Reval Consulting
Innovation | Trust | Sustainability

Critical Minerals:
Leading India's Green Transformation

ReVal Consulting partners with businesses to tackle their most significant challenges and capture their greatest opportunities in the Mineral and Mining Sector. We work closely with our esteemed clients to embrace a transformational approach aimed at benefitting all stakeholders across the value chain and driving positive business outcomes.

Our diverse team brings deep industry experience, functional expertise, and a range of perspectives that help us deliver solutions through leading-edge management consulting, technology, and design. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, fueled by the motto of serving them with the best possible solution.

Introduction

Critical minerals are essential for modern technology, including solar panels, semiconductors, wind turbines, and advanced batteries. These minerals are crucial for the energy transition and India's economic future relies on effectively utilizing its energy and mineral resources to align with the global shift towards zero emissions.

India is undergoing a significant transformation at this juncture as it gears towards adopting green technologies and sustainable methodologies. With an increasing global focus on mitigating climate change, as has been the agenda of the recently held COP'28, convened at Dubai, UAE and keeping the global pre-industrial temperature rise below 1.5 degrees Celsius as mandated by the Paris Climate Agreement, 2015, it's imperative both for the world as well as India to shift from fossil fuel-based energy sources to cheaper, cleaner, greener and reliable renewable front. Thus, keeping the global vision in mind, India has vowed to completely transition to net-zero by 2070, and taking significant strides in that direction, in June, 2023, the Ministry of Mines has taken the initial step of identifying and declaring thirty minerals as 'Critical & Strategic' for the country depending upon factors like economic importance, supply chain vulnerabilities, disruption potential, substitutability and import reliance, aligning with the European Union's approach of delineating a three stage assessment of strategic importance.

With the recent amendments introduced in the Mines and Minerals (Development & Regulation) Act, 1957, the government has proactively brought these minerals under its tutelage to facilitate commercial exploration and in-house mining of these resources to boost economic efficiency and unlock growth potential, crucial for future prosperity.

"Keeping the global vision in mind, India has vowed to completely transition to net-zero by 2070, and taking significant strides in that direction, in June 2023, the Ministry of Mines has taken the initial step of identifying and declaring thirty minerals as 'Critical & Strategic'"

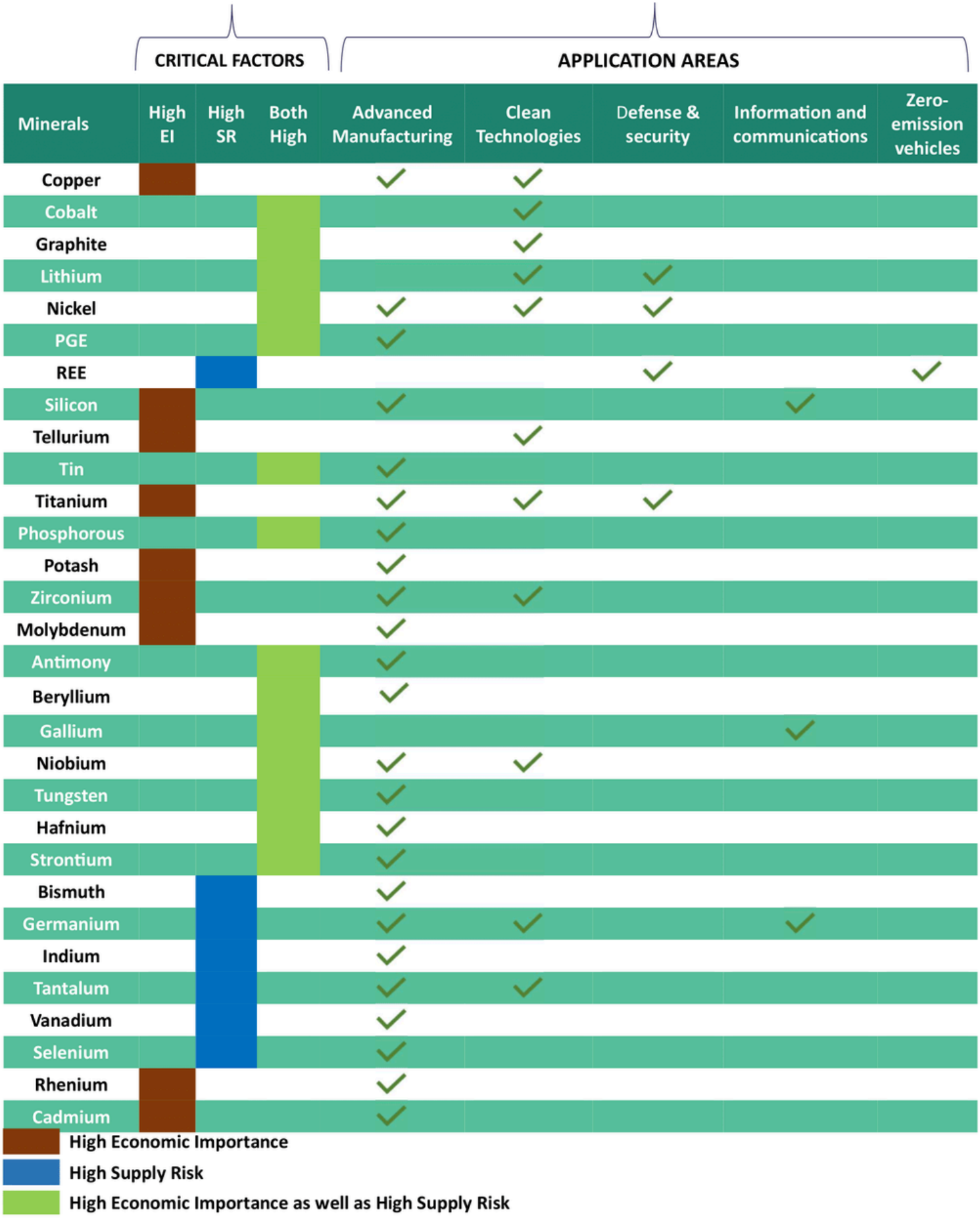
These thirty minerals identified by the Seven-member Committee of Ministry of Mines are Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, Lithium, Molybdenum, Niobium, Nickel, PGE, Phosphorous, Potash, REE, Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium and Cadmium.

As per the Report of the Committee on Identification of Critical Minerals & 2020 data India is 100% import dependent for Lithium, Cobalt, Nickel, Vanadium, Niobium, Germanium, Rhenium, Beryllium, Tantalum, & Strontium, 80% for Zirconium, 50% for Manganese, 3% for Chromium & <1% for Silicon. Thus, identification of these mineral deposits within the country will pave the way for their acquisition, commercialization and preservation, reducing import dependency.

Also, the significance of critical minerals in supporting green technologies, renewable energy (RE), and the electric vehicle (EV) industry underscores the need to closely monitor global demand and supply trends. Additionally, analyzing the adoption rates of RE and the penetration of EVs in India is crucial at this juncture & the impediment concerning the same needs to be dealt.

