INDIA'S NEED TO SECURE CRITICAL MINERALS FOR ENERGY TRANSITION

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India's Need to Secure Critical Minerals for Energy Transition

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Executive Summary

Critical minerals broadly refer to non-fuel minerals that fulfil the criteria of holding both, economic importance and a high risk of supply disruption. These minerals, which, inter alia, typically include copper, lithium, nickel, cobalt, and graphite, are essential components in key industries like telecommunications, defence and aerospace, as well as in mineral-intensive clean energy technologies like wind turbines, solar panels, batteries for electric vehicles (EV), to name a few.

The rising focus on global decarbonisation efforts to achieve 'Net Zero' commitments along with other climate goals, have resulted in the demand for critical minerals gaining momentum.

Amidst this, the vulnerable nature of the critical mineral supply chain remains an area of concern for developing countries like India, as it strives to achieve its ambitious goal of decarbonising energy to 50% and achieving 500 GW of fossil fuel-free generating capacity by 2030.

The aforesaid challenges in the supply chain get further exacerbated by the high level of concentration of mineral mining and refining in select countries; and geopolitical risks, political upheaval, presence of mineral cartels, restrictive trade policies, to name a few.

While there exists a wide range of critical minerals which are vital to different industry applications, this Study focuses on select key critical minerals, namely, copper, lithium, nickel, cobalt and graphite, all of which are considered crucial to evolving clean energy technologies.

Global Scenario

With regard to critical minerals used for clean energy technologies in particular, the total global demand in 2023 amounted to 10,111.5 kilotons (kt). Copper saw the highest demand at 6371.7 kt, with electricity networks and solar PV being the highest consuming segments.

Lithium too plays a vital role in delivering a clean energy future. In terms of share of clean-energy technologies in the total demand for minerals, lithium was the leader, with a substantial 56% of total global lithium demand originating from the adoption of these technologies. Cobalt stands second with a share of 30%, followed by graphite (28%), copper (25%) and nickel (15%).

Notably, the EV industry alone contributes to over 90% of present and future lithium demand.

On the supply side, the high geographic concentration in select countries, both in terms of critical mineral mining as well as refining, reveals the vulnerable nature of the global critical minerals supply chain.

The high supply risk of such select minerals is particularly seen in the case of cobalt, for instance. In 2023, the Democratic Republic of Congo (DRC) was the largest producer of cobalt with a mining share of 65.5% and China, with an overwhelming share of 76.7%, was the largest cobalt refining country.

A similar trend is also observed in the case of global graphite supply wherein China dominates in both, mining of natural graphite as well as production of battery grade graphite. Overall, China is both, the world's largest mineral-refining hub as well as the largest importer of critical minerals. China in fact plays an outsized role, particularly in the midstream and downstream portions of the critical mineral supply chain.

Indian Scenario

In 2023, the Ministry of Mines through an inter-ministerial committee, identified 30 critical minerals for India based on select parameters, under the broad determinants of ‘economic importance (EI)’ and ‘supply risk (SR)’.

As per this report, all the key critical minerals being analysed in this Study namely, cobalt, lithium, nickel and graphite, with the exception of copper, have been identified to be of both, high EI as well as high SR.

The Government of India is broadly taking two policy paths – one of increasing domestic exploration and mining, and the other of acquiring overseas mineral assets to meet domestic demand. The Union Budget 2025-26 identified the mining sector as one of the 6 domain areas for transformative reforms in the next 5 years, and announced reforms like Basic Customs Duty (BCD) elimination on scrap and waste of 12 critical minerals, among other policy plans. In January 2025, the Union Cabinet also approved the launch of the National Critical Mineral Mission (NCMM) with an expenditure of ₹ 16,300 crore and an expected investment of ₹ 18,000 crore by Public Sector Undertakings (PSUs), and other entities.

Out of the 30 identified critical minerals by the Ministry of Mines, India is 100% import dependent in 10 of them. With regards to this Study, India is 100% import dependent for 3 of the 5 minerals analysed, namely, cobalt, lithium and nickel. India relies on imports to meet around 60% of its graphite demand. For copper, India has, in recent years, turned into a net importer since the closure of Vedanta’s Sterlite Copper smelter in Thoothukudi, Tamil Nadu in 2018, that drastically reduced India’s copper production capacity.

In terms of quantity, India’s major import sources for these critical minerals in 2023-24 are stated below.

Table: Overseas Supply of India's Critical Minerals in 2023-24

Critical Mineral	HS Code	Product	Quantity (tonnes)	Share of Major Import Sources
Lithium	28252000	Lithium oxide and hydroxide	1148	Belgium (33%), Russia (26%)
	28369100	Lithium carbonates	1146	Ireland (35%), Netherlands (17%)
Nickel	282540	Nickel oxides and hydroxides	91564.5	Australia (98.9%), China (0.4%)
	282735	Chlorides of nickel	258	Japan (67%), Belgium (18%)
	283324	Sulphates of nickel	1517	Belgium (53%), Japan (26%)
	7502	Unwrought nickel	33733	Norway (17%), China (15%)
	7503	Nickel waste and scrap	4346	Saudi Arabia (24%), USA (16%)
Cobalt	2605	Cobalt ores and concentrates	1.1	UK (91%), China (9%)
	28220010	Cobalt oxides	333	Belgium (93.9%), China (3.1%)
	28220020	Cobalt hydroxides	215	Belgium (62%), China (21%)
	28220030	Commercial cobalt oxides	27.4	China (91%), Germany (5%)
	81052020	Unwrought cobalt	316.9	Belgium (42%), China (30%)
Graphite	2504	Natural Graphite	54784	Madagascar (45%), China (39%)
	3801	Artificial Graphite	101886	China (66%), Germany (5%)
Copper	2603	Copper ores and concentrates	1016.3 (P)	-
	740311	Refined copper cathode	363.0	-

Note: (P) – Provisional

Source: Mining of Critical Minerals, Ministry of Mines, Lok Sabha Unstarred Question No. 3818 Answered on 18.12.2024; Annual Report 2024-25, Ministry of Mines; Copper Quality Control Order: A step towards Atma Nirbharta, PIB (December 2024)

Recommendations & Way Forward

Develop Mineral Recovery and Recycling Market

India, a mineral import dependent country, could focus on developing its mineral recovery and recycling market with the objective of creating a secondary source of mineral supply. This will also help mitigate the otherwise adverse environmental and social impacts of sustained mineral mining.

Different intervention mechanisms may be resorted to, including boosting investment in mineral recycling infrastructure comprising efficient collection and segregation of mining waste; funding R&D for new recycling technologies; and exploring direct subsidies to mineral recycling companies. Given the surge in e-waste generation in India, a policy focusing on 'urban mining' may also be explored to recover various critical minerals from e-waste like mobile phones and other electronic devices, plastics, construction waste, among others.

Introduction of a well-targeted Production Linked Incentive (PLI) scheme by the Government could catalyse mineral recycling in India through say, mineral recovery from urban mining, thereby promoting a circular economy.

Build on Mineral Processing Technology

The mineral processing stage of critical minerals supply chain requires advanced technological solutions to extract, separate, and purify usable minerals. The high degree of geographical concentration for mineral processing in select countries has created a major bottleneck in the supply chain, resulting in high mineral import dependency for countries like India. Therefore, increasing mineral processing capacity is vital for India, that lacks large-scale mineral processing and downstream value-addition technologies.

Given the capital-intensive nature of mineral processing technologies, there is urgent need to scale up investment in required mineral processing facilities, along with increased R&D, to create innovative technologies. To bolster mineral processing capabilities of India, international partnerships are imperative. Acquiring processing knowledge through technology transfers by dominant players, or the joint development of these facilities in proximity to India's overseas mineral assets are also key. Setting up of 'Critical Mineral Processing Parks' in mineral rich states, preferably in close proximity to mining projects, will also assist in scaling up India's mineral processing capacity and reduce import reliance.

Accelerate International Partnerships

Growing decarbonisation effort around the world has led to a surge in demand for critical minerals, particularly, those used in manufacturing of clean energy technologies. To strengthen its critical mineral supply to meet the surging demand, India will need to develop strategies to partner with resource-rich countries across the different broad stages of the critical minerals supply chain, like mineral exploration, extraction, refining etc., using various channels.

India could introduce a national stockpiling system to safeguard its critical mineral supplies through a joint collaboration, either bilaterally or with friendly regional blocs. Other potential areas of partnership include those through offtake agreements with resource-rich countries as well as other agreements pertaining to areas of mineral exploration and mining. Infrastructure projects like the Lobito Corridor rail link, for instance, which connects ports in Angola to mines in the DR Congo and Zambia, can be instrumental in forming international partnerships in the sphere of critical minerals, by easing potential logistical issues in the supply chain.

Empowered Committee for Overseas Critical Minerals Supply

India could increasingly invest in critical mineral assets abroad either through a joint venture, acquisition, or on a lease basis. In this regard, a broad-based Empowered Committee to take prudent and quick decisions, especially when it comes to overseas transactions is crucial.

Presently, in India, there are around 7 PSUs and other related offices which report to the Ministry of Mines. However, other related entities like say, IREL (India) Limited, functions under the administrative control of the Department of Atomic Energy. Therefore, to deliberate on strategic issues like critical minerals while ensuring a consensus is drawn amongst the multiple related ministries, it is essential for India to have an Empowered Committee. Such a committee could have representation from the different Ministries and related PSUs, thus helping to make well co-ordinated and informed decisions regarding overseas investments in critical minerals.

Use of Emerging Technology for Critical Minerals

India should also focus on promoting technological innovation and integrating emerging technologies like Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML) into its mining sector. This would serve to enhance efficiency and productivity across all stages of the critical mineral supply chain.

Integration of such advanced technologies have the benefits of real time analysis of geological data, enhanced compliance with Environmental, Social, and Governance (ESG) standards, predictive maintenance of mining equipment, transparent traceability of mineral supplies, and increased worker safety due to automation, to name a few. These technologies can be used in the proposed Critical Mineral Processing Parks to further optimise and centralize the critical minerals supply chain in India. Increasing R&D in sector-specific emerging technologies like 'phytomining' would also be beneficial for India's critical minerals sector.

Improve ESG Framework for India's Mining Sector

With growing emphasis on sustainability, India may prioritise improving Environmental, Social, and Governance (ESG) principles within the mining sector to ensure long term economic and social benefits, while also minimising environmental damage.

Globally, investors are pushing for greater adoption of green energy solutions and alignment with global standards on the part of mining companies, to ensure steady investment flows. In this context, to attract greater foreign investment into the critical minerals sector, India may introduce directives to enforce stricter adherence to ESG principles. Other measures may include setting up of a dedicated working group that focuses on drawing up mining sector specific principles; incentivising and rewarding companies that comprehensively implement the ESG principles; as well as focus on harmonisation of these norms within India's trading blocs or regional cooperation blocs, to ease mineral trade and data sharing.

Focus on Funding Mechanisms

As the need for critical minerals is projected to significantly rise going forward, India continues to explore various funding mechanisms to diversify and expand its mineral supply chain. India could look at exploring and supporting public-private partnerships (PPP) towards funding mining projects in India and overseas through say, a Special Purpose Vehicle (SPV) that would isolate financial risks, without affecting the parent company's balance sheet or operations.

Other alternate funding mechanisms may include offtake agreements with private companies that offer advanced technology for production and mineral recycling; an innovation fund for mineral processing, in particular, given the R&D intensive nature of this stage of supply chain; and use of green bonds to catalyse the mineral recovery and recycling market.

The anticipated surge in demand of critical minerals for India's potential growth sectors like defence, electronics, telecommunications, renewable electricity generation, technology, to name a few, is well established in this Exim Bank Study. The situation gets aggravated given India's high import dependence for these minerals thus highlighting the need to diversify its foreign supply chains while simultaneously developing its domestic capabilities.

This Study has focused on five key critical minerals required for the production of clean energy technologies and their global demand and supply landscape while also analysing India's capability to source them. Further, the Study has also delineated focussed interventions for policy makers which would be important for India to build resilient critical mineral supply chains as required for its energy transition efforts.

1. Critical Minerals – An Overview

'Critical' Nature of Minerals

Critical minerals, despite the lack of a universally accepted definition, broadly, refer to the non-fuel minerals that fulfil the criteria of holding both, economic importance and a high risk of supply disruption.

Figure 1.1: 'Critical' Nature of Minerals

Here, economic importance may refer to the use of these minerals across specific key industries in an economy, like telecommunications, defence, electronics, as well their wide applicability in energy transition initiatives.

Critical minerals are increasingly gaining more importance given the rising global efforts towards decarbonisation, resulting in the adoption of several 'Net Zero' commitments across countries. This becomes even more critical for developing and less developed countries. Such a shift is driving up global demand for critical minerals given the mineral-intensive nature of clean energy technologies like including wind turbines, solar panels, batteries for electric vehicles (EV), to name a few.

Figure 1.2: Key Differences between Fossil Fuels and Critical Minerals

Fossil Fuels

- Large mining quantity
- Huge rent generation
- Combusted as fuel
- Supply disruption leads to risk in energy security
- Not recyclable

Critical Minerals

- Low mining quantities
- Small profit generation
- Used as input to manufacturing
- Supply disruption leads to risk in energy transition
- Reusable and recyclable

Source: Adapted from International Renewable Energy Agency (IRENA)

Another prominent characteristic of critical minerals is the high risk of supply disruption owing to factors like scarcity of mineral reserves; high level of concentration for mineral mining and refining in select countries; and geopolitical risks like resource nationalism, political upheaval, presence of mineral cartels, restrictive trade policies.

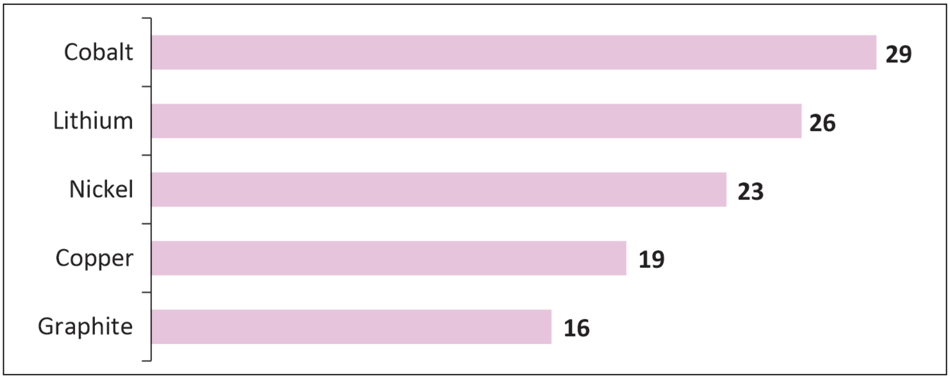
Such interruption of critical minerals impacts the supply chain, resulting in price hikes and other adverse economic impacts, thus highlighting their critical nature.

Considering that the definition and assessment determining the criticality of minerals is generally country-specific, reflecting its own geopolitical and economic conditions, there exists no worldwide consensus over the complete list of critical minerals. As per International Renewable Energy Agency (IRENA), in 2023, taking into consideration 35 lists by country and region that define energy transition materials as critical, cobalt was deemed critical in as many as 29 instances[1]. While there exists a wide range of critical minerals which are vital to different industry applications, this Study focuses on select

[1] Geopolitics of The Energy Transition: Critical Materials, International Renewable Energy Agency (IRENA) (2023)

key critical minerals, namely, copper, lithium, nickel, cobalt and graphite, all considered crucial for production of clean energy technologies[2].

Figure 1.3: Key Energy Transition Minerals Defined Critical by Countries in 2023



Note: Defined critical as per 35 lists covering 51 materials in 2023

Source: International Renewable Energy Agency (IRENA)

The major end-use of these select key critical minerals and their usage classified as per value chains is provided in Tables 1.1 and 1.2, respectively. Thus, as observed, there is high potential for such select critical minerals in energy-transition technologies, with applications in value-chains across EV batteries, hydrogen fuel cells, advanced batteries, solar panel, among others.

Notably, nickel shows potential across all stated value chains. It is used as an input in advanced manufacturing such as high value-added metals and electronic materials, and is particularly used in the defence sector for military hardware plating, to reduce corrosion.

[2] International Energy Agency (IEA) refers to copper, lithium, nickel, cobalt, graphite and rare earth elements as the “key energy transition minerals” or “focus minerals” in the wider context of critical mineral lists published across countries. The Study thus covers all these critical minerals with the exception of rare earth elements given the relatively wider scope of the same.

Table 1.1: Major Applications of Key Critical Minerals

Critical Mineral	Select Applications
Copper	• Electricity grid • EV batteries • Solar PV • Automotive industry
Lithium	• EV batteries • Glassware • Lubricant • Medicinal and botanical products
Nickel	• EV batteries • Stainless steel • Solar Panel • Jet and combustion engine components
Cobalt	• EV batteries • Corrosion resistant alloys • Catalysts for petroleum and chemical industries • Drying agent
Graphite	• EV batteries • Lubricant • Foundry facings • Fuel cells

Note: EV – Electric Vehicle; Solar PV - Solar Photovoltaics

Source: India Exim Bank Research

Table 1.2: Usage of Key Critical Minerals by Value Chain

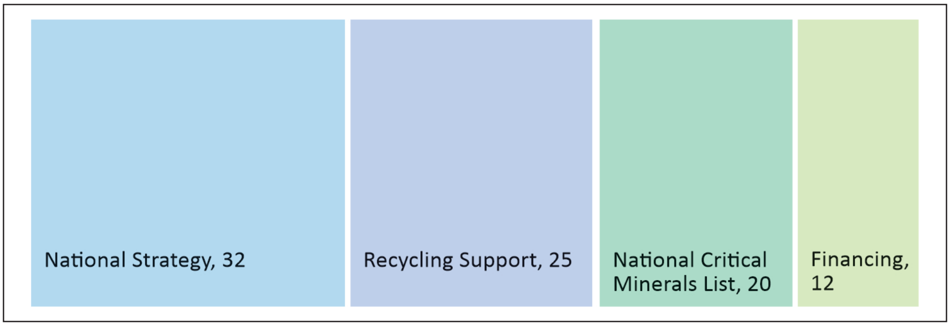
Critical Mineral	Clean Technologies	Advanced Manufacturing	Defence & Security Technologies
Copper	✓	✓	✓
Lithium	✓		✓
Nickel	✓	✓	✓
Cobalt	✓		
Graphite	✓		

Source: Ministry of Mines, Government of India

As of December 2023, upon tracking the various critical minerals related policies introduced at the national level across the world, it was observed that around 32 countries already have in force a strategic roadmap that lays out various relevant action points, in order to maintain an uninterrupted supply of critical minerals in their respective countries (Figure 1.4).

Other types of major policy support provided by governments across the world, include recycling policies that help develop a secondary-material supply market; identification, publication and timely update of country-specific critical minerals lists; and provision of grants, preferential loans and other financial instruments to help build resilient critical minerals supplies in the respective countries.

