically due to its oversupply in the market driven by steady production in DRC and Indonesia and an increase in China's refined metal supply. Additionally, the increased supply coincided with a slight decrease in the mineral's demand owing to an uptake in lithium-iron-phosphate batteries that use little to no cobalt.⁴⁸

Thus, immediately afterwards, the government put a four-month ban on cobalt exports starting in February 2025. This was their first big intervention to manage the cobalt market and fix the issue of oversupply. The ban was effective as it helped in boosting the prices.⁴⁹



INDONESIA

Large resource base and a better producer position

Indonesia accounts for almost two-thirds of the global supply of mined nickel.⁵⁰ It also produced 43 per cent of refined nickel out of the total production in 2024 as per IEA. Thus, giving the country a great bargaining power in the global supply chains.

Export-ban policy successfully pulled capital into domestic processing

In 2014, Indonesia put a ban on exporting nickel ore and required companies building smelters to meet a local-content rule. This export ban was part of a larger partnership between China and Indonesia, which involved China providing financing, helping to set up projects, and creating special industrial zones within Indonesia. Indonesia is also focused on building an end to end Electric Vehicle (EV) supply chain, covering everything from raw materials to battery cells, battery packs, and electric cars. To achieve this, the government has offered support through tax breaks, import-duty exemptions, funding for infrastructure development, and R&D subsidies. These incentives have complemented export bans and local content requirements to attract over US \$20 billion in investments from EV battery companies into its industrial parks in recent years. Thus, Indonesia is now the world's largest producer of refined nickel with the revenue from value-added exports soaring from US \$1 billion in 2015 to US \$20.9 billion in 2021.⁵¹



CHILE

Innovator in reducing mining's ecological impact

Chile holds the world's largest copper reserves and supplies one-fourth of globally mined copper, but its significant role in the development and commercial use of copper bioleaching has been pioneering. It is a process that uses microorganisms to dissolve insoluble metal sulphides and oxides, an alternative to the traditional method of obtaining the mineral from the ore. Bioleaching offers advantages such as lower costs, simpler equipment, low energy use, and no atmospheric contamination, making it ideal for treating low-grade or waste copper ores that are not economical for smelting.⁵²

Cost-effective production of lithium

Chile is the second-largest producer of lithium globally (behind Australia). Its main strength lies in the Salar de Atacama, which boasts the highest lithium concentration in the world in its brines. This, combined with high solar radiation in the region, allows for the most cost-effective solar evaporation process globally. However, Chile's lithium production has stagnated in recent years and it is attributed to the need for more flexible legislation surrounding the lithium industry.⁵³



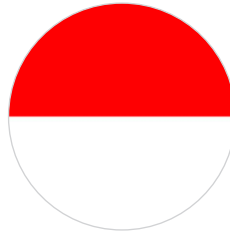
DEMOCRATIC REPUBLIC OF CONGO

Low profit margins captured domestically from cobalt value chain

Despite supplying two-thirds of raw cobalt globally, DRC refines negligible per cent of the mineral while China accounts for 79 per cent of global refined cobalt supply.⁵⁴ China's dominance is reflected through the control of eight out of the 14 largest cobalt mines in DRC that produce more than half of the country's cobalt.⁵⁵ China's influence in gaining access to the mines in DRC is attributed to its foreign direct investment in the country.

Economic dependence and price sensitivity

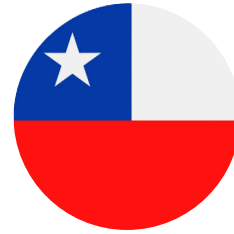
Heavy reliance on one strategic mineral exposes export revenues to cyclical prices and demand swings; this is worsened by periodic market oversupply and price collapses. Additionally, the projected upsurge in Indonesia's supply of primary cobalt would further shrink DRC's market share.⁵⁶



INDONESIA

Uneven value addition across sectors

The stainless steel industry saw strong growth, with exports reaching US \$11.9 billion in 2022, alongside increased production and financial support within the country. However, the Electric Vehicle (EV) battery sector struggled, with its exports dropping by nearly one-third between 2014 and 2022. The EV battery industry only became a top national priority in 2019, which meant that it did not receive appropriate time to fully build a comprehensive manufacturing system.⁵⁷ Furthermore, the country initially lacked the crucial midstream processing capacity needed to make batteries.



