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Critical Minerals and Rare Earth Elements: Driving India's Transition to a Resilient and Self-reliant Economy

February 2026

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FICCI would also like to thank Deloitte for preparing the report after close consultation with industry representatives, policymakers and other sectoral experts. The Deloitte team undertook comprehensive secondary research and stakeholder interactions to deliver a well-rounded analysis, offering a 360-degree perspective on India's critical minerals landscape and its alignment with national priorities for resilience and self-reliance.

This report seeks to present an integrated view of trends, opportunities, challenges and policy imperatives shaping India's critical minerals ecosystem, highlighting pathways for sustainable growth and strategic positioning in the global value chain.

FICCI also expresses its appreciation to various organisations, associations and individual experts in the sector for sharing their insights and contributing to the report. Their views have contributed immensely to finalising the report.

FICCI expresses its gratitude to everyone whose efforts were essential to the development of this report.

Foreword by FICCI



The accelerating global transition towards clean energy, digitalization, and advanced manufacturing is fundamentally highlighting towards the strategic importance of critical minerals and rare earth elements. These materials are indispensable for emerging applications across renewable energy, electric mobility, energy storage, electronics, and defence technologies.

For India, the ability to anticipate demand, secure reliable supply, and build domestic capabilities across critical minerals value chain will be central to sustaining economic growth, energy security, and technological competitiveness.

Policy announcements in the last one year or so have reinforced Government□s commitment to strengthening critical minerals ecosystem through targeted interventions. Initiatives such as National Critical Minerals Mission, PLI Scheme for Sintered Rare Earth Permanent Magnets, Dedicated Rare Earth Corridors in four mineral-rich coastal states and other schemes / incentives mark significant steps toward establishment of critical minerals' value chain indigenously, thereby reducing import dependence and enhancing supply-chain resilience.

We are delighted to share that FICCI and Deloitte have jointly developed this report on Critical Minerals and Rare Earths: Enabling India's transition to a resilient and self-reliant economy. The report offers a structured analysis of India's current and future demand–supply scenario for critical minerals and rare earth elements, driven by emerging and strategic applications.

It highlights the evolving macroeconomic and policy landscape, evaluates supply constraints and vulnerabilities, and highlights opportunities across mining, exploration, processing, recycling, international tie-ups, and value addition that can strengthen India□s position in global critical minerals value chain.

We hope that you will find the report useful.



Jyoti Vij
Director General
FICCI

Foreword by Deloitte



India stands at a pivotal moment in its economic journey. The next decade will be defined by two reinforcing forces that include decarbonisation at scale and a strategic re-industrialisation that prioritises resilience, technology depth and value addition at home. Critical minerals and REEs sit at the nexus of these shifts. They are the hidden architecture of clean power, electric mobility, digital infrastructure, defence platforms and advanced manufacturing. Securing timely, sustainable and affordable access to these materials is no longer a sectoral concern; it is a strategic imperative that underpins energy security, industrial competitiveness and national preparedness.

Over the past few years, India has taken important steps to address this agenda, from legislative reforms and the creation of a national mission to faster exploration, auctions and an emerging focus on mid-stream processing, recycling and international collaborations. Yet, the centre of gravity of the global supply chain remains concentrated, with refining and separation capabilities clustered in a few geographies. Converting India's geological promise into manufacturing strength will therefore require disciplined execution across the value chain. This includes targeted exploration, bankable project development, domestic processing hubs for battery and magnet materials, circularity at scale and deep collaboration between government, industry, finance and research institutions.

This report, Critical minerals and rare earth elements: Enabling India's transition to a resilient and self-reliant economy, has been prepared to inform that execution. It maps the evolving global context, quantifies demand–supply realities and highlights where India can build durable advantages, spanning upstream discovery and overseas asset access to midstream refining, standards, skills and technology. It also sets out practical pathways to de-risk investments while embedding high environmental, social and governance benchmarks that align with India's long-term development goals.

Deloitte commends the collaborative spirit with which stakeholders across government, industry, academia and finance have engaged on this agenda. We hope this report serves as a clear, actionable guide for decision-makers, helping India move decisively from vulnerability to designed resilience, and from a price-taker in raw materials to a value-maker in global clean-technology supply chains. India's competitiveness for decades will depend on the choices made today. Focused action and collaboration are key to securing the mineral foundations of Viksit Bharat.

Rajib Maitra
Partner, Deloitte India

1. Executive summary

The global economy is entering a decisive decade of structural change driven by decarbonisation and strategic re-industrialisation. As countries advance towards net-zero goals, demand for Critical Minerals (CMs) and REEs, used in batteries, motors, power grids, semiconductors and advanced alloys, is accelerating. Lithium, nickel, cobalt, graphite, copper and REEs anchor this transition, with demand expected to multiply by 2030. However, supply chains remain structurally imbalanced. Mining has diversified modestly, but midstream processing is overwhelmingly concentrated in East Asia, particularly China, which refines a dominant share of energy-transition minerals. This concentration amplifies exposure to export controls, policy shocks and price volatility.

In response, major economies are reshaping trade architecture through friend-shoring and targeted industrial policy. Frameworks such as the Minerals Security Partnership (MSP) aim to diversify supply, while emerging producers in Indonesia, Latin America and Africa expand upstream capacity. Yet medium-term bottlenecks persist, especially in copper and lithium, given declining ore grades, long project lead times and environmental constraints. Recycling and secondary supply will be increasingly relevant in the years ahead, but require coordinated technology, standards and financing.

For India, the landscape comprises risk and opportunity. Ambitions for 500 GW of renewables, 30 percent EV penetration by 2030 and net-zero by 2070 hinge on reliable access to these inputs, even as India remains import-dependent on key battery and magnet materials. Recent reforms, including the MMDR Amendment (2023) and the National Critical Mineral Mission (NCMM), mark a pivot from ad-hoc measures to a systemwide strategy spanning accelerated exploration and auctions, creation of domestic processing hubs, strategic overseas asset acquisition, scaled recycling and capability building across research, skills and finance.

Complementing these structural reforms, the Government of India has rolled out a set of targeted policy instruments to catalyse investment across the critical minerals value chain. Production-Linked Incentive (PLI) schemes for advanced chemistry cell batteries, electric vehicles, electronics and renewable energy equipment are indirectly driving downstream demand for critical minerals while incentivising domestic value addition alongside these reforms, new policy initiatives are emerging to support midstream capabilities, including incentives for Rare Earth Permanent Magnets (REPMs) manufacturing, critical mineral processing corridors and recycling technologies. The recently notified Tailings Policy further expands the resource base by recognising mine tailings, slags and overburden as potential secondary sources of critical minerals and REEs, enabling recovery, improved resource efficiency and reduced environmental footprints. Together, these measures seek to align mineral development with industrial growth, circular economy objectives and supply-chain resilience.

India has significant geological potential for lithium, graphite, nickel, cobalt, copper and REEs, though exploration and processing remain limited. The binding constraint is midstream, where the absence of commercial-scale refining for battery-grade chemicals and high-purity REE products drives value leakage and vulnerability. Executing NCMM with precision, including de-risking early-stage projects, crowding in private capital, enforcing ESG discipline and integrating circularity, can convert resource exposure into a strategic advantage.

The imperative is clear that securing and processing critical minerals at scale will determine India's manufacturing competitiveness and energy security. With disciplined implementation and international collaborations, India can transition from dependency to designed resilience, moving from a price-taker in materials to a value-maker in global clean-technology supply chains.

2. Introduction

Over the past decade, the global discussion on climate change has moved from awareness to urgency. Governments, industries and financial institutions are now aligning long-term strategies around decarbonisation and resilience. Most nations plan to reach net zero by 2050. This transition is driving an unprecedented demand for technologies such as renewable energy systems, electric vehicles, energy storage solutions and advanced electronics.

Critical minerals and rare earth elements form the foundation of these technologies. They are the silent enablers powering battery chemistries, permanent magnets, semiconductor fabrication and precision manufacturing. However, their supply chains are highly concentrated and vulnerable. A small number of countries control most of the mining and processing capacity, creating strategic chokepoints that affect prices, trade flows and technological sovereignty. When these chokepoints tighten, innovation slows, industrial development stalls and geopolitical concerns increase.

In recent years, export restrictions, resource nationalism and price volatility have forced governments to rethink their dependencies. Developed economies are redesigning procurement strategies, subsidising domestic processing and forming international mineral alliances. Investors are redirecting capital towards mining exploration, recycling technologies and advanced refining methods. The race to secure these resources has begun for economic growth, national security and industrial advantage.

For India, this global realignment presents both challenges and promising opportunities. With ambitious renewable energy targets, an expanding electric mobility programme, rapid digitalisation and a growing defence manufacturing ecosystem, the country's demand for critical minerals is expected to rise sharply. However, a sizeable portion of this demand is currently met through imports of both raw and processed materials, exposing domestic value chains to external disruptions.

At the same time, India possesses considerable untapped geological potential, a progressive reform agenda and increasing investor interest in mineral exploration and processing. Emerging policy instruments, incentive structures and international collaborations are creating an enabling environment for industry to scale domestic capabilities and reduce strategic dependencies.

Beyond securing inputs for clean energy technologies, developing a robust critical minerals ecosystem can generate second-order economic benefits for India. Localised processing, refining and metallurgical capabilities can catalyse downstream industries such as battery manufacturing, power electronics, aerospace components, high-performance alloys and permanent magnet production. These linkages have the potential to unlock high-value manufacturing exports, enhance domestic value addition and create skilled employment across geosciences, metallurgy, automation and advanced chemical engineering. As nations compete to anchor sunrise industries within their borders, the strategic control of these foundational materials will increasingly define industrial competitiveness over the next two decades.

Realising this vision, however, requires coordinated action across policy, trade, industry, academia and financial institutions. The complexity of critical mineral value chains, spanning exploration geology, environmentally responsible mining, complex hydrometallurgy, separation technologies, recycling and end-use integration, demands multi-stakeholder participation and long-term capital commitment. India's emerging ecosystem of mineral research centres, public–private innovation platforms, strategic joint ventures and green financing mechanisms signals a shift from reactive policy to proactive capability-building. India can do more than merely fill supply gaps; it can architect a resilient, innovation-driven ecosystem that evolves with technological advances and global sustainability expectations.

As the global supply chain undergoes structural diversification, India is well-positioned to strengthen its role in the critical minerals ecosystem. To fully realise this potential, it is essential to identify avenues for domestic exploration, development of processing capacity, value addition and overseas asset acquisition. This report examines the evolving macro landscape, assesses India's current demand–supply scenario and highlights key opportunities to support a resilient and competitive critical minerals value chain, advancing the nation's clean energy ambitions and long-term economic security.

3. Macro landscape for critical minerals

The global economy is entering a phase of structural transformation driven by three converging megatrends, including rapid technological advancement, the sustainability transition and strategic re-industrialisation. These forces are reshaping trade patterns, investment priorities and the demand for materials that underpin modern industry. Governments and corporations are increasingly investing in resilient, high-technology and low-carbon economic systems, marking one of the most significant shifts in industrial policy since the post-World War era. This transition spans both advanced and emerging economies, accelerating the need for metals, minerals and enabling technologies.

Amid this realignment, several sectors have emerged as strategic priorities due to their economic scale, technological intensity and reliance on critical materials. Energy transition, aerospace and defence, agriculture (including fertiliser minerals), electronics and semiconductors and speciality steels are widely recognised as sunrise sectors of the global economy. Each is supported by a distinct set of minerals essential to technological advancement, and as activity expands across these industries, demand for these enabling resources continues to rise.[2,3]

Table 1: Application of critical minerals[1]

Critical mineral	EV & ESS	Solar PV	Wind Power	Electronics	Specialty steel	Defence	Fertilizers	Applications
Lithium	●	○	○	○	○	○	○	Li-ion batteries (EVs, ESS)
Nickel	●	○	◑	○	●	○	○	Batteries & superalloys
Cobalt	●	○	○	○	◑	○	○	Battery cathode & alloys
Rare earths	◑	◑	●	◑	○	●	○	Permanent magnets
Copper	●	●	●	●	○	◑	○	Electronics, appliances & grid
Graphite	●	○	○	○	○	○	○	Battery anodes, refractories
Vanadium	◑	○	◑	○	●	○	○	Steel, redox batteries
Titanium	○	○	◑	○	●	●	○	Aerospace, pigments
Tungsten	○	○	○	○	●	●	○	Machine tools, alloys
Zirconium	○	○	○	○	○	●	○	Nuclear cladding, alloys
Molybdenum	○	○	○	○	●	○	○	Steel alloying
Niobium	○	○	○	○	●	●	○	Steel & Superalloys
Rhenium	○	○	○	○	○	●	○	Superalloys
Platinum group elements	○	○	○	○	○	◑	○	Catalysts, fuel cells, sensors

1. https://mines.gov.in/admin/download/649d4212cceb01688027666.pdf
2. https://zerotracker.net/
3. https://www.stimson.org/wp-content/uploads/2025/06/GGIR-2025.pdf

Critical mineral	EV & ESS	Solar PV	Wind Power	Electronics	Specialty steel	Defence	Fertilizers	Applications
Tin	○	○	○	●	○	○	○	Solder, electronics
Tantalum	○	○	○	●	○	●	○	Capacitors & electronics
Beryllium	○	○	○	○	○	●	○	Nuclear energy, electronics
Cadmium	○	●	○	○	○	○	○	CdTe solar cells, coatings
Indium	○	●	○	●	○	○	○	ITO coatings, displays
Gallium	○	◑	○	●	○	◑	○	Semiconductors, LEDs
Selenium	○	●	○	●	○	○	○	Solar PV
Tellurium	○	●	○	○	○	○	○	Solar PV
Potash (and Glauconite)	○	○	○	○	○	○	●	Fertilizers
Phosphorite	○	○	○	○	○	○	●	Fertilizers
Bismuth	○	○	○	◑	○	◑	○	Alloys and solders
Silicon	○	●	◑	●	○	◑	○	Solar cells, semiconductors,
Hafnium	○	○	○	◑	◑	●	○	Nuclear reactors, superalloys
Antimony	◑	○	○	●	○	●	○	Semiconductors, alloys
Strontium	○	○	○	◑	○	◑	○	Magnets, ceramics & glass

● High importance ◑ Medium importance ○ Low/no importance

As global investment accelerates across these sunrise sectors, a relatively small group of minerals is emerging as the backbone of multiple strategic value chains. Whether enabling clean energy systems, powering advanced defence technologies, improving agricultural productivity or driving electronic and metallurgical innovation, these materials have become indispensable to twenty-first-century industrial progress. Their importance extends far beyond their commercial value; they are the building blocks of technology leadership, energy security and national competitiveness.

Despite their growing prominence, there is no single, universally accepted definition of what constitutes a critical mineral. Each country defines criticality through its own lens, based on strategic priorities, industrial dependencies and perceived risks of supply disruption. For advanced economies, this may reflect dependence on imports for clean-energy technologies; for others, it may relate to defence readiness, manufacturing competitiveness or high-technology innovation.

At its core, however, a critical mineral refers to one that is economically essential yet vulnerable to supply disruption, arising from geological scarcity, geographic concentration of production or geopolitical uncertainty. As nations race to build resilient, low-carbon economies, the security of supply for these materials has become a defining policy concern worldwide.

The table below compares the classification of key minerals deemed critical across six major jurisdictions, including the US, European Union, China, India, Australia and Canada. These classifications are based on national assessments of economic importance, supply risk and strategic value for clean energy, defence and advanced manufacturing sectors.

Minerals identified as critical by five or more countries are highlighted, reflecting their global significance and cross-border strategic importance.