In this article, we aim to thoroughly understand the Critical & Strategic mineral scenario of India, their importance, the recent enticing trends in their auctions and further we delve deep into the important scenario concerning the value chain, the global renewable adoption picture & how policymakers, industry stakeholders, and investors can make informed decisions to support the sustainable development of these strategic assets & green technologies leading to the transition to a low-carbon economy. Already the first and second tranche of auction of the critical minerals are underway with 20 and 18 blocks on offering respectively and it's yet to see how the bidding results unfold.

Application & Importance of Critical Minerals



Global Demand & Supply Scenario

Analyzing global demand and supply trends of critical minerals is essential to ensure a stable and secure supply for high-tech devices, renewable energy technologies, and defense systems. By monitoring these trends, industries can make informed decisions regarding investment, resource allocation, and strategic planning. This understanding is vital for developing sustainable practices for the extraction, use, and recycling of these minerals.

Fig: Present & Anticipated Global Demand & Supply Scenario of Lithium (Kt)

The demand for lithium is growing rapidly, driven by the widespread adoption of all solid-state batteries used in automotives, energy storage, consumer electronics & aerospace.

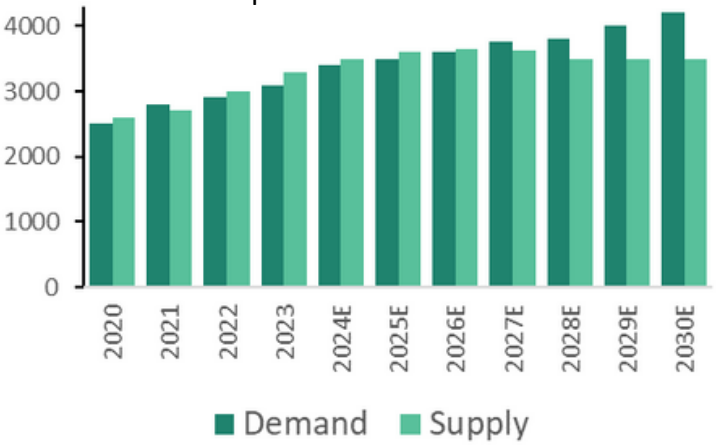


Fig: Present & Anticipated Global Demand & Supply Scenario of Nickel (Kt)

The market is expected to remain in surplus over the medium term due to increased supply of Nickel from expansion projects in Indonesia. Additionally, there is a projected higher demand for class I nickel, primarily used in electric vehicle batteries.

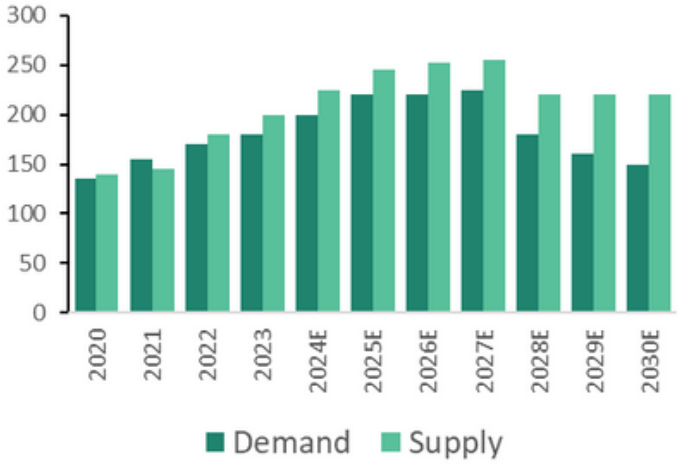


Fig: Present & Anticipated Global Demand & Supply Scenario of Cobalt (Kt)

The Cobalt market is expected to remain in surplus due to evolving battery technology, including the shift towards cobalt batteries used extensively in consumer electronics space.

Source: IEA The Role of Critical Minerals in Clean Energy Transitions
IEA Global Electric Vehicle Outlook 2022

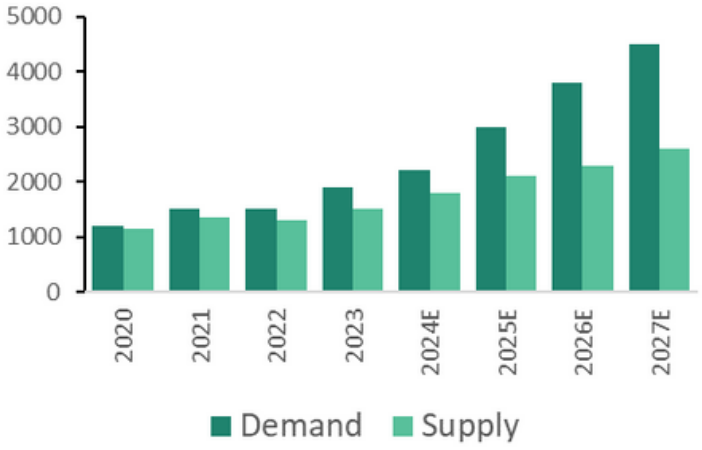


Fig: Present & Anticipated Global Demand & Supply Scenario of Graphite (Kt)

The demand for graphite from battery anodes is expected to increase manifold. This shift is driven mostly by ESG factors favoring natural graphite over synthetic alternatives.

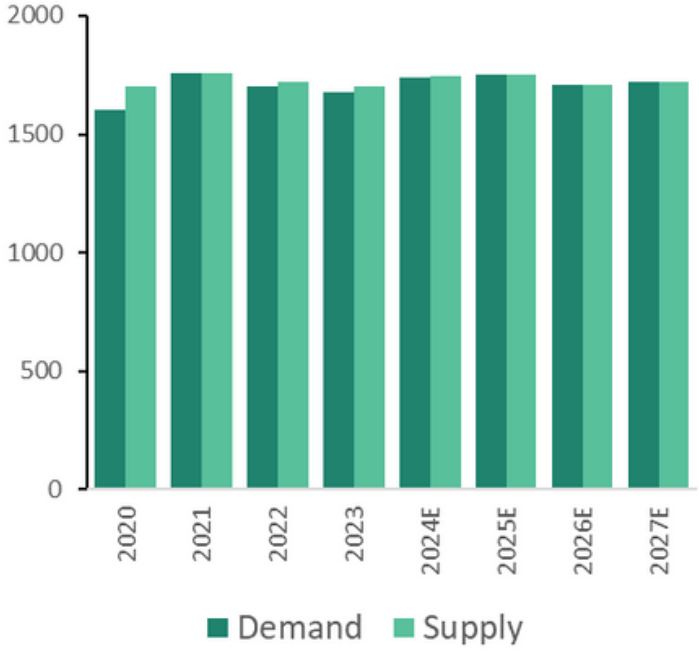


Fig: Present & Anticipated Global Demand & Supply Scenario of Manganese (Kt)

The manganese market is expected to remain balanced due to the high-grade ore production from South Africa, as well as other mines in South Africa and Australia. India also contributes roughly 5% of the global output and this mineral find application mostly in steel, ceramics, fertilizers & rubber industry.