Figure 1.4: Global Tracker of Critical Minerals Related Policies (in number of countries)[3]



Note: Policies included cover those in force as of January 2025 across approximately 35 countries, only at the national level of jurisdiction. Includes data last updated in December 2023

Source: Critical Minerals Policy Tracker, International Energy Agency (IEA)

[3] National Strategy – National plan or roadmap identifying key priority actions relevant to critical minerals; Recycling Support – Policies at national level targeting the development of a secondary-material supply market of critical minerals supporting recycling of relevant waste and minerals; National Critical Mineral List – List of minerals designated as critical by relevant national authorities following set assessment methods; Financing – Refers to direct funding to support domestic supply of critical minerals through various mechanisms like loan guarantees, grants etc. for, say, mineral extraction projects and other relevant projects.

Scope of the Study

Given the increasing need to secure critical minerals, Government of India too has taken several steps in this regard. In 2023, Ministry of Mines, through an inter-ministerial committee, identified 30 critical minerals for India[4], based on their degree of economic importance and risk of supply disruption.

The Union Budget 2024-25 announced setting up the 'Critical Mineral Mission' with the objective of establishing an effective framework for India's self-reliance in the critical minerals sector. Thereafter, in January 2025, the Union Cabinet approved the launch of the National Critical Mineral Mission (NCMM) with an expenditure of ₹ 16,300 crore and an expected investment of ₹ 18,000 crore by PSUs, and other entities.

These recent government initiatives coupled with India's clean energy targets to be achieved by 2030, including 50% non-fossil fuel electricity capacity and introducing 80 million EVs on India's roads, to name a few, sets the tone for India's quest to secure its critical minerals supply chain.

Given the aforesaid, such initiatives necessitate an analysis of the current critical minerals scenario in India with respect to domestic reserves, demand and supply, import dependency and its performance at the various stages of the critical minerals value chain. Subsequently, the Study also aims to provide suitable recommendations to build a more resilient mineral supply chain so as to mitigate India from the possible economic repercussions of external shocks, owing to high supply risks.

[4] https://mines.gov.in/admin/download/649d4212cceb01688027666.pdf

2. Critical Minerals - The Global Scenario

The global need for critical minerals assume significant importance for a variety of reasons. Decarbonisation efforts across countries and the consequent demand for clean energy technologies remain the primary growth driver.

Climate Targets

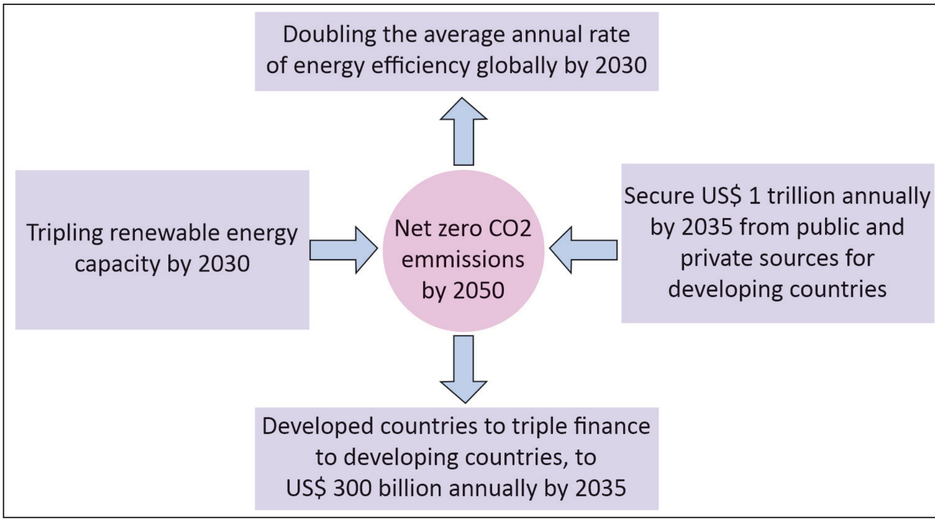
As the global response to climate change witnesses growing urgency, countries around the world are also working towards achieving their adopted net zero goals by mitigating carbon dioxide emissions and transitioning towards clean energy technologies. Such a shift is tightening focus on critical minerals, which are essential for a low-carbon economy.

To tackle concerns of climate change, the Paris Agreement was adopted in 2015 by 196 parties, thereby setting the goal to “hold the increase in the global average temperature to well below 2^{o}C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5^{o}C above pre-industrial levels.” Other recent global climate goals adopted have been highlighted below (Figure 2.1).

Thus, the global demand for critical minerals is expected to continue increasing as efforts to meet the various climate goals intensify, both at the international and domestic levels.

In 2023, lithium saw the highest demand growth at 30% among the select critical minerals, with ‘Electric Vehicles’ (EV) establishing itself as the largest-consuming segment of the mineral. Other critical minerals like nickel, cobalt and graphite saw demand growth in the range of 8%-15% in the same year.

Figure 2.1: Global Climate Action Goals



Source: Compiled as outcomes of United Nations (UN) Conference of the Parties 28 (COP 28) and Conference of the Parties 29 (COP29)

As per the global demand outlook of International Energy Agency (IEA), amongst the select critical minerals, lithium continues to witness the largest expected jump in demand under all demand scenarios, namely, Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS) and Net Zero Emissions by 2050 (NZE) Scenario[5]. This is primarily due to the rapid adoption of EVs across the world that use lithium-ion batteries as source of power.

With respect to their respective global demand in 2023, demand for lithium soars the highest among the key critical minerals, by a factor of ten, by 2040 under both, the APS and NZE scenario (Table 2.1).

Graphite is likely to see the second-largest demand growth, quadrupling by 2040, under the NZE scenario.

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[5] As per IEA, Stated Policies Scenario (STEPS) - Based on the prevailing policy conditions and a 50% probability of a temperature rise of 2.4°C by 2100; Announced Pledges Scenario (APS) – Based on the assumption that governments across the world meet their respective climate goals including longer term net zero emissions targets and pledges in nationally determined contributions (NDCs). This scenario assumes a 50% probability of a temperature rise of 1.7°C by 2100; and Net Zero Emissions by 2050 (NZE) Scenario – Based on the assumption that global climate goals are achieved, including net zero CO2 emissions by 2050, limiting the global temperature rise to 1.5°C above pre-industrial levels by 2100, with at least a 50% probability, and other energy-related UN Sustainable Development Goals (SDGs) are also met.

Table 2.1: Global Demand Outlook of Key Critical Minerals (in kilotons)

Critical Mineral	2023	Stated Policies Scenario (STEPS)			Announced Pledges Scenario (APS)			Net Zero Emissions by 2050 Scenario (NZE)		
		2030	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**
Copper	25915.0	30883.1	33980.9	37637.5	31357.6	36163.2	39484.7	33445.5	38911.6	40712.5
Lithium	165.4	471.3	990.5	1196.2	531.5	1326.1	1607.1	705.4	1430.8	1728.3
Nickel	3104.5	4451.1	5530.6	5428.0	4754.4	6237.9	6146.3	5570.2	6386.1	6029.6
Cobalt	214.8	323.5	384.7	438.5	344.0	453.8	520.7	410.2	472.1	539.2
Graphite	4632.4	9609.3	13099.5	12487.2	10419.0	16023.5	14732.5	13022.6	17872.9	16351.7
Total Demand of Select Critical Minerals	**34032.0**	**45738.2**	**53986.3**	**57187.4**	**47406.6**	**60204.5**	**62491.3**	**53153.8**	**65073.4**	**65361.3**

Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

Transition Technology – A Major Growth Driver

Given that transition technology or more specifically, clean energy transition related measures, particularly the growing adoption of EVs, are largely acknowledged to be amongst the largest growth drivers for several critical minerals, it becomes imperative to analyse the clean energy technology-wise critical mineral demand.

In 2023, the total global critical minerals demand - encompassing 38 such minerals - for the purpose of such clean energy technology applications amounted to 10,111.5 kilotons (kt).

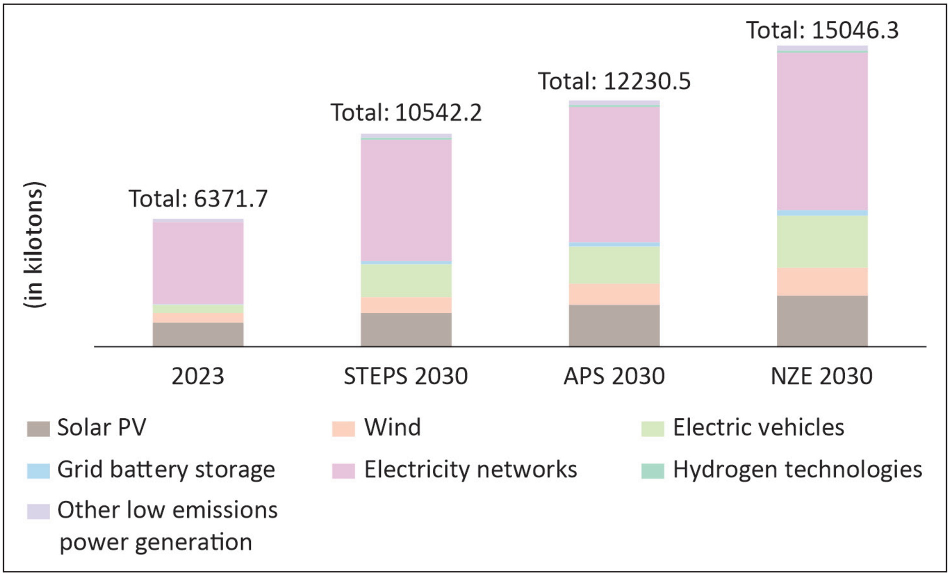
Copper saw the highest demand – comprising both refined and scrap - in 2023, at 6371.7 kilotons, with electricity networks and solar PV being the highest consuming segments. Copper's huge global demand is linked to it being the only critical mineral used in majority of the clean energy technologies, owing to its characteristics of electronic conductivity, longevity, ductility, and corrosion resistance. Other uses of copper include industrial machinery and equipment, and in the manufacturing of transportation-related components.

Besides, copper, amongst the other four minerals in this Study graphite (772.2 kt), followed by nickel (477.7 kt), lithium (92.1 kt), and cobalt (64.4 kt) are the others in demand.

Further on, in 2023, in terms of share of clean technologies in the total demand for minerals, lithium was the leader, with a substantial 56% of total global lithium demand originating from the adoption of these technologies, followed by cobalt (30%) and graphite (28%).

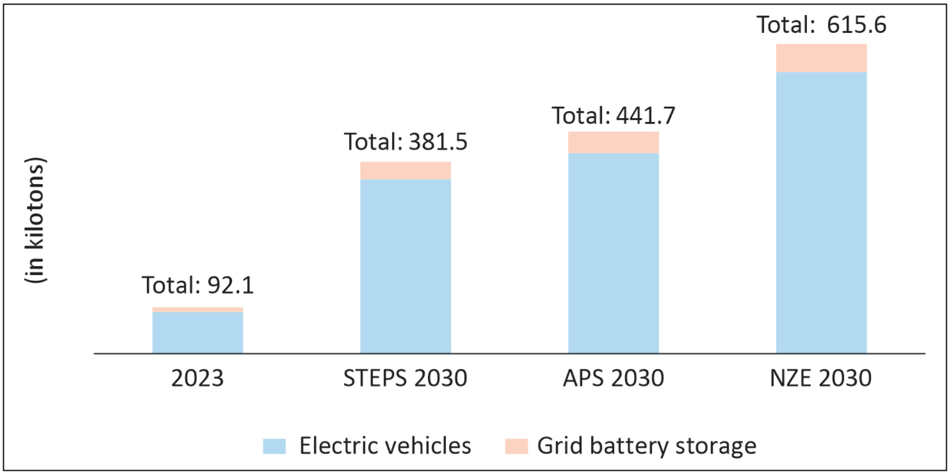
Lithium plays a vital role in delivering a clean energy future. Among the wide array of its industry applications, its usage in lithium-ion (Li-ion) battery in different portable electronic products dominates. This is owing to lithium being among the lightest metals in the periodic table and possessing high energy density, resulting in low maintenance and long life-spans of such batteries. In pursuit of decarbonisation of the global economy, Li-ion batteries hold greatest potential for lithium use in EVs. The EV industry contributes to over 90% of present and future lithium demand. In fact, EVs remains the undisputed growth driver with it using almost six times more minerals than conventional vehicles. The clean-technology wise global demand for key critical minerals is provided below.

Figure 2.2: Clean Technology-wise Global Copper Demand (in kilotons)



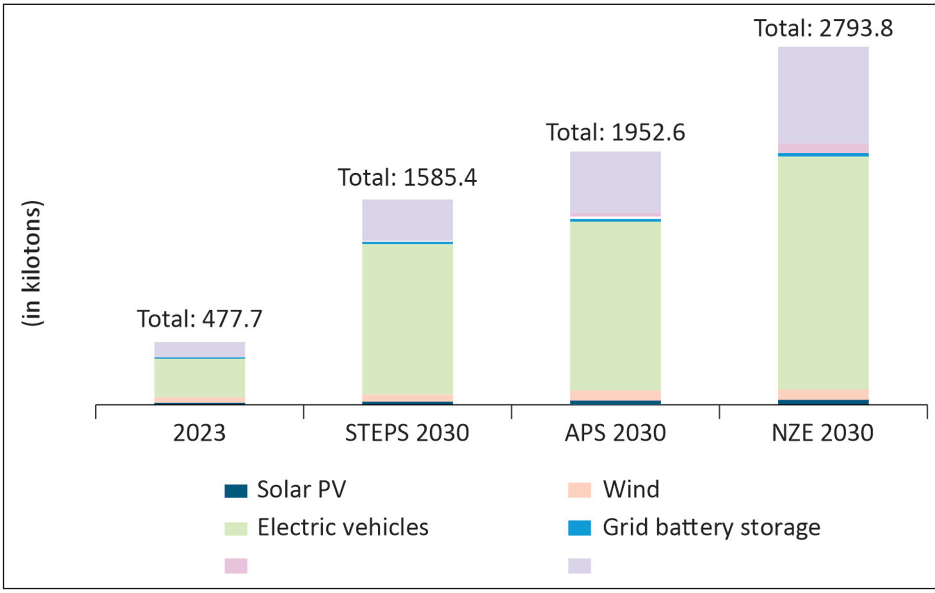
Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

Figure 2.3: Clean Technology-wise Global Lithium Demand (in kilotons)



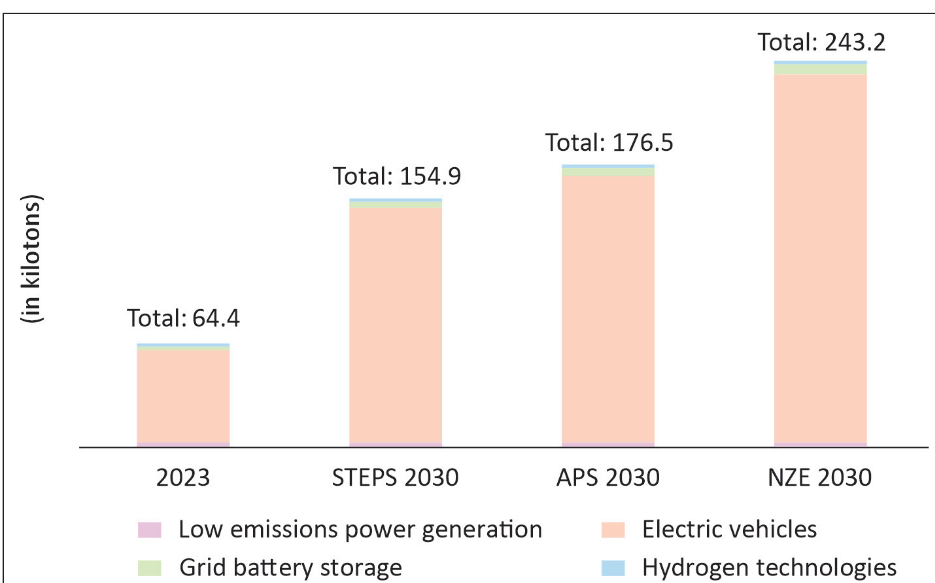
Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

Figure 2.4: Clean Technology-wise Global Nickel Demand (in kilotons)



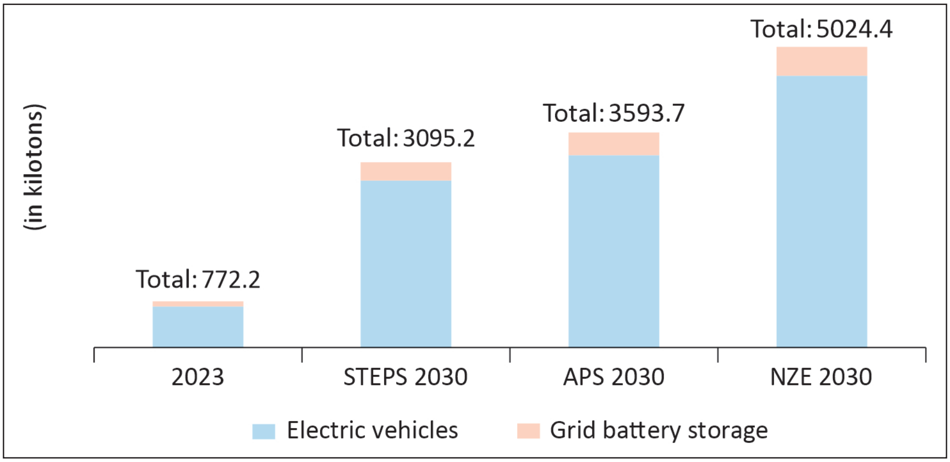
Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

Figure 2.5: Clean Technology-wise Global Cobalt Demand (in kilotons)



Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

Figure 2.6: Clean Technology-wise Global Graphite (Battery-grade) Demand (in kilotons)



Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

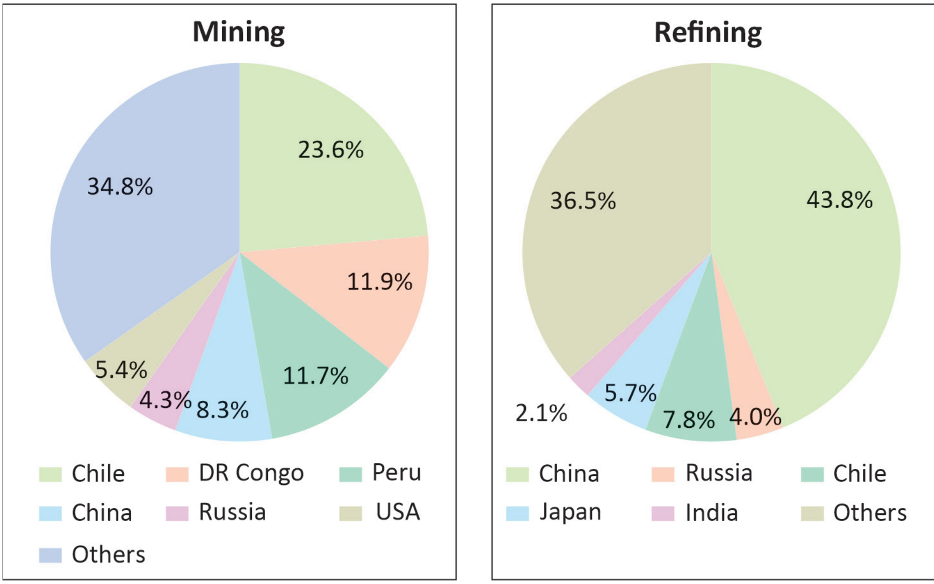
The 'critical' aspect of the discussed minerals is partly derived from their characteristically high vulnerability to supply chain disruptions caused by high geographic concentration in select countries both in terms of critical mineral mining as well as refining. Notably, critical mineral reserves are relatively more evenly dispersed as compared to their production[6].