Table 2: Critical minerals across major geographies[4]

Material	US[1]	EU[5]	China[6]	India[7]	Australia[8]	Canada[9]
Lithium	✓	✓	✓	✓	✓	✓
Nickel	✓	✓	✓	✓		✓
Cobalt	✓	✓	✓	✓	✓	✓
Rare earth elements	✓	✓	✓	✓	✓	✓
Cobalt	✓	✓	✓	✓	✓	✓
Graphite	✓	✓	✓	✓	✓	✓
Vanadium	✓	✓		✓	✓	✓
Titanium	✓	✓		✓	✓	✓
Tungsten	✓	✓	✓	✓	✓	✓
Zirconium	✓		✓	✓	✓	
Molybdenum			✓	✓		✓
Niobium	✓	✓		✓	✓	✓
Rhenium				✓	✓	
PGE	✓	✓		✓	✓	✓
Tin	✓	✓	✓	✓	✓	✓
Tantalum	✓	✓		✓	✓	✓
Beryllium	✓	✓		✓	✓	
Cadmium		✓		✓		
Indium	✓			✓	✓	✓
Gallium	✓	✓		✓	✓	✓
Selenium				✓	✓	
Tellurium	✓			✓		✓
Potash			✓	✓		
Phosphorus		✓	✓	✓		
Bismuth	✓	✓		✓	✓	✓
Silicon	✓	✓		✓	✓	
Hafnium	✓	✓		✓	✓	✓
Antimony	✓	✓	✓	✓	✓	✓
Strontium		✓		✓		

4. https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-
5. https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en
6. https://bulletinofcas.researchcommons.org/journal/vol37/iss11/9/?
7. https://mines.gov.in/admin/download/649d4212cceb01688027666.pdf?
8. https://www.ga.gov.au/scientific-topics/minerals/critical-minerals?
9. https://www.canada.ca/en/campaign/critical-minerals-in-canada/critical-minerals-an-opportunity-for-canada.html



There is clear convergence across major economies on a core set of critical minerals, notably lithium, cobalt, nickel, graphite, copper, PGEs, hafnium, gallium, tungsten, niobium, tin, vanadium, titanium, antimony, germanium and REEs, highlighting high importance and concentrated supply.

As economies intensify efforts towards energy transition, advanced manufacturing, green mobility and self-reliance, the demand for these minerals is projected to surge in the coming decade. However, supply remains highly concentrated, often controlled by a few countries and vulnerable to geopolitical and logistical disruptions. Ensuring reliable access, therefore, has become a central policy priority for governments and industries alike.

The following section examines the **global demand and supply dynamics** of these key minerals, assessing current production patterns, projected demand growth to 2030 and beyond and the emerging risks and opportunities that will shape the future of critical-mineral value chains.

3.1 Global demand and supply scenario

3.1.1 Demand scenario

The global demand landscape for critical minerals is undergoing a structural shift, driven by the accelerating transition to clean energy systems and advanced technologies. As economies decarbonise, growth is becoming increasingly mineral-intensive, reflecting the rising importance of electrification, digitalisation and energy storage.

The energy sector is expected to account for the largest share of incremental mineral demand over the next decade. The International Energy Agency (IEA) projects that demand for minerals used in clean-energy technologies could increase two- to three-fold by 2030, depending on policy ambition and the pace of technology deployment. Lithium, nickel, cobalt, graphite, copper and REEs have emerged as the primary drivers of this growth, given their essential role in batteries, electric motors and power transmission infrastructure. Lithium, nickel, cobalt and graphite underpin battery chemistries; copper provides critical conductivity for renewable grids and electric vehicles; and REEs are indispensable for permanent magnets used in high-efficiency motors and wind turbines.

Demand is being propelled by rapid capacity additions across solar photovoltaics, wind power, electric vehicles and battery storage systems. According to IRENA, **renewable capacity expanded by about 585 GW in 2024,** accounting for **over 90 percent of total new power capacity,** with **solar and wind leading the growth.**[10] Solar installations have reached 2.2 TW following strong growth in recent years, while wind capacity reached roughly 1.14 TW in 2024. Electric vehicle sales continued to expand at about 30 percent annually, and battery storage recorded the fastest growth, reflecting large-scale deployment across major economies.[11]

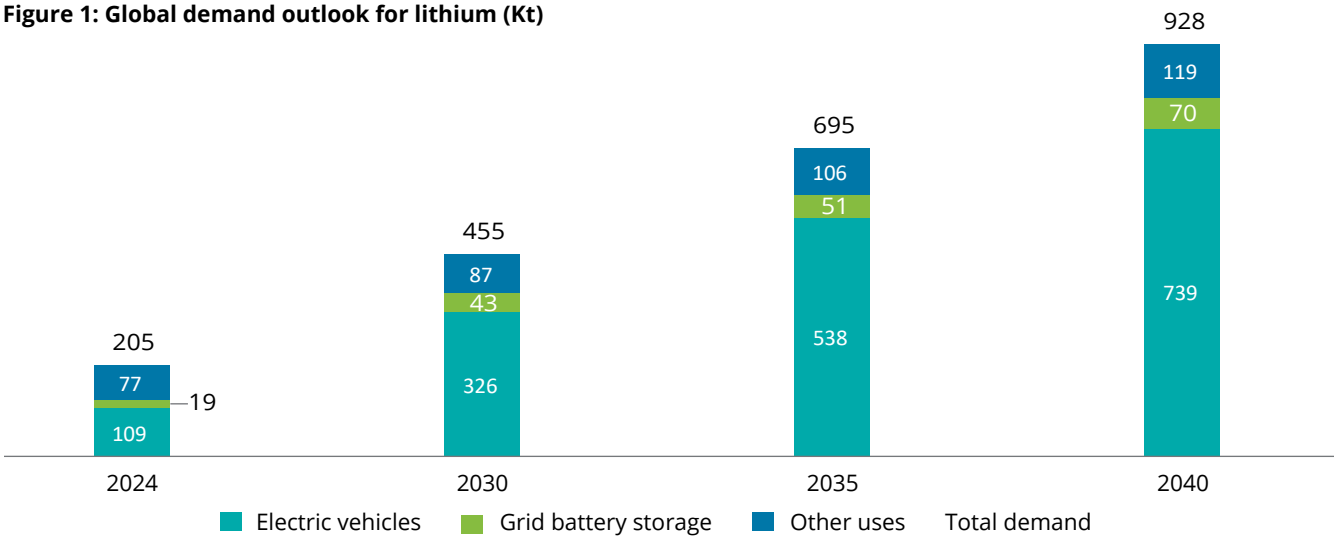
This technological expansion has triggered a sustained increase in demand for energy-transition minerals, signalling the beginning of a long-term upward trajectory as policy commitments translate into industrial and infrastructure investments. The following section examines the current and projected global demand outlook for these key critical minerals under alternative scenarios.

10. https://www.axios.com/2025/03/26/renewables-record-growth-solar-wind-power
11. https://www.mercomindia.com/global-wind-capacity-117-gw-additions-increase-from-2023

Lithium[12]

Lithium demand has tripled since 2020 and is expected to triple again by 2035. The EV sector accounts for 90 percent of additional demand, with energy storage also driving growth. Currently dominated by China (75 percent), followed by Japan and Korea. However, this demand is expected to expand to new regions such as the US, European Union, Indonesia and India in the next decade.

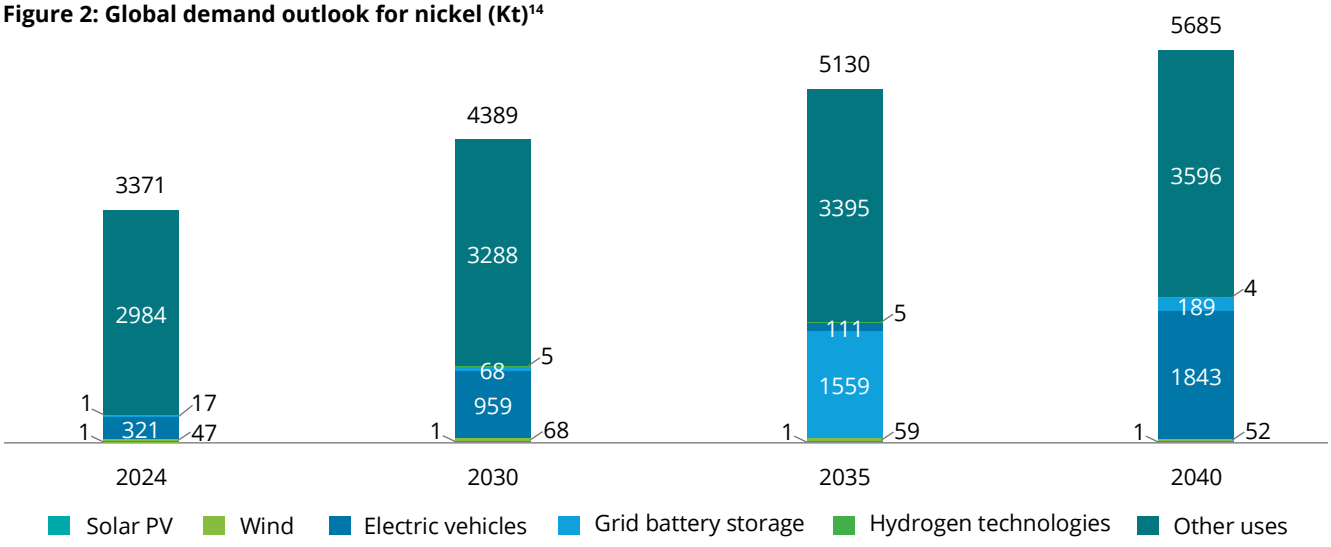
Figure 1: Global demand outlook for lithium (Kt)



Nickel[13]

Nickel demand rose by 6 percent in 2024 to 3.4 Mt. Under the STEPS scenario, total nickel demand is projected to rise to 5.5 Mt by 2040, with clean energy technologies accounting for 42 percent of demand. Energy technologies, particularly EV batteries, are the largest contributors to demand growth. Nickel-rich chemistries remain a major part of EV batteries outside China. China has been the largest consumer of nickel, accounting for an average of 60 percent of global demand from 2020 to 2024, primarily for stainless steel production. However, China's battery-related nickel consumption is also set to rise substantially. Indonesia follows as the second-largest consumer, with demand linked to stainless steel production.

Figure 2: Global demand outlook for nickel (Kt)[14]

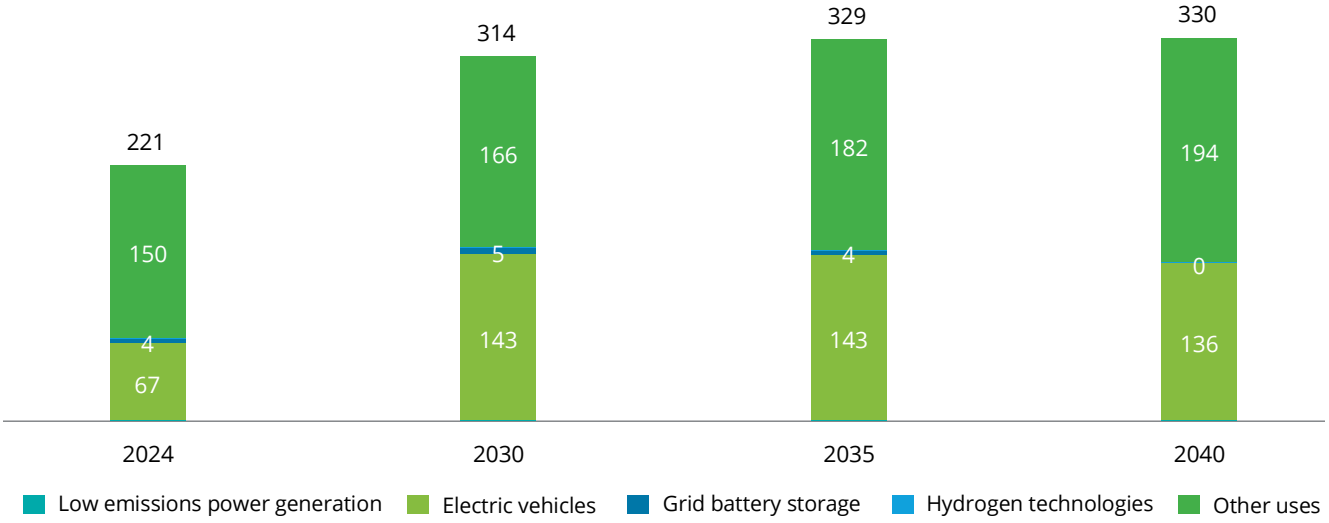


12. IEA Critical Mineral Dataset 2025, STEPS Scenario
13. IEA Critical Mineral Dataset 2025, STEPS Scenario
14. IEA Critical Mineral Dataset 2025, STEPS Scenario

Cobalt[15]

Cobalt demand grew by 10 percent over the last two years, reaching 220 kt in 2024. Under the STEPS, demand is projected to reach 330 kt by 2040, with clean energy technologies accounting for 41 percent of demand. EV batteries are the largest source of demand growth, despite a downward revision due to shifts towards less cobalt-rich chemistries such as LFP batteries. China dominates cobalt demand, accounting for 70 percent of total consumption in 2024.

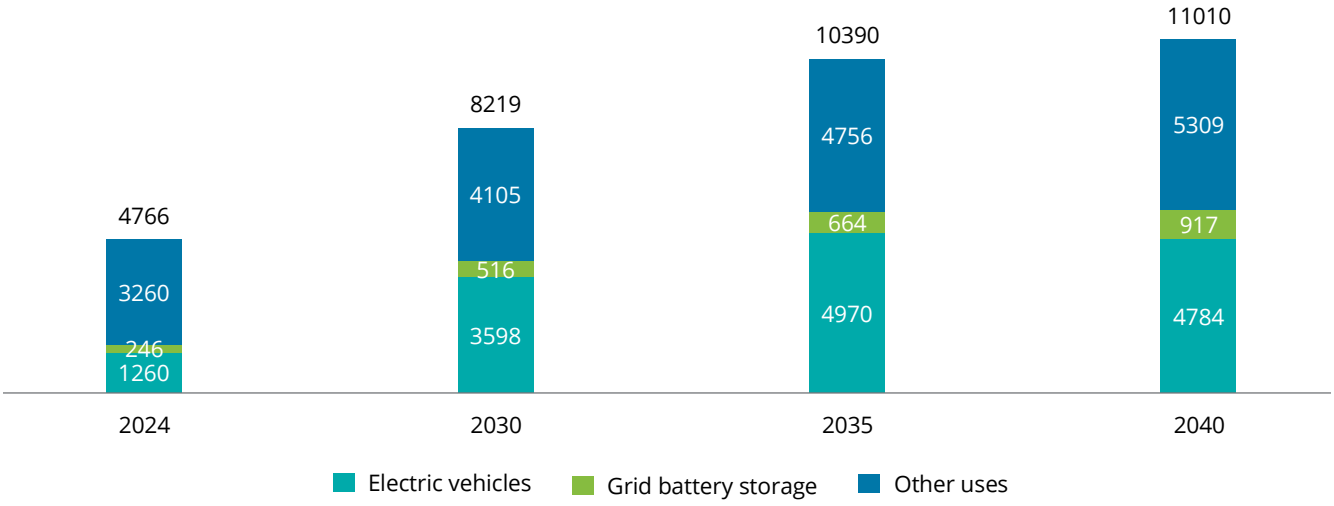
Figure 3: Global demand outlook for cobalt (Kt)



Graphite

Graphite demand reached 4.8 Mt in 2024, with battery-related demand tripling to over 6 Mt by 2035 in STEPS. Total graphite demand is projected to reach over 10 Mt by 2035, doubling from today. EV batteries are the largest source of demand, with an average electric car containing about 60 kg of graphite anode materials.