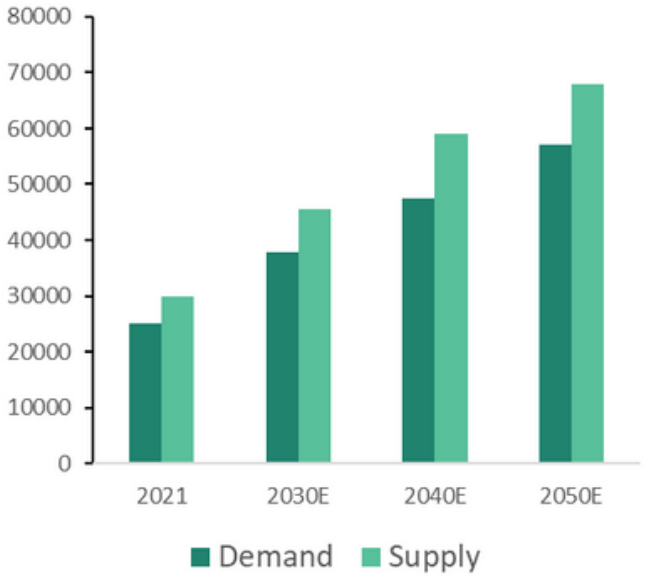


Fig: Present & Anticipated Global Demand & Supply Scenario of Copper (Kt)

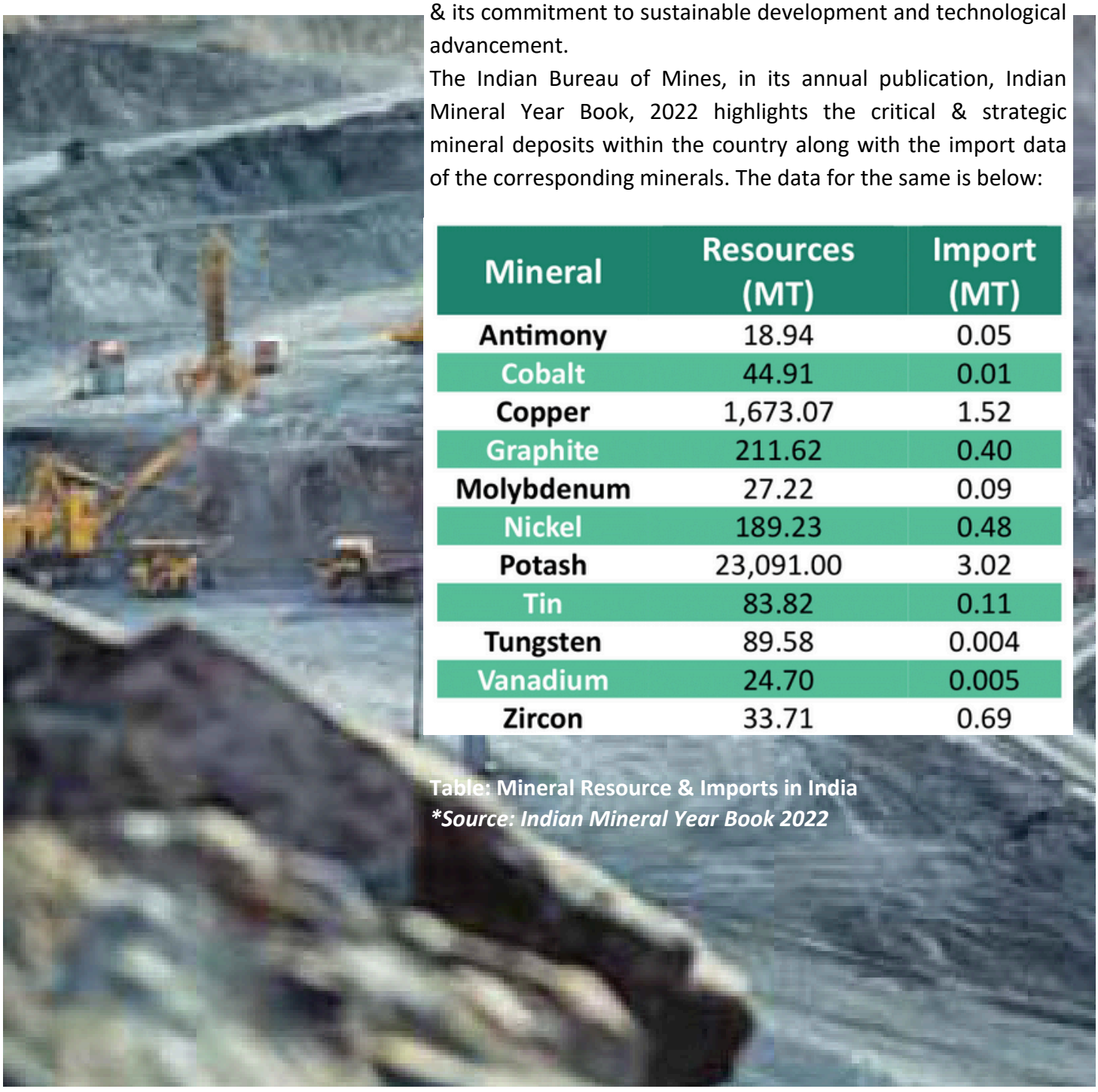
The Demand & Supply trend of copper is expected to rise in near future as it plays a vital role in the development of renewable energy and electric mobility solutions components. Worldwide, Copper production for 2023 stands at 22 million metric tons, a 37.5% rise Y-o-Y, with Chile being the front-runner and India contributing roughly about 2% of the global production.

Source: IEA The Role of Critical Minerals in Clean Energy Transitions
IEA Global Electric Vehicle Outlook 2022
Kt: Killo Tonne

India's Resources: Deposits & Imports

India relies on several critical minerals to support its economy and various industries. Being at the nascent stage of exploration of critical & strategic minerals, our country still relies on imports for meeting its cardinal needs, however, with the aim of becoming self-reliant due to the evolving geo-political scenario, it's imminent for India to pursue its in-house deposits of these minerals in line with its firm agenda of decarbonization by 2070 & its commitment to sustainable development and technological advancement.

The Indian Bureau of Mines, in its annual publication, Indian Mineral Year Book, 2022 highlights the critical & strategic mineral deposits within the country along with the import data of the corresponding minerals. The data for the same is below:



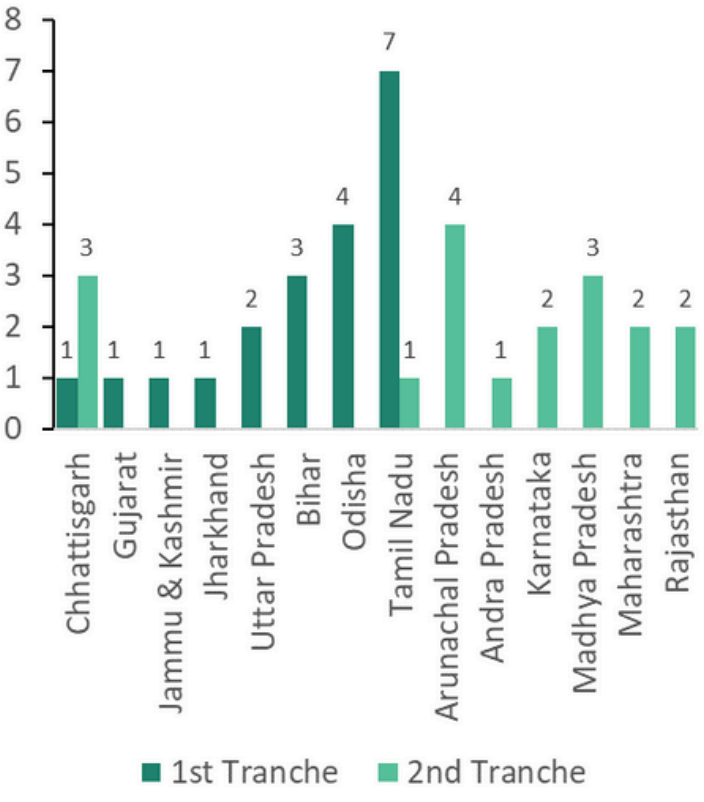
Mineral	Resources (MT)	Import (MT)
Antimony	18.94	0.05
Cobalt	44.91	0.01
Copper	1,673.07	1.52
Graphite	211.62	0.40
Molybdenum	27.22	0.09
Nickel	189.23	0.48
Potash	23,091.00	3.02
Tin	83.82	0.11
Tungsten	89.58	0.004
Vanadium	24.70	0.005
Zircon	33.71	0.69

Table: Mineral Resource & Imports in India
Source: Indian Mineral Year Book 2022

With such enormous deposits within the country, it's imperative for India at this juncture to mobilize resources to initiate more surveys & exploration activities for identification of such blocks and open them up for commercialization.

India's Critical Mineral Blocks Auction Scenario:

As the government steps up to promote the mining and in-house production of the critical minerals and establish the complete value chain surrounding them, certain amendments were introduced in the Mines and Minerals Development and Regulation Act, 1957 (MMDR Act, 1957) through the MMDR Amendment Act, 2023, empowering the Central Government to auction critical and strategic minerals blocks with the aim to reduce our reliance on imports and ensuring a more secure and resilient supply chain.

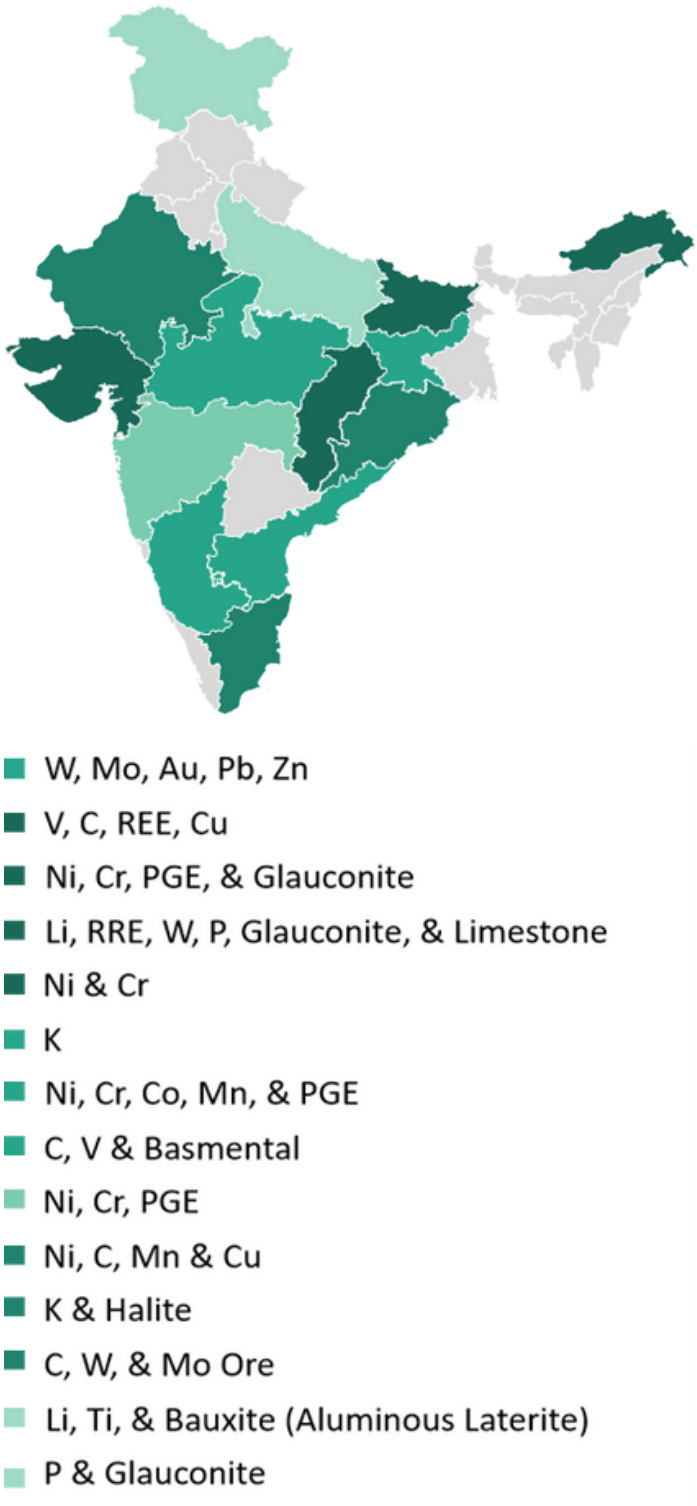


The Government of India launched the first tranche of auction of these minerals on 29th November 2023 for 20 blocks & the second tranche of auction of these minerals on 29th February 2024 for 18 blocks.

Out of 20 blocks in 1st tranche 04 Block is having Mining Lease (ML) & 16 Blocks are having Composite License (CL).

