The Rare Earth Industry: Global Landscape and India's Strategic Position

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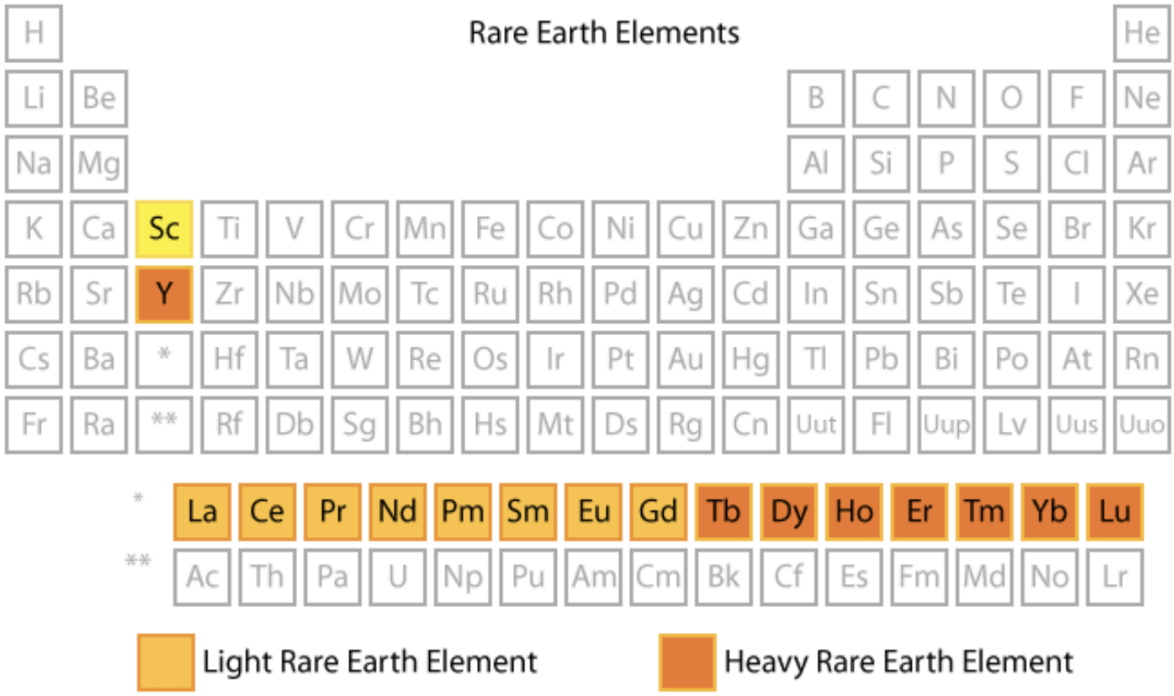
1. Overview

Rare earth elements have now taken center stage as critical minerals, driven by rapid technological advancements that necessitate sustainable practices. They are a basket of 17 elements, including the 15 Lanthanides plus Yttrium and Scandium that form the bedrock fueling civilisations today and in times to come.



Source: ResearchGate

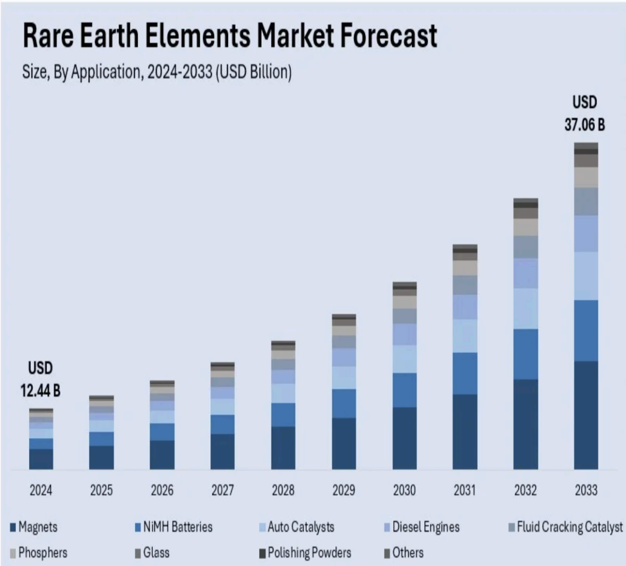
After facing supply chain disruptions in the pandemic era, India is now underpinning self-reliance, which now places REEs at the heart of its economic and security strategy. The country is working proactively to reduce import dependence and harness its own resources for sectors ranging from electronics and clean energy to defence.