Figure 4: Global demand outlook for graphite[16] (Kt)

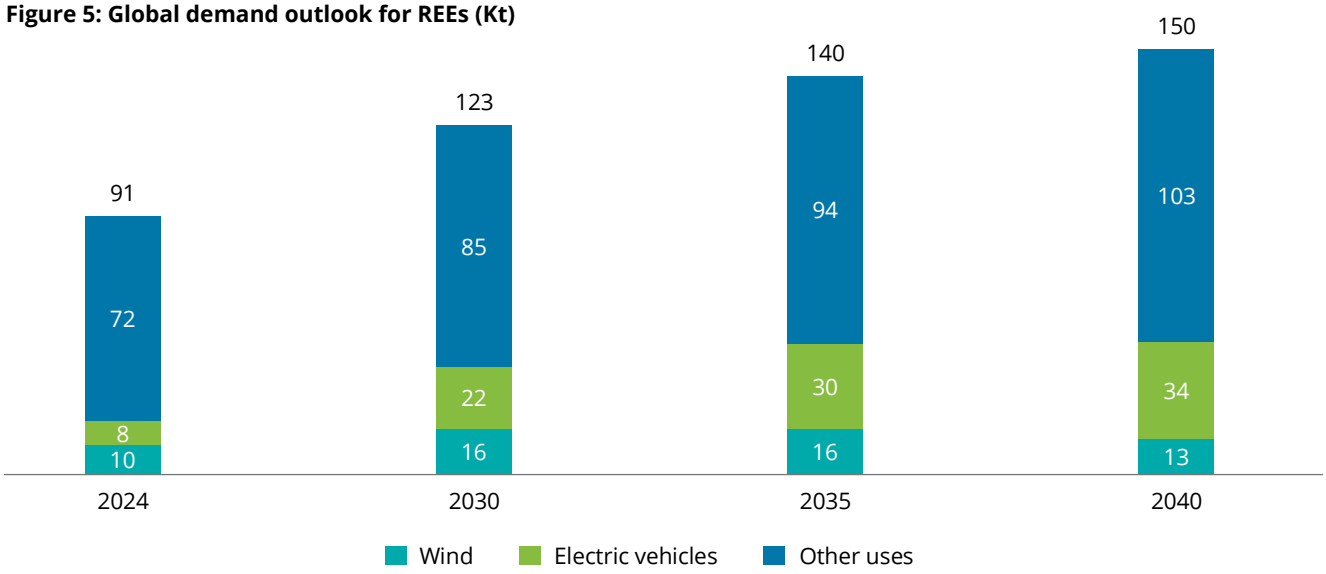


15. IEA Critical Mineral Dataset 2025, STEPS Scenario
16. IEA Critical Mineral Dataset 2025, STEPS Scenario

Rare Earth Elements (Nd, Pr, Dy, Tb)[17]

The demand for REEs covers praseodymium (Pr), neodymium (Nd), terbium (Tb) and dysprosium (Dy). The demand for these REEs has nearly doubled since 2015, reaching 90 kt in 2024. In STEPS, demand is projected to reach 120 kt by 2030 and 180 kt by 2050. Permanent magnets used in EV motors and wind turbines drive demand growth, with their share rising from 60 percent today to about 70 percent by 2050. EV motors are expected to account for 22–25 percent of demand by 2050. China is the largest consumer, accounting for 57 percent of global demand in 2024.

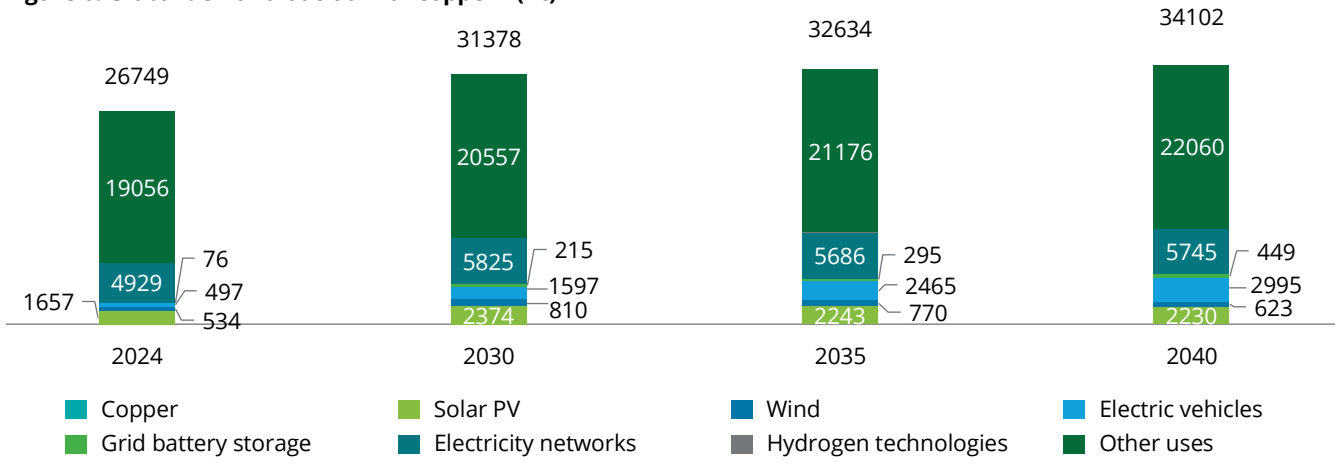
Figure 5: Global demand outlook for REEs (Kt)



Copper[18]

Copper demand grew by 3.2 percent in 2024, reaching 26.7 Mt. In STEPS, demand is projected to grow to 34.1 Mt by 2040, with clean energy technologies accounting for 36 percent of demand. Construction and electricity networks remain the largest sources of demand, while EVs are the fastest-growing source, increasing sevenfold from 2 percent of global copper demand in 2024 to 10 percent in 2050 in STEPS. China accounts for almost 60 percent of global refined copper demand in 2024. India and Vietnam are emerging as major demand centres, with India projected to account for over 10 percent of global demand by 2050.

Figure 6: Global demand outlook for copper[19] (Kt)



[17] IEA Critical Mineral Dataset 2025, STEPS Scenario
[18] IEA Critical Mineral Dataset 2025, STEPS Scenario
[19] IEA Critical Mineral Dataset 2025, STEPS Scenario

Synthesis and outlook

The global demand outlook for critical minerals reflects both opportunity and imbalance. While China continues to dominate consumption across nearly all energy-transition minerals, demand is steadily diversifying towards North America, Europe, India and Southeast Asia, mirroring the global diffusion of clean-energy manufacturing. Across scenarios, lithium and graphite show the steepest growth trajectories, followed by nickel, copper and REEs, each driven by electrification and renewable integration.

However, this expansion is also exposing systemic vulnerabilities, including environmental pressures at mining sites, high water and carbon footprints of refining and processing, and limited recycling infrastructure. Meeting the projected two- to threefold increase in demand by 2030 will therefore depend on new mine capacity and on investment in circular supply chains, technology substitution and transparent ESG standards.

The decade ahead will define whether the world can align its mineral supply base with its energy transition ambitions.

3.1.2 Supply scenario

While demand for critical minerals is expanding rapidly, the supply landscape remains uneven, fragile and deeply concentrated. The upstream mining of key energy minerals is limited to a handful of geographies, and the refining and processing stages are even more geographically skewed, largely dependent on China. Over the past decade, despite robust growth in mined output, the global supply chain has become more exposed to geopolitical frictions, trade restrictions and environmental constraints.

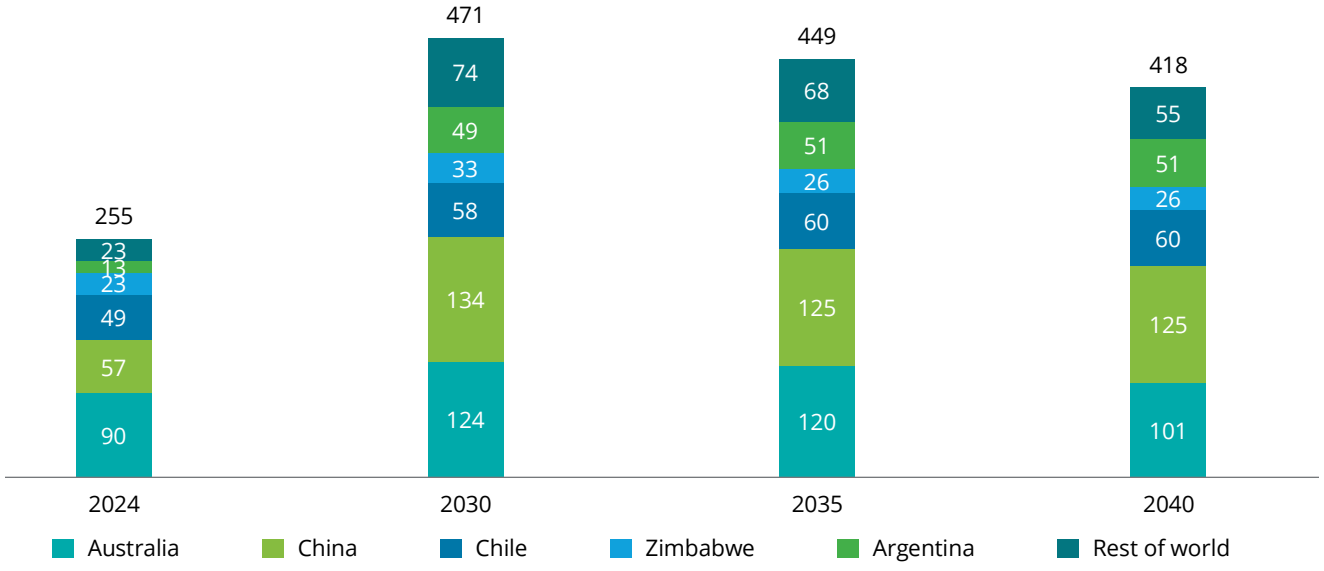
This section examines the structure of global supply for key critical minerals, highlighting patterns of concentration, emerging diversification trends and the challenges of ensuring resilient and sustainable supply chains through 2035 and beyond.

Lithium[20]

Lithium production is highly concentrated among a few key countries. Australia is the largest producer, accounting for ~35 percent of global mined lithium in 2024, primarily from hard rock (spodumene) deposits. Major operations include Greenbushes, Mount Holland and Kathleen Valley, which form the backbone of global spodumene supply. China ranks second, contributing ~22 percent of global production, mainly from hard rock mines in Sichuan Province, Huaqiao and Da Hongliutan. Chile follows with ~19 percent of global output, with lithium extracted from brine deposits in the Salar de Atacama, known for its high lithium concentration and low extraction costs.

Emerging producers such as Zimbabwe, the US and Canada are gradually diversifying supply. Together, they contribute a small but growing share, expected to expand by 2030 as new capacity gets added in Africa and North America. Despite this, the top three producers (Australia, Chile and China) still account for 77 percent of global output, a share projected to decline only modestly to about 67 percent by 2030.

Figure 7: Global mine production landscape of lithium (Kt)



[20] Analysis based on IEA Critical Mineral Dataset 2025, STEPS Scenario



Lithium refining is even more concentrated than mining. China dominates the global lithium chemical supply chain, accounting for ~70 percent of refined lithium production in 2024. It processes both domestic ore and imported spodumene from Australia to produce lithium hydroxide and carbonate for battery manufacturing. Chile contributes about 20 percent, primarily from brine-based carbonate production, while Argentina adds a smaller but growing share.

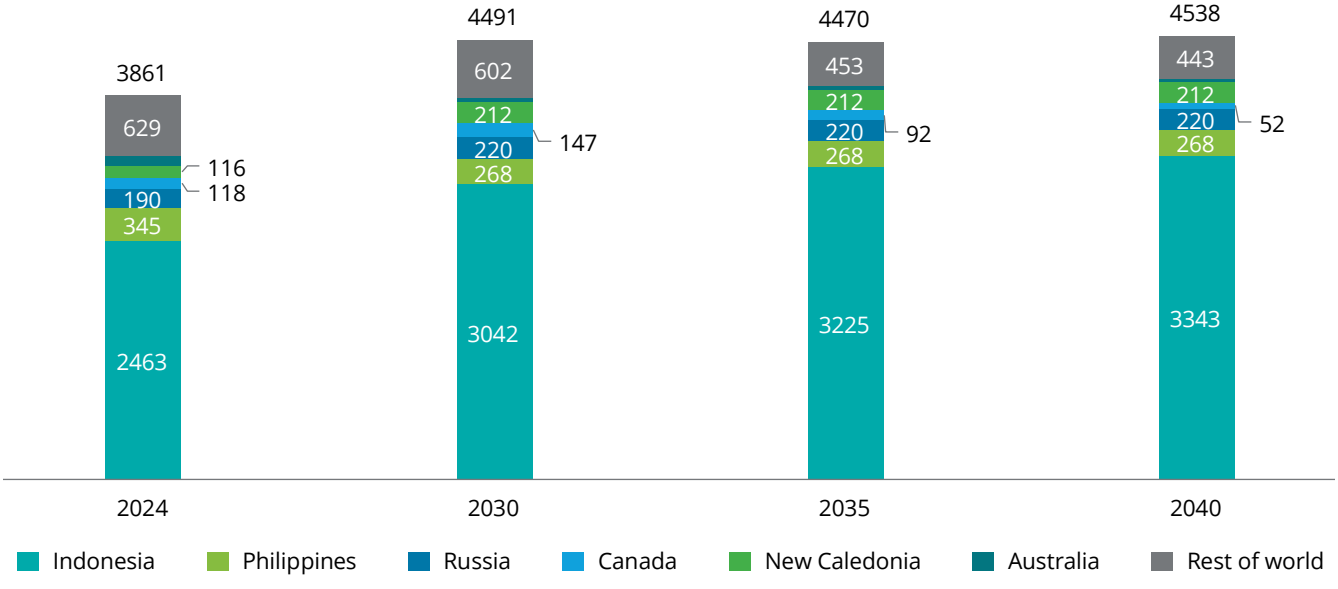
Among emerging refiners, Australia is expanding capacity through projects such as Kemerton and Kwinana, focused on lithium hydroxide production. The US is also developing refining capability, with Bessemer City and Tesla's Texas refinery expected to achieve large-scale output by 2030. Despite these efforts, refining remains highly concentrated, with the top three producers, China, Chile and Argentina, accounting for 96 percent of global lithium chemical output in 2024, projected to decline modestly to about 85 percent by 2030 as new capacity emerges in North America, Europe and Australia.

Nickel[21]

Global nickel production is highly concentrated, led by Indonesia, which supplied ~64 percent of global mined nickel in 2024, mainly from laterite ores processed into Nickel Pig Iron (NPI), ferronickel and through HPAL technology. The Philippines is the second-largest producer with ~9 percent share of the global production, exporting much of its laterite ore to Indonesia for processing. Russia remains a key supplier, though its share has declined due to sanctions and operational challenges.

The top three producers (Indonesia, the Philippines and Russia) accounted for 78 percent of global output in 2024, a share expected to rise to about ~84 percent by 2035–2040 as Indonesia's dominance grows. Key challenges include declining high-grade ore reserves, environmental impacts from energy-intensive RKEF and HPAL processes and price pressures that threaten production in higher-cost regions such as Caledonia and Australia.

Figure 8: Global mine production landscape of nickel (Kt)



[21] Analysis based on IEA Critical Mineral Dataset 2025, STEPS Scenario

Refining is similarly concentrated. Indonesia leads with 43 percent of global refined nickel in 2024, producing NPI, ferronickel and nickel matte as feedstock for battery-grade nickel sulphate. China follows with ~33 percent, dominating nickel sulphate production for EV batteries using Indonesian intermediates. Russia, Japan and Europe provide the remaining output, though their combined share continues to fall.