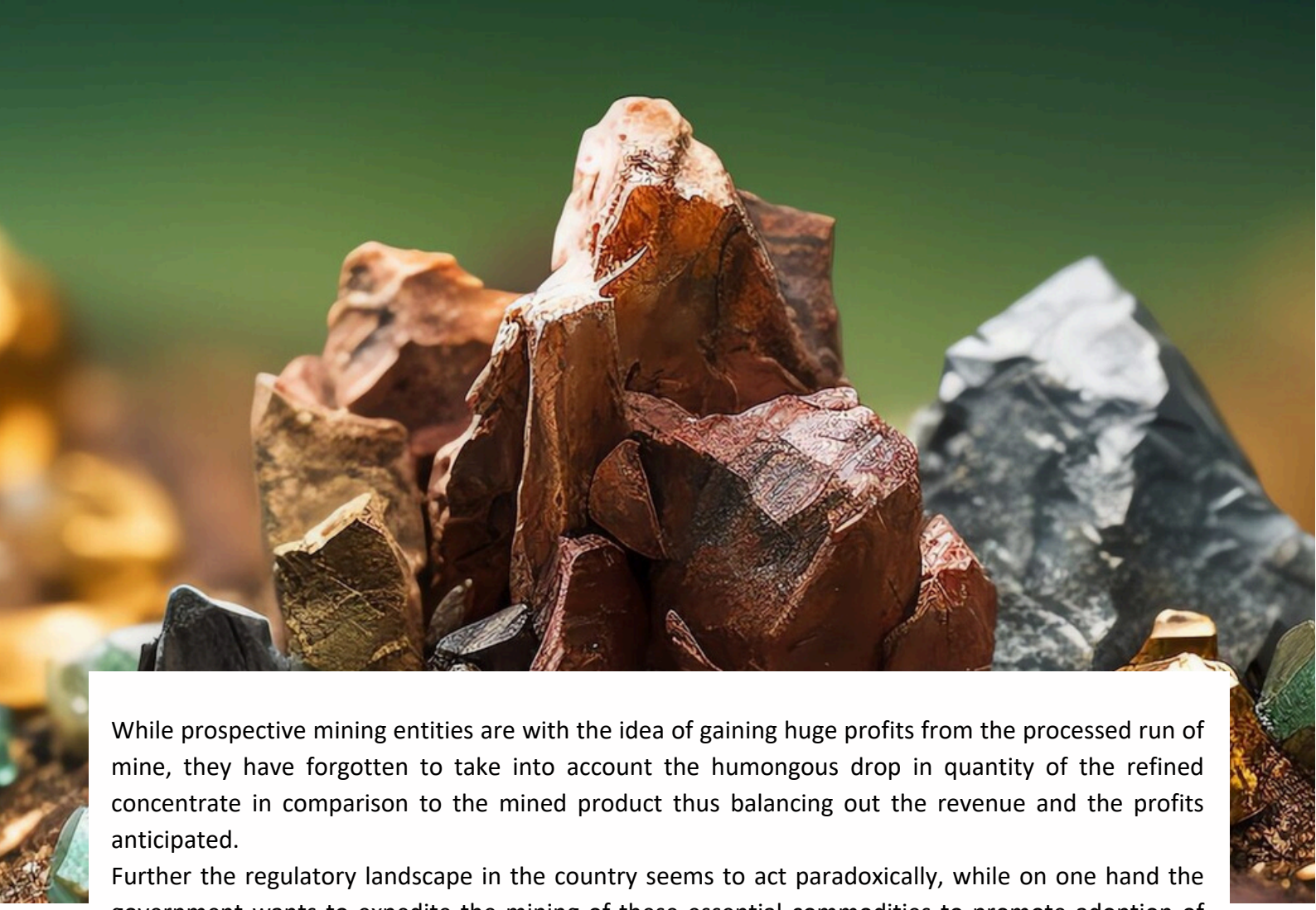
Out of 18 blocks in 2nd tranche 01 Block is having Mining Lease (ML) & 17 Blocks are having Composite License (CL).

Major players participated for auction: CIL, DCBL, Hindalco, Jindal Power, MOIL, NLC India Limited, Rungta Sons Private Limited, & Vedanta.



Critical & Strategic mineral auctions pose serious challenges as is evident from the first two tranches. Foremost reason behind the same is the lack of exploration data of the thirty-eight blocks tabled for auction, thus acting as an impediment for prospective bidders to decide on their participation. It's well known that exploration and prospecting activities are capital intensive in nature hence, furnishing with relevant data of the blocks is mandated. This unavailability of data has led to cancellation of bids for thirteen blocks due to unfulfillment of the prescribed criterion of minimum three participants. Further to make matters worse, the entire spectrum of events encompassing the auction process doesn't have any fixed timeline, rather the first round of auction got delayed due to amendments in the date by the government and the second tranche is still on-going with little to no clarity of its final declaration.

Also, in certain scenarios, bidders have overestimated the economic value of these resources, thus quoting high premiums in the range of 70% – 300% in the revenue sharing model. The sole reason attributable to such high premiums can be contributed to the lack of expertise & understanding of value chain.



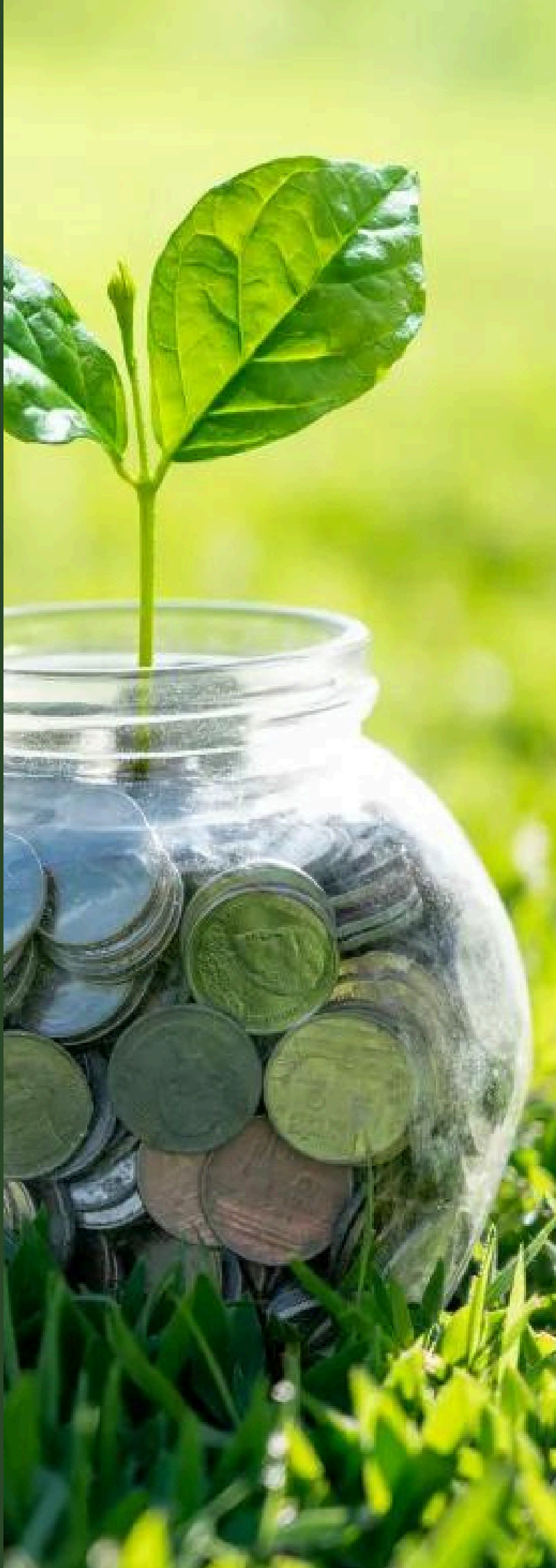
While prospective mining entities are with the idea of gaining huge profits from the processed run of mine, they have forgotten to take into account the humongous drop in quantity of the refined concentrate in comparison to the mined product thus balancing out the revenue and the profits anticipated.

Further the regulatory landscape in the country seems to act paradoxically, while on one hand the government wants to expedite the mining of these essential commodities to promote adoption of green technology, on the other hand numerous approvals and clearances hinder the process of commercialization of these mines. These instances have led to huge delays in production especially in case of coal and iron-ore mines and since critical and strategic minerals are mostly found in sensitive ecosystems, they are bound to pose more challenges. While it's evident mining activities will result in certain levels of ecological disturbances, it's imperative for the government to introduce policy frameworks that helps in maintaining a balance without posing as an obstacle for the sector.