The global supply of cobalt, in particular, perfectly highlights this supply vulnerability of critical minerals. In 2023, while the Democratic Republic of Congo (DRC) was the largest producer of cobalt with a mining share of 65.5%, China, with an overwhelming share of 76.7%, was the largest cobalt refining country.

Figures 2.7 to 2.11 states the top countries mining and those refining the key critical minerals being analysed in the Study.

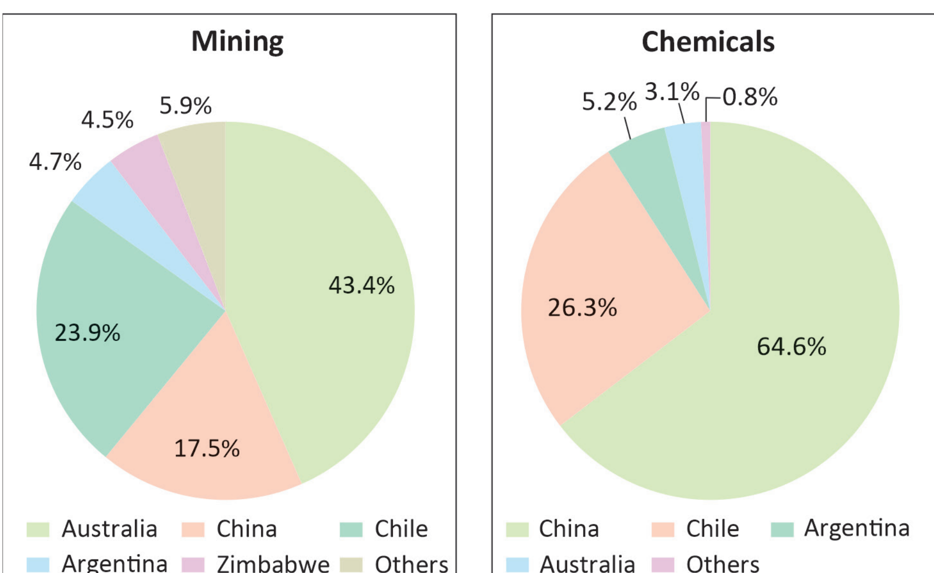
[6] Geopolitics of the Energy Transition: Critical Materials, IRENA (2023)

Figure 2.7: Global Copper Supply in 2023



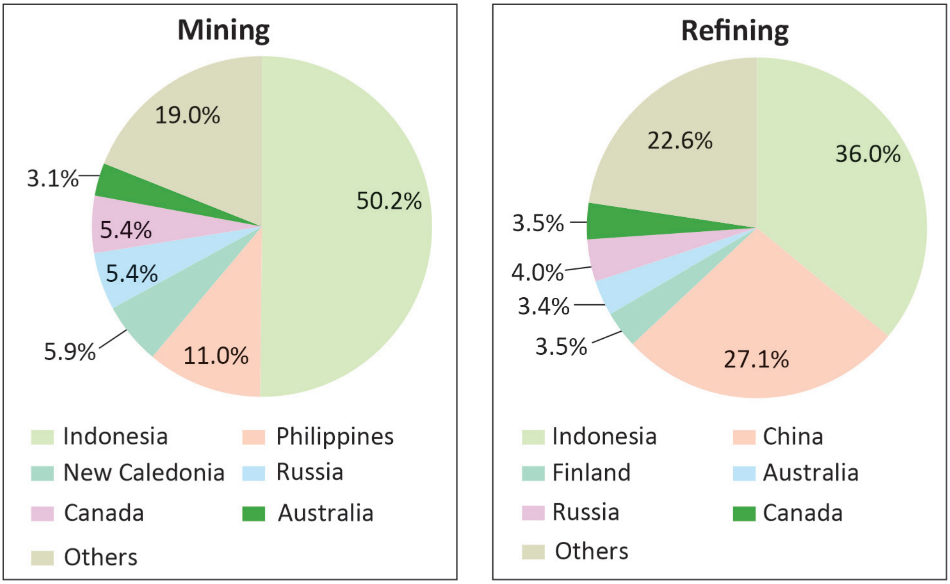
Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA); India Exim Bank Research

Figure 2.8: Global Lithium Supply in 2023



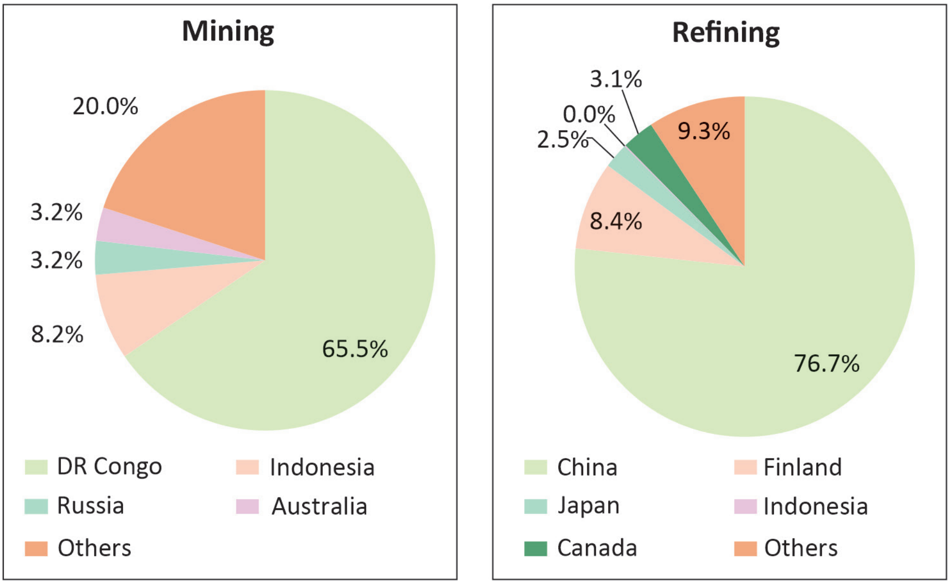
Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA); India Exim Bank Research

Figure 2.9: Global Nickel Supply in 2023



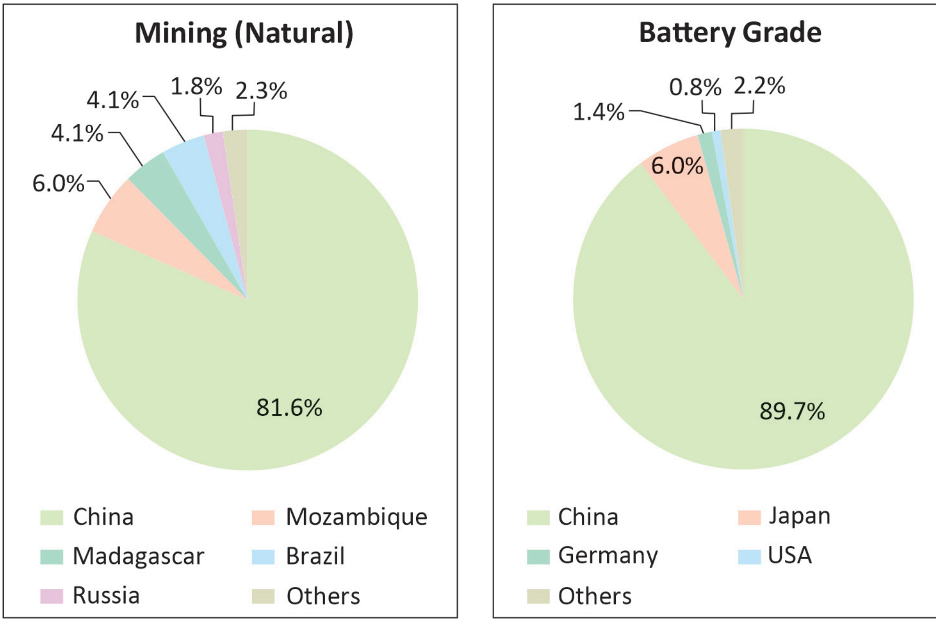
Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA); India Exim Bank Research

Figure 2.10: Global Cobalt Supply in 2023



Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA); India Exim Bank Research

Figure 2.11: Global Graphite Supply in 2023



Source: Critical Minerals Data Explorer 2024, International Energy Agency (IEA); India Exim Bank Research

Thus, as analysed, while developing countries like Chile, DR Congo, Indonesia, to name a few, lead the mining of the stated focus critical minerals, China is the dominant player in the refining stage of all select critical minerals.

Further, in the mining stage of the critical mineral supply chain, there exists high industry concentration in terms of asset ownership and corporations involved in mineral production, too. As per IRENA, mineral mining globally is often interpreted as an oligopolistic market, dominated by a select few multinational corporations and state-owned/controlled enterprises. Companies from the USA and Europe dominate the supply of copper and lithium while those from China play a central role in nickel and cobalt production despite these minerals being mined in, say, Indonesia (nickel) and DRC (cobalt).

Box 1.1: China's Dominance in the Race for Critical Minerals

As the quest for critical minerals intensifies worldwide owing to rapid decarbonisation efforts being implemented across countries, China's position in this race keeps getting dominant. Factors like extensive mineral refining capacities, global investments in the mining sector through partnership agreements and part-equity-stake deals, as well as supply chain integration of critical-mineral associated industries like EV manufacturing, and favourable domestic policy support, underlie China establishing itself as the global leader in the critical mineral industry.

China is the world's largest mineral-refining hub as well as the largest importer of critical minerals. The country plays an outsized role, particularly in the midstream and downstream portions of the critical mineral supply chain. Despite not dominating the upstream of the supply chain, China, remains the largest producer when it comes to rare earth elements (REEs).

In terms of share in global supply of refined minerals, China accounts for 100% of the refined supply of natural graphite and dysprosium (a REE), 70% of cobalt, and approximately 60% of lithium and manganese supply. It also refines almost 70% of nickel globally. Being the largest critical mineral importer, China relies heavily on imports of raw minerals which it refines and exports to the rest of the world, while also consuming domestically. The dominant position it holds in the midstream and downstream global EV battery supply chain - considered as the largest growth driver of the critical minerals industry - makes China a steady force in this sphere.

With the intention of securing a resilient minerals supply for domestic use and build dominance in the upstream activities in this supply chain, China has also been steadfast in bolstering investments in mining projects across countries. In early 2023, China's expenditure on acquisition of overseas mines amounted to US$ 10 billion, with special focus on minerals associated with battery manufacturing, like lithium, nickel and cobalt. During 2020-23, the country also accounted for about 44% of global mergers and acquisitions (M&A) in lithium investments, by value, for projects related to mineral exploration, feasibility and development.

In Africa, the Belt and Road Initiative (BRI) has been particularly instrumental in boosting China's footprint in the continent's mining sector, both in terms of investments and consumption, especially in case of critical minerals like lithium and cobalt, often through the 'resource-for-infrastructure swap model'. Herein, concessional loans are offered by banks in China to resource-rich African countries for projects related to infrastructure development, in return for mineral exploitation rights.

During 2000-2021, China has provided approximately US$ 57 billion worth of aid and subsidized credit - majorly non-public and publicly-guaranteed (PPG) loans - for transition mineral projects, to 19 BRI participating low-income and middle-income countries from China's policy banks and state-owned commercial banks. Such financing is generally aimed at ensuring some extent of Chinese ownership of the projects through joint ventures (JVs) and special purpose vehicles (SPVs). Primary focus is on upstream extraction in the mineral supply chain with utmost priority given to copper extraction and processing operations.

In Central Asia too, China's presence in the critical mineral sector is sizeable, given that it holds the maximum number of extraction licenses in the Kyrgyz Republic and Tajikistan, and that the majority of mineral exports from Kazakhstan and Mongolia are to China.

To leverage its dominance in the sphere of critical minerals mining and refining, and also, often in retaliation to tariff imposition by other countries, China has also, since 2023, implemented several export controls over select minerals. The latest instance is curbing of exports of tungsten, tellurium, bismuth, indium and molybdenum-related products to the USA, through the introduction of export licensing, as announced on February 04, 2025. Export controls on these key critical minerals that are used across industries like defence and clean energy, among others, was announced in response to the USA imposing an additional blanket tariff of 10% on imports from China. Other such restrictions include export controls on mineral processing technology and those on antimony, gallium, germanium, graphite, while export of rare earth magnet manufacturing technology faces a ban. Notably, China follows a complete export ban for antimony, gallium, germanium and superhard materials to the USA.

Source: Geopolitics of the energy transition: Critical materials, International Renewable Energy Agency (IRENA) (2023)

Global Critical Minerals Outlook 2024, International Energy Agency (IEA) (May 2024)

Power Playbook: Beijing's Bid to Secure Overseas Transition Minerals, AidData at William & Mary (January 2025)

Critical Mineral Strategies Across the World

In alignment with Sustainable Development Goal 13 (SDG 13) that calls for urgent action to combat climate change and its impacts, the demand for low emission, clean energy technologies is continuously rising.

The resultant surge in global demand for minerals deemed 'critical' for these technologies has led to governments around the world adopting different policies and strategies to ensure resilient supply of such minerals in their respective countries.

Table 2.2: Country-wise Select Strategies for Critical Minerals Industry

Country	Strategy
USA	• As required by the Energy Act of 2020, the US Geological Survey (USGS) published the revised critical minerals list in 2022, containing 50 such minerals. This is complemented by another list released by the US Department of Energy (DOE), last in 2023, containing 18 critical minerals, a few overlapping with those included by USGS. • The 'America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition (2022)' involves strategies across seven main opportunities viz. increasing raw material availability; expanding domestic manufacturing capabilities; investing and supporting diverse and reliable foreign supply chains; increasing the adoption and deployment of clean energy; improving end-of-life waste management; supporting skilled US workforce for energy transition; and enhancing supply chain knowledge in this area. • The 'Strategy to Support Domestic Critical Mineral and Material Supply Chains (2021)' outlines the action plan to secure critical minerals based on key pillars – supply diversification, substitute development, and improvement in reuse and recycling. It covers four primary goals viz. driving scientific innovation and developing technologies to better secure domestic supply devoid of foreign adversaries; pushing for greater private sector participation; fostering new capabilities to minimise supply challenges; and boosting international collaborations to diversify mineral supply chains.

Country	Strategy
China	• In 2016, the National Mineral Resources Planning (2016-2020), published by the Ministry of Land and Resources of China, identified 24 strategic minerals, and outlines the exploration, development and downstream application of these mineral resources. These listed minerals have been acknowledged to be vital to all economic activities in China, particularly defence and other high-tech industries. • China's 14th Five Year Plan for Raw Material Industry Development focuses on rare earth metals, besides other raw materials. Herein, rare earth enterprises are encouraged to merge and reorganize and also extend their industrial chains to further downstream.

European Union (EU)	• In 2023, a fifth list of 34 Critical Raw Materials (CRM) was published by the European Commission. The minerals that do not meet the CRM thresholds are included in the CRM lists as strategic raw materials.
	• The Critical Raw Materials Act (CRM Act) was adopted by the European Commission in 2023 to secure and strengthen EU's capacities along all stages of the critical raw materials value chain; diversify EU's mineral imports; increase monitoring capacity and reduce risk of supply disruptions; and increase the circularity and sustainability of critical raw materials consumed in the Union.
	• The CRM Act also sets voluntary targets with respect to annual EU consumption, for encouraging domestic production of critical minerals along the supply chain, by 2030:–
	  ○ At least 10% extracted in the EU
	  ○ At least 40% processed in the EU
	  ○ At least 15% recycled in the EU
	  ○ Not more than 65% of the EU's annual consumption of each strategic raw material at any relevant stage of processing from a single third country

Country	Strategy
Japan	• As of 2023, Japan's Ministry of Economy, Trade and Industry (METI) named 35 minerals as critical with uranium being the latest addition. • Although not in force currently in 2025, Japan had adopted the International Resource Strategy in 2020. As a national stockpiling program, this strategy covered critical minerals along with oil, LNG and climate change actions. Thereby, Japan Organization for Metals and Energy Security (JOGMEC) had the authority to implement a national stockpiling program for 34 types of rare metals to ensure that no supply disruptions are faced. • Japan's Economic Security Protection Act (ESPA) includes the establishment of a system to 'ensure stable supplies of critical materials' which are defined as being essential for the citizens and their economic activities on a daily basis. The act thereby introduces designation of materials deemed critical and the associated initiatives to ensure their stable supply including plan approval and grant measures for businesses; government initiatives like stock-piling as and when required; and other relevant surveys. • In alignment with ESPA, JOGMEC continues to provide support to Japanese companies through loans, partnership agreements, among other measures, to strengthen the various stages of the country's critical minerals supply chain.

Source: Accumulated from various policy documents

Apart from the afore-mentioned strategies adopted at the national level, countries have also signed notable bilateral and multilateral agreements. The Minerals Security Partnership (MSP) is one such plurilateral agreement launched in 2022, led by the USA and signed by a total of 14 countries and the EU, to enhance global cooperation to build responsible and sustainable critical minerals supply chain. India joined the MSP in June 2023.

In conclusion, the global demand for critical minerals is at an all-time high, driven largely by the global urgency to decarbonise economies and shift to clean energy technologies to achieve set climate targets. Countries around the world have laid out national roadmaps to identify and build resilient critical minerals supplies to meet their domestic demands.

The supply risk of these critical minerals - in accordance with the ‘critical’ moniker - remains high, given the concentration across the key stages of the mineral supply chain, particularly, at the stages of mining and refining. In fact, the World Bank has stated that an estimated US$ 1.7 trillion in global mining investment is needed to support the energy transition and the growing demand for critical minerals, essential for renewable energy technologies.