In total, the top three refining regions (Indonesia, China and Russia/Japan) supplied 78 percent of global refined nickel in 2024, projected to rise to ~83 percent by 2035–2040. This concentration poses supply-chain risks due to Indonesia's ore export restrictions, China's control of sulphate refining and the high carbon intensity of Indonesian operations, which rely heavily on coal-based power. Diversification efforts face barriers from high costs and technical challenges in scaling battery-grade refining outside Asia.

Cobalt[22]

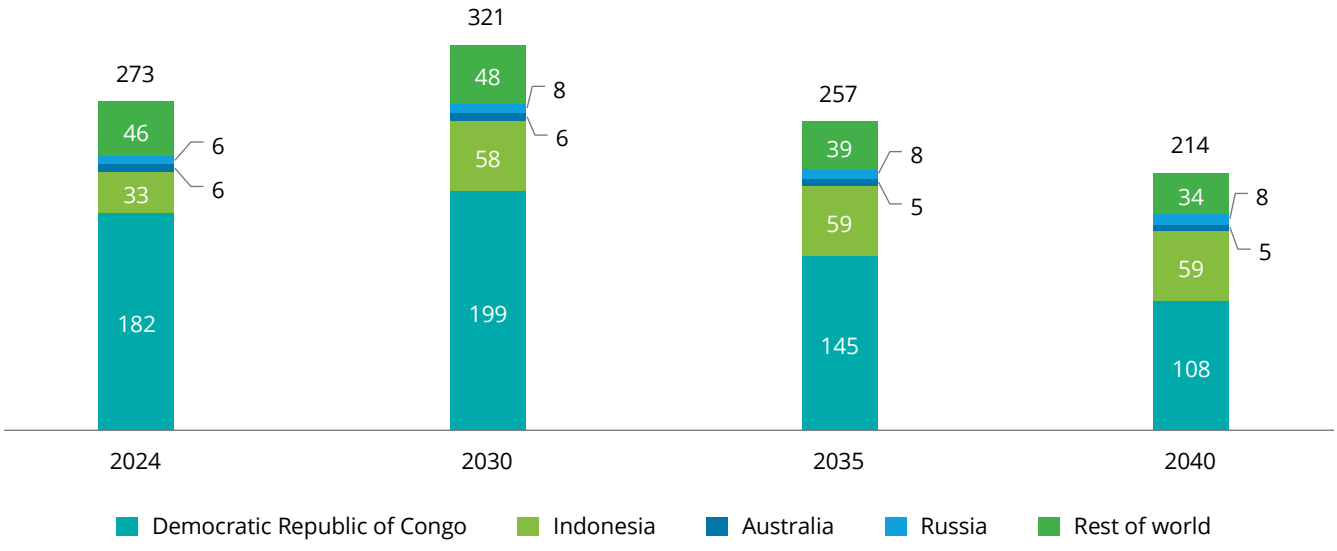
Global cobalt production is highly concentrated, with a few countries dominating supply. The Democratic Republic of the Congo (DRC) is the largest producer, accounting for about 70 percent of global mined cobalt in 2024. However, declining ore grades after 2030 are expected to reduce output by up to 45 percent during the 2030s. Indonesia is the second-largest producer, contributing about 12 percent, primarily as a by-product of nickel mining. Major operations such as Obi Island, Weda Bay and Morowali Industrial Park continue to expand using High-Pressure Acid Leaching (HPAL) technology.

Despite this growth, HPAL faces criticism due to its high carbon footprint and environmental impact. Mining concentration remains extreme, with the top three producers (DRC, Indonesia and Russia) supplying 81 percent of global mined cobalt in 2024, a share expected to remain around 82 percent by 2040. Persistent political instability and governance risks in the DRC further add uncertainty to future supply.

Cobalt refining is even more geographically concentrated than mining. China dominates global refining, accounting for 78 percent of refined cobalt production in 2024, processing most of the DRC's mined material. It also leads in cobalt sulphate production, a key precursor for EV batteries, with a 60 percent global share. Europe contributes about 10 percent of refined output, with Finland emerging as a growing hub. Indonesia is also expanding refining capacity, particularly in cobalt sulphate associated with its nickel industry.

Overall, the top three refining regions (China, Europe and Japan) accounted for 89 percent of global refined cobalt in 2024, a level expected to stay high at about 86 percent by 2040. China's continued dominance in refining represents a major supply-chain vulnerability, as global cobalt processing remains heavily dependent on a single geography.

Figure 9: Global mine production landscape of cobalt (Kt)



22. Analysis based on IEA Critical Mineral Dataset 2025

Graphite (natural)[23]

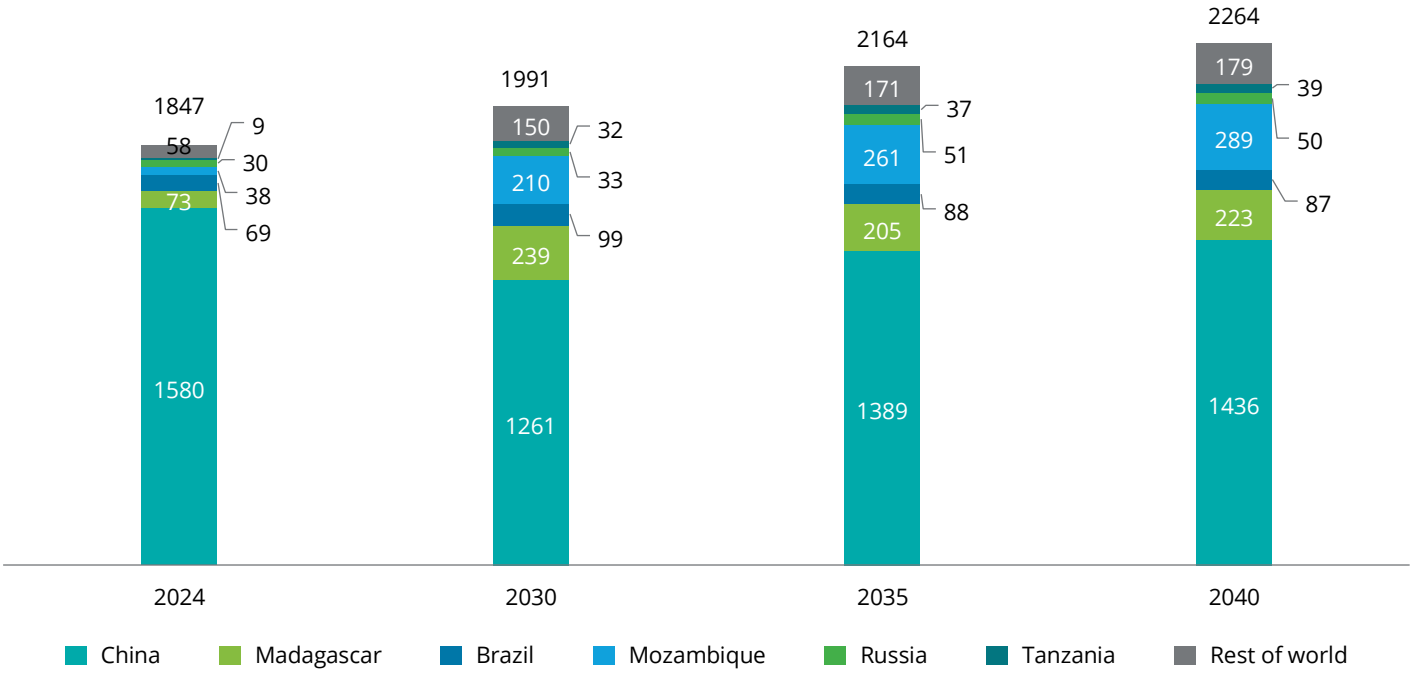
Global graphite production remains highly concentrated, with China overwhelmingly dominating the supply chain. In 2024, China accounted for approximately 86 percent of global natural graphite output, primarily sourced from flake graphite deposits in Heilongjiang, Inner Mongolia and Shandong. Madagascar, the second-largest producer, contributed about 4 percent, supplying high-quality flake graphite from deposits such as Molo and Graphmada. Brazil closely follows accounting for roughly 4 percent of the global graphite mine production.

The top three producers (China, Brazil and Madagascar) collectively supplied ~93 percent of global mined graphite in 2024, a share expected to decline slightly to 86 percent by 2035 as new projects emerge in Africa and North America. However, China's dominance in mining continues to present geopolitical and supply-chain risks, especially following export restrictions on graphite-related products introduced in 2023 and 2024. Meanwhile, emerging producers face challenges in scaling up production due to high capital costs, logistical barriers and limited technical expertise.

Graphite refining is even more concentrated than mining. China controls ~95 percent of global refined battery-grade graphite production in 2024, processing both natural flake graphite and synthetic graphite into spherical graphite used in lithium-ion battery anodes. The main refining hubs are located in Shandong, Heilongjiang and Inner Mongolia. Japan is the second-largest producer, contributing ~2 percent of refined graphite, with a focus on synthetic graphite for high-performance and industrial applications.

Overall, refining concentration remains extreme, with China alone accounting for 95 percent of the global supply of battery-grade graphite, a share projected to decline only slightly to about 85 percent by 2035 as capacity gradually develops in Europe, North America and Africa. This geographic dependence on China represents a major supply-chain vulnerability, particularly as the country controls nearly all spherical graphite production used in EV batteries and its export policies continue to influence global availability and pricing.

Figure 10: Global mine production landscape of graphite (Kt)



[23] Analysis based on IEA Critical Mineral Dataset 2025



Rare Earth Elements (Nd, Pr, Dy, Tb)[24]

Global production of REEs is heavily concentrated, with China leading the supply chain. In 2024, China accounted for 61 percent of global mined magnet REEs, primarily from the Bayan Obo mine in Inner Mongolia, the world's largest REE deposit. It produces mainly Light Rare Earth Elements (LREEs) such as neodymium (Nd) and praseodymium (Pr), while Heavy REEs (HREEs) such as dysprosium (Dy) and terbium (Tb) are extracted from deposits in southern provinces such as Jiangxi and Guangdong.

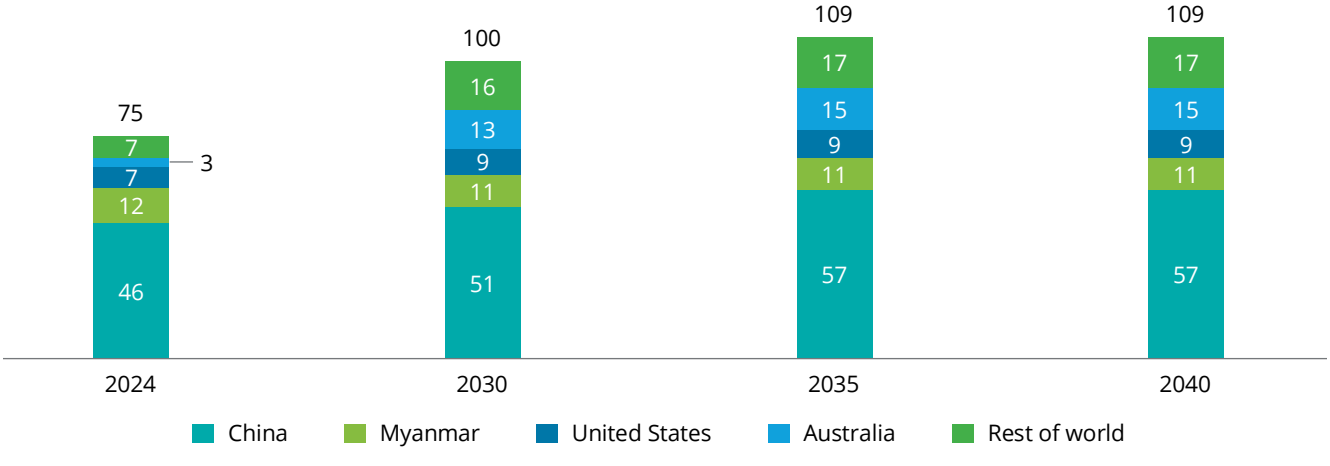
Myanmar is the second-largest producer, supplying ~16 percent of global mined REEs, focused on HREEs from deposits in the Kachin State. However, production remains vulnerable due to political instability, border conflicts and intermittent export restrictions to China. Australia contributes ~4 percent, led by Lynas Rare Earths' Mount Weld mine, while the US provides ~9 percent, primarily from the Mountain Pass mine in California.

Together, the top three producers (China, Myanmar and the US) accounted for about 86 percent of global mined REEs in 2024, a share expected to ease to 74–76 percent by 2035–2040 as new projects emerge in Brazil, Africa and North America. Scaling up remains difficult due to high capital costs, long project timelines and technical challenges in REE processing.

Refining of REEs is the most concentrated segment of the supply chain. China dominates global refining, producing ~91 percent of refined magnet REEs in 2024, with major processing hubs in Baotou and Ganzhou. These facilities possess advanced separation and solvent-extraction technologies that enable the processing of both light and heavy REEs. Malaysia ranks second, accounting for ~4 percent of global refined supply through a Rare Earth facility in Kuantan, which processes concentrate from the Mount Weld mine in Australia.

Australia is developing additional refining capacity through several projects, with operations expected to begin between 2026 and 2027. Despite these efforts, refining remains highly concentrated, with China alone controlling about 91 percent of global refined REE production in 2024, projected to decline to ~75 percent by 2035 as diversification progresses in Australia, Europe and North America.

Figure 11: Global mine production landscape of REEs (Kt)



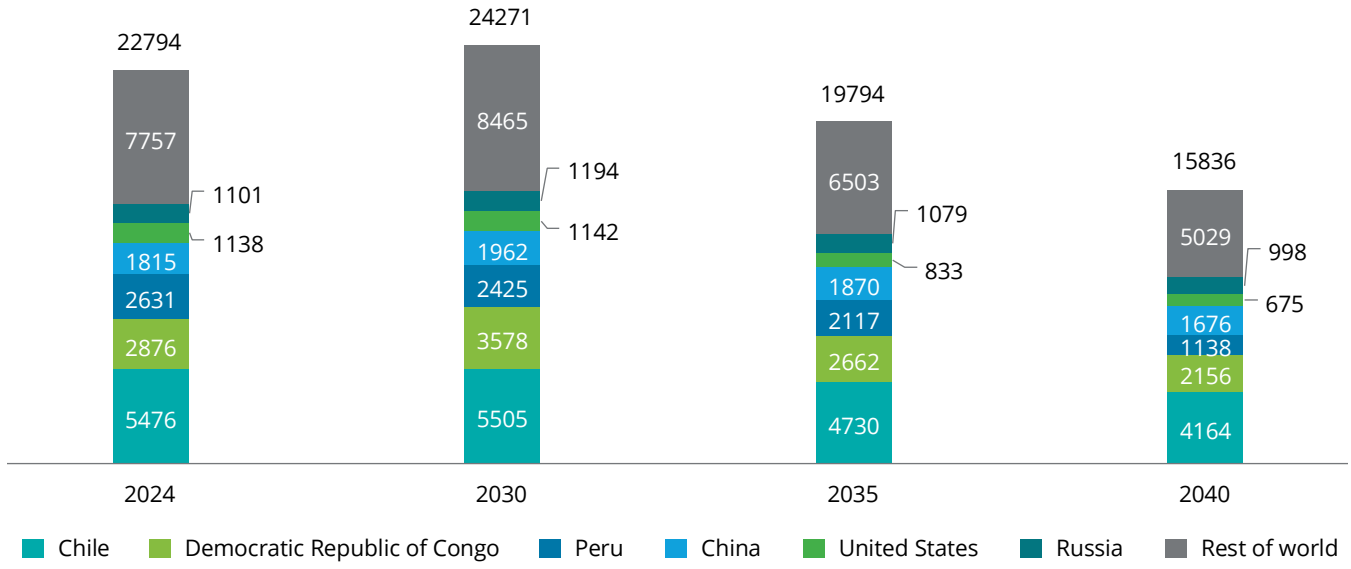
[24] Analysis based on IEA Critical Mineral Dataset 2025, STEPS Scenario

Copper[25]

Copper production remains concentrated in a few key countries. Chile is the largest copper producer, accounting for 24 percent of global mined output in 2024. The Democratic Republic of the Congo (DRC) is the second-largest producer with 13 percent, followed by Peru. Together, these three countries supplied about 48 percent of global mined copper in 2024, a share projected to increase to 53 percent by 2040.