As the world undergoes a green transition, it's imperative for India to acknowledge the importance of critical and strategic minerals and how they have a significant role to play in fulfilling the sustainability agenda of our nation.

Going Green

Critical minerals are essential for the development and deployment of renewable energy technologies like wind and solar power, as well as for advanced electric mobility solutions. These minerals are crucial for energy storage, transmission, and generation, and their availability and sustainable management are key to ensuring a steady transition to a low-carbon economy & achieving the global agenda circumventing climate goals, and it's a mandate at this juncture to prioritize the development and management of these essential commodities.



Global Drivers for Critical Minerals

FACTOR	DRIVERS
Economical	• Critical minerals are vital for economic security, offering strategic and competitive advantages, while also supporting industrial and social development objectives, alongside infrastructure needs.
Supply Chain	• Risks and vulnerabilities in the supply chain, import dependency, and geographic concentration of production and processing underscore the importance of securing critical minerals, which often lack substitutes and secondary sources.
Technology Sustainability	• Considering the dynamic geopolitical landscape, it's imperative for India to become self-reliant in terms of raw materials needed for supporting new-age green tech. • Critical minerals are essential for clean technologies and the low-carbon transition, driving technological innovations and potentially leading to the emergence of mineral substitutes within various industries. • For minimizing environmental impact, requiring robust regulatory frameworks to ensure responsible extraction and usage, aligning with sustainability goals.
Geopolitical	• National security considerations and the risk of monopolization or stockpiling highlight the geopolitical importance of critical minerals, particularly in the face of external shocks and geopolitical realignments.

Global Emission Scenario

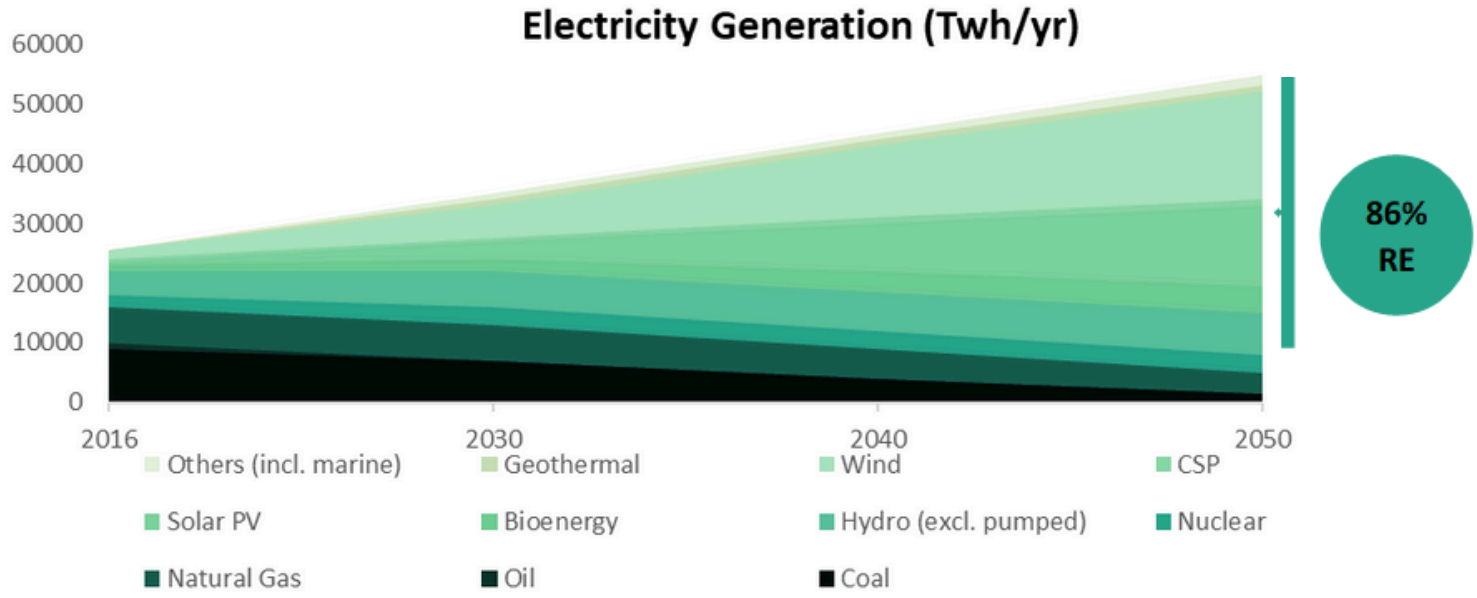


Fig: Wind and solar power dominate growth in renewable-based generation globally

Adoption of RE can significantly reduce the dependency on fossil fuels for power generation and from the above figure by 2050 power generation by RE will be 86% which indicates the decline in usage of fossil fuel such as coal, oil & natural gas.

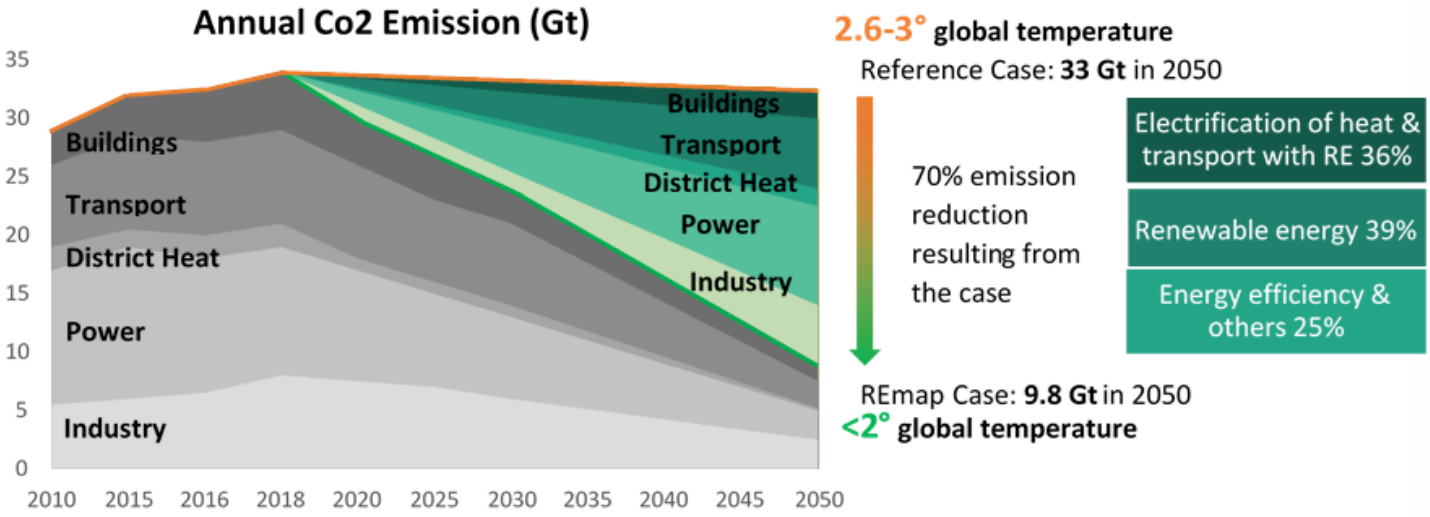


Fig: Annual CO2 Emission reduction by 2050 if RE is adopted

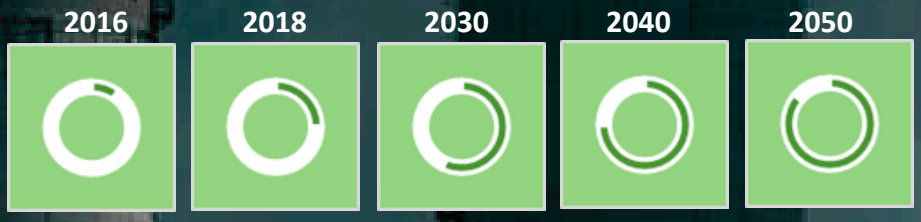
Reference Case: This scenario considers current and planned policies of countries. It presents a perspective based on governments' current projections and energy plans.