Unlike their name, they are not truly rare. They are abundantly available all over theEarth'ss surface. However, they are rarely found in sufficient abundance in a single location for their mining to be economically viable, which is why the name. REEs form the bedrock of modern-day industries. They can be mainly classified as Light Rare Earth Elements (LREEs) and Heavy Rare Earth Elements (HREEs).

These compounds generally display high melting and boiling points, which makes them indispensable and irreplaceable in many electronic, optical, magnetic, and catalytic applications. They have extraordinary magnetic and optical qualities,s which make them crucial for high-tech applications in industries ranging from defence and medicine to clean energy, electronics, petroleum, and advanced manufacturing.

Rare earths are valuable because they can change the behavior of materials in very precise ways. Without rare earths, much of modern electronics, clean energy technology, and advanced aerospace and defense would not function as efficiently or at all.

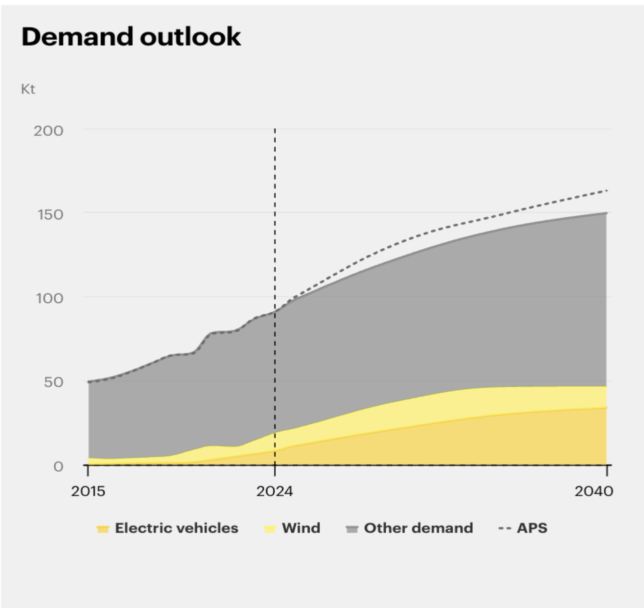
2. Global Industry Landscape:



Source: IMARC

The global Rare Earths market reached USD 12.44 billion in 2024, witha volume of rare earth oxides produced around ~197 kt in 2025. It is estimated to reach a market value of USD 37.06 billion by 2033, indicating a CAGR of 12.83%.

The difference between total rare earth oxide production (~197 kt) and energy-transition demand (~91 kt) reflects the fact that a large share of REEsise used in non-energy applications such as catalysts, polishing powders, and glass additives.