However, the mining sector faces several structural challenges. The average copper ore grade has fallen by nearly 40 percent since 1991, increasing extraction and processing costs. New resource discoveries have slowed, with only 14 new copper deposits found globally in the past decade compared with 239 discoveries between 1990 and 2023. As a result, a supply deficit of about 30 percent is expected by 2035, driven by declining ore grades, rising project costs and long lead times for new developments.

Figure 12: Global mine production landscape of copper (Kt)



Copper refining capacity is heavily concentrated in Asia. China dominates global refining, producing 44 percent of refined copper in 2024, followed by Chile (7 percent) and Japan (6 percent). India accounts for about 2 percent of global refined copper production. The top three refining countries (China, Chile and Japan) together contribute about 57 percent of global refined copper output, a share expected to remain about 60 percent by 2040.

This high concentration of refining capacity, particularly in China, poses a supply chain risk, as most copper ore and concentrates are processed in limited geographies. The imbalance between mining regions (Latin America, Africa) and refining hubs (East Asia) increases vulnerability to trade disruptions and supply constraints.

Synthesis and forward outlook

Global critical mineral supply has grown in absolute terms but remains structurally imbalanced and highly concentrated. While new mining capacity is being added across Africa, Latin America and Southeast Asia, this expansion has not translated into true supply diversification. Refining and midstream processing remain overwhelmingly dominated by East Asia, particularly China, which refines about 70 percent of 19 strategic minerals globally.[26] The resulting dependence has deepened systemic vulnerability, where local policy actions, trade restrictions or logistical bottlenecks can disrupt entire industrial value chains.

Short-term market conditions reflect both oversupply and fragility. Output of key critical minerals, especially nickel

[25] Analysis based on IEA Critical Mineral Dataset 2025, STEPS Scenario
[26] https://www.iea.org/commentaries/with-new-export-controls-on-critical-minerals-supply-concentration-risks-become-reality

and graphite, has risen sharply in recent years, putting downward pressure on prices and straining producer margins. However, structural supply deficits are still anticipated by the mid-2030s for minerals such as copper and lithium, driven by declining ore grades, escalating capital costs and slow project development cycles. The mismatch between production growth and resilience underscores that volume expansion alone does not guarantee security of supply.

Meanwhile, export controls and resource nationalism are redefining trade flows. Recent restrictions by China on gallium, germanium, graphite and heavy REEs, and temporary cobalt export suspensions in the DRC, demonstrate how geopolitics now directly shape mineral availability.[27,28] Over half of all energy-transition minerals are currently subject to some form of export regulation or trade measure, amplifying market uncertainty and reinforcing the need for diversification.

Emerging suppliers such as Indonesia, Mozambique and Madagascar are starting to rebalance the global map, supported by initiatives such as the international collaborations and bilateral frameworks among India, Australia, Japan and the US. Yet scaling mining and refining capacity outside dominant hubs remains a costly and complex project; new jurisdictions face roughly 50 percent higher capital costs alongside technical, logistical and environmental challenges.[29] Recycling and circular-economy strategies will play a critical complementary role post-2030, but require coordinated policy, infrastructure, trade and technology investment to achieve meaningful scale.

In essence, while global critical mineral supply capacity is growing, it is not yet resilient. Building a stable, diversified and sustainable supply chain will require coordinated public-private investment, technological collaboration in refining and recycling and a renewed policy focus on transparency, environmental safeguards and strategic collaborations. The next decade will determine whether the global minerals sector can transition from concentration to resilience, which is an essential prerequisite for a secure and sustainable energy future.

3.2 Perspectives on global trade and collaboration

The global trade in critical minerals has become a defining feature of 21st-century geopolitics, energy transition and industrial competitiveness. As the demand for clean energy technologies, Electric Vehicles (EVs) and digital infrastructure accelerates, critical minerals such as lithium, cobalt, nickel, copper, graphite and REEs have emerged as essential inputs to global economic growth and decarbonisation. In 2023, global trade in raw and semi-processed minerals reached approximately US$2.57 trillion in imports and US$2.52 trillion in exports.[30] The following are the region-specific trade volumes as noted by UNCTAD analysis:[31]

1. **Asia** recorded the largest share of global mineral trade in 2023, with **imports of approximately US$1.5 trillion** and exports of about US$0.83 trillion, reflecting its role as the primary global processing and manufacturing hub.
2. **Africa** was a strong net **exporter, with exports of about US$266 billion** and **imports of about US$68 billion,** underscoring its position as a major supplier of raw and semi-processed minerals.
3. **Oceania** registered significant export dominance, with **exports exceeding US$239 billion** and relatively low import volumes, driven mainly by Australia's mineral exports.
4. **The Americas** posted a positive trade balance, with **exports exceeding imports by roughly US$194 billion,** supported by large-scale mineral production and exports from Latin America and Canada.
5. **Europe** showed a broadly balanced trade profile, with **imports and exports at comparable levels,** reflecting high import dependence for raw minerals offset by exports of processed and semi-processed mineral products.

27. https://www.reuters.com/world/china/china-expands-critical-mineral-export-controls-after-us-imposes-tariffs-2025-02-04/
28. https://www.reuters.com/world/china/china-expands-critical-minearal-export-controls-after-us-imposes-tariffs-2025-02-04/
29. https://www.gcsp.ch/sites/default/files/2025-09/SSA-2025_43_Zhiyenbayev_Securing%20the%20New%20Resource%20Frontier%3Bdigital.pdf
30. https://sdgpulse.unctad.org/critical-minerals/
31. https://sdgpulse.unctad.org/critical-minerals/



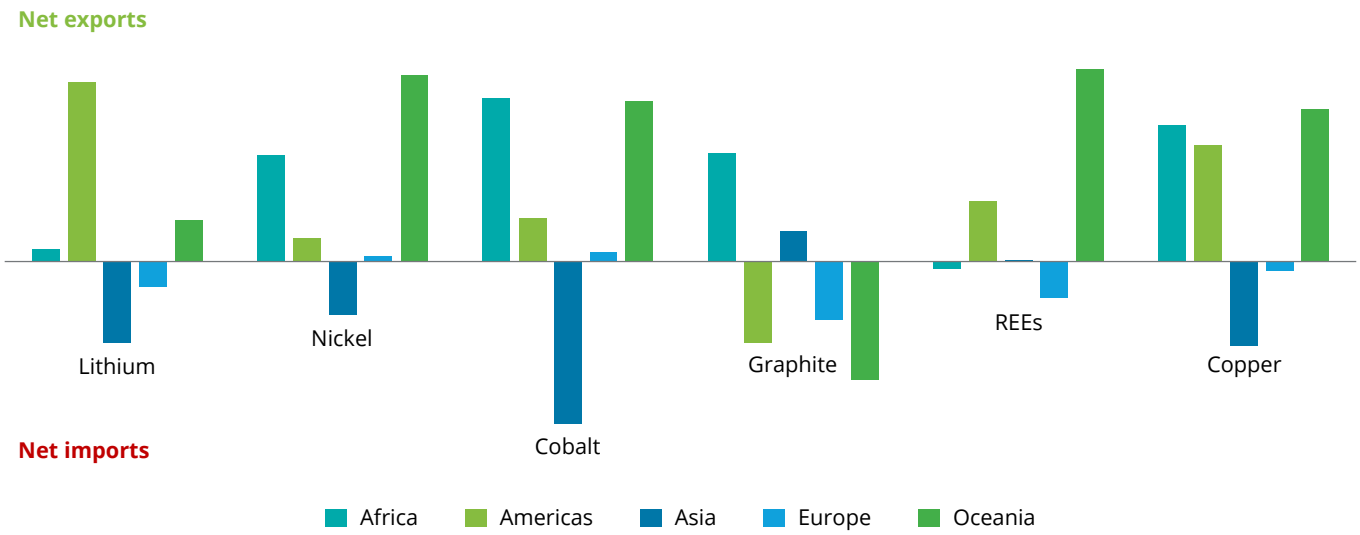
The global trade in critical minerals is increasingly defined by an asymmetric structure between rapidly expanding demand centres and highly concentrated supply hubs. Regionally, Asia emerged as the largest market for critical minerals, accounting for US$1.5 trillion in imports, more than half of the global total, while exporting only US$825 billion, with China accounting for roughly 40 percent of imports in the Asia region, reflecting its integrated battery, magnet and clean-energy manufacturing ecosystem.[32,33]

However, demand growth is also rapidly diversifying towards emerging industrial regions such as India, Vietnam and Indonesia, where EV and solar manufacturing are expanding, and towards Europe and the US, which are building strategic mineral collaborations to secure supply for domestic clean energy industries.

By contrast, Africa, the Americas and Oceania recorded substantial trade surpluses, underscoring their positions as major suppliers of critical minerals. Africa exported about US$266 billion (10.6 percent of global trade), while importing only US$68 billion. Oceania, driven largely by Australia's mineral exports, shipped goods worth over US$239 billion despite relatively low import volumes. The Americas also posted a strong surplus of nearly US$194 billion, reflecting their significant mining output. In comparison, Europe exhibited a more balanced trade profile, with exports marginally exceeding imports.

The global supply network for critical minerals remains heavily concentrated, with mining and refining dominated by a few regions. China's dominance is unmatched; it processes about 70 percent of 19 major energy-transition

Figure 13: Net trade in minerals balance[34]



32. https://www.iea.org/commentaries/with-new-export-controls-on-critical-minerals-supply-concentration-risks-become-reality
33. https://sdgpulse.unctad.org/critical-minerals
34. UNCTAD calculations based on UN Comtrade Database (https://sdgpulse.unctad.org/critical-minerals/)



minerals, creating a structural trade imbalance where raw materials flow from Africa, Latin America and Southeast Asia to Chinese refineries, before being exported as intermediate products to Europe, North America and other manufacturing hubs. This concentration heightens global exposure to supply disruptions, price disruptions and underscores the urgent need for diversification and resilient trade collaborations.

The resulting trade pattern reveals a pronounced asymmetry, where mineral-rich developing regions export unprocessed ores, while industrialised and refining-heavy economies capture higher value through midstream and downstream processing. This dynamic may contribute to supply concentration, where disruptions in a limited number of supplier nations have the potential to affect segments of the global energy supply chain. For instance, China's export restrictions on graphite, gallium and germanium in 2023–24. China imposed export controls on five other metals used in defence, clean energy and other industries (tungsten, indium, bismuth, tellurium and molybdenum) after the US 10 percent tariff on Chinese goods took effect.[35] The country also proposed restrictions on certain technologies used in the manufacture of advanced battery components and in the processing of critical minerals such as lithium and gallium. With similar export controls imposed by DRC and Indonesia, more than half of all energy-transition minerals are now subject to some form of export regulation or trade measure, reshaping global trade flows and contributing to price volatility.[36]

These export controls have also fostered international alliances and bilateral frameworks, as critical minerals have become a core instrument of industrial and strategic policy. Western economies are prioritising "friendshoring" and mineral security collaborations to counterbalance dependence on Chinese refining. The MSP, involving the US, EU, Australia, Japan, India and others, aims to build diversified and ESG-compliant supply chains through coordinated investments and offtake agreements.[37] Similarly, the EU's Critical Raw Materials Act (2024) targets reducing external dependency by capping imports from any single supplier to under 65 percent of total demand for strategic minerals by 2030.[38] India and Australia have advanced bilateral frameworks to jointly develop lithium, cobalt and REE value chains,[39] while the G7 is exploring a dedicated critical-minerals investment fund to de-risk and scale allied supply chains in resource-rich countries such as Vietnam, Namibia and the DRC.[40]

Looking ahead, the global trade architecture for critical minerals is likely to bifurcate between consolidated processing hubs and diversified strategic alliances (US, EU, India, Australia) that promote resilient and sustainable sourcing. Recycling and secondary supply chains will become increasingly trade-relevant after 2030, particularly for cobalt, lithium and REEs recovered from end-of-life batteries and magnets.

In summary, global trade in critical minerals reflects a structural tension between booming, geographically diversified demand and narrow, concentrated supply and refining capacity. This imbalance amplifies exposure to geopolitical risk, price volatility and environmental pressures. Strengthening trade resilience will require coordinated global action, including investing in new mining jurisdictions, expanding refining outside China, integrating recycling flows and harmonising trade standards under multilateral frameworks. The ability of the world to move from resource dependence to cooperative resilience will influence both the future of clean energy and the stability of the global economic order.

35. https://www.reuters.com/world/china/chinas-curbs-exports-strategic-minerals-2025-10-09/?
36. https://www.iea.org/commentaries/with-new-export-controls-on-critical-minerals-supply-concentration-risks-become-reality
37. https://www.state.gov/minerals-security-partnership
38. https://insightplus.bakermckenzie.com/bm/projects/europe-the-eus-critical-raw-materials-act-enters-into-force
39. https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1905863
40. https://www.csis.org/analysis/g7-cooperation-de-risk-minerals-investments-global-south

4. Overview of India's Indian demand and supply scenario

4.1 Demand and supply outlook

Critical minerals are essential inputs for many high-demand manufacturing products, with diverse applications across metallurgy, chemical industries, Energy Storage Systems (ESS) for renewable energy, electric mobility, power generation, high-end electronics, aerospace, defence and data transmission hardware.

With ambitious climate goals, such as installing 500 gigawatts (GW) of renewable energy capacity by 2030, transitioning 30 percent of vehicles to electric by 2030 and achieving net zero GHG emissions by 2070, India's demand for critical minerals is set to grow exponentially over the next decade.

India has deposits of critical minerals across various regions, partially meeting the demand for minerals such as tin, REEs, copper, silicon and titanium. However, domestic production is insufficient to meet the growing demand. India remains heavily dependent on imports, with 100 percent reliance on foreign sources for minerals such as cobalt, beryllium, bismuth, indium, lithium, niobium, rhenium, strontium, tantalum and tungsten.