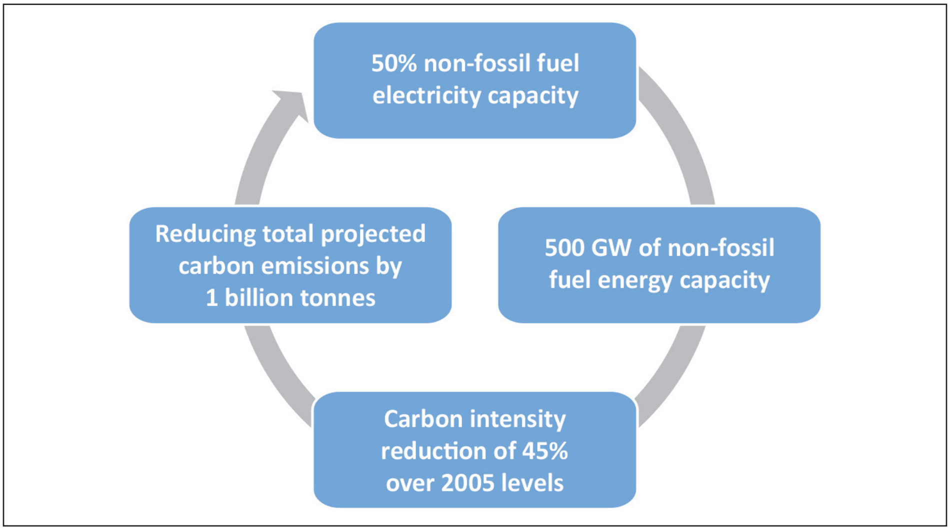
3. Critical Minerals - India's Perspective

Critical minerals are essential for economic development and national security, and the limited accessibility of these minerals through, say, concentration of reserves, extraction or processing in a few geographical locations, may lead to supply chain vulnerability and disruption.

India needs critical minerals to support its economic growth and technological advancement, particularly in the clean energy sector, considering these minerals are essential inputs in the manufacture of green technologies like solar panels, wind turbines, and EV batteries. Given such minerals also play a crucial role in key sectors like high-tech electronics, telecommunications, and defence, it is beneficial for India to focus on reducing reliance on imports and enhance its strategic autonomy.

With its commitment to achieve net-zero emissions by 2070, India needs to bolster efforts to secure mineral supplies required for such an energy transition by mitigating its mineral dependency on a few select countries and boosting domestic involvement across the various stages of the mineral supply chain. Building a reliable critical minerals supply chain will help India achieve growth across industries deemed to be vital for its economic sovereignty, strengthen its energy security requirements and insulate itself from the geopolitical implications of mineral dependency.

Figure 3.1: India's Decarbonisation Targets by 2030



Source: India Exim Bank Research

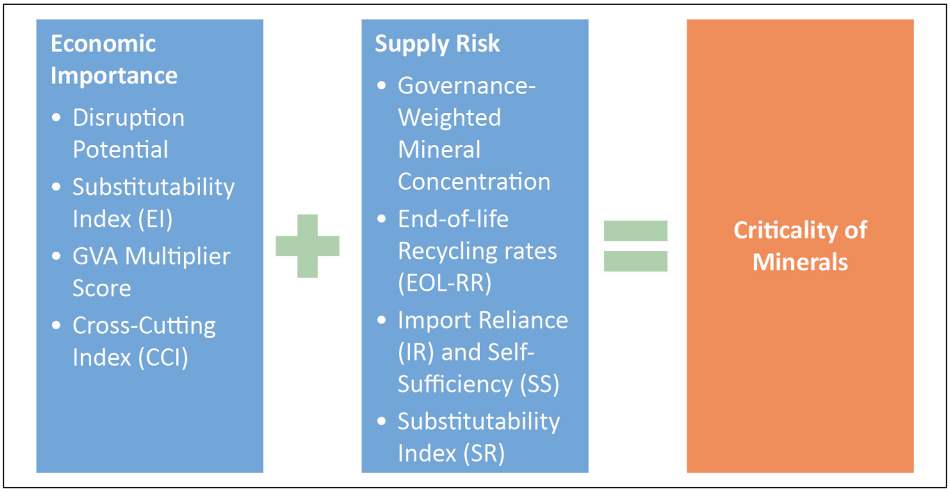
India's Critical Minerals List

In this regard, the Ministry of Mines in 2023, through an inter-ministerial committee, identified 30 critical minerals for India.

The definition of critical minerals is often country-specific, linked to its natural resource endowment, stage of economic development, and is related to concerns of energy security and national security, among other determinants. In India, the Ministry designated the status of 'critical' to those minerals that are deemed essential for the country's 'economic development and national security' and the supply chain disruption of which, could adversely impact the economy.

Following a three-stage assessment process, the inter-ministerial committee published the national critical mineral list based on select parameters, under the broad determinants of 'economic importance' and 'supply risk' (Figure 3.2).

Figure 3.2: Criticality Parameters in India



Source: Report of the Committee on Identification of Critical Minerals, Ministry of Mines (2023)

Based on the above, the 'Report of the Committee on Identification of Critical Minerals' lists the following 30 minerals as 'critical' in India. India is 100% import dependent in 10 of these critical minerals.

Table 3.1: India's Critical Minerals List

Antimony	**Lithium**	**Strontium**
Beryllium	Molybdenum	**Tantalum**
Bismuth	**Niobium**	Tellurium
Cobalt	**Nickel**	Tin
Copper	PGE	Titanium
Gallium	Phosphorous	Tungsten
Germanium	Potash	**Vanadium**
Graphite	REE	Zirconium
Hafnium	**Rhenium**	Selenium
Indium	Silicon	Cadmium

Note: Critical minerals in which there is 100% import dependency are in bold and highlighted

Source: Report of the Committee on Identification of Critical Minerals, Ministry of Mines (2023)

Thus, the publishing of India's critical minerals list has brought forth the need to address, in particular, the issue of mineral dependency, by expanding India's participation in the mineral supply chain, which entails mineral exploration, mining, processing, and manufacturing.

India's Mining Sector

In India, the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act) serves as the primary legislation that governs the mining sector. According to the Ministry of Mines, the Index of Mineral Production (base year = 2011-12) for the year 2023-24 is projected at 128.9, compared to 119.9 in the previous year, showing a growth of almost 8%. As per the first advance estimates, the Gross Value Added (GVA) for the mining and quarrying sector at 2011-12 prices is expected to reach ₹ 3,47,271 crore for 2024-25, growing at a relatively slower rate of 2.9% over the GVA for 2023-24.

In India, the total mineral production (excluding atomic and fuel minerals) in 2023-24 is estimated to amount to ₹ 1,92,734 crore, showing a growth of 2.03% over 2022-23. Of this, metallic minerals accounted for 57.5% of the total production value with non-metallic minerals, including minor minerals, holding a share of 42.5%. Approximately 98% of this total mineral production of India was concentrated only in 8 States.

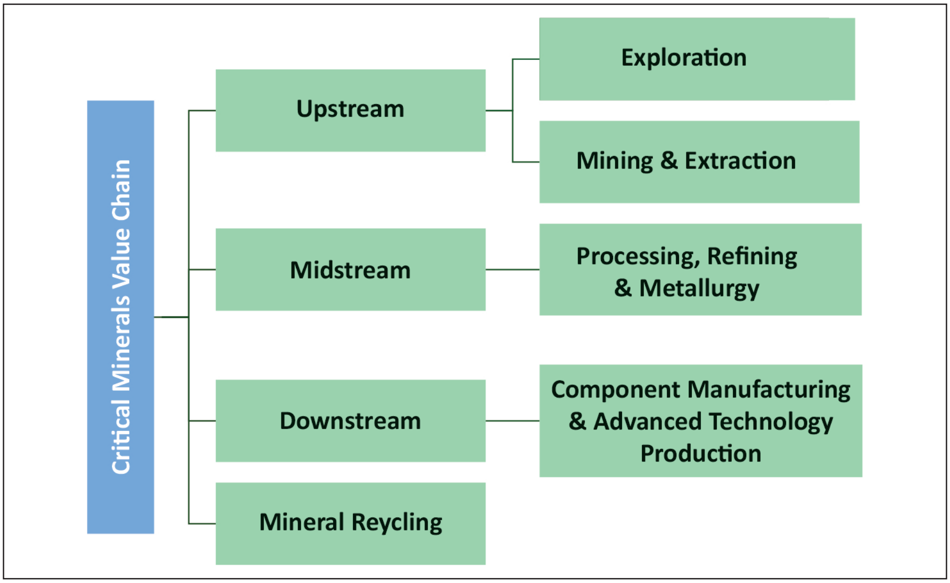
Domestic Supply of Critical Minerals in India

To safeguard India's economic, geopolitical, and energy interests, it must build competitive critical minerals value chains spanning across the different stages of mineral exploration, mining, refining and manufacturing.

Among the many crucial initiatives being taken towards building a resilient critical minerals supply chain in India, the Central Government is focused on increasing investment in mineral exploration. Mineral exploration is being prioritised particularly in the Obvious Geological Potential (OGP) areas through the Geological Survey of India (GSI), Central Mine Planning and Design Institute Limited (CMPDIL) and National Mineral Exploration

Trust (NMET)[7]. As of 2023-24, India's OGP has increased to 6.88 lakh square kilometres (sq. km), of which, an area of 2.31 lakh sq.km. has been covered through reconnaissance surveys[8], thus achieving a mineral exploration share of 30%[9].

Figure 3.3: Critical Minerals Value Chain



Source: Adapted from Report of the Committee on Identification of Critical Minerals, Ministry of Mines (2023)

India's demand and supply scenario for the select critical minerals in the Study is detailed below.

[7] Slow Pace of Mine Operationalisation, Rajya Sabha Starred Question No – 137, Answered on 09.12.2024, Ministry of Mines, Government of India

[8] Reconnaissance Survey (G4) is among the 4 stages of geological assessment. As per Indian Bureau of Mines, it refers to the preliminary prospecting of a mineral through regional, aerial, geophysical or geochemical surveys and geological mapping, and excludes pitting, trenching, drilling.

[9] National Mining Ministers' Conference 2025, Ministry of Mines (January 2025)

Copper

Copper is a non-ferrous base metal that is highly valued for its characteristics of ductility, malleability, corrosion resistance, high thermal and electrical conductivity, and recyclability. It finds application across various industries like power generation and transmission, defence and space programmes, clean energy technology, among others.

In India, there exists a demand-supply mismatch for copper ore. Domestic demand is met broadly through the production of copper ore and concentrates, import of copper concentrates and recycling of scrap for secondary copper. Hindustan Copper Limited (HCL) is the only public sector primary copper producer involved in indigenous mining. It is also the only vertically integrated company in India that is involved in mining and beneficiation of copper ore, and the smelting, refining, and casting of refined copper. HCL operates a total of 5 mines (4 underground mines and 1 opencast mine), with a combined ore production capacity of about 3.5 million tonnes annually. In the private sector, Hindalco Industries Limited and Vedanta Resources Limited are the prominent players that rely on imported copper concentrates, owning copper mines abroad.

In 2021-22, total copper ore production in India amounted to 3.56 million tonnes, showing a growth of 9% as compared to the previous year (Table 3.2). Provisional data indicates copper ore production to stand at 3.32 million tonnes in 2022-23 and estimated to be 3.41 million tonnes in 2023.24. The largest copper ore resource in India is in Rajasthan, amounting to 868 million tonnes, with a share of 52.25% of total resources found in the country.

As for copper concentrates, the provisional data for copper concentrate production in 2023-24 stands at 125 thousand tonnes, an increase of approximately 11.1% compared to the previous year.

Table 3.2: Copper Supply in India (in million tonnes)

Critical Mineral	Production		Reserve (a)	Remaining Resources (b)	Total Resources (a + b)*
Copper Ore	FY 2021-22	3.56	163.89	1496.98	1660.87
	FY 2022-23 (P)	3.32			
	FY 2023-24 (E)	3.41			
Copper Metal	27,622 tonnes		2.16	10.04	12.20

**Provisional data as on 1st April 2020*

Note: (P) – Provisional; (E) – Estimated

Source: Annual Report 2023-24, Ministry of Mines, Government of India; Indian Minerals Yearbook 2022, Indian Bureau of Mines

Lithium

Lithium, an alkali metal, is commonly present as a constituent in several salts or compounds. It is found in underground brine deposits, mineral ores, hard rocks (pegmatite), sea water, clay-based sedimentary deposits, and geothermal wells. Globally, extraction from granitic pegmatite ores and from brines, are the two most common sources of lithium.

With the growing pace of decarbonisation in the transportation sector, lithium demand is soaring driven by its usage in the manufacture of lithium-ion batteries used in EVs. Lithium ensures stable and uninterrupted power delivery and storage in such batteries. Lithium-ion batteries are also used in power backup appliances, mobile phones and other electronic devices. In India, lithium is also extensively used for pharmaceuticals, medicinal chemicals and botanical products apart from being used in ceramics, lubricants, aircraft components, among other applications.

India is 100% import dependent for fulfilling its domestic lithium demand. In 2023, a major lithium block was discovered in the country by GSI. An inferred resource of 5.9 million tonnes of lithium ore was confirmed by the GSI in the Salal-Haimana area of Reasi District of Jammu & Kashmir, as per the G3 stage of geological assessment[10]. As of October 2024, however, the Ministry of Mines has directed the GSI to conduct a re-exploration of this lithium block following a setback in the auctioning of the same, owing to lack of sufficient exploration data. The Ministry, through this re-exploration task, aims to reach a higher stage of geological assessment, that is, G2 (General Exploration) before proceeding for its auction again[11].

Nickel

Nickel, an integral part of the clean energy technology chain, is not found in its natural state. Bulk of the nickel mined globally comes from two types of ore deposits, nickeliferous limonite and garnierite, or pentlandite. Primary use of nickel lies in alloys, including stainless steel, and non-ferrous applications for manufacturing of components used in specialised industries like defence and aerospace. However, with growing emphasis on energy transition, nickel finds increasing application in lithium-ion battery cathodes, nickel-metal hydride batteries, and other clean energy technologies.

India is 100% import dependent for meeting its nickel demand, given that the mineral is not produced from primary sources in the country. The entire availability of nickel in India amounting to 189 million tonnes, falls under the 'remaining resources' category, often in the form of oxides, sulphides and silicates (Table 3.3).

Table 3.3: Nickel Supply in India (in million tonnes)

Critical Mineral	Production	Reserve (a)	Remaining Resources (b)	Total Resources (a + b)*
Nickel Ore	0	0	189.00	189.00

**Provisional data as on 1st April 2020*

Source: Indian Minerals Yearbook 2022, Indian Bureau of Mines

[10] G3 refers to the 'prospecting' or 'preliminary exploration' stage of geological assessment.

[11] J&K's 5.9 mn tonne lithium reserve to be re-explored after failed auction, Business Standard (October 2024)

Odisha is endowed with the largest nickel ore resource in India at 175 million tonnes, accounting for a share of 93% of total nickel resources, followed by Jharkhand and Nagaland.

The 'Nickel, Copper, and Acid Recovery Plant' at Hindustan Copper Limited's (HCL) Indian Copper Complex (ICC) in Ghatshila, Jharkhand, aims to be India's first facility to produce London Metal Exchange (LME) grade nickel from primary resource, and recover nickel sulphates using the imported EMEW technology from Canada.

Cobalt

Cobalt, often extracted as a by-product of copper and nickel mining, finds usage in metallurgical applications. Characteristics like a high melting point and ferromagnetic properties make cobalt suitable for applications like lithium-ion battery cathodes and superalloys. Other uses include cutting tools, magnetic materials, petrochemical catalysts, pharmaceuticals, and glaze materials.

In India, there exists no commercial cobalt production from primary resources, mainly due to the absence of cost-effective extraction capabilities. The entire domestic demand is met through imports.

At present, India's remaining resources for cobalt amount to approximately 45 million tonnes, of which, around 60% are estimated to be found in Odisha, followed by Jharkhand and Nagaland (Table 3.4).

Table 3.4: Cobalt Supply in India (in million tonnes)

Critical Mineral	Production	Reserve (a)	Remaining Resources (b)	Total Resources (a + b)*
Cobalt Ore	0	0	44.91	44.91

**Provisional data as on 1st April 2020*

Source: Indian Minerals Yearbook 2022, Indian Bureau of Mines

With refining capacity estimated to be a modest 2,060 tonnes per year, India's demand for battery-grade cobalt is met entirely through imports. Nicomet Industries Ltd in Goa and Rubamin Ltd in Gujarat remain India's leading producers of cobalt cathodes and compounds.

Graphite

Graphite is a mineral essential for the growing adoption of clean energy technologies, with characteristics such as low weight, high electrical and thermal conductivity, as well as excellent thermal stability. This critical mineral is found in two forms, namely, natural graphite which is mined, and synthetic graphite, which is processed from petroleum coke or coal tar. Synthetic graphite, although it offers superior performance, is costlier and more emission intensive as compared to natural graphite.

Graphite is a key element used as both, anode material and as a conductive additive in lithium-ion batteries for EVs, which is also the major growth driver for its demand worldwide. Other applications include refractories, electrodes, foundry additives, and lubricants.

In India, total resources of graphite amount to 211.62 million tonnes (Table 3.5), of which, resources containing +40% fixed carbon, constitute about 2.91 million tonnes, resources with 10%–40% fixed carbon amount to 43.98 million tonnes and the rest are considered as unclassified. About 60% of demand for natural graphite in India is met through imports.

Production of graphite in India stood at about 57 thousand tonnes in 2021-22, showing a jump of over 60% from the year prior, with Tamil Nadu as the lead producing state. There were 11 mines reporting production in the year with almost 88% of this total production accruing to 3 mines.

Table 3.5: Graphite Supply in India (in million tonnes)

Critical Mineral	Production (thousand tonnes)		Reserve (a)	Remaining Resources (b)	Total Resources (a + b)*
Graphite	FY 2021-22	62.88	8.56	203.06	211.62
	FY 2022-23 (P)	94.78			
	FY 2023-24 (E)	137.1			

**Provisional data as on 1st April 2020*

Note: (P) – Provisional; (E) – Estimated

Source: Annual Report 2023-24, Ministry of Mines, Government of India; Indian Minerals Yearbook 2022, Indian Bureau of Mines

The committee report by the Ministry of Mines has named all the select critical minerals being analysed in this Study – with the exception of copper – to be of both, high economic importance (EI) as well as high supply risk (SR). As observed, out of the five select key critical minerals being analysed, India has a domestic production base of two of them, namely, copper and graphite.

Given the critical nature of these minerals, Government of India is undertaking broadly two policy paths – one of increasing domestic exploration and mining, and the other of acquiring overseas mineral assets to meet domestic demand. The following chapter takes note of the several such policy initiatives being implemented to secure India's critical minerals supply chain.

4. Policy Support and Initiatives to Secure India's Critical Minerals Supply

The Union Budget 2025-26 has identified the mining sector as one of the 6 domain areas for transformative reforms in the next 5 years. Notably, in the previous year's Budget, Basic Customs Duty (BCD) on 25 critical minerals which are domestically unavailable received full exemption. The changes as announced in Budget 2025-26 are in the Figure 4.1.