CHILE

Unable to move up the value chain of lithium

Chile remains focused on the basic extraction and export of lithium (with only first-stage chemical processing). It has failed to achieve the goal of value-added industrialization, such as battery cell and battery pack production. This exposes Chile to disruption, as it remains a supplier of a raw commodity rather than a producer of advanced goods. This failure is already evident as the Chinese firm BYD has 'paused' its investment plans for battery production in the country.⁵⁸

Discouraging private-sector investments

The government seeks to maximize state revenue and retain direct control simultaneously. However, this may be counterproductive, as revenue maximization could be better achieved by attracting private investment, increasing production, and implementing an optimal mix of taxes and royalties. This approach could make Chile less attractive than competitors like Argentina, which is choosing a full private-sector model with large public incentive.⁵⁹

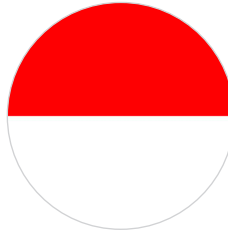
WEAKNESSES



DEMOCRATIC REPUBLIC OF CONGO

Developing local processing through a coherent industrial policy

Since DRC has a sufficient mineral reserve of cobalt, it has been able to implement policies such as export bans and local content requirements to generate revenue and encourage domestic value-addition. However, the country's dependence on cobalt also means that they should formulate long-term policies which account for technological advancements that may disrupt a mineral's demand.⁶⁰ Additionally, there needs to be a delicate balance between maximizing the economic benefits of cobalt locally without causing global prices to spike too high that it becomes less attractive for various actors vis-à-vis investments in the value chain.



INDONESIA

Climbing the EV battery value chains through international collaborations

The growth in Indonesia's EV battery sector is being driven by major investment announcements. A key step was the establishment of High-Pressure Acid Leaching (HPAL) plants in 2021, an essential technology that produces materials which are prerequisites for manufacturing the cathodes of EV batteries. Six HPAL projects attracted at least US \$13 billion in foreign funding by 2023 with major car companies such as Mitsubishi and Toyota committing US \$667 million and US \$1.80 billion respectively from 2022.⁶¹ However, much high-end cell production and chemistry expertise still sits with Chinese, Korean and Japanese firms who continue to invest in Indonesia's EV battery sector.⁶² In this context, supply-chain diversification of the sector becomes important to widen the market access and the country has started to do so with exports of battery materials to US-based company Tesla; however the uncertain geopolitics remains a main hurdle.⁶³



CHILE

Boosting lithium through effective governance of existing 'resource nationalist' policies

In 2023, the Chilean government announced a set of policies that aimed to establish a state-owned enterprise for managing the country's lithium as well as attracting foreign investments to break the duopoly of two multinational companies, who control the two active lithium mines in the Atacama salt flat.

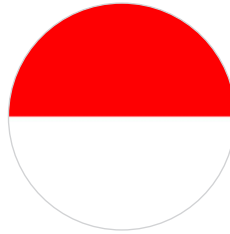
The government did so by mandating value addition via industrialization and focusing on the environment by designating one-third of Chile's salt flat as 'no-go' zones for extraction.⁶⁴ However, the government is already facing hurdles in the implementation. For instance, it had to rely on the existing state copper company, Codelco, to enter a temporary joint venture with SQM, which has a history of regulatory violations and has faced public criticism.⁶⁵



DEMOCRATIC REPUBLIC OF CONGO

Internal political challenges

The failure of DRC to contribute substantially in supplying refined cobalt is due to ongoing issues of political instability, weak governance, and poor infrastructure. Furthermore, instances of human rights abuses and use of practices like child labour in its mines makes it difficult for the country to attract significant investment in more lucrative downstream activities such as refining and other domestic value addition.⁶⁶



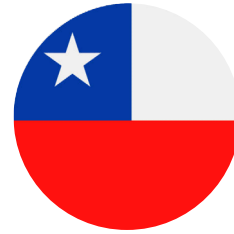
INDONESIA

Social and environmental costs of mining

A deadly explosion occurred on January 6, 2024, at a nickel furnace in the Indonesia Morowali Industrial Park (IMIP) on Sulawesi, killing 21 workers (including eight Chinese migrants) and critically injuring 33 others. The incident highlighted a pattern of serious occupational health and safety failures at the industrial park.⁶⁷ This operational failure creates a severe reputational risk for the nickel sector, threatening to jeopardize foreign investments due to ethical sourcing concerns. It could also limit the country's access to global markets, especially the West who place environmental, social and governance (ESG) standards as a crucial factor when determining the supply of nickel.