Table 3: Outlook for critical minerals in India

Mineral Name	Current demand (FY25, Kt)	Projected demand[41] (FY30,Kt)	Supply	End user industry
Lithium	3.4[42]	21.2 – 30.4	Import dependency of 100 percent[43]	EV and ESS, others* (*ceramics, paint)
Nickel	128.1[44]	212.6 – 276.2	Import dependency of 100 percent[45]	Stainless steel, EV, ESS, other batteries and others* (*alloys, chemicals)
Cobalt	5.5[46]	31.9 – 45.6	Import dependency of 100 percent[47]	EV and ESS, others* (*superalloys, magnets, pigments)
Graphite (Natural)	75[48]	235.9 – 335.4	India produced 85.33 KT of Graphite (ROM) in FY25[49] Import dependency of 70 - 80% (natural graphite)[50]	EV and ESS, electrodes, refractories and others* (*foundries, lubricants)
REEs (NdPr)	1.1[51]	1.7 – 3.4	Import dependency of 100 percent[52]	EV, wind, others* (*catalyst, polishing). About 80 percent are used in permanent magnets[53]

41. Deloitte analysis basis growth projections in key end user industries and their consumption levels of these critical minerals
42. Current demand derived from production and import data; demand projections aligned with growth in key consuming industries.
43. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2041804
44. Current demand derived from production and import data; demand projections aligned with growth in key consuming industries.
45. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2041804
46. Current demand derived from production and import data; demand projections aligned with growth in key consuming industries.
47. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2041804
48. Current demand derived from production and import data; demand projections aligned with growth in key consuming industries.
49. Monthly Statistics of Mineral Production March 2025
50. Analysis based on production and import-export of various commodities of natural and synthetic graphite: IBM, Ministry of Commerce
51. Current demand derived from production and import data; demand projections aligned with growth in key consuming industries.
52. https://pib.gov.in/PressReleasePage.aspx?PRID=1914305
53. https://pib.gov.in/PressReleasePage.aspx?PRID=1914305

Mineral Name	Current demand (FY25, Kt)	Projected demand[41] (FY30,Kt)	Supply	End user industry
Copper	1875[54]	3000 - 3260	India produced ~105 KT of Copper concentrate in FY25[55] Import dependency > 90 percent[56]	Electrical and Telecommunications (56 percent),[57] Transport (8 percent), construction (7 percent), others* (*consumer durables, general engineering goods and process industries)
Potash (K_2O Eq.)	2380[58]	3,400 – 3,600	Import dependency of 100 percent[59]	Fertilisers
Phosphorite (P_2O_5 Eq.)	8400[60]	11,200 – 11,500	India produced ~1806 KT of Phosphorite in FY25[61] Import dependency of 75 – 85 percent[62]	Fertilisers, others* (*chemicals, additives)
Vanadium	4.7[63]	8.1 – 9.2	Import dependency of 100 percent[64]	Steed & alloys, chemicals and energy storage
Tin	14[65]	15.1 – 17.5	India produced ~9.3 T of Tin concentrate in FY25[66] Import dependency > 99 percent[67]	Alloys & chemicals
Tungsten	0.85[68]	1.0 - 1.3	Import dependency of 100 percent[69]	Alloys, defence, cutting tools, others* (*catalysts, pigments)

54. Copper Vision Document (Ministry of Mines, 2025); Current demand for FY24
55. Monthly Statistics of Mineral Production March 2025
56. https://mines.gov.in/webportal/internationalmineralscenario
57. https://mines.gov.in/admin/storage/ckeditor/24_pages__desktop_1752835254.pdf
58. https://www.faidelhi.org/wp-content/uploads/2025/09/Annual-Report-2024-25_Final.pdf
59. IBM Mineral Yearbook. 2023
60. https://www.faidelhi.org/wp-content/uploads/2025/09/Annual-Report-2024-25_Final.pdf
61. Monthly Statistics of Mineral Production March 2025
62. Analysis based on production and import-export of various commodities
63. Current demand is calculated through imports and is primarily linked to steel sector consumption
64. No primary production of Vanadium, IBM Mineral Yearbook 2023
65. Current demand is calculated through imports
66. Monthly Statistics of Mineral Production March 2025
67. Analysis based on production and import-export of various commodities
68. Current demand is calculated through imports
69. IBM Mineral Yearbook, 2023



4.2 Challenges and opportunities in India

Challenges for the domestic critical minerals landscape

The critical minerals industry in India is at a pivotal juncture, driven by the nation's ambitious goals for technological advancement, sustainable development and energy transition. However, the following challenges hinder the growth of the critical minerals sector:

Unavailability of quality reserves: India lacks proven and/or declared reserves for key critical minerals such as cobalt, niobium, germanium and rhenium. The absence of quality exploration data has led to weak investor interest, with 22 out of 55 critical mineral blocks (up to tranche 5) remaining unauctioned.

Difficulty in economic extraction: India faces challenges in the economic extraction of critical minerals due to deep-seated deposits and insufficient technological capabilities. For instance, despite possessing 5.9 million tonnes of lithium resources in Jammu and Kashmir, India lacks the technological capability to extract lithium from such geological formations.

Challenges in mine development: Developing mines for critical minerals is a complex process, involving difficulty in land acquisition due to vein deposits often extending beyond lease boundaries, significant resettlement and rehabilitation challenges and long development timelines.

Lack of advanced processing capacities: India lacks processing and downstream value-addition technologies for several critical minerals, leading to difficulty in establishing its value chain. For instance, despite having the world's third-largest deposits of titanium-bearing minerals and the third-largest deposits of REEs, India depends on imports due to the absence of suitable commercial-scale technologies for value addition. Downstream value-addition (for example, transforming ilmenite into titanium sponge or metal or converting monazite into separated REEs and finished magnets) remains limited.

Skill development: A robust domestic critical minerals supply chain requires developing a skilled workforce. The National Critical Mineral Mission prioritises human resource development as a key component. This includes establishing skill development centres, creating specialised training modules on critical minerals and offering capacity-building programmes to resource-rich countries. An expenditure of INR100 crore[70] has been proposed to set up these skill development centres under the mission.

70. https://mines.gov.in/admin/storage/ckeditor/24_pages__desktop_1752835254.pdf

Opportunities in critical minerals

India's strategic push towards clean energy and industrial self-reliance has made critical minerals a central part of its resource agenda. With the launch of the National Critical Mineral Mission and rising demand across sectors such as EVs, renewables and defence, the country is unlocking new possibilities across exploration, mining, processing and innovation. The following opportunities highlight how India is positioning itself to build a resilient and globally competitive critical minerals ecosystem.

Opportunity to scale advanced exploration: India has fewer established reserves relative to resource potential due to limited deep-seated mineral mapping. This creates an opportunity to deploy AI-based targeting, drone geophysics and seismic surveys, supported by regional exploration hubs integrating GSI, MECL and state agencies. The recently introduced Exploration License allows foreign participation, risk-sharing and faster discovery conversion. Many deposits remain classified as G3 inferred resources. Collaborative programmes between GSI, MECL and private players can accelerate metallurgical testing and feasibility, enabling a steady pipeline of blocks eligible for auction.

Sustained auction momentum: Since November 2023, the Ministry of Mines has launched six auction tranches covering more than 80 critical mineral blocks, out of which 46 blocks have been awarded to preferred bidders.

Financing and institutional capacity growth under NCMM: The National Critical Mineral Mission (January 2025) allocates INR34,300 crore through FY2030–31 (of which INR16,300 crore is government funding and INR18,000 crore expected from PSUs). Planned outcomes include new exploration campaigns, strategic overseas acquisition funding, recycling ecosystem development and skill centres, all of which expand supply security.[71]

Creation of midstream processing and recycling capacity: NCMM proposes specialised hubs for lithium, cobalt, nickel, graphite and REEs, supported by PLI scheme, PPPs and infrastructure access. Upcoming investments propose lithium carbonate, graphite purification, cobalt precipitation and rare-earth separation plants, reducing reliance on imported intermediates currently dominated by China. Moreover, India has untapped potential in recovering critical minerals from secondary sources, such as cobalt from zinc waste and vanadium from steel slag, which can be scaled up with proper infrastructure and policy support.

Opportunity in innovation and collaborations: The country is also deepening international collaborations to secure raw materials and technology, such as acquiring lithium blocks in Argentina through KABIL and collaborating with nations such as Australia and Japan. Domestic institutions such as CSIR, BARC and IITs are advancing hydrometallurgical and electrowinning technologies, which are essential for processing minerals such as lithium, cobalt and nickel.

With rising demand from sectors such as electric vehicles, solar PV, wind energy and defence, India has a timely opportunity to reduce import dependency, create jobs and become a competitive player in the global critical minerals landscape. To fully realise this potential, India must now focus on building a resilient and transparent supply chain ecosystem for critical minerals, integrating exploration and processing. This sets the stage to unlock opportunities in India's critical mineral supply chains.

71. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2166793

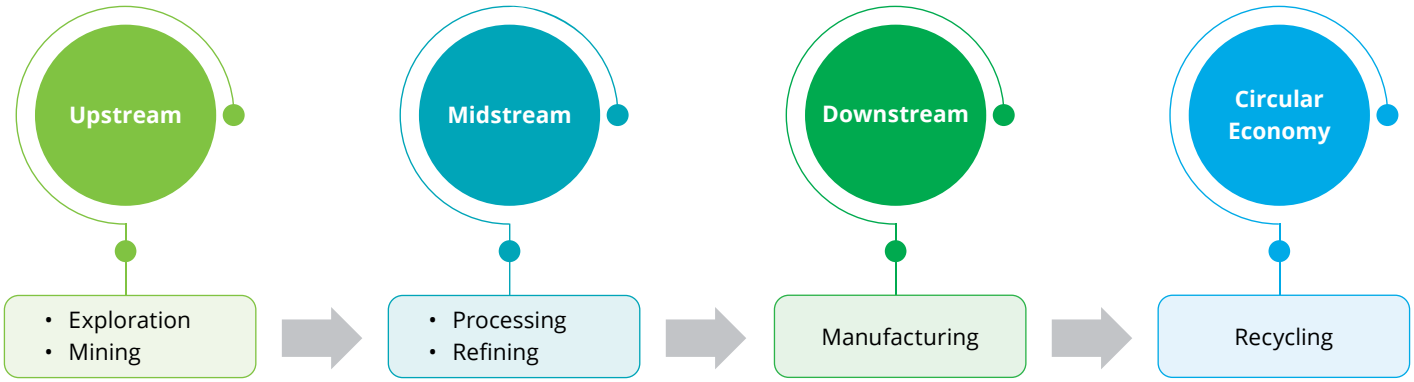
5. Supply chain diversification

The global critical mineral supply chain is characterised by significant vulnerabilities, primarily due to the high geographical concentration of both extraction and processing activities.

For India, securing the critical minerals supply chain is a strategic imperative directly linked to its core national ambitions. The country's goals of achieving self-reliance (Atmanirbhar Bharat), becoming a global manufacturing hub (Make in India) and realising its vision of a developed nation by 2047 (Viksit Bharat) are all contingent on the availability of these minerals. Furthermore, India's international climate commitments, including achieving 500 GW of non-fossil fuel energy capacity by 2030, achieving 30 percent EV penetration by 2030 and reaching net-zero emissions by 2070, depend entirely on technologies built with critical minerals.[72]

Despite this, India faces acute import dependencies as it depends on other countries for 100 percent of its lithium, cobalt and nickel requirements. This vulnerability could impact key industries and impede national progress if supply chains are disrupted. Recognising this challenge, the Government of India has launched ambitious initiatives, such as the National Critical Minerals Mission (NCMM), to strengthen the domestic supply chain at all stages.

The critical mineral supply chain consists of four distinct stages:



5.1 Domestic opportunities

5.1.1 Upstream: Exploration and mining

The basis of a secure critical mineral supply chain is the ability to find and extract resources from our own land. For many years, India's great geological potential has stayed mostly theoretical because of insufficient exploration. However, recent discoveries and important policy changes have created a unique chance to turn this potential into real economic and strategic benefits. This section gives a data-based look at India's mineral resources. It breaks down the new policy framework meant to unlock these resources and examines the opportunities and challenges in the process from exploration to auction.

Geological potential and distribution of critical minerals

A comprehensive understanding of India's geological wealth is the first step in formulating a targeted and effective national exploration strategy. A recent survey by GSI and other agencies has begun to reveal the significant scale of domestic critical mineral resources. The table below consolidates these figures.

[72] https://www.psa.gov.in/mission/electric-vehicles/36



Table 4: India's critical mineral geological wealth

Critical mineral	Key discoveries and resource estimates
Lithium	About 5.9 MT (Inferred, G3) in Salal-Haimana, Reasi district. 1,600 tonnes (Inferred) in Marlagalla, Mandya district (AMD discovery).[73,74]
Graphite	Nearly 24.8 MT of high-quality natural flake graphite reserves confirmed by GSI.[75]
Cobalt	Approximately 44.9 MT of estimated cobalt ore resources, with Odisha having 30.91 MT of resources[76]
Nickel	About 189 MT of estimated nickel resources, with Odisha having 175 MT of resources. Nickel resources are primarily concentrated in Odisha's Sukinda Valley[77]
Rare Earth Elements (REEs)	Nearly 28.6 MT (G3) REE-bearing syenite in Jashora, Karbi Anglong.[78] 2.2 MT REE-bearing phyllite (high Neodymium) in Lodoso,[79] 13.15 MT of monazite resources in the beach sand mineral placer deposits (Tamil Nadu, Kerala, Andhra Pradesh, Odisha, West Bengal),[80] 109.91 MT of carbonatite type in Ambadongar (Gujarat) and Barmer (Rajasthan)[81],
Copper	Resources:1496.98 MT, with Madhya Pradesh having 120.3MT reserve[82]

73. https://www.pib.gov.in/PressReleasePage.aspx?PRID=1897799
74. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2037050
75. The Handbook on Geological Potential of Northeast India – Ministry of Mine
76. Indian Minerals yearbook 2024, IBM
77. https://steelmines.odisha.gov.in/sites/default/files/2023-10/Growth%20Potential%20and%20New%20Initiatives.pdf
78. https://epaper.assamtribune.com/assam/gsi-identifies-rare-earth-element-deposits-in-assam-unveils-exploration-roadmap-1594014
79. https://economictimes.indiatimes.com/news/new-updates/how-north-east-may-become-a-goldmine-for-indias-quest-for-rare-earth/articleshow/123715623.cms
80. Ministry of Mines, US Geological Survey 2025
81. Ministry of Mines, US Geological Survey 2025
82. Indian Minerals yearbook 2024, IBM

Opportunities in critical mineral exploration in India

India is making groundbreaking strides in the mining sector to secure its critical minerals supply chain. Historically, state governments auctioned mineral concessions, and several critical minerals were classified as atomic minerals, restricting their exploration and mining to government entities. The government made significant amendments to remove the six critical minerals (lithium, beryllium, titanium, niobium, tantalum and zirconium) from the list of atomic minerals, enabling private sector participation. The central government has been empowered to auction the critical mineral blocks to expedite their development. About 24 critical mineral blocks have been auctioned since the beginning of critical minerals auctions in November 2023. Royalty rates for critical minerals such as Beryllium, Cadmium, Cobalt, Gallium, Indium, Rhenium, Selenium, Tantalum, Tellurium, Titanium, Tungsten and Vanadium have been rationalised. The area limits for prospecting licences and mining leases for critical minerals have been raised, with prospecting licences increasing from 25 to 100 sq. km and mining leases from 10 to 50 sq. km.

An **Exploration Licence** (EL) has been introduced to attract Foreign Direct Investment (FDI) and small-scale mining companies. It also provides a mechanism to share the project costs associated with the exploration of critical minerals.

Under the **Offshore Areas Mineral (Development and Regulation) (OAMDR) Amendment Act 2023,** the central government has been empowered to auction offshore mineral blocks containing critical minerals such as REE, titanium, nickel and cobalt, in heavy placer deposits, polymetallic nodules and crusts, etc.

Khanij Bidesh India Ltd. (KABIL), a joint venture under the Ministry of Mines, is actively enhancing India's supply of critical and strategic minerals through international collaborations. KABIL has begun lithium exploration in Argentina's Catamarca province and has signed an MoU with a UAE-based company, alongside ONGC Videsh and Oil India, focusing on project identification, due diligence, development strategies, risk management and offtake strategies.

KABIL has signed an MoU with the Council of Scientific and Industrial Research-Institute of Minerals and Materials Technology (CSIR-IMMT) for technical and knowledge cooperation for critical minerals. KABIL will use the technical expertise and services of CSIR-IMMT to undertake various projects, including the design and analysis of metallurgical test work plans, the development and review of process flowsheets and the selection of process technologies for mineral processing, beneficiation and metal extraction. The agreement will also embark on joint research and facilitate the exchange of scientific information between the two entities.

Under the National Critical Mineral Mission (NCMM), approximately **INR4,000 crore** has been allocated to the Geological Survey of India (GSI) and **INR3,000 crore** through the National Mineral Exploration Trust (NMET), with a target to complete **1,200 domestic critical mineral exploration projects,** thereby strengthening India's resource security and expanding the pipeline of mineable assets.