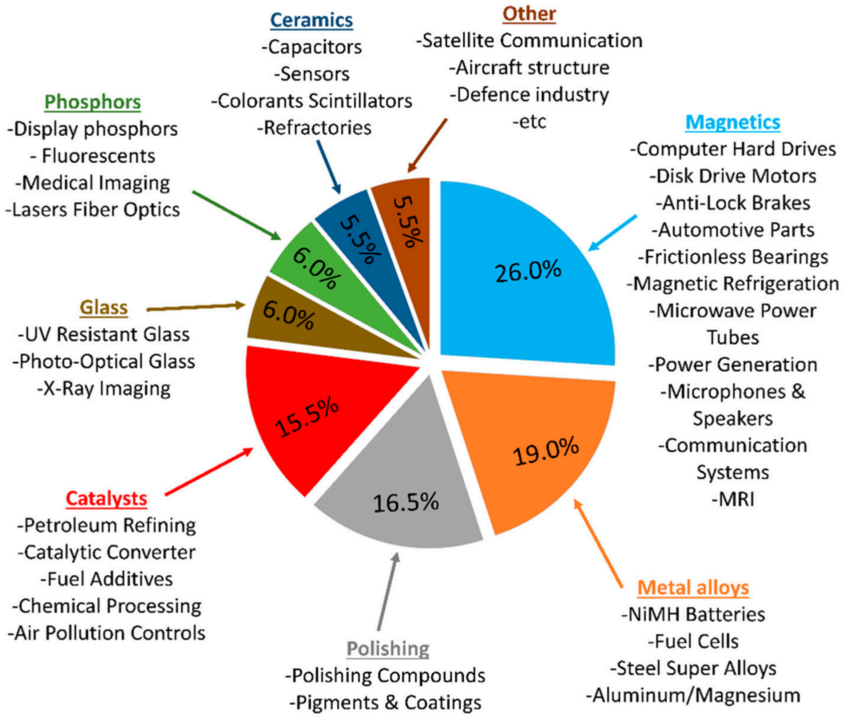


Source IEA

Following the STEPS scenario, IEA projects the demand from energy-transition technologies for Rare Earths to rise from ~91 kt in 2024 to ~123 kt in 2030, implying a CAGR of around 5-6%. (Figure 1)

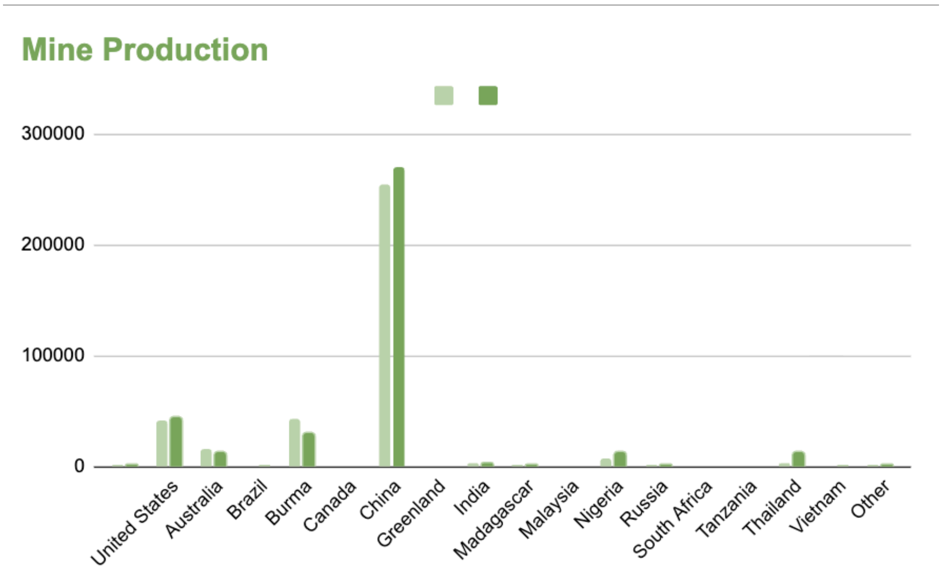
The demand is largely driven by REEs being crucial for permanent magnets used in EVs and wind turbines. In addition to this, given the rise in demand for electric vehicles, clean energy systems, and advanced electronics, growth in the REE industry is expected to remain stable.

Rare earth elements have endless applications, which makes them so crucial.

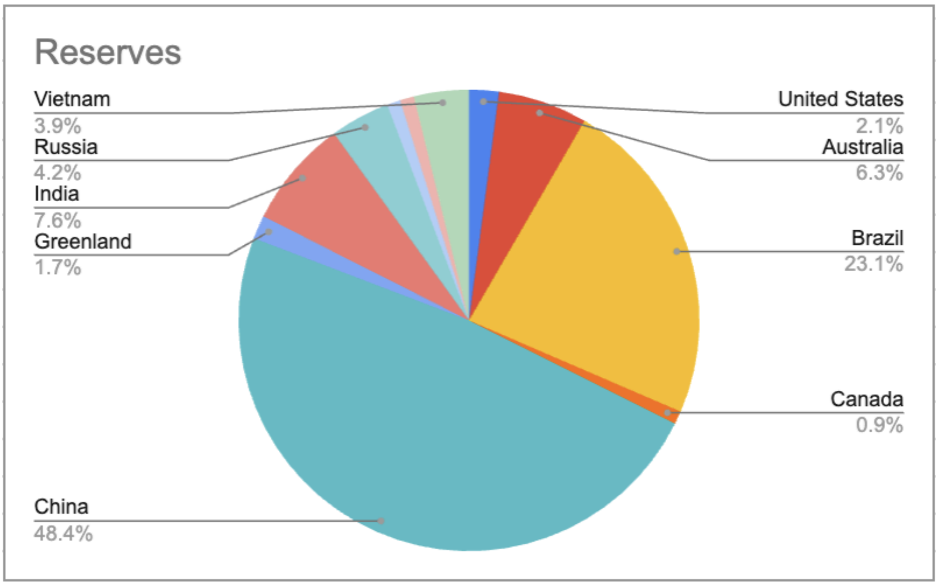


Source: ResearchGate

While rare earth reserves are distributed across several regions, global supply is highly concentrated, with a limited number of countries accounting for the majority of production and processing.