High dependence on raw material exports

Despite successfully moving up the value chain for Nickel, Indonesia's heavy reliance on raw material exports in other commodities, such as palm oil and coal, makes its economy highly sensitive to global commodity price fluctuations. When prices fall, export earnings shrink, causing a widening current account deficit, pressure on the rupiah, and reduced fiscal revenues. This dependence undermines Indonesia's economic stability, limits its ability to build diversified value-added industries, and exposes vulnerability to global market volatility and external shocks.⁶⁸



CHILE

Environmental woes in the Atacama

Chile's lithium boom presents a major conflict. While the mineral is vital for the clean energy transition via its use in EV batteries, its extraction, especially in the Atacama Desert, has caused serious local harm. The water-intensive, evaporation-based mining method severely depletes groundwater, threatening fragile desert ecosystems and the ancestral lands of indigenous communities, who are often excluded from decision-making processes, leading to legal challenges and environmental justice concerns.⁶⁹

Reduced demand of lithium due to alternative battery technologies

Sodium-ion batteries can potentially complement stationary energy storage and some lower-end electric vehicles. The batteries use globally abundant and low-cost sodium instead of lithium. If sodium-ion batteries become widespread, they could reduce the demand growth for lithium, particularly in grid storage applications where their lower energy density is less of an issue, potentially affecting lithium prices and Chile's revenue.⁷⁰

THREATS

Table 1: Stocktake of the policy landscape of DRC, Indonesia and Chile which pertains to crucial aspects of the value chain and governance

Policy category	Policy tools	DRC	Indonesia	Chile
Ensuring supply reliability and resiliency	Strategic plans: supply reliability			
	Strategic mineral lists			
	International coordination mechanisms			
	Stockpiling mechanisms			
	Public investment			
	Trade mechanisms			
Promoting exploration, production and innovation	Financing			
	Tax incentives			
	Enhanced geological surveys			
	Recycling support for processing			
	Innovation funds			
Encouraging sustainable and responsible practices	Environmental standards			
	Social standards			
	Transparency norms			
	Due diligence obligations			
	Permitting regimes			
Minerals recycling	Strategic plans: minerals recycling			
	Extended producer responsibility			
	Financial incentives			
	Cross-border trade			

Source: IEA: Critical Minerals Policy Tracker

Note: ■ No policy ■ Between one and three policies ■ More than three policies

In this mapping of policy measures across the three countries, Indonesia shows the most comprehensive policy framework, particularly in permitting or licencing regimes for mining, environmental standards, and trade mechanisms, reflecting an active industrial policy and regulatory control. Chile's focus lies in strategic planning and innovation with initiatives across supply reliability, geological surveys, and sustainable and responsible practices. The DRC, by contrast, exhibits limited policy framework, which indicates a less developed policy and institutional landscape. As backed by the SWOT analysis, the mapping further demonstrates Indonesia's strong state interventions, while Chile emphasizes innovation and sustainability, while the DRC is yet to create a coherent set of policies relevant to the value chain and governance of critical minerals.

4

KEY FINDINGS AND THE WAY FORWARD FOR THE GLOBAL SOUTH

Sufficiency needs to be among the guiding principles of critical-minerals-led green economies of the future. Pushing for reduction of overall demand from the North, to reduce the disproportionate socioecological impacts on the South, must be considered.

Recycling must be a pillar of the critical minerals strategy for countries across the globe. While recycling alone cannot replace mining or its revenues, it provides a secondary supply that lessens dependence on new extraction, and also strengthens importers' supply chain security.

Catalysing regional cooperation to aid developing countries in climbing up value chains is crucial. By leveraging the capacities of different stages of the value chain possessed by different countries, net benefits through the South, for the South, can be achieved.

This paper shows that the present critical mineral trade reveals an imbalance: countries of the Global South sit atop vast reserves yet capture little of the value they generate. Their exports, largely raw ores, yield volatile revenues tied to commodity price cycles, while refining and processing, where real value is created, remain concentrated elsewhere. For these economies, the challenge is not access to minerals but access to the means of transforming them: technology, capital, and institutional cohesion that convert natural resource endowments into stable current-account gains and broader economic resilience.