Figure 4.1: Mining and Critical Minerals Sector Reforms in Union Budget 2025-26

Policy for recovery of critical minerals from tailings envisaged	BCD elimination on scrap and waste of 12 critical minerals	BCD elimination on cobalt powder and waste, scrap of lithium-ion battery, lead, zinc	Institution of a State Mining Index

Note: BCD – Basic Custom Duty

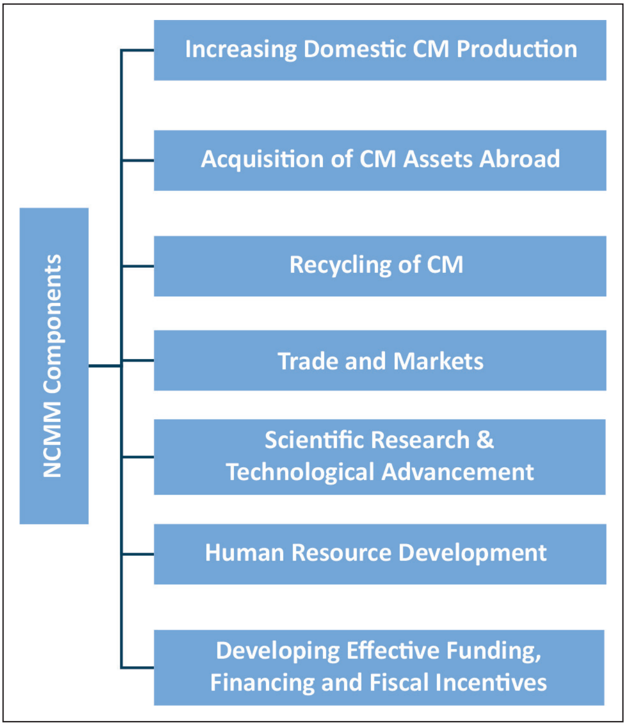
Source: Union Budget Documents 2025-2026

National Critical Minerals Mission (NCMM)

In January 2025, the Union Cabinet approved the launch of the National Critical Mineral Mission (NCMM) following its announcement in the Union Budget 2024-25. In pursuit of an 'Atmanirbhar Bharat', the NCMM lays out a roadmap with the objective to secure India's long-term critical minerals supply chains from both, domestic and foreign sourcing, and strengthen all stages across the value chain from mineral exploration to end-of-life products, using tools like policy reforms, financial support, international collaborations, among other such interventions.

The NCMM has been set up with an allocation of ₹ 16,300 crore wherein PSUs are expected to contribute ₹ 18,000 crore worth of investment. The total outlay for the mission amounts to ₹ 34,300 crore over 2024-25 to 2030-31[12]. The components of NCMM have been highlighted below (Figure 4.2).

Figure 4.2: Components of National Critical Mineral Mission (NCMM)



Source: National Critical Mineral Mission (NCMM), Ministry of Mines

Supplementing the expanding exploration and mining activities is among the key components of NCMM, to boost India's domestic critical minerals production. In this regard, the Mines and Minerals (Development and Regulation) Act, 1957, was amended in 2023, to increase exploration and mining of critical and deep-seated minerals, through greater private sector

[12] Cabinet Approves 'National Critical Mineral Mission' to build a resilient Value Chain for critical mineral resources vital to Green Technologies, with an outlay of Rs.34,300 crore over seven years, PIB (January 2025)

participation, auctioning mineral concessions for critical minerals, and by introducing Exploration Licences (EL) to attract foreign direct investment (FDI), among others.

The GSI has taken up various mineral exploration projects including those on various critical and strategic minerals (Table 4.1). The Annual Programme of GSI for the upcoming Field Season (FS) year 2025-26 includes a big push for critical minerals with 227 dedicated projects targeting strategically important mineral commodities such as REE (Rare Earth Elements), RM (Rare Metals), graphite, lithium, vanadium, and PGE (Platinum Group Elements). For FS 2025-26, the GSI has allocated about ₹ 300 crores for critical mineral exploration and investigation[13].

Table 4.1: Mineral Exploration Projects by Geological Survey of India (GSI)

Field Season	2021-22	2022-23	2023-24	2024-25	2025-26
Total number of mineral exploration projects	251	319	360	448	450
Total number of projects on strategic and critical minerals	118	123	127	195	227

Source: Overview of Mining Sector in India, Ministry of Mines (January 2025)

The Ministry of Mines also focuses on mining exploration projects through the National Mineral Exploration Trust (NMET), a not-for-profit body established to promote mineral exploration through financial assistance by the Central Government. As of November 2024, NMET has funded a total of 443 projects, out of which, 139 projects are of critical minerals through various exploration agencies[14].

As of March 2024, the Central Government, through 4 tranches, has successfully auctioned 24 mineral blocks out of the 48 blocks put up for auction, including 4 Mining Lease (ML) and 20 Composite License (CL) blocks,

[13] Mines Secretary Emphasizes Collective Efforts to Drive Innovation, Sustainability, and Growth in India's Mineral & Mining Sector at the 64th CGPB Meeting in Bhubaneswar, PIB (January 2025)
[14] Critical Mineral Mission, Lok Sabha Unstarred Question No. 442 Answered on 27.11.2024

spread across the country (Table 4.2)[15]. Among all states, Arunachal Pradesh has the maximum number of successfully auctioned critical mineral blocks at 4, to preferred bidders like Hindustan Zinc Limited, Vedanta Limited, Mamco Mining Private Limited and Oil India Limited[16].

Table 4.2: Auction of Critical Mineral Blocks

Tranche	Date of Notice Inviting Tenders (NIT)	No. of blocks	Critical Mineral Blocks
I	29th November 2023	20	Glauconite (3), Nickel (2), Nickel & PGE (1) Potash (1), Graphite (5), Molybdenum (5), Phosphorite (1), Lithium & Titanium (1), Lithium & REE (1)
II	29th February 2024	18	Tungsten (3), Graphite & Vanadium (4), REE (1), Graphite (2), Glauconite (1), Phosphorite (1), Cobalt (1), Nickel & PGE (2), Nickel & Cobalt (1), Potash (2)
III	14th March 2024	7 (Auctioned under second attempt)	Glauconite (3), Graphite (1), Potash (1), Lithium & Titanium (1), Nickel & PGE (1)
IV	24th June 2024	21 (10 fresh blocks; 11 re-auctioned)	Graphite (2), Graphite and Vanadium (3), Cobalt, Manganese and Iron (Polymetals) (1) Glauconite (2), Nickel, Chromium and associated minerals (1), Nickel, PGE (1), Phosphorite (1), Phosphorite & Limestone (2), Phosphate & REE (1), Potash & Halite (2), Tungsten (2), Tungsten & Associated Minerals (Mo,Au,Pb,Zn) (1), REE and Associated Minerals (Copper, Gold& associated minerals) (1), REE (1)

Source: Ministry of Mines, Government of India

[15] According to the Indian Bureau of Mines (IBM), a Mining Lease (ML) is a lease granted for the purpose of undertaking mining activities and includes a sub-lease granted for the same; a Composite Lease (CL) refers to license for undertaking both, prospecting operations followed by mining.

[16] E-auction of Critical and Strategic Mineral Blocks, Lok Sabha Unstarred Question No – 1444 Answered on 04.12.2024

In January 2025, the 5th tranche of critical mineral block auctions was initiated for 15 such blocks, covering 8 states[17]. The Ministry of Mines is also expected to launch the 1st tranche of auction for EL blocks in March 2025[18].

Private Sector Participation

The Government of India is undertaking several measures to boost private sector participation in the strengthening of India's critical minerals supply chain. Through amendments to the MMDR Act, like the removal of 6 critical minerals (lithium, beryllium, titanium, niobium, tantalum and zirconium) from the list of atomic minerals that were earlier reserved for exploration only by PSUs, private sector participation has been enabled. The introduction of Exploration Licences also incentivises private sector participation in mineral exploration.

New 'Notified Private Exploration Agencies (NPEAs)' are also being notified for mineral exploration projects through funding by NMET. As of 2024, a total of 28 NPEAs have been added.

Further, the government has also rationalised and approved new mining royalty rates for the 24 critical and strategic minerals, including lithium, which is also expected to encourage greater private sector involvement in India's mining sector.

Overseas Critical Minerals Acquisition

Khanij Bidesh India Limited (KABIL) is a joint venture set up by the Ministry of Mines, including participation by National Aluminium Company (NALCO), Hindustan Copper Limited (HCL), and Mineral Exploration and Consultancy Limited (MECL), to strengthen India's critical minerals from foreign sources, through international collaborations. Following are KABIL's recent collaborations –

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[17] Mines Ministry in Collaboration with Odisha Government Organizes 3rd National Mining Ministers' Conference in Konark, PIB (January 2025)

[18] Ministry of Mines will Launch the 1st Tranche of Auction of Exploration License Soon: Union Minister G Kishan Reddy, PIB (February 2025)

- In January 2024, KABIL signed an Exploration and Development Agreement with CAMYEN, a state-owned enterprise of the Catamarca province of Argentina, for exploration and mining of 5 adjacent lithium blocks viz 1. Cortadera-I, 2. Cortadera-VII, 3. Cortadera-VIII, 4. Cateo-2022-01810132 and 5. Cortadera-VI, covering an area of about 15,703 hectares.
- KABIL, alongside Oil India Limited (OIL) and ONGC Videsh Limited (OVL) signed a Memorandum of Understanding (MoU) with UAE-based International Resource Holdings (IRH) to secure critical minerals supply chains encompassing project identification, due diligence, development strategies, risk management, and off-take strategies.
- In Australia, KABIL has signed an MoU with the Critical Mineral Office (CMO), Department of Industry, Science and Resources (DISER), Government of Australia, to focus on joint due diligence and further investment in lithium and cobalt mining assets of Australia, and also assist in long term investment decisions through off-take arrangements.
- Further, a non-disclosure agreement (NDA) with ENAMI, a state-owned company of Chile, has also been signed by KABIL to take up exploration of brine type lithium block in Chile.

International Collaborations

To better secure critical minerals supply, India is focusing on facilitating international collaborations and agreements in terms of acquisition of foreign critical mineral assets, technology transfers used for mining, exploration and recycling purposes, as well as joint R&D activities, among other activities (Table 4.3).

Table 4.3: India's International Partnerships for Critical Minerals Supply

Collaboration	Activity
Mineral Security Partnership (MSP)	• Launched in 2022, the MSP is a USA-led multilateral collaboration involving 14 countries and the EU to diversify and strengthen global critical minerals value chain with commitments to high environmental, social, and governance (ESG) standards. It also aims to catalyse investment across the chain and increase recycling of critical minerals. • India joined MSP in June 2023 as the 14th member to contribute towards building sustainable mineral supply chains.
Indo-Pacific Economic Framework (IPEF)	• Another USA-led initiative launched in 2022, IPEF includes 14 partners of the Indo-Pacific region that aim to advance economic growth and stability structured around 4 pillars, namely, Trade (Pillar I); Supply Chains (Pillar II); Clean Economy (Pillar III); and Fair Economy (Pillar IV). • India joined Pillars II to IV while maintaining an observer status in Pillar-I. • Under IPEF, India signed the Supply Chain Resilience Agreement (Pillar-II) in November 2023 to strengthen the critical mineral supply chain, that is crucial for national security and economic stability. The Supply Chain Council (SCC) thus formed recognised critical minerals as a key focus area, in September 2024. • In September 2024, India signed the Agreement on Clean Economy (Pillar III) which aims to facilitate development, access and deployment of clean energy and climate-friendly technologies to accelerate energy transition efforts, among other focus areas. • Activities under the clean economy agreement will be undertaken through joint collaborative actions such as Cooperative Work Programmes and the IPEF Catalytic Capital Fund.

Collaboration	Activity
Quadrilateral Security Dialogue (Quad)	• Initially formed in 2009 by Australia, India, Japan, and the USA, the Quad is currently a diplomatic partnership working with the objective to maintain a peaceful and prosperous Indo-Pacific region across various problem domains. • In 2023, the countries announced a Quad statement of 'Principles on Clean Energy Supply Chains in the Indo-Pacific'. Endorsement of the principles implied focus on - ○ diversifying clean energy supply chains in the Indo-Pacific; ○ supporting future clean energy workforce needs; ○ exploring inter-operability in technical standards, policies and measures across the partner countries; ○ promoting enhanced cooperation towards ESG practices for clean energy supply chains; ○ promoting greater investment – both private and public - and collaboration in clean energy research, development & demonstration (RD&D) and innovation; and ○ encouraging and incentivising companies to increase decarbonisation solutions.
India-USA	• Announced in 2022, the India-USA Initiative on Critical and Emerging Technologies (iCET) aims to deepen bilateral collaboration in key technology areas, critical minerals and clean energy, alongside artificial intelligence, semiconductors, telecommunications, space, biotechnology, etc. • An MoU was signed between both countries in October 2024 to 'expand and diversify critical mineral supply chains' and thereby, develop all stages of the chain – from exploration to recycling. • As part of the 'Roadmap For U.S.-India Initiative to Build Safe and Secure Global Clean Energy Supply Chains', both countries are aiming to secure US$ 1 billion in new multilateral finance through the International Bank for Reconstruction and Development (IBRD), to expand manufacturing of clean energy technology components.

Collaboration	Activity
India-Australia	• Both countries are focused on better fostering the India-Australia Critical Minerals Investment Partnership. • Apart from the MoU signed between India's KABIL and Australia's Critical Minerals Office, in 2023, the partnership has identified 5 target projects (2 lithium and 3 cobalt) on which to undertake detailed due diligence. • The India-Australia Economic Cooperation and Trade Agreement (ECTA) signed in 2022, supports investment in Australia's critical minerals and resources sectors while also allowing India access to Australian minerals exports, through custom duty reduction or elimination. Thus, from 29 December 2022, tariffs on imports of most of the critical minerals from Australia such as zirconium and titanium were eliminated. • The Australia-India Critical Minerals Research Hub (AICMRH) has also been established following an MoU between India's IIT, Hyderabad and Australia's Monash University. In January 2025, India's Ministry of Education approved the first instalment of US$ 1.1 million as part of the US$ 5 million funding plan under the Scheme for Promotion of Academic and Research Collaboration (SPARC), to support AICMRH's activities.

Source: Accumulated from policy documents and news articles

Alongside the above stated multilateral and bilateral partnerships to secure India's critical minerals supply chain, the country is also exploring opportunities or has already partnered to access either critical mineral assets or related technology transfers, with countries like Zambia, DR Congo, Israel, Saudi Arabia and Sri Lanka, to name a few.

In November 2024, India also signed an MoU with IEA for critical minerals-related capacity building and knowledge-sharing across areas of data collection, modelling, and policy analysis.

5. India's Overseas Critical Minerals Supply

To meet its critical minerals domestic demand, India often relies on these minerals from overseas sources. This Chapter studies India's major import sources and trends for the key critical energy transition minerals that has led to import dependency of varying degrees for the same.

Copper

India has turned into a net importer of copper since the closure of Vedanta's Sterlite Copper smelter in Thoothukudi, Tamil Nadu in 2018 that drastically reduced India's copper production capacity.

In 2023-24, as per provisional data, India's import quantity of copper ores and concentrates amounted to 1016.3 thousand tonnes while that of refined copper stood at 363 thousand tonnes (Table 5.1).

Table 5.1: India's Copper Import in 2023-24

HS Code	Product	Quantity (thousand tonnes)
2603	Copper ores and concentrates	1016.3 (P)
740311	Refined copper cathode	363.0

Note: (P) – Provisional

Source: Compiled from Annual Report 2024-25, Ministry of Mines; Copper Quality Control Order: A step towards Atma Nirbharta, PIB (December 2024)

Chile and Indonesia are among India's largest sources for copper ores and concentrates. Chile was the largest contributor to global copper mining with a share of 23.6% of copper mining in 2023. Indonesia houses the world's largest copper and gold deposits in the Grasberg minerals district in Papua which held 15.1 million metric tonnes of copper reserves as of 2020[19]. Indonesia's exports of copper ores and concentrates to India face 0% Effectively Applied (AHS) tariff[20], that is, it enters India duty-free benefiting from the ASEAN-India Free Trade Area (AIFTA)[21]. However, starting 1 January 2025, Indonesia's Ministry of Trade Regulation has implemented an export ban on its copper concentrate exports as part of the country's policy of 'commodity down streaming' to boost instead the export of higher value products. This policy change holds the possibility of adversely impacting India's copper supply.

As for refined copper, in 2023-24, Japan was India's largest import source, followed by Tanzania and Mozambique. Japan's estimated copper smelter production amounted to 1,591,500 metric tonnes in 2020 with Sumitomo Metal Mining Co. Ltd. (SMM), Hibi Kyodo Smelting Co. Ltd. and JX Metals Smelting Co. Ltd being among the companies operating major copper smelters in the country[22].

It may be noted that as announced in the Union Budget 2025-26, India's tariff rate on copper waste and scrap has been reduced to nil effective from May 2025.

Over the decade of 2014-15 to 2023-24, the value of India's copper imports comprising copper ore and concentrates as well as refined copper has risen at a CAGR of 2.3% (Figure 5.1).

However, to discourage copper imports of poor quality from entering India, the Department for Promotion of Industry and Internal Trade (DPIIT) has

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[19] The Mineral Industry of Indonesia, Minerals Yearbook—2020–2021, U.S. Geological Survey (January 2025)

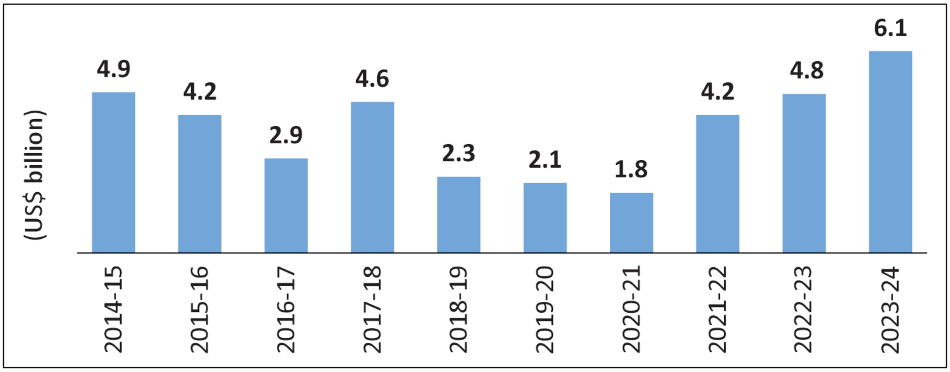
[20] The AHS is the actual tariff rate a country imposes on its imports, considering any preferential trade arrangements or trade agreements with the exporting country, in addition to the country's MFN tariffs.

[21] World Integrated Trade Solutions (WITS) Database

[22] The Mineral Industry of Japan, Minerals Yearbook—2020–2021, U.S. Geological Survey (December 2024)

notified QCO Copper Products (Quality Control) Order, 2023 to enforce adherence to India's set quality standards. Accordingly, 9 standards of copper products must obtain the Bureau of Indian Standards (BIS) certification in order to be able to cater to the Indian market. As of December 2024, 4 domestic suppliers namely, Adani Group's Kutch Copper Ltd, Hindalco Industries Ltd, Gujarat Victory Forgings Pvt Ltd and Vedanta Ltd and 4 foreign suppliers, 1 each from Japan and Austria, and 2 from Malaysia have been certified by BIS to supply copper cathode to Indian market[23].

Figure 5.1: India's Copper Imports (FY 2015 to FY 2024)



Note: Data included for HS 2603 - Copper ore and concentrates

Source: Directorate General of Commercial Intelligence and Statistics (DGCIS); India Exim Bank Research

Given its aim to diversify its mineral supply chain, India is also expected to sign an agreement with Mongolia focusing on cooperation in geology and exploration, particularly of copper and coking coal[24]. Similar agreements with Zambia and DR Congo are also in discussion.