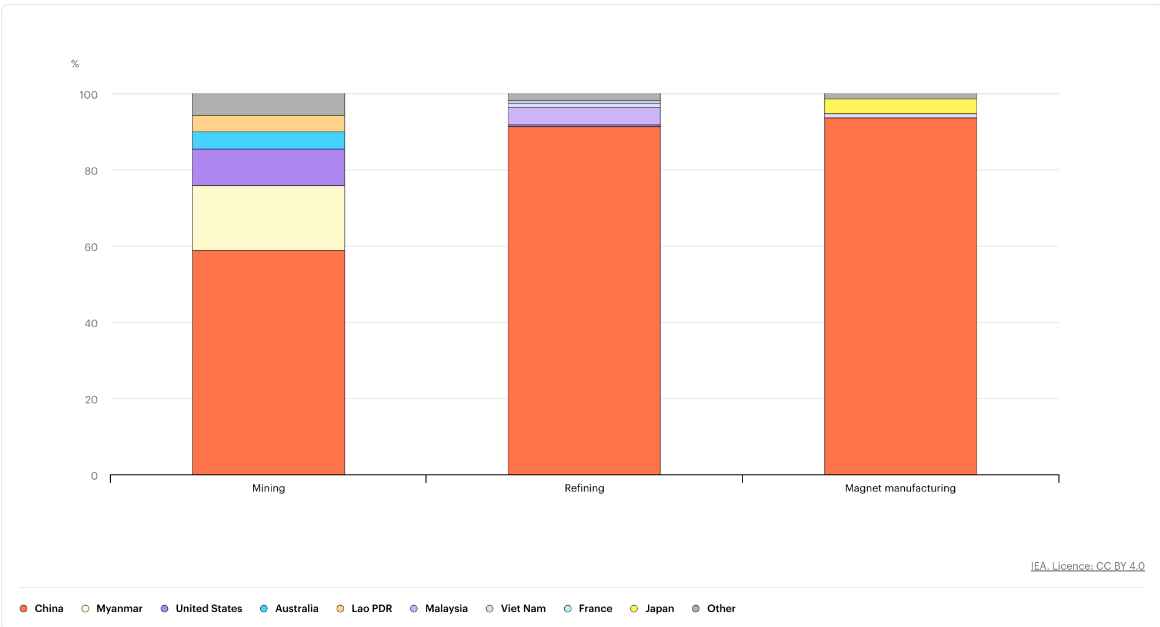
Source: USGS



Source: USGS

The market is largely dominated by China. The country controls around 60-70% of global mining of REEs and refines 90% of the world's rare earths and manufactures over 90% of the permanent magnets.

Regional composition of rare earths and permanent magnet production, 2024



Source: IEA

China identified the importance and abundance of rare earths in the country as early as the 1980s and began developing mining and refining facilities. They monopolised the market and established their dominance across the value chain through low-cost and efficient production infrastructure. China was successful in doing this, mainly using export controls and licensing. It first imposed restrictions and curtailed export of rare earths by over 30,% citing domestic increased demand. One of the earliest signs of China using this as a power play was when it temporarily cut off exports to Japan during a diplomatic dispute in 2010. It then introduced changes to the export control law in 2020 to introduce curbs covering elements that affect national security. It also banned some exports to the US in December 2024.

And then on April 4 this year, as a result of the trade war between the USA and China, it announced additional export controls on seven items related to medium and heavy rare earth elements. The updated rules require foreign companies to secure government approval before exporting products made with Chinese rare earths, and to disclose their intended use. These policy shifts highlight the vulnerability of the supply chain and the urgency for diversification, given the growing global demand for rare earths. China's Bureau of Security and Control expanded export curbs by also putting controls on equipment used to extract (Centrifugal Extraction Equipment) and refine (Impurity removal and Precipitation Equipment) the rare earth metals.