As the energy transition accelerates, critical minerals offer a development opportunity, but one rife with socioeconomic negative impacts if it repeats the extractive premise of fossil fuel based growth. Building a more just mineral economy will require embedding guardrails in policy, at the national and multilateral level. These include: centring human rights and environmental safeguards, diversifying processing beyond single-country dominance, and linking refining to domestic industrial growth. For the Global South, capturing value will depend on policies that move beyond extraction toward beneficiation and equitable partnerships, ensuring that the minerals from countries powering the world's decarbonization also power their own economic transformation.

4.1 Sufficiency: A paradigm for centring equity in critical minerals expansion

A common argument is that using resources more efficiently will help separate economic growth from environmental harm, i.e. decoupling. But in reality, often, when resource use is improved either through efficiency, such as using less energy or less of a particular material, it often makes those resources cheaper and/or easier to use. As a result, people or industries tend to use more of the resource overall. This was alluded to back in the eighteenth-century book *The Coal Question* by Stanley Jevons, and has been referred to as Jevon's paradox.

More recently, it has been noted that such 'rebound effects' imply that the real environmental savings are usually smaller than what was hoped for. Critical minerals, or 'green industries' in general are no exception to this.⁷¹ An example is the case of electric vehicles, where batteries that require lesser minerals can lead to more car production overall. Without limits on total material use, focusing on efficiency or merely greening alone can shift mining pressure to new regions, often in the Global South. That's why sufficiency must go hand in hand with efficiency. Perhaps, setting clear caps on resource use, designing policies that cut unnecessary production and focusing on wellbeing rather than sheer growth, as has been argued in this policy brief, for the European Environmental Bureau, need to be considered.⁷²

In essence, sufficiency is a concept based on the due recognition of ecological constraints.⁷³

Sufficiency in the critical-minerals discourse means reducing total demand for primary extraction by meeting needs with lesser material input. This could span smaller, longer-lived, repairable products, to higher utilization, reuse and recycling, as well as shifting consumption patterns, especially in high-income economies. The Intergovernmental Panel on Climate Change (IPCC) frames sufficiency as policies and practices that avoid demand for energy and materials while safeguarding wellbeing, complementing efficiency and clean supply. Considerations for deploying demand-side measures and thinking to reduce GHG emissions is not new.⁷⁴

Even in the context of transition-critical minerals, this can be applied. The IEA has reported that material-efficiency measures in vehicles, buildings and industry can substantially cut needs for steel, cement and aluminium, including through reuse in future scenarios.⁷⁵ For critical minerals too, literature suggests similar possibilities. A report by the climate and economy think tank Climate and Community Project finds that the US can reduce the demand for lithium by up to 92 per cent by 2050 in comparison to the most lithium-intensive scenarios considered in the paper. This can be done through policies that prioritize public transit, smaller EV batteries, and better recycling, showing that reducing total individual car dependence is just as crucial (and effective) as deploying clean technology.⁷⁶ Similarly, a report by the US-based nonprofit Union of Concerned Scientists also found that with the right ‘reduction strategies’ in place, the demand for newly mined lithium could reduce by nearly half—48 per cent—between 2025 and 2050.⁷⁷

For the Global South, increasing sufficiency in the North could lower pressure to expand mining and its local socioenvironmental harms, preserving climate and ecological space for development.

4.2 Recycling: A necessary pillar for economic resilience through critical mineral value chains

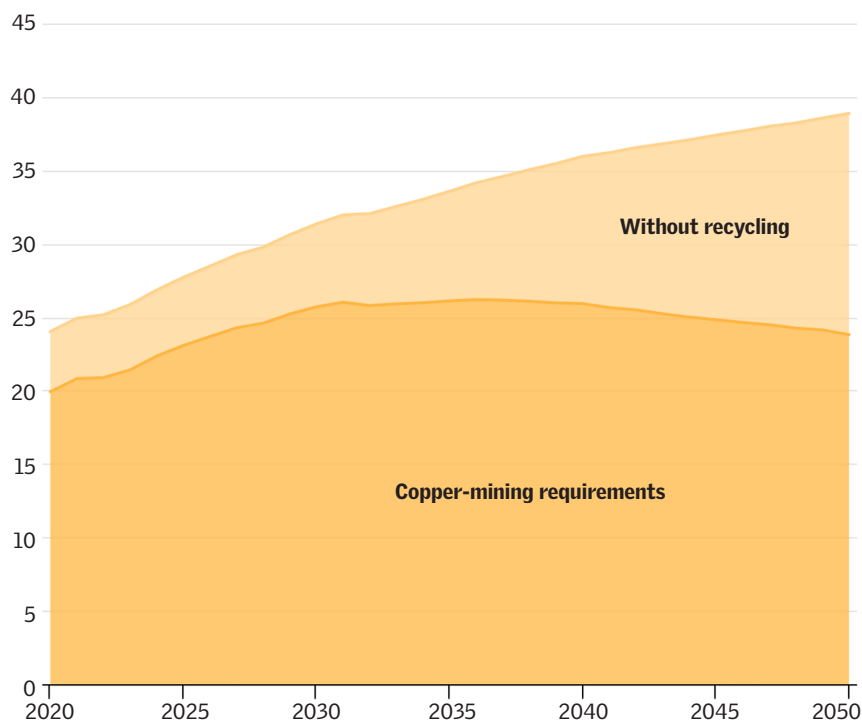
Materials circularity is gaining prominence across sectors in the world today.⁷⁸ The need for broader circular economies approaches, particularly for low-carbon transitions is also increasing.⁷⁹ This paper suggests that developing countries can use the momentum of the critical minerals race to their advantage. Given that projected demand for critical minerals is only increasing, one pillar of doing so, to minimize further environmental degradation for achieving the twin objectives of economic resilience and decarbonization, is foregrounding recycling as a means of procuring critical minerals.