REmap Case: This scenario includes the deployment of low-carbon technologies, based largely on renewable energy and energy efficiency to reach the rise in global temperature to well below 2 degrees Celsius.

Source: IRENA Global Energy Transformation; Roadmap to 2050
Gt: Giga Tonne
Twh: Terra Watt Hour
RE: Renewable Energy

By 2050, the aim is to increase the Global Renewable Energy share considerably to combat Greenhouse Gas (GHG) Emissions

RE share in global Power Generation



RE share in India's Power Generation Portfolio

**Source: International Renewable Energy Agency*
Global Energy Transformation: A Roadmap to 2050

India's Renewable Energy Adoption

The adoption rate of RE & EV in the country ultimately leads to adoption of Critical minerals as they form the basket of crucial raw materials supporting these sectors.

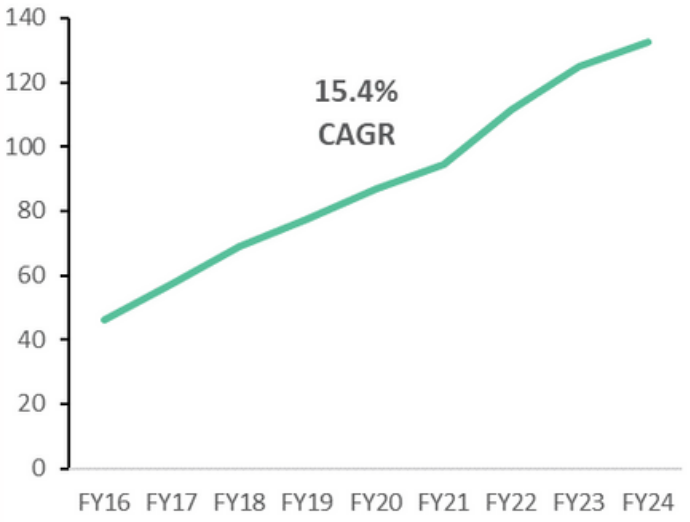


Fig: RE Capacity (GW)

Globally, India stands as the fifth largest country in terms of the installed capacity of Solar power generation & the fourth largest in terms of Wind power generation capacity.

Further, the nation has also been at the forefront in EV adoption with a sudden increase in the same since 2021 onwards.

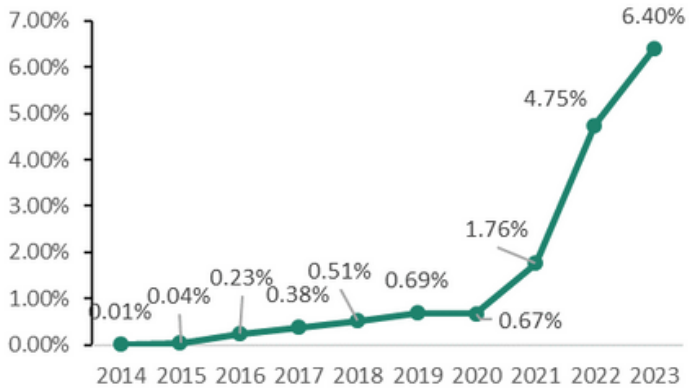


Fig: High EV Penetration

In 2023, approximately 15 lakh electric vehicles were sold in comparison to 10 lakh electric vehicles in 2022, a whooping 49% increase in adoption Y-o-Y.

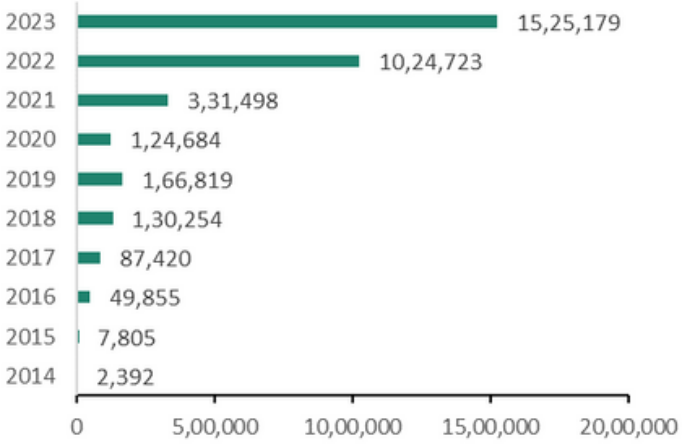


Fig: EV Sale exponential growth

This has solely been possible because of the conducive & friendly policies introduced by the government to promote the net-zero transition.

GW: Giga Watt
EV: Electric Vehicle

Government Policies for Renewable Energy

Repowering Policy

Optimize Utilization of wind energy sources through Interest rate rebate of 0.25% over & above existing interest rate for new project & Fiscal & financial benefits.

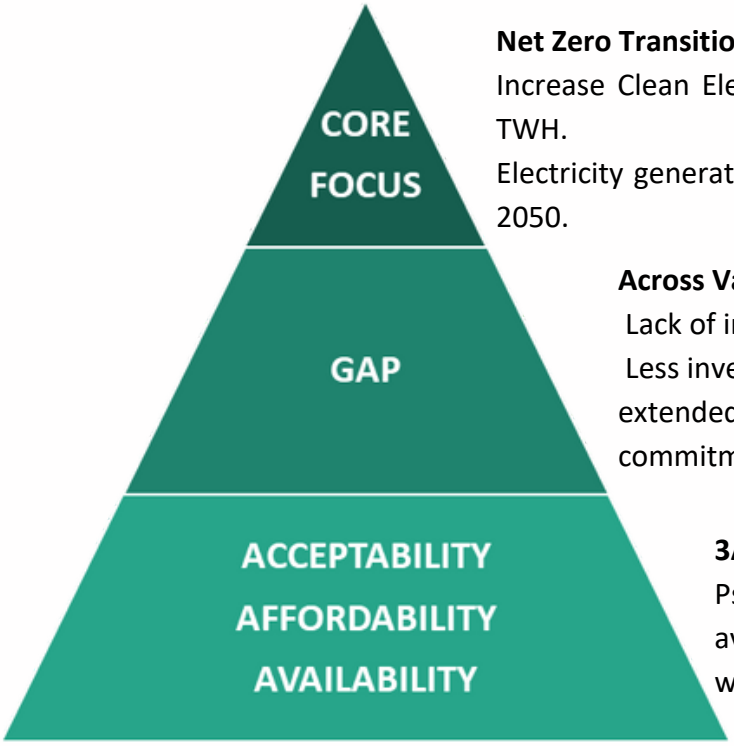
Wind-Solar Hybrid Policy

Minimize Variability & Optimal utilization of infrastructure including land & transmission through Hybridization of two technologies.