Lithium

In 2023, in value terms, Australia and Zimbabwe were the largest global exporters of unprocessed lithium. This unprocessed lithium is then treated

[23] Copper Quality Control Order: A step towards Atma Nirbharta, PIB (December 2024)

[24] India to Sign Mining Pact with Mongolia Soon, Govt Source Says, Economic Times (January 2025)

and concentrated into processed chemicals like lithium carbonate and lithium hydroxide. These two compounds are used in producing either cathode materials or further processed to create battery electrolyte. In 2023, Chile and China were the largest exporters worldwide for both these compounds of lithium, thus indicating their dominant position in the processing stage of the lithium value chain.

India is 100% import dependent for its lithium supplies. Globally, in 2023, the country was the 9th largest and the 10th largest importer of lithium carbonate, and lithium oxide and hydroxide, respectively. In Table 5.2, as observed, except for China and Russia, India's major lithium import sources like Belgium, Ireland and the Netherlands, are in fact neither in possession of substantial lithium reserves nor are dominant lithium producers globally. This indicates that these countries presumably only function as mineral trading hubs for rerouting lithium supply.

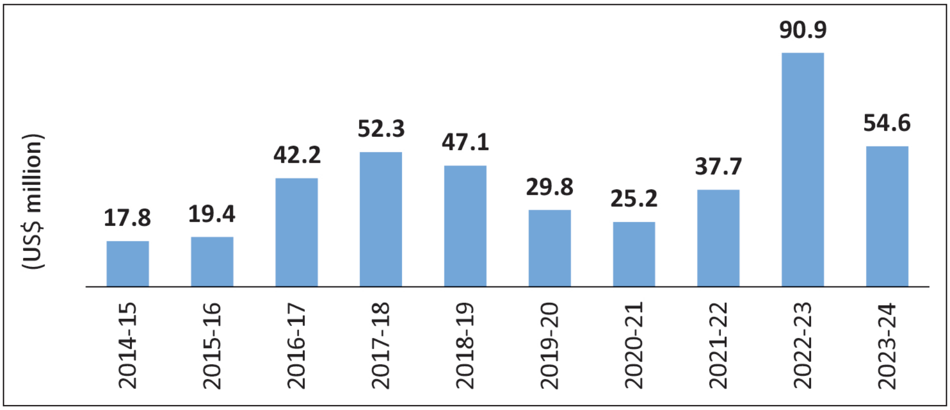
Table 5.2: India's Lithium Import Sources in 2023-24

HS Code	Product	Import Source	Quantity (tonnes)	Share in Total Import of Product (%)
28252000	Lithium oxide and hydroxide	Belgium	384	33
		Russia	304	26
		China	228	20
		Others	231	20
		Total	1148	100
28369100	Lithium carbonates	Ireland	400	35
		Netherland	200	17
		Belgium	167	15
		Others	379	33
		Total	1146	100

Source: Mining of Critical Minerals, Ministry of Mines, Lok Sabha Unstarred Question No. 3818 Answered on 18.12.2024

During the decade 2014-15 to 2023-24, the value of lithium imports into India has increased at a CAGR of 11.9% (Figure 5.2). In 2023-24, in terms of value of lithium imports, the USA, Russia and Belgium proved to be dominant players.

Figure 5.2: Value of India's Lithium Imports (FY 2015 to FY 2024)



Note: Data included for HS Codes: 28252000 - Lithium oxide and hydroxide; 28369100 - Lithium carbonates

Source: Directorate General of Commercial Intelligence and Statistics (DGCIS); India Exim Bank Research

Given China's dominant position in lithium processing and India's dependence on the same, India is now seeking partnerships with countries to receive technical assistance to reduce this dependency.

Nickel

Nickel, in its various forms is imported by India to meet its demand across various industry applications. The high cost of exploration and extraction of nickel has made commercial production of the mineral challenging in India, thereby resulting in 100% import dependency.

In 2023-24, in quantity terms, India's import of nickel oxides and hydroxides was the largest among the select nickel subcomponents being analysed, amounting to 91.6 thousand tonnes with Australia alone providing almost the entire supply (Table 5.3). The India-Australia Economic Cooperation and Trade Agreement (ECTA) signed in 2022, has proved to be a major growth driver for increased mineral imports from Australia owing to tariff elimination for energy sector products including critical minerals like zirconium, titanium and metallic ores like copper, cobalt, nickel, among others[25]. As per WITS (World Integrated Trade Solution) database, nickel oxides and hydroxides thus enter India duty free, that is, at 0% effectively applied tariff (AHS).

[25] Australia-India ECTA benefits for Australia (overview), Department of Foreign Affairs and Trade, Government of Australia

Further on, Japan and Belgium are also prominent suppliers of nickel to India, particularly of nickel sulphate. This is owing to the presence of efficient, advanced metallurgical and refining plants like Umicore in Belgium and Sumitomo Metal Mining (SMM) in Japan that produce high-quality nickel sulphate adhering to international standards

Notably, the import of other nickel waste and scrap (HS 75030090) is currently 'restricted' in India, as per Directorate General of Foreign Trade (DGFT).

Table 5.3: India's Nickel Import Sources in 2023-24

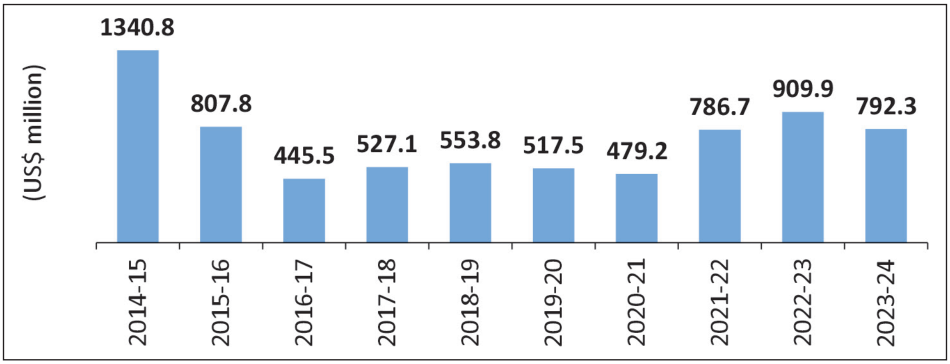
HS Code	Product	Import Source	Quantity (tonnes)	Share in Total Import of Product (%)
282540	Nickel oxides and hydroxides	Australia	90561.2	98.9
		China	361.6	0.4
		Sweden	296	0.3
		Others	345.7	0.4
		Total	**91564.5**	**100**
282735	Chlorides of nickel	Japan	174	67
		Belgium	46	18
		France	20	8
		Others	18	7
		Total	**258**	**100**
283324	Sulphates of nickel	Belgium	810	53
		Japan	398	26
		South Africa	181	12
		Others	128	8
		Total	**1517**	**100**
7502	Unwrought nickel	Norway	5878	17
		China	4942	15
		Netherland	4500	13
		Japan	3892	12
		Canada	3129	9
		Others	11392	34
		Total	**33733**	**100**

HS Code	Product	Import Source	Quantity (tonnes)	Share in Total Import of Product (%)
7503	Nickel waste and scrap	Saudi Arabia	1061	24
		USA	698	16
		UAE	593	14
		Singapore	300	7
		Malaysia	222	5
		Others	1473	34
		Total	**4346**	**100**

Source: Mining of Critical Minerals, Ministry of Mines, Lok Sabha Unstarred Question No. 3818 Answered on 18.12.2024

During 2014-15 to 2023-24, the value of nickel imports into India contracted at a CAGR of (-) 5.1%. In 2023-24, in value terms, unwrought nickel (HS 7502) saw the highest import into India, among the select nickel subcomponents being analysed in the Study, amounting to US$ 696.1 million. Norway was the largest source with unwrought nickel imports from the country being worth US$ 121.6 million in the same year.

Figure 5.3: Value of India's Nickel Imports (FY 2015 to FY 2024)



Note: Data included for HS Codes: 2604 - Nickel Ores and concentrates; 282540 - Nickel oxides and hydroxides; 282735 - Chlorides of Nickel; 283324 - Sulphates of Nickel; 7502 - Unwrought nickel; 7503 - Nickel waste and scrap

Source: Directorate General of Commercial Intelligence and Statistics (DGCIS); India Exim Bank Research

The Philippines which is the second-largest producer of nickel globally, has invited India to source its nickel for the latter's EV battery manufacturing, with the objective to diversify its nickel exports beyond China[26].

Cobalt

At present, India has a modest cobalt refining capacity estimated at 2,060 tonnes per year with Nicomet Industries Ltd. in Goa and Rubamin Ltd. in Gujarat being the lead producers. Globally, cobalt mining and refining have among the highest geographical concentrations with DR Congo and China being dominant players in these respective areas.

In 2023-24, among the select cobalt subcomponents analysed, India's import of cobalt oxides was the highest which was almost entirely sourced from Belgium (Table 5.4). As of 2021, Belgium is the largest cobalt refiner in the EU after Finland, with an annual cobalt refining capacity of 3,000 metric tons[27]. Belgium has emerged as a key import source of cobalt for India which may be attributable to the presence of Umicore's cobalt refineries that produce a variety of cobalt oxides, salts, and cobalt metal powders. According to the U.S. Geological Survey, in 2019, Umicore produced an estimated 1,500 metric tons of refined cobalt in Olen, Belgium. In the same year, Umicore also acquired Freeport Cobalt's cobalt refinery in Kokkola, Finland - Europe's largest cobalt refinery – thereby transferring certain cobalt refining and processing activities there, starting late 2023.

Further on, China which is the largest producer of refined cobalt in the world holding an annual cobalt refining capacity of 166,000 metric tons as of 2021, is also a vital import source for India's cobalt supply. In 2023-24, China supplied over 90% of India's import of commercial cobalt oxides, among other cobalt subcomponents as well. China houses the world's largest cobalt refining company Zhejiang Huayou Cobalt Co., Ltd. (Huayou), along with other dominant players like Shenzhen GEM High-Tech Co. Ltd. (including subsidiary Jiangsu Cobalt Nickel Metal Co. Ltd.), and Jinchuan Group Co. Ltd.

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[26] Philippines eyes India as a key nickel buyer for EV batteries, trade pact talks gain momentum, ET Energy World (March 2025)

[27] Cobalt (Advance Release), Minerals Yearbook 2021, U.S. Geological Survey (February 2025)

Notably, the import of cobalt waste and scrap (HS Code 8105 3000) which earlier was under a 'restricted' import policy in India, shall henceforth face full exemption of Basic Customs Duty along with imports of cobalt powder, as announced in the Union Budget 2025-26.

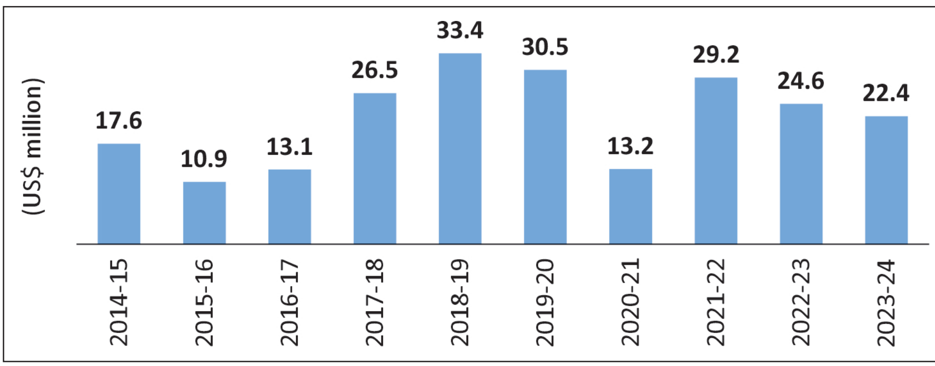
Table 5.4: India's Cobalt Import Sources in 2023-24

HS Code	Product	Import Source	Quantity (tonnes)	Share in Total Import of Product (%)
2605	Cobalt ores and concentrates	UK	1	91
		China	0.1	9
		Total	**1.1**	**100**
28220010	Cobalt oxides	Belgium	313	93.9
		China	10	3.1
		Finland	8	2.4
		Others	2	0.6
		Total	**333**	**100**
28220020	Cobalt hydroxides	Belgium	133	62
		China	45	21
		Korea	10	5
		Others	27	13
		Total	**215**	**100**
28220030	Commercial cobalt oxides	China	25	91
		Germany	1.4	5
		France	0.95	3
		Total	**27.4**	**100**
81052020	Unwrought cobalt	Belgium	132.8	42
		China	96.6	30
		Japan	41	13
		Norway	40	13
		Others	6.5	2
		Total	**316.9**	**100**

Source: Mining of Critical Minerals, Ministry of Mines, Lok Sabha Unstarred Question No. 3818 Answered on 18.12.2024

During 2014-15 to 2023-24, India's import value of select cobalt subcomponents increased at a CAGR of 2.5% (Figure 5.4). Among these, in 2023-24, unwrought cobalt was India's highest import at US$ 10.8 million, with Belgium as the largest import source at US$ 4.3 million worth of the product.

Figure 5.4: Value of India's Cobalt Imports (FY 2015 to FY 2024)



Note: Data included for HS Codes: 2605 - Cobalt ores and concentrates; 28220010 - Cobalt oxides; 28220020 - Cobalt hydroxides; 28220030 - Commercial cobalt oxides; 81052020 - Cobalt, unwrought; and 81053000 - Cobalt, waste and scrap

Source: Directorate General of Commercial Intelligence and Statistics (DGCIS); India Exim Bank Research

Graphite

India relies on imports to meet around 60% of its graphite demand. Domestic production of graphite in India has been estimated to be at 137.1 thousand tonnes in 2023-24. Among the two broad kinds of graphite being traded, India has greater import dependence on artificial graphite, the other being natural graphite.

In 2023-24, India's import of artificial graphite amounted to 101.9 thousand tonnes with high sourcing concentration from China which accounted for a share of 66% of India's total artificial graphite imports in the year. Import sources of natural graphite into India were relatively diverse led by Madagascar (45%) and China (39%). In 2023, China was the largest supplier of both, natural and artificial graphite worldwide with a global share of 81.6% and 89.7%, respectively[28]. China also refines 90% of global graphite used for EV battery anodes.

Notably, while India's dependence on China for natural graphite is analysed to be decreasing, the opposite is true for synthetic graphite[29]. In December 2023, China implemented export control measures on natural graphite through export certification requirements citing national security reasons.

Madagascar and Mozambique were the other notable graphite suppliers to India in 2023-24. Following China, these countries are also the other major suppliers of graphite, covering all grades, globally.

Table 5.5: India's Graphite Import Sources in 2023-24

HS Code	Product	Import Source	Quantity (tonnes)	Share in Total Import of Product (%)
2504	Natural Graphite	Madagascar	24429	45
		China	21326	39
		Mozambique	5548	10
		Others	3482	6
		Total	**54784**	**100**
3801	Artificial Graphite; colloidal or semi colloidal graphite; preparations based on graphite or other carbon in form of pastes, blocks, etc.	China	67088	66
		Germany	5435	5
		UAE	5354	5
		Others	24010	24
		Total	**101886**	**100**

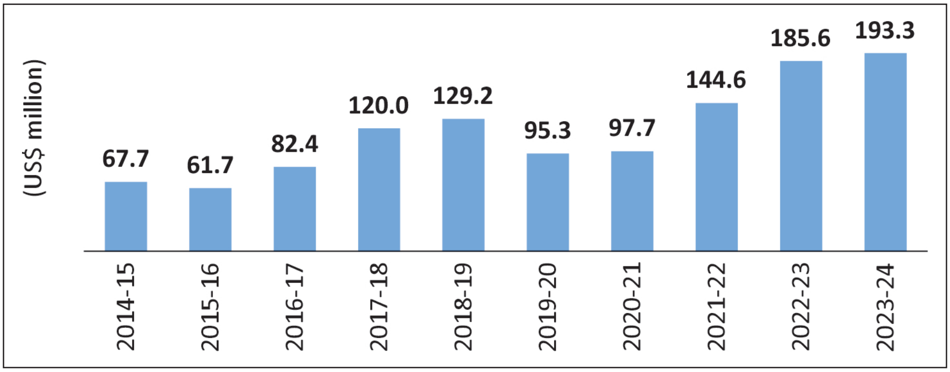
Source: Mining of Critical Minerals, Ministry of Mines, Lok Sabha Unstarred Question No. 3818 Answered on 18.12.2024

[28] Critical Minerals Data Explorer 2024, International Energy Agency (IEA)

[29] India's Hunt for Critical Minerals, Institute for Energy Economics and Financial Analysis (IEEFA) (October 2024)

Over the period of 2014-15 to 2023-24, the value of India's graphite imports increased at a CAGR of 11.1% (Figure 5.5). In 2023-24, India's imports of artificial graphite amounted to US$ 154.6 million far exceeding natural graphite imports at US$ 38.7 million.

Figure 5.5: Value of India's Graphite Imports (FY 2015 to FY 2024)



Note: Data included for HS Codes: 2504 - Natural graphite; 3801 - Artificial graphite; colloidal or semi colloidal graphite; preparations based on graphite or other carbon in form of pastes, blocks, etc.

Source: Directorate General of Commercial Intelligence and Statistics (DGCIS); India Exim Bank Research

India is also said to be holding discussions with Sri Lanka to acquire a graphite mine block from the latter, in line with the aim to better secure its critical mineral supplies through international agreements and partnerships. Sri Lanka's graphite is considered among the purest in the world with more than 98% carbon content[30].

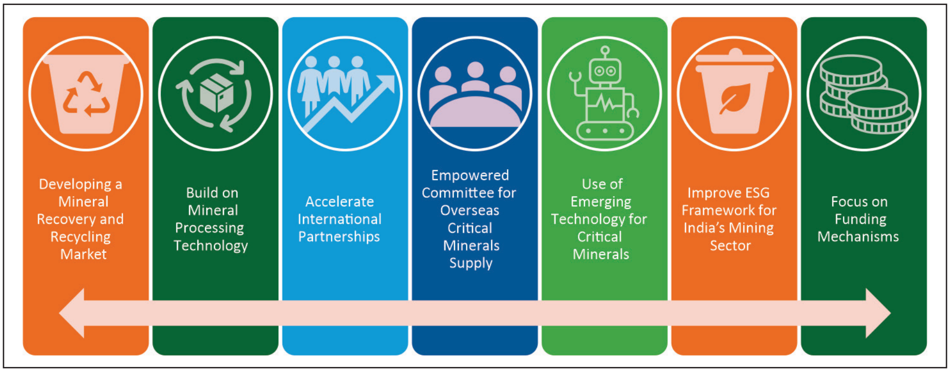
[30] India in talks with Sri Lanka to acquire graphite mine block, The Economic Times (May 2024)

6. Recommendations and Way Forward

As climate change concerns continue to rise, the adoption of clean energy technologies is expected to remain as the largest growth driver for global critical minerals demand. Under the IEA's Sustainable Development Scenario (SDS) that describes the energy sector requirements to meet key energy-related goals of the United Nations, the share of clean energy technologies in the total demand is expected to rise up to over 40% for copper and REEs, 60-70% for nickel and cobalt and almost 90% for lithium by 2040. Supply risk for these minerals remain vulnerable for all countries, especially for mineral import dependent countries like India.