While recycling can't replace mining or its revenues, it provides a secondary supply that lessens dependence on new extraction and strengthens importers' supply security. One study suggests 42 developing countries and 31 developed countries can recover more than their current imports of select critical minerals if they have access to the latest technologies for recovering and recycling critical minerals from waste and scrap.⁸⁰

The International Energy Agency has also noted that increasing recycling of critical minerals provides countries with significant financial benefits as well, in addition to sustainability benefits, and the creation of reliable supply chains for critical minerals.⁸¹

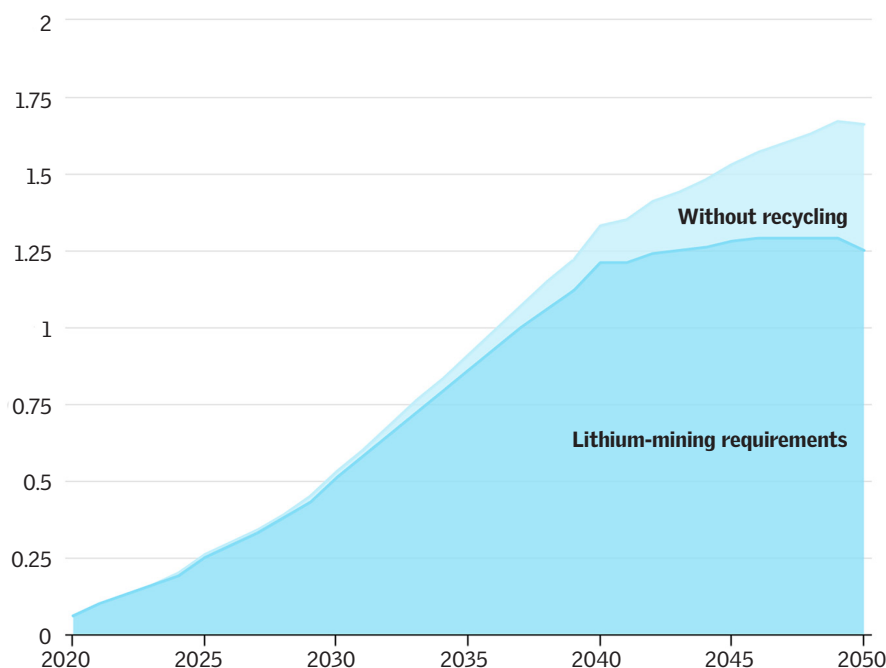
IEA analysis also shows the potential extent of reduction of mining requirements for different critical minerals, if sufficient recycling aligned policies are introduced. For instance, the graphs below indicate the demand for mining of copper and lithium, would be significantly higher without recycling measures in place.

Graph 16: Copper: Mining requirements in the Announced Pledges Scenario, 2020–50 (in Mt)



Source: IEA

Graph 17: Lithium: Mining requirements in the Announced Pledges Scenario, 2020–50 (in Mt)



Source: IEA

A cornerstone of circular economy approaches is Extended Producer Responsibility, a policy approach that makes producers responsible for their products throughout their lifelines. One example of a developing country adopting this approach is India. Under its National Critical Minerals Mission, the country launched a scheme centring EPR and recycling to ensure a supply chain of critical minerals in the country. Under the scheme, it has allocated Rs 1,500 crore to develop industry capacity for recycling of e-waste, spent batteries and other scrap materials.⁸²

Developing countries should make recycling a core part of their critical mineral strategy. Embedding it in industrial and climate planning through tools like Extended Producer Responsibility can strengthen supply security, reduce ecological costs, and help capture more value from the global energy transition.