If we look at other key players, the US holds 2.1% of the world's reserves and is contributing 12% to global mining production, making it the second largest producer after China. Still, it relies heavily on imports from China, accounting for nearly 70% of its rare earths. Countries like Australia are playing an increasingly important role, too. Australia holds approximately 6% of the world's total known reserves, and it accounts for 4% share of global mining production. Another key region,n according to the carereporto, rt is the Arctic. Greenland hosts some of the world's largest undeveloped deposits of rare earths and is strategically located in the global supply chain, ins and this has led to heightened interest from the US, C,hina and the European Union in the region. South Africa and Brazil are also emerging players in this domain.

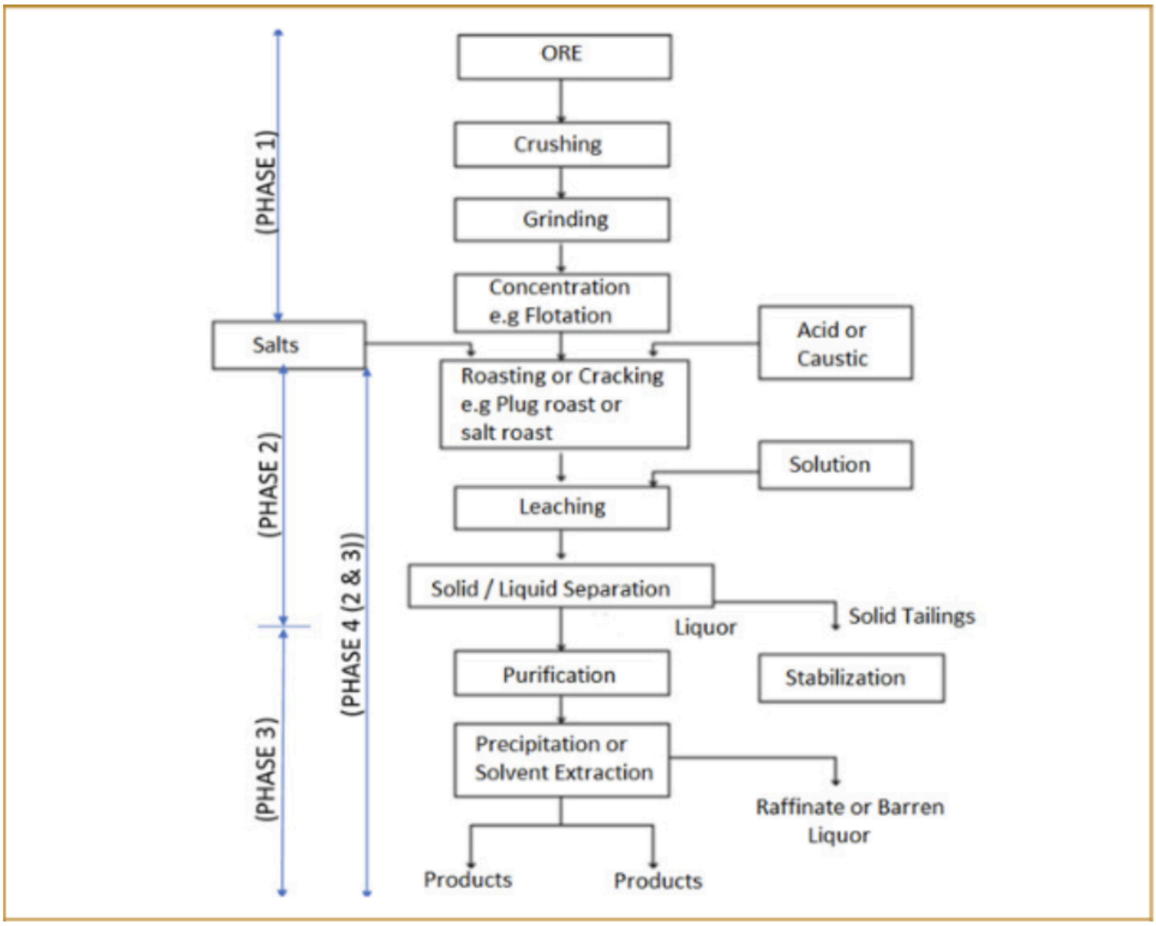
China’s export restrictions imposed in April this year led to a strategic “de-risking” response from other economies dependent on rare earth elements. The US and Japan have agreed to a deal on new generation nuclear power reactors and rare earths as both look to reduce China's dominance. The European Union launched a new initiative, U”, with ~€3bn support to diversify away from China, including potential legal pressure on industry to reduce Chinese exposures. It also introduced the European Critical Raw Materials Act, targeting the development of upstream, midstream, and recycling facilities.