5.1.2 Mid-stream: Processing

India is highly dependent on imports for critical battery metals such as lithium, cobalt and nickel, as the country lacks commercial-scale refining capacity for producing battery-grade lithium hydroxide, cobalt sulphate or nickel sulphate. The core vulnerability of India's supply chain is the near-total absence of domestic capacity to refine critical minerals to the high-purity levels demanded by advanced technology sectors. Even if domestic mining were to begin, ores would likely need to be exported for refining and re-imported as value-added chemicals, resulting in the loss of both economic value and supply security.

In the rare earth sector, Indian Rare Earths Limited (IREL) has established capabilities in separating mixed rare earth chlorides into individual oxides. Building on this foundation, there is a significant opportunity for India to further strengthen its value chain by developing advanced capabilities in high-purity rare earth metal production and permanent magnet manufacturing. Enhancing these capabilities would support domestic self-reliance, promote technological advancement, and reinforce India's position in the global rare earth ecosystem

Though India has some domestic graphite processing capacity, it is insufficient to meet demand, particularly for producing high-purity, spherical graphite required for battery anodes. Additionally, India is entirely import-dependent for other critical minerals such as bismuth, germanium, niobium and strontium.

This domestic deficit is set against a backdrop of China's overwhelming dominance in global midstream processing. China's strategic, decades-long industrial policy has allowed it to capture a commanding share of the world's refining capacity.

Table 5: Geographic concentration of processing of select minerals[83]

Critical mineral	Processing (%)
Copper	40 China, 10 Chile, 6 Japan, 44 Other
Cobalt	65 China, 10 Finland, 5 Belgium, 20 Other
Lithium	58 China, 29 Chile, 10 Argentina, 3 Other
Nickel	35 China, 15 Indonesia, 8 Japan, 42 Other
REEs	87 China, 12 Malayasia, 1 Estonia

Status of India's critical mineral processing

India boasts a diverse geological landscape with a range of minerals found in varying concentrations and mineralogical complexities. These minerals, which contribute to various sectors such as energy, electronics and manufacturing, play a crucial role in India's industrial growth and technological advancements. The shortlisted minerals and their production details are outlined in the table below.

Table 6: Critical mineral processing and associated Indian institutions

Mineral	Processing technology	Products	Indian organisation
Lithium	Calcination, Leaching, Precipitation	Lithium carbonate, Lithium hydroxide	Neogen Chemicals Limited, Altmin Private Limited, Bhabha Atomic Research Centre
Nickel	Smelting, Leaching, Electrowinning	Nickel cathode, Nickel sulphate	Vedanta Nico, LOHUM Cleantech Private Limited, CSIR-IMMT- Bhubaneswar
Cobalt	Leaching, Solvent extraction, Electrowinning	Cobalt metal, Cobalt salts	CSIR-NML-Jamshedpur, CSIR-IMMT- Bhubaneswar
Graphite	Pyrometallurgy (devolatilisation, tar distillation, graphitisation)	Graphite electrodes, carbon products used in metallurgical operations, and graphite equipment	Epsilon Advanced Materials, Graphite India Limited, CSIR-IMMT Odisha
Rare Earth Elements	Chemical treatment, Solvent extraction, Metallothermic reduction	Mixed rare earth oxides, Rare earth metals	IREL, CSIR-NML Jamshedpur, CSIR-IMMT Bhubaneswar, Bhabha Atomic Research Centre (BARC), Kerala Minerals and Metals Limited (KMML)
Copper	Pyrometallurgy, Hydrometallurgy	Copper cathode, Copper wire rods	Hindalco Industries Limited, CSIR-IMMT-Bhubaneswar, Kutch Copper Limited, Sterlite Copper, Hindustan Copper Ltd

Source: Secondary research

83. https://csep.org/working-paper/critical-minerals-for-india-2023/

Opportunities in critical mineral processing in India

India has a significant opportunity to become a global hub for critical mineral processing, driven by its strategic policy initiatives, existing industrial capabilities and rising demand from clean energy and strategic sectors. The launch of the **National Critical Mineral Mission (NCMM) in 2025, with a budget of INR34,300 crore (INR500 crore allocated for 4 processing parks to build infrastructure),** marks a major step towards building domestic processing infrastructure. India already processes seven out of fifteen key critical minerals, such as copper, graphite, REEs, silicon, tin, titanium and zirconium, at a commercial scale, using its strong base in bulk mineral processing such as iron and aluminium. The country is also actively collaborating with resource-rich nations such as Argentina, Australia and Japan to secure raw materials and technology, including acquiring five lithium blocks in Argentina through KABIL.[84]

India's research institutions, such as **CSIR, BARC and IITs, are developing advanced hydrometallurgical and refining technologies,** which are essential for processing minerals such as lithium, cobalt and nickel. There is also untapped potential in recovering critical minerals from secondary sources, such as cobalt from zinc waste and vanadium from steel slag, which can be scaled up with proper infrastructure and policy support.

In addition, the proposed **basic customs duty exemption** on capital goods for critical minerals processing will enhance the viability of projects and encourage investments in domestic processing.

India's policy push has created a clear opening for domestic critical-mineral processing. The government's recently approved **Rare-Earth Permanent Magnet (REPM) scheme** (INR7,280-crore incentive) to build an end-to-end REPM manufacturing ecosystem,[85] aims to convert rare-earth oxides into finished high-value magnets domestically, directly creating demand for upstream oxide refining and intermediate chemical processing. The Critical Mineral Recycling Incentive Scheme launched in September 2025 aims to enhance recycling capacity for critical minerals in India, with a financial outlay of ₹1,500 crore over six years, targeting both established and new recyclers. The scheme targets recycling of lithium-ion batteries, e-waste & other waste.

The Union Budget 2026 announced measures to support mineral-rich coastal states (Odisha, Kerala, Andhra Pradesh and Tamil Nadu) in **establishing dedicated rare earth corridors for mining, processing, research and downstream manufacturing, which** will help in building a resilient and globally competitive critical minerals and REEs ecosystem in India.

5.2 International opportunities

Global reserves and production of critical minerals, such as lithium, cobalt, nickel and REEs, are sharply concentrated in a handful of countries. In Latin America, the "Lithium Triangle" (Chile, Argentina, Bolivia) continues to dominate lithium reserves and output, with Chile and Argentina together accounting for over 28 percent[86] of the world's lithium production in 2024 and holding some of the largest known reserves. Brazil is also emerging as a lithium producer, alongside its established strength in niobium, with more than 90 percent[87] of the world's production.

Africa's mineral-rich nations, including the Democratic Republic of Congo (DRC), South Africa and Gabon, are indispensable for cobalt and platinum group metals. The DRC alone produced over 75 percent[88] of global cobalt and ~14 percent of the global mined copper in 2024, and possesses more than half the world's reserves, making African supply critical for battery and clean energy technologies. South Africa's dominance in manganese and platinum group metals further secures its strategic relevance.[89]

China's overwhelming position in refining, processing and extraction remains unmatched. In 2024, China produced nearly 70 percent[90] of REEs and more than 78 percent[91] of graphite, while also being among the top producers of tungsten.

Australia is another essential node for lithium and nickel supply; it has led the world in lithium production for many years and is a top-three player for nickel reserves. Russia continues to serve as a key source of PGMs, nickel and REEs, particularly important as geopolitical dynamics influence critical minerals security.

84. https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1996380
85. https://www.pmindia.gov.in/en/news_updates/cabinet-approves-rs-7280-crore-scheme-to-promote-manufacturing-of-sintered-rare-earth-permanent-magnets-repm
86. Lithium Statistics USGS 2025
87. Niobium statistics USGS 2025
88. Cobalt Statistics USGS 2025
89. Copper Statistics USGS 2025
90. REE Statistics USGS 2025
91. Graphite Statistics USGS 2025

5.2.1 Exploration

Established exploration hubs (high activity, mature jurisdictions)

Australia and Canada remain exploration powerhouses with deep capital markets, prolific juniors and major miners undertaking regional greenfield and brownfield programmes (for example, Mt Weld/Lynas,[92] Australian lithium majors and graphite projects). In the US, projects such as Mountain Pass (MP Materials)[93] and Bear Lodge[94] are advancing REE exploration-to-development pipelines supported by public and private capital. These jurisdictions combine geological prospectivity with stable permitting and ready access to capital and downstream collaborators.

High-potential/fast-developing regions (large upside, accelerating activity)

Africa is rapidly emerging as a frontier for critical-mineral discovery and scale-up, including Mozambique's Balama graphite (Syrah Resources) and growing lithium and REE exploration in Madagascar, Zimbabwe and Tanzania. These jurisdictions offer competitive resource upside and favourable entry valuations but require careful country-risk, community-engagement and logistics planning. Similarly, South America's salar basins (Chile, Argentina, Bolivia) continue to attract major exploration capital for lithium brines and associated downstream projects.

Commodity-specific regional footprints and processing linkages

The exploration opportunity must be read alongside midstream capability. Indonesia is rapidly scaling nickel-to-battery-chemical capacity (HPAL/RKEF projects and state/private tie-ups such as Antam/Merdeka), making exploration in Indonesian laterite provinces attractive where downstream processing is available. By contrast, graphite and REE exploration in parts of Africa or Australia has to be assessed against China's dominant downstream processing position, though alternatives (Lynas Malaysia, MP Materials in the US, European and Southeast Asian processors) are expanding.

Table 7: An illustrative list of key minerals and their exploration agencies across the globe

Mineral	Country	Exploration agency
Lithium	Australia	Geoscience Australia,[95] Pilbara Minerals,[96] Lithium Plus Minerals Ltd.[97]
	Argentina	SEGEMAR,[98] Lithium Argentina,[99] Argentina Lithium and Energy[100]
	Chile	Lithium Chile,[101] SQM Salar,[102] ENAMI[103]
Nickel	Indonesia	PT Aneka tambang (Antam),[104] PT Vale Indonesia tbk[105]
	Australia	Antares Metals,[106] Alliance Nickel Limited,[107] IGO Limited,[108] Galileo Mining[109]
	Russia	Nornickel[110]

92. https://lynasrareearths.com/mt-weld-expansion-project/
93. MP Materials Deal Marks a Significant Shift in US Rare Earths Policy - Center on Global Energy Policy at Columbia University SIPA | CGEP %
94. https://www.rareelementresources.com/wp-content/uploads/2025/06/rer_corporate-presentation_june-2025.pdf
95. https://www.ga.gov.au/scientific-topics/minerals/critical-minerals
96. https://pls.com/our-projects/exploration-projects
97. https://lithiumplus.com.au/
98. https://www.panorama-minero.com/en/news/segemar-geologists-reveal-the-mining-potential-of-jujuy
99. https://www.lithium-argentina.com
100. https://argentinalithium.com/news/argentina-lithium-energy-corp-announces-initial-mineral-resource-estimate-at-the-rincon-west-lithium-project/
101. https://lithiumchile.ca/company-overview
102. SQM's Salar de Atacama operation becomes the world's first lithium mining operation to achieve IRMA 75 - SQM | SQM
103. https://www.reuters.com/business/energy/chiles-enami-says-lithium-venture-with-rio-tinto-start-production-2032-2025-05-23
104. https://www.idnfinancials.com/news/57864/antm-spends-idr-176-95-billion-on-gold-nickel-bauxite-exploration
105. https://saladeimprensa.vale.com/indonesia/about-pt-vale-indonesia
106. https://antaresmetals.com.au/carlingup-lithium-nickel-project
107. https://alliancenickel.au/about-alliance-nickel
108. https://www.igo.com.au/site/exploration/exploration1
109. https://www.galileomining.com.au/priority-projects/fraser-range-project
110. https://ar2024.nornickel.com/about-company/geography

Mineral	Country	Exploration agency
REE	Australia/ Canada	US Geological Survey, Geoscience Australia,[111] Geological Survey of Canada
Graphite	Mozambique	Triton Minerals,[112] National Mining Institute (INAMI)
	Madagascar	NextSource Materials Inc.[113]
	Tanzania	Geological Survey of Tanzania, Volt Resources Limited[114]
Copper	Zambia	First Quantum Minerals,[115] Cooperlemon Consultancy Ltd.[116]
	Peru	Latin Metals Inc.,[117] King Copper Discovery Corp.,[118] MMG Ltd.[119]

While NCMM explicitly funds domestic exploration (notably INR4,000 crore for GSI and INR3,000 crore for NMET), it does not ring-fence a separate grant line solely for overseas exploration. Instead, overseas acquisition and exploration are expected to be financed from the PSU investment pool, company balance-sheets, consortium arrangements and project finance, with NCMM providing policy coordination and facilitation (diplomatic, institutional and technical). KABIL and similar pooled public-sector vehicles are highlighted as replicable models for coordinated overseas access.

Indian corporates and PSUs are already active overseas. Large-scale mining and processing investments in Australia, Africa and Ireland, as well as major coal and port interests in Australia, illustrate examples of corporate overseas resource portfolios. Several other Indian entities have pursued exploration agreements, offtake pacts, or asset-level evaluations in resource jurisdictions such as Australia, Africa, South America and Southeast Asia, often using joint ventures, earn-ins, or consortium structures to share risk and secure feedstock.

5.2.2 Sourcing of processed minerals

The global critical-minerals value chain is highly consolidated in a small number of countries, which can be classified as "Established (multiple opportunities)", "Established (limited opportunities)" and "Emerging" based on their reserves, current production and mid-/ downstream processing capacity.

A few countries dominate by combining large geological endowments with industrial processing, finance and stable policy frameworks, enabling them to mine the ore and to refine, smelt and chemically process it into battery-grade and high-value intermediates. That integrated capability (upstream → midstream → downstream) is what concentrates market power and supply security in select locations.

- **Established countries (multiple opportunities):** Countries with broad, large endowments plus strong refining/processing and market access.
- **Established (limited/concentrated opportunities):** Countries that are world-class for one or two commodities but less diversified or subject to governance/geopolitical constraints.
- **Emerging countries:** Countries with sizable upside from recent discoveries, growing project pipelines and active policy incentives for local value-add, but with higher execution/infrastructure or ESG risk.

111. https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/australian-resource-reviews/rare-earth-elements
112. Triton Minerals expands graphite footprint with award of exploration licence in Mozambique | ASX:TON
113. NextSource Materials Announces First Production of SuperFlake® Graphite at Molo Mine in Madagascar - Next Source
114. https://voltresources.com/about/company-overview
115. https://www.first-quantum.com/what-we-do/exploration
116. Zambian Exploration Licence Joint Venture | Company Announcement | Investegate
117. Latin Metals Inc. | News
118. King Copper Discovery (TSXV:KCP) Company Profile & Description
119. Company Overview - MMG

Table 8: List of countries that exist in the critical mineral value chain

Established potential (multiple opportunities)	Established potential (limited opportunities)	Emerging potential
Australia	Indonesia	Zambia
China	South Africa	Mozambique
US	Russia	Madagascar
Peru	Brazil	Tanzania
	Argentina	Zimbabwe
		Namibia

Source: Secondary research

The global critical mineral supply chain is characterised by significant vulnerabilities, primarily due to the high geographical concentration of both extraction and processing activities. A handful of nations dominate the market; for instance, China controls a significant portion of the world's refining capacity for rare earths (~90 percent),[120]cobalt and lithium (~58 percent).[121] This concentration creates profound supply risks, exposing consumer nations to potential disruptions from price volatility, trade restrictions and geopolitical leverage.

For India, securing the critical minerals supply chain is a strategic imperative directly linked to its core national ambitions. The country's goals of achieving self-reliance (Atmanirbhar Bharat), becoming a global manufacturing hub (Make in India) and realising its vision of a developed nation by 2047 (Viksit Bharat) are all contingent on the availability of these minerals.