4.3 Catalysing regional cooperation to climb up global value chains

Regional cooperation is a crucial pathway for developing countries to move up critical-minerals value chains. As we have observed throughout the paper, individual countries rarely have the combination of reserves, finance and the technology needed to establish processing and refining domestically.

In this context, existing frameworks such as the African Continental Free Trade Area (AfCFTA) become crucial to build continental commodity markets that can facilitate international investment, especially in the midstream and downstream processes of the mineral value chains. However, African markets are often fragmented and lack the necessary scale to justify investment in processing units and local value chains.⁸³ The AfCFTA aims to achieve the scale needed to attract the investments by integrating mineral supplies and constituting a unified market. Furthermore, this could be accomplished by harmonizing licensing requirements and standards and eliminating other non-tariff barriers.⁸⁴

Latin America is another region that can harness regional integration by leveraging its natural endowments to create a substantial market size that enables the flow of finance and fosters technology transfer. The challenge for the region would be the potential technological disruptions that risks substitution of minerals such as copper and lithium in clean energy technology which is supposed to play a significant role in their demand.⁸⁵

4.4 Diversification as a pathway to economic resilience

Economic diversification in the context of critical minerals offers developing countries a strategic pathway to strengthen their productive base beyond the extraction of raw resources. According to the data on export revenue and share of reserves, mining and processing production in section 1, many mineral-rich developing countries face the danger of merely exporting unprocessed ores and thus they remain locked into low-value segments of global value chains; diversification entails moving into processing, refining, or even downstream manufacturing of mineral-derived products, which in turn builds greater economic complexity and resilience.^{86, 87}

By broadening industrial linkages, for instance by linking mining to machinery, logistics, and services, countries can reduce their vulnerability to commodity price shocks and volatile export revenues, while creating jobs, enhancing skills, and generating higher returns from their endowment.⁸⁸

However, effective diversification in the critical minerals space requires more than just geological endowments. Coherent industrial policy, investment in infrastructure (transport, power, processing plants), human-capital development, and stronger governance frameworks are essential so that the benefits from value-addition accrue locally rather than being captured externally.⁸⁹

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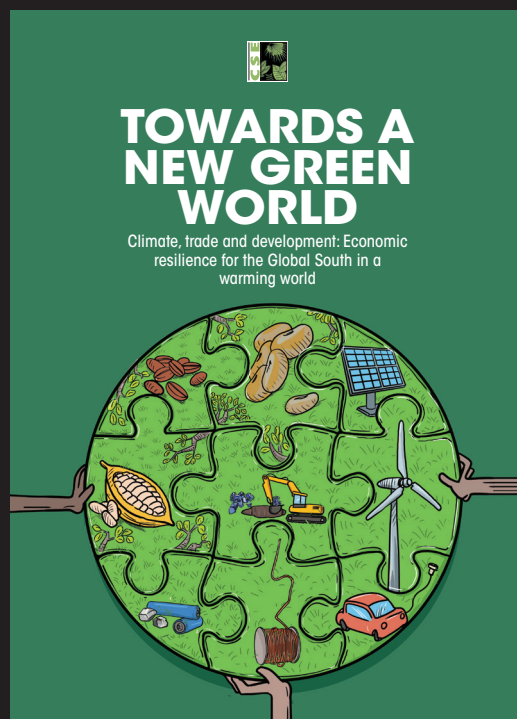
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The interlinkages between trade, climate change and development are apparent today. This paper delves into the question at the heart of this discourse: how can developing countries climb up the global critical minerals value chain?

By focusing on the critical minerals necessary for catalysing the clean energy transition, this paper examines the present landscape of critical mineral use and trade. It also explores strategic partnerships, and highlights emerging South-South efforts in this vein. Finally, the paper presents a snapshot of the strategic plans of select developing countries, and a list of principles and recommendations for paving the way forward for Global South in the climate-trade-development nexus.

This is the second paper in a series of three by CSE addressing the questions of climate, trade and development, and pathways for economic resilience for the Global South in the new green economy.



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