In this regard, the following suggestions are provided to help build and secure India's critical minerals supply, both from domestic and foreign sources.

Figure 6.1: Select Recommendation for Securing Critical Minerals by India



Source: India Exim Bank Research

1. Develop Mineral Recovery and Recycling Market

India may focus on developing a mineral recovery and recycling market with the objective of supplementing its critical mineral supply base, through a secondary source while also mitigating the environmental and social impacts of sustained mineral mining.

Critical minerals, unlike non-renewable fossil fuels, have the potential to be recovered from mining waste and also recycled from end-use products, thereby helping to promote the principles of a circular economy and mitigate the environmental burdens caused by new mineral mining projects.

Interventions to Scale up Recycling Capacity

Development of mineral recovery and recycling markets is at the core of sustainable minerals development and creates a secondary supply source of these energy transition minerals to meet their soaring demand. This is of great benefit to mineral import dependent countries like India in easing energy security concerns and mitigating the impact of volatile supply chains and prices of minerals.

Potential sources for the recovery of critical minerals include topsoil overburden, fly ash, and mining waste like tailings from processing, red mud and metal slags. Further, mineral recycling involves reprocessing of minerals from scrap used in manufacturing, electronic waste, construction materials, end-of-life batteries, to name a few.

According to IEA, by 2040, recycled quantities of copper, lithium, nickel and cobalt from spent batteries could reduce combined primary supply requirements for these minerals by around 10%.

Globally, the EU holds the leading position in the critical minerals recycling market with over 50% of its base metal production demand being met using recycled metals. In this regard, the European Raw Materials Alliance (ERMA) was announced in 2020, as part of an Action Plan on Critical Raw Materials, with the aim of promoting a circular economy approach for critical minerals and supporting mineral recycling efforts, among other objectives.

Therefore, India too may explore different intervention mechanisms to promote mineral recovery and recycling in the country. Focusing on boosting investment in mineral recycling infrastructure, comprising efficient collection of mining waste, segregation of minerals and further metallurgical processing to recover the concerned critical minerals, will help build mineral buffers from secondary sources. Financial assistance may also be provided by way of funding R&D for new recycling technologies, that is key to the functioning of this market, along with direct subsidies to mineral recycling companies.

A policy focusing on 'urban mining' in India may also be explored. Urban mining involves recovering various critical minerals from e-waste, plastics, construction waste, among others. In an urban setting, discarded mobile phones and other electronic devices are major potential items for urban mining. Given that India witnessed a surge in e-waste generation over the past five years, rising from 1.01 million metric tonnes in 2019-20 to 1.75 million MT in 2023-24[31], a focused policy intervention for urban mining/safe disposal will not only secure better mineral supply through recycling but also generate urban employment, reduce the potential for environmental damage and mitigate the threat to public health.

India's announcement in the Union Budget 2025-26 to fully exempt waste and scrap of critical minerals like cobalt, copper and lithium-ion battery from import duty, is also expected to promote mineral recycling in the country.

In February 2025, as part of the India-US TRUST (Transforming Relationship Utilizing Strategic Technology) initiative, India and the USA announced the launch of the Strategic Mineral Recovery initiative to recover and process critical minerals like lithium, cobalt and rare earths, from heavy industries like aluminium, coal mining and oil and gas[32]. Similar cooperation agreements can be explored with countries from the EU which are dominant players in the market.

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[31] E-Waste Management in Urban Areas, Ministry of Housing and Urban Affairs, Unstarred Question No. 2384 to be Answered on December 16, 2024

[32] India - U.S. Joint Statement during the visit of Prime Minister of India to US, PIB (February 2025)

PLI for Recycling of Critical Minerals

Recycling of critical minerals includes recovering them from end-of-life products through techniques like urban mining, and processing them to separate and clean the minerals for reuse. This is a key component of sustainable development, which aligns with the circular economy principles, thereby reducing resource depletion and environmental impact.

Given that this requires significant investments, the Central Government could play a key role by providing grants, incentives and support for such projects. Besides, this also would require technical manpower well-qualified in materials science and chemical engineering.

In this regard, the Government may also consider a Production Linked Incentive (PLI) scheme which would serve to deepen the recycling of critical minerals within India, through focus on recovering minerals under urban mining, and promoting a circular economy.

It may be noted that for the making of the Tokyo 2020 Olympic medals, Japan embraced the circular economy by extracting precious metals from recycled e-waste, like smartphones and other discarded electronics, collected from across the country; and using them to make the approx. 5,000 medals. In fact, it was a two-year national effort involved collecting approximately 78,985 tons of small electronic devices, including mobile phones, digital cameras, laptops, and other devices. Over 90% of Japanese cities, towns, and villages participated by setting up donation pick-up sites, encouraging citizen participation in the recycling effort.

Box 6.1: Exim Bank Supports Recycling of Critical Minerals

The cumulative stock of lithium-ion batteries in India is approximately 22 Gigawatt hours (GWh). The growing focus on clean energy and electrification is expected to further push the demand for these batteries. Depending on the use, these batteries typically last for 5-15 years and continue to retain more than 60% of their capacity post their ‘end-of-life’, with a significant amount of critical battery materials.

These batteries that hit landfills can pose a threat to human health and the overall environment. It is also complex and expensive to clean up the leaked chemicals. Moreover, as batteries, even at the end of their life, have more than 50% of their capacity, there is massive wastage in terms of raw materials.

Against this backdrop, battery recycling plays a critical role in conserving natural resources, reducing environmental pollution, and promoting the sustainable development of electric vehicle and energy storage industries. By recovering valuable materials from used batteries and reintegrating them into the production cycle, recycling helps mitigate the environmental/ public health impacts of battery manufacturing and disposal. Recycling also creates a circular loop for critical battery materials, thereby ensuring resource efficiency.

To support this crucial stage of the battery lifecycle, Exim Bank has supported a company engaged in lithium-ion cell recycling. The firm collects end-of-life lithium-ion cells from electronics (laptops, mobile etc.), EVs and other devices and recycles them. Using their proprietary Net Zero Waste and Zero Emissions process, the company can recycle cells into high-grade black mass with less than 1% impurities. The black mass contains materials like lithium, cobalt, nickel, manganese, and graphite etc. The company, as part of its endeavour towards forward integration, has established the process of extraction of these valuable metals such as lithium, cobalt, nickel, manganese from black mass through its indigenous R&D and has also built a pilot project of processing the same.

The objective of the company, supported by Exim Bank, is to conserve resources and reduce environmental/health impact through battery recycling.

Source: India Exim Bank Research

2. Build on Mineral Processing Technology

Mineral processing typically involves the segregation of commercially valuable minerals from the surrounding rock or brine and other impurities. This stage of the mineral value chain requires advanced technological solutions to extract, separate, and purify usable minerals. Globally, mineral processing has a higher degree of geographical concentration relative to mineral reserves and production. This is a major bottleneck in the critical minerals supply chain, resulting in high mineral import dependency for countries like India.

Table 6.1: Critical Mineral wise Processing Technique

Critical Mineral	Mineralogy	Common Ores	Processing Techniques
Copper	Sulphide, carbonate	Chalcopyrite, bornite, malachite	Smelting, Electrorefining
Lithium	Pyroxene, mica	Spodumene, lepidolite	Roasting, electrolysis, ion-exchange
Nickel	Silicates, sulphides	Pentlandite, laterite	Pyrometallurgical, hydrometallurgical, precipitation
Cobalt	Arsenide	Cobaltite, lateritic nickel ores	Roasting, electro-winning, precipitation
Graphite	Native element	Natural graphite, flake graphite	Froth flotation, gravity separation, and magnetic separation

Source: Addressing Vulnerabilities in the Supply Chain of Critical Minerals, Council on Energy, Environment and Water (CEEW), International Energy Agency (IEA), Institute of Transportation Studies UC Davis and World Resources Institute India (WRII), Ministry of Mines (April 2023)

Incentivise Mineral Processing Capabilities

Despite the presence of a few companies in India that have built domestic processing capacity, overall, the sector shows slow technological adoption and a lack of large-scale mineral processing and downstream value-addition technologies. Strengthening of mineral processing capabilities in India will enable clean energy technology manufacturers in the country to procure raw materials domestically and reduce import dependency for the same. This highlights the urgency in scaling up mineral processing capacity in India.

Presently, China holds a quasi-monopoly in the sphere of mineral processing and refining in the world. For instance, as per IRENA, China currently accounts for 100% share in the global supply for refined natural graphite and dysprosium (a REE), over 90% share for manganese, 70% for cobalt, almost 60% for lithium and about 40% for copper. In 2023, China also banned the export of rare earth extraction and separation technologies, thereby further leveraging its dominant position in this stage of mineral supply chain.

Therefore, to safeguard itself from such potential supply shocks, India must focus on building its mineral processing capabilities through various measures. Considering the capital-intensive nature of mineral processing technologies, increasing investment in required mineral processing facilities is a must, along with scaling up of R&D to adopt innovative technologies. Incentives through tax-breaks may be imperative to increase private sector participation in processing facilities. International partnerships are instrumental in acquiring processing knowledge through technology transfers or joint development of these facilities in proximity to India's overseas mineral assets.

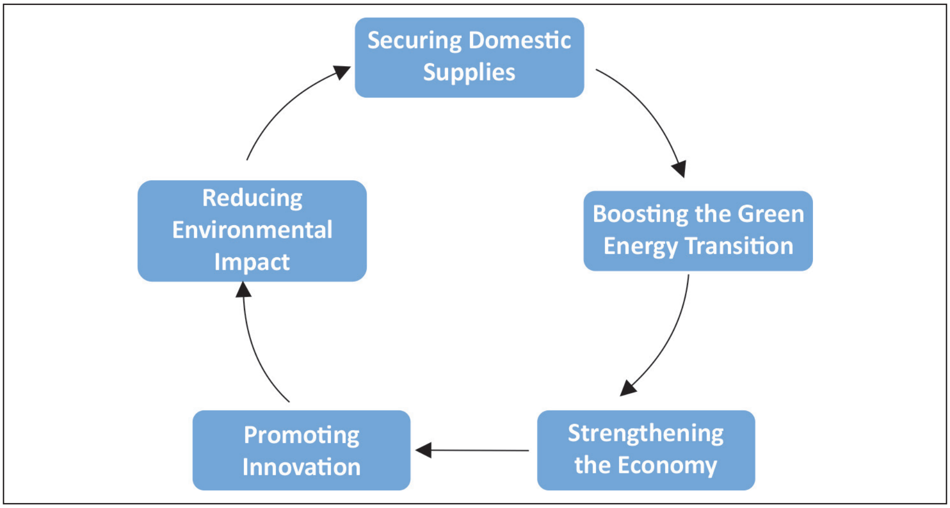
Critical Mineral Processing Parks

The National Critical Mineral Mission of 2025 has allocated funds to support the 'Critical Mineral Processing Park'.

A Critical Mineral Processing Park would focus on providing required infrastructure for processing and refining, thereby driving competition and strengthening supply resilience, while maximizing efficiency and reducing costs by handling large volumes of ores and concentrates. These parks will facilitate the streamlining of processing facilities and help develop long-term processing capacity in the country.

India can explore setting up these parks strategically in mineral rich states, like Rajasthan, Odisha, Jharkhand, and Maharashtra, to name a few, preferably in close proximity to mining projects to ease transportation cost and increase productivity. Availability of a conducive logistics ecosystem that includes railways, highways, and ports, enabling efficient movement of materials; besides water and available essentials, are key location determinants to set up these parks.

Figure 6.2: Opportunities Afforded by a Critical Mineral Processing Park



Box 6.2: Critical Mineral Processing Hubs Abroad

Establishment of critical mineral processing hubs have been led by China, and are now also found in countries like Australia, Canada, and Indonesia (especially for minerals like lithium and nickel). These hubs develop processing capabilities and leverage their geographic and resource advantages to establish themselves as pivotal players in the mineral supply chain. Chile, for example, is doing so with copper and lithium.

At the same time, they require significant investments. Australia, for example, by fast-tracking approvals for lithium and rare earth elements (REEs) projects, has attracted global investment and strengthened its position in the critical minerals supply chain.

Indonesia offers a prime example of the hub concept in action. Its ascent as a global nickel-processing hub is not solely due to it holding the world's largest nickel reserves. Policy adjustments supporting domestic mid-stream activities, instituted in January 2020, helped accelerate the growth of its processing industry. Indonesia subsequently attracted US$ 21 billion in foreign investment for mining and processing, as well as for strategic partnerships. From 2019 to 2024, the number of smelters in the country increased from 11 to 44, with over 20 more under construction.

The value of Indonesia's nickel exports grew enormously, from US$ 1 billion in 2015 to US$ 20 billion in 2022, reinforcing the country's importance in the global EV battery supply chain. Domestically, expansion of the industry has created more than 150,000 jobs, contributing to Indonesia's economic growth and underscoring its strategic importance in the global critical minerals landscape.

Source: India Exim Bank Research

3. Accelerate International Partnerships

With demand for critical minerals in key sectors such as EVs and defence expected to continue growing, India will need to develop strategies to partner with resource-rich countries across the different broad stages of the critical minerals supply chain, like mineral exploration, extraction, refining, using various channels.

Although India is implementing several policy measures and initiatives to build resilient critical minerals supply chains, like the National Critical Minerals Mission announced in January 2025 to promote exploration within the country and at offshore locations, with an expenditure of ₹16,300 crore and expected investment of ₹18,000 crore; import duty exemptions for 12 critical minerals, including cobalt powder and waste, lithium-ion battery scrap, and lead and zinc, among others; the supply risk posed by the heavy concentrations globally, of mineral mining and processing remains. To insulate itself from such supply vulnerabilities, India could focus on mineral supply diversification and accelerate engagements with different countries to build resilient supply chains.

India may focus on introducing a national stockpiling system to safeguard its critical mineral supplies, either through the establishment of a national concerned body or implementation of such a national or multilateral scheme. Acting as a shock absorber, the stockpiling of mineral reserves is undertaken in times of low commodity prices to build up inventories that serve as buffers during short-term supply disruptions or high demand scenarios. Such a mechanism could be adopted by India along with resource rich countries or India's regional partners like ASEAN, as a joint initiative. A similar set up for joint procurement and stockpiling of critical minerals is being explored by Japan and the EU to enhance their minerals supplies.

Increasing India's engagement overseas through offtake agreements will also serve to enhance international cooperation and strengthen the mineral supply position. Such agreements are mutually beneficial for the mining company as well as mineral manufacturers. India's clean energy producers like manufacturers of EV batteries and solar panels can enter into offtake agreements with foreign mineral suppliers to secure themselves against supply shocks.

Opportunities for entering into international partnerships with resource-rich countries also exist in the spheres of mineral exploration and mining. Agreements like the one between India's KABIL and Argentina's CAMYEN, signed in 2024 for the exploration and mining of five lithium blocks in Argentina, may be actively pursued in future. Along similar lines, India is also expected to sign an agreement with Mongolia for cooperation in geology and exploration, with focus on copper and coking coal[33]. Such agreements with Zambia and DR Congo are also in discussion.

Furthermore, India must combine strategies that ensure access to capital and leverage partnerships such as the USA-led Mineral Security Partnership, which emphasises ESG-focused supply chains; and the Quad partnership, to secure critical mineral resources. India could, in fact, use ESG compliance as a unique selling point for building new relationships.

Additionally, India could take advantage of infrastructure projects such as the Lobito Corridor rail link, supported by the USA and the European Union, which connects ports in Angola to mines in the DR Congo and Zambia.

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33 India to Sign Mining Pact with Mongolia Soon, Govt Source Says, Economic Times (January 2025)

4. Empowered Committee for Overseas Critical Minerals Supply

India needs to look at investments in critical mineral assets abroad either through a joint venture, acquisition, or on lease basis. This would require a series of recurring loans for mine development and expansion, ensuring working capital to maintain operations and secure long-term access to their outputs.

As India needs to secure its mineral supply, especially of those minerals which are of critical nature, an Empowered Committee is needed to take prudent and quick decisions, especially when it comes to overseas transactions.

This may be more important wherein there is a probability of securing overseas critical minerals, especially at the time any default.

Currently, various ministries have their respective areas of focus. But, while deliberating on strategic issues like critical minerals, it is important that there is a consensus amongst many related ministries.

For example, there are around 7 PSUs and other related offices, reporting to the Ministry of Mines[34], which are responsible for all matters ranging from production to survey and exploration of all minerals, including rare earth minerals. At the same time there is IREL (India) Limited which is a Central Public Sector Undertaking under the administrative control of the Department of Atomic Energy, Government of India, which reports to the Prime Minister's Office. Most importantly, there is the Minerals and Metals Trading Corporation Limited (MMTC), which falls under the administrative control of the Ministry of Commerce and Industry.

Given that there are multiple government agencies involved in the broader contours of the mining sector, it is important for India to have a single 'Empowered Committee' (EC) focused on overseas investments in critical minerals. The Empowered Committee could constitute officials from the

[34] PSUs: NALCO, HCL, MECL, BGML; Attached office: GSI; Autonomous body: NIRM, JNARDDC

various PSUs of the ministries listed above, including Ministry of Mines, besides Ministry of External Affairs (MEA), Department of Economic Affairs (DEA), Department of Financial Services, including the National Security Advisor besides the related PSUs. The Empowered Committee would give comprehensive directions after evaluating the opportunities and risks in the overseas investment proposals.

However, the objective of this proposal is to set up an Empowered Committee for Critical Minerals only. Financial institutions like Exim Bank may also be a part of the Empowered Committee, inter-alia, for highlighting opportunities in select regions, and also possibly supporting strategic acquisitions. Such an EC mechanism could act as a focal point for devising India's strategy to secure critical mineral resources overseas.

Further, it may also be mentioned that India has in place a Concessional Financing Scheme (CFS) which supports Indian entities bidding for strategically important infrastructure projects abroad and which is operated by Exim Bank.

Box 6.3: China's Financing Mechanism for Overseas Critical Minerals Projects

Globally, China is the largest importer of critical minerals and the largest hub for mineral processing, post which it exports the processed minerals across the world. The 'Going Out' strategy announced in 1999, forms the foundation for China's mineral resource seeking initiatives which comprises 'resource-for-infrastructure' (RFI) arrangements, with lending from China's policy banks — Export-Import Bank of China (China Eximbank) and China Development Bank (CDB), among other institutions.

Critical mineral acquisition is a major focus area in the implementation of these RFI arrangements, wherein lenders from China extend loans for various infrastructure projects in the host country, the repayment of which is done with the cash proceeds from the host country's natural resource exports to China. In this regard, the Belt and Road Initiative (BRI) has also been instrumental in facilitating mining extraction across participating countries, in return for minerals exports to China.