Despite this, India faces acute import dependencies, relying on other countries for 100 percent of its lithium, cobalt and nickel requirements. This vulnerability could cripple key industries and impede national progress if supply chains are disrupted. Recognising this challenge, the Government of India has launched ambitious initiatives such as the National Critical Minerals Mission (NCMM) to fortify the domestic supply chain across all its stages.

The global midstream for critical minerals is highly concentrated, with China dominating refining, processing and battery/magnet chemical manufacturing, especially for REEs and graphite. This dominance gives China significant control over supply chains, even as much of its production feeds domestic manufacturing.

As China tightens export controls on strategic minerals, import-dependent economies are diversifying their sourcing. New processing hubs in Europe (notably the Netherlands and Belgium) and Southeast Asia (such as Thailand and Indonesia, particularly in nickel chemicals) are emerging as alternative suppliers of processed materials.

The commodity footprint remains regionalised, with South America (Chile and Argentina) continuing to lead lithium carbonate exports, while graphite production and

120. https://timesofindia.indiatimes.com/business/india-business/rare-earths-are-new-assets-india-to-become-credible-alternative-in-critical-mineral-game-heres-how/articleshow/124716297.cms

121. https://www.thehindu.com/business/Industry/indias-reliance-on-china-for-critical-minerals-explained/article69020390.ece

Table 9: An illustrative list of processed minerals being exported from the above countries

Processed mineral	World exports in FY25 (In KT)	Leading exporting countries
Lithium[122] (carbonate)	~326	Chile (73%), Argentina (22%), South Korea (2%)
Graphite[123] (Natural powder form/ flakes)	~338	China (43%), Madagascar (21%), Belgium (5%), Netherlands (4%)
REE[124] (metal)	~10	China (81%), Thailand (8%), US (4%)
Nickel Sulphate[125]	~382	Indonesia (49%), South Korea (17%), China (6%), South Africa (6%)
Cobalt[126] (oxides and Hydroxides)	~37	Namibia (33%), Zambia (15%), China (14%)
PGE[127] (metal, unwrought form)	~0.35	South Africa (22%), UK (16%), China (15%), US (7%)

downstream processing remain largely China-centric, limiting diversified access to high-purity graphite products.

For India, the opportunity and gap are both clear. While India has strong technical capabilities and policy intent to build midstream processing capacity, it remains reliant on imports of lithium, cobalt, nickel and REE intermediates. Developing commercial-scale processing will require time, investment and coordinated policy support to move from import dependence to domestic value addition.

5.2.3 Mineral asset acquisition

Categories of assets for acquisition

Overseas acquisition of critical mineral assets has become a strategic imperative for India to mitigate supply concentration risks, secure long-term access to raw materials and support the development of domestic downstream manufacturing. Critical mineral assets for acquisition can be categorised into the following categories, which differ in terms of development timeline, costs and associated risks.

Exploration stage assets

Early-stage assets with minimal or no resource estimates, where exploration and feasibility activities are limited or preliminary. They carry high geological and regulatory risks, long gestation, high exploration costs and limited resource certainty.

Developmental stage assets

Assets with proven reserves and completed or ongoing feasibility studies, where development activities are in progress. They have a 3–5-year production horizon, moderate risk, require significant CAPEX, and allow scope to influence mine design and logistics.

Operating stage assets

Fully operational mines with established infrastructure, steady revenues, and long-term offtake support. They carry minimal geological risk but command high acquisition costs and valuation, offering immediate material availability and a hedge against price volatility.

Stressed non-operating assets

Idle assets with confirmed reserves, halted by financial, regulatory or operational constraints. They offer low-valuation acquisition opportunities but carry risks of high restart costs, delays and legacy issues.

Mixed assets

Assets with partial production and ongoing exploration/development, offering both immediate output and long-term potential but requiring due diligence on integration, phased investments and regulatory complexities.

122. Trade Map - List of exporters for the selected product
123. Trade Map - List of exporters for the selected product
124. Trade Map - List of exporters for the selected product
125. Trade Map - List of exporters for the selected product
126. Trade Map - List of exporters for the selected product
127. Trade Map - List of exporters for the selected product

Overseas critical mineral asset acquisition structure

Indian Public Sector Enterprises (PSEs), joint venture platforms and private sector entities can adopt multiple participation models to access overseas critical mineral resources. These structures differ in ownership control, capital requirements, governance complexity and risk-sharing mechanisms. The most relevant models for India are outlined below:

a. Corporate acquisition

Direct purchase of equity in an asset-owning mining company, subsidiary or special-purpose vehicle provides full operational control and assured access to reserves. This model is most effective for **mature assets** with proven reserves, completed feasibility studies and supporting infrastructure (power, transport, logistics). While it requires **high upfront capital** and entails exposure to **existing liabilities** (environmental, contractual or financial), it ensures **immediate material availability** and enables direct integration into downstream supply chains. Typical steps include due diligence, valuation, deal structuring, regulatory clearances and operational integration.

Example: A leading metals and mining company acquired a 51 percent controlling stake in a Zambian copper mining company in 2004 for a total cash consideration of US$48.2 million[128]

b. Joint Ventures (JVs)

Joint ventures with **host-country entities, local miners or global operators** allow for shared financial and operational risk while building on **local expertise and stakeholder networks.** This structure is especially suitable where **regulatory or community participation requirements** encourage local collaborations. Although shared governance may limit unilateral control, JVs provide a balanced approach to **greenfield and expansion projects** by combining foreign technical or financial strength with domestic resource access. Typical process includes collaborator identification with a strong local presence, preliminary agreement, due diligence, JV agreement, asset transfer to the JV and regulatory approvals.

For India, JVs offer a pragmatic pathway to participate in both greenfield and brownfield critical mineral projects while reducing political and execution risks. However, shared governance structures require clear alignment on operational control, offtake rights and exit mechanisms.

Example: A major Indian steel producer, entered into a joint venture agreement with Riversdale Mining Ltd (Australia) in 2007 to acquire a 35 percent interest in the Benga and Tete coal licences in Mozambique's Moatise basin, paying about AUD 100 million (approximately US$88 million) and securing long-term access to hard coking and thermal coal for its global operations.[129]

c. Carry or earn-in arrangements

Under **carry financing or earn-in mechanisms**, a participant secures future equity or offtake rights by allowing the operating collaborator to fund early-stage exploration or development. The investor's share of costs is recovered later from production revenues or equity conversion. This model suits **high-risk or early-stage projects,** enabling gradual entry, capital preservation and strategic positioning in new jurisdictions. Typical process includes Initial agreement, work programme definition, monitoring frameworks, conversion triggers, repayment terms, regulatory acknowledgement and final participation.

For India, earn-in arrangements are well-suited to lithium, copper and nickel exploration projects in emerging jurisdictions, where geological upside is significant but commercial viability is yet to be proven.

Example: Farm-in arrangements incorporating carry mechanisms have been used in India's upstream sector; for example, BP's farm-in to Reliance Industries' KG-D6 block involved funding exploration and development costs in exchange for equity participation and future production rights.[130]

Collectively, these acquisition structures provide India with a flexible toolkit to secure overseas critical mineral supplies based on asset maturity, risk appetite and strategic importance. A calibrated mix of corporate acquisitions, joint ventures and earn-in arrangements, anchored by government-backed institutions and complemented by private sector participation, will be essential for building long-term raw material security.

By systematically deploying these models, India can move beyond transactional sourcing towards strategic ownership and influence in global critical mineral value chains, directly supporting domestic processing, manufacturing competitiveness and energy transition objectives.

128. A China Lithium Company to Spend US$76.50 Million to Acquire Overseas Lithium Mine | SMM
129. https://www.tatasteel.com/newsroom/press-releases/india/2007/tata-steel-signs-jv-with-riversdale-mining-for-mozambique-coal-project/
130. https://www.thehindu.com/business/BP-inks-mega-deal-to-pick-up-30-in-RIL-oil-gas-blocks-for-7.2-billion/article15453743.ece

6. Navigating the way forward

To build a resilient and self-reliant critical minerals ecosystem, India must adopt a comprehensive and actionable strategy. By implementing a structured, institution-led and time-bound execution-focused strategy across exploration, processing, collaborations, recycling, financing and human capital, India can transition from import dependence to becoming a globally competitive hub for critical minerals. This will underpin India's clean energy transition, industrial competitiveness and long-term economic and strategic security.

Strengthen institutional and governance frameworks

- **Operationalise the National Critical Minerals Mission (NCMM)** with a clearly defined mandate, dedicated budgetary support and measurable time-bound deliverables.
- **Establish a National Critical Minerals Board (NCMB)** to enable coordinated decision-making across ministries, PSUs, state governments, industry and academia, similar to Australia's Critical Minerals Facilitation Office.
- **Create a single-window policy coordination mechanism** to streamline approvals, align incentives and reduce fragmentation across the value chain

Accelerate exploration and resource mapping

- **Scale up advanced exploration technologies,** including AI-driven mineral targeting, hyperspectral imaging, drone-based surveys and deep-seated geophysics.
- **Use the Exploration License (EL) regime** to attract private and foreign participation through risk-sharing frameworks.
- **Promote public–private exploration collaborations,** with GSI and MECL collaborating with global exploration firms, drawing from Canada's proven PPP-led discovery model.
- **Prioritise systematic basin-scale exploration** for lithium, REEs, nickel, cobalt, graphite and PGE-bearing formations.

Develop midstream processing and refining capabilities

- **Establish dedicated critical mineral processing and refining hubs** for lithium, cobalt, nickel, graphite and REEs with integrated infrastructure for power, water, logistics and waste management.
- **Support midstream investments through targeted incentives,** including Production Linked Incentives (PLIs), Viability Gap Funding (VGF), capital subsidies and long-term offtake assurances.
- **Encourage PPPs** in separation, refining and chemical processing to bridge technological and capital gaps.

Deepen strategic international collaborations

- **Expand government-to-government (G2G) and commercial collaborations** with resource-rich countries such as Australia, Argentina, Chile, Brazil and African jurisdictions.
- **Pursue overseas asset acquisition and joint ventures** through PSUs and strategic consortia, including earn-in and phased equity participation models.
- **Secure long-term supply agreements** for raw materials, processing technologies and downstream chemicals.
- Scale and replicate precedents such as KABIL's lithium engagements in Argentina, with clear timelines and capital commitments.

Promote circular economy and urban mining

- **Develop a national urban mining framework** for recovery of critical minerals from e-waste, spent batteries, industrial residues and tailings.
- **Scale recycling and recovery capacities** for lithium, cobalt, nickel and REEs through fiscal incentives and technology support.
- **Strengthen Extended Producer Responsibility (EPR) mechanisms** to ensure systematic feedstock availability.
- **Support domestic recyclers,** building on existing initiatives to reduce import dependence and environmental footprint.

Enable financing and risk mitigation

- **Establish a critical minerals development fund** to support early-stage exploration, pilot projects and technology validation.
- **Adopt blended finance structures,** combining public funding, private capital and multilateral support (World Bank, ADB).
- **Introduce sovereign insurance and guarantee mechanisms** to de-risk overseas investments and long-gestation projects.
- **Facilitate access to low-cost, long-tenure capital** for processing and refining infrastructure.

Build human capital and technical capabilities

- **Create specialised training and research centres under NCMM** focused on geosciences, mineral processing, metallurgy and chemical engineering. Separate fund allocation and incentives to set up Skill Development Centres in PPP mode would be critical.
- **Partner with IITs, CSIR laboratories, BARC and global institutions** to design industry-aligned curricula and certification programmes.
- **Encourage industry-academia collaboration** for applied research, pilot plants and commercialisation of processing technologies.
- **Incentivise the adoption of advanced digital and AI tools** across academia and industry to attract talent and expand specialised course offerings.

Embed ESG and sustainability standards

- **Mandate responsible and green mining practices,** including water stewardship, waste management and energy efficiency.
- **Ensure robust community engagement and social safeguards** across domestic and overseas operations.
- **Align India's critical minerals sector with global ESG frameworks,** such as the Extractive Industries Transparency Initiative (EITI).

By shifting decisively from policy articulation to execution, and by anchoring reforms in institutional accountability and investment certainty, India can move beyond import dependence to become a globally competitive hub for critical minerals, supporting its clean energy transition, industrial growth and long-term economic and strategic security.

7. Conclusion

India's path to achieving energy independence and industrial leadership in the 21st century will hinge on its ability to secure, process and innovate around critical minerals. As global supply chains realign amid the twin forces of decarbonisation and technological transformation, mineral security has become synonymous with economic security. The National Critical Mineral Mission (NCMM) offers India a once-in-a-generation opportunity to convert vulnerability into strategic strength, transforming from an import-dependent market to a value-creating hub within global clean technology ecosystems. Success will depend on relentless execution: deepening domestic exploration, scaling midstream refining capabilities, forging global collaborations, mobilising innovative financing models and embedding innovation and sustainability across the value chain. If effectively implemented, this strategy can position India not merely as a participant but as a pivotal architect of the global energy transition, anchoring its vision of Viksit Bharat through resource resilience, industrial competitiveness and long-term strategic autonomy for critical minerals and REEs.





Abbreviations

~	Approximately
INR	Indian Rupee
%	Percentage
$	United States Dollar
OC	Degree Celsius
AI	Artificial Intelligence
AMD	Atomic Minerals Directorate for Exploration and Research
Atmanirbhar Bharat	Self reliance
AUD	Australian Dollar
BARC	Bhabha Atomic Research Centre
Bn	Billion
BSS	Battery Storage Systems
CAPEX	Capital expenditure
CPI	Corruption Perceptions Index
CSIR	Council of Scientific and Industrial Research (Domestic Institution)
DRC	Democratic Republic of the Congo
Dy	Dysprosium
EL	Exploration License
EPR	Extended Producer Responsibility
ESG	Environmental, Social and Governance
ESS	Energy Storage Systems
EU	European Union
EV	Electric Vehicles
FDI	Foreign direct investment
FY	Financial Year
GII	Global Innovation Index
GSI	Geological Survey of India
GW	Gigawatts
HDI	Human Development Index
HPAL	High Pressure Acid Leaching
HREEs	Heavy Rare Earth Elements
IEA	International Energy Agency
IITs	Indian Institutes of Technology
IMF	International Monetary Fund
IREL	Indian Rare Earths Limited (a Mini Ratna-1 company under Department of Atomic Energy)
JVs	Joint Ventures
KABIL	Khanij Bidesh India Ltd.
KMML	Kerala Minerals and Metals Limited
Kt	Kilotonnes
ktpa	Kilotonnes per annum
LCE	Lithium carbonate equivalent
LFP	Lithium Iron Phosphate
LREEs	Light Rare Earth Elements
MECL	Mineral Exploration and Consultancy Ltd.
MMDR	Mines and Minerals (Development and Regulation) (as used in the context of the Amendment Act)
MSP	Minerals Security Partnership
Mt	Million tonnes
NAGMP	National Aero Geophysical Mapping Programme
NCMM	National Critical Mineral Mission
Nd	Neodymium
NdPr	Neodymium Praseodymium
NGDR	National Geo Data Repository
NMET	National Mineral Exploration Trust
NMEP	National Mineral Exploration Policy
NMP	National Mineral Policy
NPI	Nickel pig iron
NPEAs	Notified Private Exploration Agencies
OC	Degree Celsius
PGEs	Platinum Group Elements
PGMs	Platinum Group Metals
PLIs	Production Linked Incentives
Pr	Praseodymium
PSUs	Public Sector Undertakings
PV	Photovoltaics
REEs	Rare Earth Elements
REPM	Rare Earth Permanent Magnet
RGI	Resource Governance Index
RKEF	Rotary Kiln Electric Furnace
STEPS	The Stated Policies Scenario
Tb	Terbium
TW	Terawatts
US	United States
UNCTAD	United Nations Conference on Trade and Development.

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