Renewable Purchase Obligations

Purchase Certain percentage of power from RE sources through Obligation of state electricity commissions to purchase. Floor price set at US$ 144 per MW.

India’s Gap in Adoption Compared to Developed Economies



Net Zero Transition:
Increase Clean Electricity Generation by 4X in 2050 to 9000 TWH.
Electricity generation Shift from 65% fossil fuel to 90% RE by 2050.

Across Value Chains:
Lack of incentives for CM exploration & mining,
Less investment in R&D across value chain,
extended time frame till 2070 vis a vis global commitment of 2050

3A’s:
Psychological barriers in people and un-availability of necessary infrastructure along with affordability of new technology.

The gap in critical mineral development between India and leading nations like Canada, US, and Australia can be attributed to their higher levels of investment and incentives. Canada offers a 30% tax credit for exploration and has invested $144.4 million in R&D. The US provides a 10% tax credit of production costs and has allocated $93.4 million for supply chain development. Australia has invested in a $100 million production project and $4 billion in exploration. In contrast, India's investments and incentives for critical mineral development is comparatively lower, leading to a gap in critical mineral development. Closing this gap will require increased investment and strategic initiatives in India. Also, limited awareness and acceptance among citizens, high upfront costs for EVs, infrastructure limitations, and lack of transmission capacity for interstate trade and storage are key barriers to the widespread adoption of electric vehicles and renewable energy technologies.

Strategic Changes in the Way the Value Chain Works for Critical Mineral

Upstream Exploration: Private sector participation in exploration

All the critical mineral blocks tabled for auction till date are unexplored i.e. they are at G4 or reconnaissance stage, posing significant challenge for the interested bidders to decide on their participation. To augment success, an inference can be drawn from the coal and iron-ore mines auction which garnered enough participation solely because the blocks were partially or completely explored, favoring proper due-diligence. Further, private participation in exploration with proper incentivization structure is the need of the hour.

Upstream Mining & Extraction: Use of heavy machinery for UG & OC mines

Critical Minerals are generally deep-seated in nature & are difficult to locate and mine in comparison to common minerals like coal & iron-ore. Further, exploration & mining of these minerals lead to serious environmental pollution that can't be reverted. Hence, deployment of modern heavy equipment and mining machineries coupled with automation and internet of things (IOT) can help tackling these challenges. Modern equipment such as Automatic Drilling Machine (ADMs), Continuous Miners, etc. embedded with technology makes operations easier & smoother.

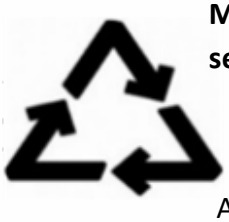
Midstream-Processing, Refining & Metallurgy: Funding mechanism for processing & refining technologies

Critical mineral mines mandate setting up of processing & refining facilities such as beneficiation plant at vicinity to enhance the value of the mined output. This is of utmost importance as unlike coal or iron-ore, the marketability and salability of these minerals are on the basis of their intrinsic purity. Since junior exploration agencies as well as mining entities engender huge capital outlays at the beginning for carrying out the requisite mining activities, external funding either from the side of the government or PE/VC/AIFs support is needed.

UG: Under Ground
OC: Open Cast

Downstream Manufacturing of Clean & Advanced Technology: PLI scheme to boost domestic manufacturing.

The Production-Linked-Incentive scheme is a step towards strengthening the agenda of 'Atmanirbharata' or self-reliance. This scheme promotes more of domestic mining thereby allotting incentives to corporates on incremental sales. Till date, India is reliant on import of most of the critical minerals needed by the EV, battery storage & renewable energy sector. Now is the time for policymakers to have a relook at the scheme and ensure proper disbursement of the incentives thereby boosting in-house production of not only the minerals, but the components of the entire value chain.



Material Recovery & Recycling: Robust recycling policy for infrastructure & secondary market

As sustainability becomes main-stream, there's an increased focus on 3Rs i.e. reduce, reuse and recycle across the entire mining and metals value chain. For critical minerals, adopting sustainable methods from mining to end-use applications to harness the resources is of utmost importance because of the attached economic value & their scarcity. Introduction of robust policy supporting the maximization of re-utilization of these resources will propel India's LiFE initiative and will also make the value chain more cost-effective and environmentally friendly.

Fostering a Conducive Business Climate: Strategies for Success

To foster Critical mineral adoption, it's imperative for India to make the business landscape conducive starting from exploration to the manufacturing of the wide range of renewable solutions to ensuring adoption among consumers. While the government has been acting pro-actively in this front, there are other avenues too that needs to be pondered upon, and on the basis of our research work we have suggested some points which may provide the necessary impetus that the sector needs

Promote Exploration Activities: Similar to the Deep Ocean Mission ('The Samudrayan Mission'), more such initiatives need to be promoted by the government to bolster exploration activities which would help in gauging the country's potential resources

Advance Market Commitments:

- Control volatility & stabilize demand cycles for interested players.
- Ensuring adequate capabilities in the private sector.

Invest in R&D for recovery of critical metals:

- Promote recycling of end use products and batteries
- Fortify supply chain and embed sustainability perspective.

JVs with foreign companies:

- Develop a local ecosystem for refining and processing of critical minerals.
- Ensure FDI in this space to promote overall growth of the sector

Establish separate Funds for:

- Geological exploration
- Financing early-stage projects off the ground.

Set up a Centre of Excellence for Critical Minerals focus area:

- Identify more efficient ways for discovering next generation critical mineral deposits by integrating geological knowledge, data analytics and modelling, and machine learning capability.

Focused Asset Investments

- Promote investments in foreign assets of critical minerals.

Authors:

Jyotirmoy Saha
Senior Consultant - Management & Strategy Consulting
jyotirmoy.saha@revalconsult.com

Dhyey Desai
Consultant - Management & Strategy Consulting
dhyey.desai@revalconsult.com

Co-Authors:

Aditya Dapki
Associate Senior Consultant - Management & Strategy Consulting
aditya.dapki@revalconsult.com

Shivam Desai
Consultant - Management & Strategy Consulting
shivam.desai@revalconsult.com

Guide:

Kumar Rajesh Singh
Managing Director - Global
krsingh*@revalconsult.com*

Project Director

Pukhraj Sethiya
Managing Director - India
pukhraj*@revalconsult.com*

Reval Consulting Private Limited

Corporate Address: 604, One World West, Ambali, SP Ring Road, Ahmedabad - 380058, Gujarat, India

Registered Address: 71, 7th Floor A, Spazy Privy, Sector 72,Gurugram – 122001, Haryana, India

For more details: www.revalconsult.com