China's funding mechanisms for its overseas critical mineral asset acquisition activities is broadly outlined below.

During the period from 2000 to 2021, the Government of China and state-owned institutions extended 1 grant commitment worth US$ 9 million and 93 loan commitments worth US$ 56.9 billion to support the extraction and processing of 5 critical energy transition minerals across 19 low and middle-income countries. This financial support is usually provided for upstream (mineral extraction) activities with primary focus on copper mining operations, the financial commitment to which amounted to US$ 47.3 billion between 2000 and 2021. The two largest copper extraction projects by China involve the acquisition and development of the Toromocho and Las Bambas copper mines in Peru.

Over this 22-year period, Peru and DR Congo were the highest fund receiving countries from China for critical mineral projects, with amounts of US$ 16.6 billion and US$ 13.2 billion, respectively. These countries also led in terms of number of loan events received over the same period.

Table: Critical Mineral wise Overseas Financial Commitments by China During 2000-2021 (at constant 2021 USD)

Critical Mineral	No. of Loans and Grants	Commitment Amount (US$ billion)	No. of Mining Sites	No. of Processing Sites	No. of Host Countries
Copper	81	47.3	38	2	17
Cobalt	25	15.9	11	1	5
Nickel	11	7.2	5	1	5
Lithium	3	3.2	1	0	1
Rare Earth Elements	1	0.3	1	0	1

From 2000 till 2021:

- about 80% (US$ 45.2 billion) of China's official sector lending to Low-Income Countries (LIC) and Middle-Income Countries (MIC) pertaining to critical mineral operations is through a special purpose vehicle (SPV)/ joint venture (JV). The highest loan amount extended to Peru (about

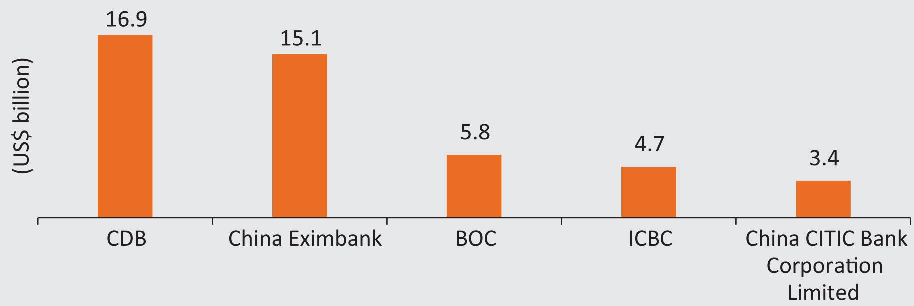
US$ 6 billion in 2012), for the mine acquisition project in Las Bambas Copper Mine, was through a SPV/JV set up, comprising creditors including CDB, China Eximbank, ICBC and BOC;

- nearly 75% (US$ 947 billion) of China's international development finance portfolio between 2000 and 2021 qualifies as public and publicly guaranteed debt[35] (PPG); and
- 83% of China's official sector lending to the critical mineral projects is partially or wholly owned by Chinese companies.

China uses a diverse set of financial institutions and instruments to address the perceived risks and rewards of different borrowing sectors and countries. During 2000-2021, two policy banks, namely, CDB and China Eximbank, together accounted for US$ 32 billion, (constituting a share of 56%) of China's total official sector financing for transition mineral projects.

It may also be noted that substantial amount of China's lending for overseas critical mineral activities is through 'syndication'[36].

Figure: China's Leading Official Sector Financiers of Critical Mineral Projects During 2000-21 (at constant 2021 USD)



Note: CDB - China Development Bank; China Eximbank - Export-Import Bank of China; BOC - Bank of China; ICBC - Industrial and Commercial Bank of China

[35] Public debt is an external obligation of a public debtor, including the national government, a political subdivision (or an agency of either), and autonomous public bodies. Publicly guaranteed debt is an external obligation of a private debtor that is guaranteed for repayment by a public entity.

[36] Syndication refers to an arrangement in which multiple creditors participate in a single loan agreement with a borrower.

In the context of ESG norms followed in China's critical minerals landscape, its non-state-owned actors are increasingly gaining importance in both, domestic and China's overseas mineral projects. The China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters (CCCMC), is among the major non-state entities that play a vital role in shaping China's ESG norms along with other players like private entities, NGOs, and civil society organizations. For instance, when a Chinese company faced human rights violation allegations in DR Congo, CCCMC collaborated with OECD and other Chinese and international companies to launch the Responsible Cobalt Initiative (RCI) in 2016, with aims to mitigate the adverse impacts of cobalt mining. This was followed by the launch of the Cobalt Refiner Supply Chain Due Diligence Standard (Version 2.0) in 2021 and the rebranding of RCI as the 'Responsible Critical Mineral Initiative' in 2022.

However, during 2000-2021, 80% of China's critical mineral projects encountered at least one type of ESG risks - social and environmental risks were the most commonly identified, followed by governance risks. As mentioned above, China often uses syndicated lending instruments in place of bilateral instruments to manage ESG related risks for its overseas critical minerals projects. This has served to strengthen ESG compliance, as, instead of relying on only one Chinese bank to evaluate borrowing institutions and proposed mineral-related transactions, China is increasingly outsourcing its ESG risk and repayment risk management to lending institutions with stronger due diligence standards and safeguard policies

Source: Power Playbook: Beijing's Bid to Secure Overseas Transition Minerals, (Escobar et al., 2025); AidData's Chinese Financing for Transition Minerals Dataset, Version 1.0; Can the Race for Decarbonization Be 'Green'?: Critical Minerals, China's Responsible Mining Initiatives, and the Role of Non-State Actors, (DiCarlo, 2024); India Exim Bank Research

5. Use of Emerging Technology for Critical Minerals

With rapid advancement in digitalisation and automation around the world, India should also focus on promoting technological innovation and integrating emerging technologies like Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML) into its mining sector, with the objective of enhancing efficiency and productivity across the different stages of mineral exploration, mining, processing, refining, production and even recycling.

Figure 6.3: Key Benefits of Using Emerging Technologies in Critical Minerals Sector

Increased adoption of emerging technologies into India's mining sector will improve efficiency of mineral exploration through say, remote sensing and Geographic Information Systems (GIS). Considering that insufficient exploration data has also been cited as the primary reason for the setback faced in the auctioning of the inferred 5.9 million tonnes of lithium found in Jammu and Kashmir's Reasi district leading to re-exploration plans of the site[37], increased use of advanced technology could help resolve such bottlenecks in India's critical minerals supply chain.

Further, automation using smart sensors and AI-powered drilling will enhance mining precision and increase worker safety at mining projects, by minimising human involvement. The utilisation of smart logistics and predictive analytics will help in supply chain optimisation by ensuring transparency in documentation and transportation of minerals. Such technologies can be used in the proposed Critical Mineral Processing Parks, in particular, thereby further optimising and centralizing the critical minerals supply chain in India.

Table 6.2: Emerging Technology-wise Select Intervention in the Critical Mineral Supply Chain

Technology	Intervention
Artificial Intelligence (AI)	• Real time analysis of geospatial data • Predictive maintenance of mining equipment • Autonomous drilling and haulage system, reducing human accidents
Machine Learning	• Identify and evaluate mineral deposits using drone and satellite imagery • Detection of counterfeit or low-quality minerals • Analyse real-time data to improve ore sorting, crushing, and refining efficiency

[37] J&K's 5.9 mn tonne lithium reserve to be re-explored after failed auction, Business Standard (October 2024

Technology	Intervention
Blockchain	• Enhances transparency and traceability in the supply chain • Streamlines logistics through automated agreements and reduced manual paperwork • Analyses data to predicts disruptions like geopolitical risks, port delays

Source: India Exim Bank Research

Research into emerging technologies like phytomining to extract domestic supply of critical minerals like nickel and cobalt, for instance, can also be explored in India as an ecologically sound technology. Phytomining uses hyper-accumulator plants to extract critical minerals from either natural soil or anthropogenic wastes such as mining wastes[38]. Use of this method will also facilitate scaling up of mineral recycling activities in India.

To sum up therefore, India may focus on boosting investment in R&D for better integration of emerging technologies into India's critical minerals sector, which will assist in achieving the multiple objectives of operational cost minimisation, real-time data monitoring, alignment with sustainability goals, supply chain optimisation, to name a few.

In this context, the Ministry of Electronics & IT (MeitY), in collaboration with the Geological Survey of India (GSI), launched the IndiaAI Hackathon on Mineral Targeting in March 2025, an initiative to leverage emerging technologies to enhance mineral discovery and geological analysis in the country by involving startups, research institutions, and industry experts, among others[39].

6. Improve ESG Framework for India's Mining Sector

With growing emphasis on sustainability, a comprehensive approach towards integrating Environmental, Social, and Governance (ESG) principles into India's

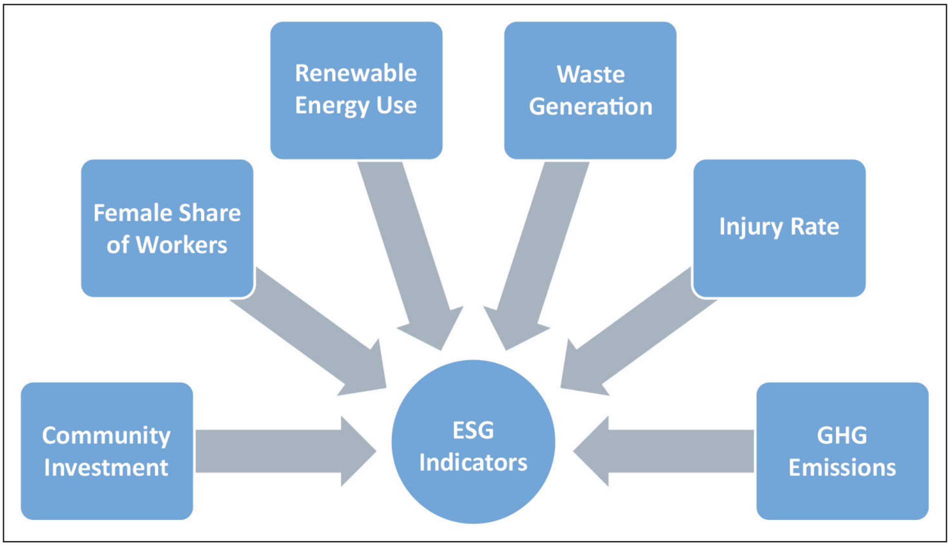
[38] How Could Phytomining Bolster U.S. Critical Mineral Supply Chains? U.S. Department of Energy (DOE) (August 2024)

[39] IndiaAI and the Geological Survey of India (GSI), Ministry of Mines, launched the IndiaAI Hackathon to revolutionize AI-driven mineral targeting, PIB (March 2025)

mining sector is the need of the hour, to ensure long term economic and social benefits, while also minimising environmental damage. In this regard, India may prioritise improving ESG frameworks within the sector.

The 26th United Nations Climate Change Conference (COP26), in 2022, highlighted the urgent need for stronger ESG standards in mining production to 'ensure economic benefits are shared and to minimise environmental impact' and thereby secure a sustainable and resilient critical minerals supply chain. With ever-increasing worldwide focus on decarbonisation, investors are pushing for greater adoption of green energy solutions and alignment with global standards on the part of mining companies, to ensure steady investment flows.

Figure 6.4: Select ESG Indicators



Source: International Energy Agency (IEA)

In this context, in the EU, the Corporate Sustainability Reporting Directive (CSRD) and the Corporate Sustainability Due Diligence Directive (CSDDD) enhance corporate accountability regarding ESG performance. While the CSRD made reporting on ESG metrics mandatory for all large European companies and companies listed on EU-regulated markets, CSDDD imposed mandatory human rights and environmental due diligence requirements on large companies in Europe.

India may also follow such directives to enforce stricter adherence to ESG principles in the mining sector through, say, transparent tax reporting, ethical business practices, environmental conservation, and active positive worker and community engagement. This will increase investor confidence besides enabling the concerned company to gain social license to operate new projects, and thereby strengthen the critical minerals supply chain in India.

In India, ESG norms can be better reported and adhered to through setting up of a dedicated working group that focuses on evolving mining sector specific principles as well as ensuring smooth implementation of the same. Incentivising and rewarding companies that are comprehensively implementing the ESG principles (mandated or otherwise) could be another focus area. Further on, harmonisation of ESG norms within India's trading blocs or regional cooperation blocs can ease trading and investment flows within the critical minerals sector by ensuring transparency in mineral supply movement through comparable data across countries, among other advantages.

7. Focus on Funding Mechanisms

Investment in the critical minerals sector in India may involve several risk factors like (i) delayed revenue streams given the highly capital-intensive nature of mining, (ii) volatile commodity prices, (iii) insufficient geological data, (iv) lack of advanced mineral processing technology, to name a few. However, to secure its critical minerals supply, India must continue to explore the various investment funding mechanisms:

Exploring PPP in Critical Minerals

As the need for critical minerals is projected to significantly rise going forward, India could look at exploring and supporting public-private partnerships (PPP) towards funding mining projects in India and overseas.

In fact, the PPP entity could explore setting up a Special Purpose Vehicle in which Indian government-owned firms hold majority stakes. This structure would enable isolating financial risk, facilitate securitisation, and enable specific financial transactions or projects without affecting the parent company's balance sheet or operations.

To encourage PPP in the acquisition of assets abroad, the Government may also look at providing suitable subsidies for mining or setting up evacuation mechanism.

Alternate Funding Mechanisms

For domestic critical mineral projects, India must pursue alternative funding mechanisms such as offtake agreements with private companies. Private companies may offer advanced technology for production and mineral recycling, thus expanding the value chain.

An innovation fund, focused on mineral processing, may be utilised in India, especially given the R&D necessity in this stage of the supply chain in the country. Along similar lines, Canada's Critical Minerals Strategy, Budget 2022, has proposed US$ 1.5 billion through its Strategic Innovation Fund (SIF) to focus on innovative projects in areas of mineral manufacturing, processing, and recycling applications[40].

Further, 'green bond' is another financial tool that may be utilised to garner capital in financing critical mineral recovery through recycling projects.

Countertrade

Countertrade has time and again emerged as an important mode of international transactions for countries facing currency or cross-border payment challenges. India can look at countertrade as an alternative framework for facilitating trade and cross-border transactions in India, with

[40] Critical minerals, Innovation, Science and Economic Development Canada, Government of Canada

the objective of securing supply of strategic mineral resources where India has significant import dependence.

Countertrade is also not new for India, as the country has engaged in several types of countertrade arrangements in the past with countries like Iraq, Malaysia, erstwhile Soviet Union, Vietnam, Iran etc. However, despite several countertrade transactions over the years, there is no definitive policy for countertrade in India. Several countries like the Philippines, Indonesia and China have comprehensive countertrade policies that have helped secure imports of critical items even in the wake of growing uncertainties.

Conclusion

This detailed Exim Bank Study on critical minerals have significantly highlighted its need for India's growth, especially in energy transition sectors like defence, electronics, telecommunications, renewable electricity generation, to name a few.

The situation would increasingly get aggravated given India's high import dependence for these critical minerals, thus bringing forth the need to diversify its foreign supply chains, while simultaneously developing domestic exploration and production capabilities.

This Study has also delineated focussed interventions for policy makers, which could possibly be explored by India to secure critical energy transition minerals, which in the process would also help to achieve its climate action goals in the medium term.

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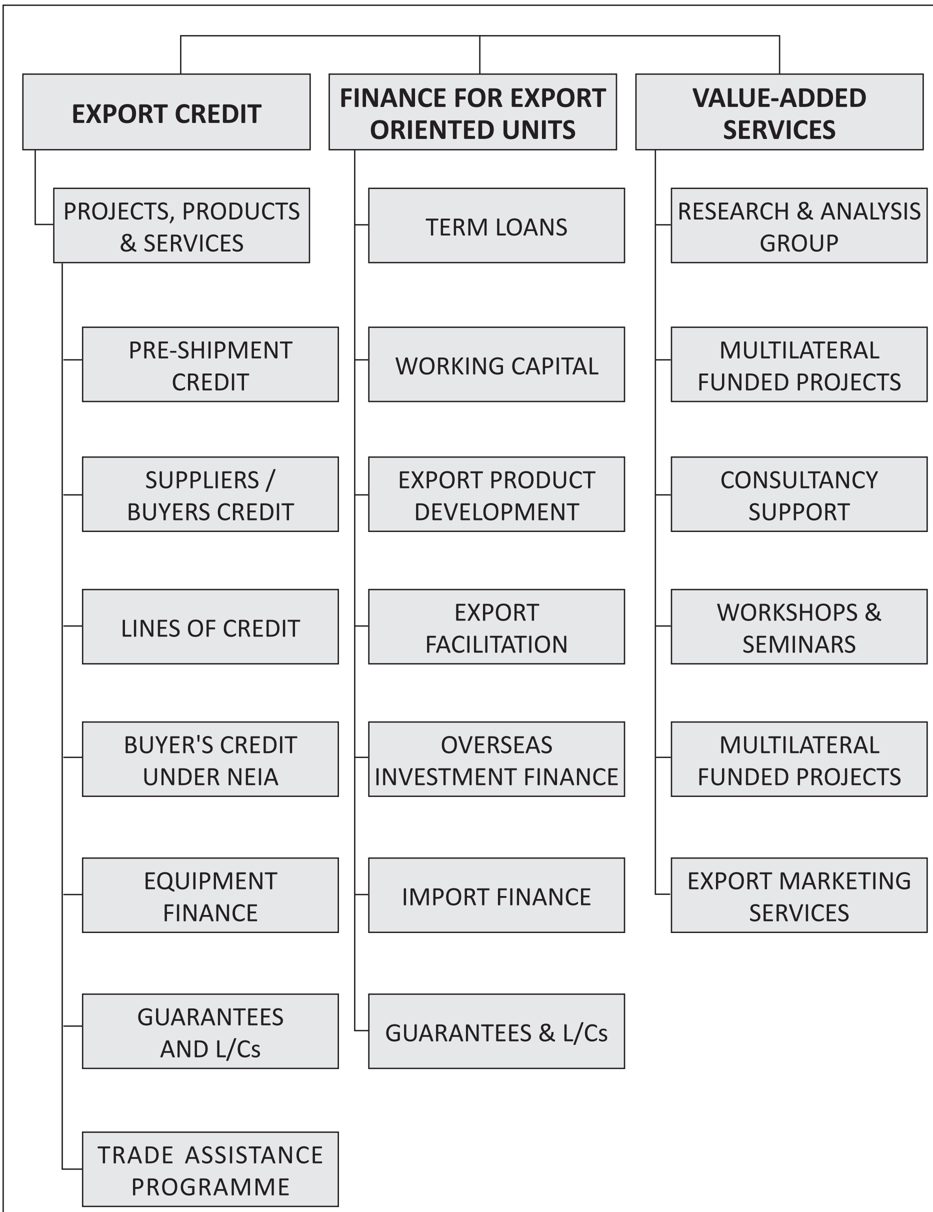
Bank's Major Programmes



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