Price floors have been offered by governments to help develop this segment outside of China. Serra Verde, an emerging Brazilian company, slashed its 10-year deal with China, having been approached by America, Canada, the EU, Japan, and many more for the supply of heavy rare earth metals. Australian company Lynas is also rapidly utilising this opportunity to diversify outside of China. Being one of the only major players outside of China, it is scaling its production and has thus opened a rare-earth processing plant in Kalgoorlie (the largest outside China). Despite these efforts, non-China supply remains constrained by midstream and magnet manufacturing capacity.

3. Rare Earth Metals Value Chain:

The rare earth industry comprises a multi-stage value chain from mineral extraction to advanced manufacturing. The control is unevenly distributed across the chain. The elements are widely distributed all over the world, the challenge lies in converting them into commercially usable and economically viable products. Due to this, the supply chain power does not lie with access to raw materials.

It is important to understand that rare elements are never used in their raw mined versions. It is this transformation from ore to final product that presents significant barriers to entry.



Source: SGS

The value chain can be divided into three main stages, starting with upstream, leading to midstream, and ending with downstream.

3.1. Upstream:

This segment begins with the exploration of rare earth deposits that are economically extractable. The deposits fall into three primary categories, with each necessitating different extraction approaches.

- Hard rock deposits, which include alkaline igneous rocks and carbonates, contain rare earth minerals like bastnasite and monazite. They are mined using conventional open-pit mining.
- Ionic clay deposits contain rare earth ions that are attached to clay particles electrostatically instead of being locked in crystalline mineral structures. Here, a special process called in-situ leaching is adopted for extraction. In this method, minerals are dissolved inside the ground through a chemical solution, and this mineral-rich solution is pumped back up for processing. Though it is less disruptive than traditional mining methods, it still carries several environmental risks.
- Mineral sands contain minerals like monazite, titanium, and zirconium. Dry mining of coastal or beach deposits is done to mine the elements.

Before it is further sent for processing, the raw ores extracted undergo mechanical and chemical processing. The beneficiation stage includes:

- Crushing and Grinding: The purpose at this stage is to separate rare earth minerals from the rock.
- Physical Separation: The processed material is then subjected to a combination of physical separation techniques that exploit differences in density, magnetic behaviour, and surface chemistry.
- Floatation: Final concentration is achieved through flotation, where specialised reagents selectively bind to rare earth mineral surfaces, enabling their separation from remaining impurities.

This, in the end, produces a concentrated material that is still a mixture of rare earth elements present in the deposit. Though upstream mining provides access to raw material, it doesn't provide pricing power or control over the supply chain unless you also hold downstream processing capacities.

At this stage, the capital expenditure is high but not as exceptional as in the further stages. This stage is poised with several challenges, which include regulatory hurdles with regard to getting ESG permits, as most deposits contain radioactive elements that need proper waste management systems. Even though this stage is capital-intensive, it does not yield returns as the value capture is low, and miners remain price takers. Unless vertically integrated, the margins are compressed compared to downstream operations.

3.2. Midstream:

This segment is the most critical bottleneck in this value chain. Though rare earth elements are abundantly available, the chemical separation capacity,y especially for magnet grade elements, ts is highly concentrated. This has created global dependence on a few processors that have this capacity built. Dominance in this segment translates to dominance over global supply chains irrespective of upstream mining capacity.

The process involves several steps:

- Cracking and Dissolution: The concentrates produced at the upstream level are brought to separation facilities as bastnasite, monazite,e or ionic clay concentrates. They need to be cracked to break down the crystal structures, leaving the rare earth elements soluble for further separation. There are various methods for cracking, including alkaline cracking and acid cracking. Selective precipitation is used to remove impurities like iron, calcium, and radioactive elements. This results in a solution that contains all REEs in mixed form.

- Rare Earth Separation: This is the most technically intensive stage of the value chain. REEs have extremely similar chemical properties,s which makes their separation all the more challenging. The most successful technique to do this is solvent extraction. There are several other technologies currently under development, including ion-exchange chromatography, membrane-based separation, etc.

- Metal Reduction: After separating rare earth oxides, they need to be converted to metallic form to be used in magnet manufacturing. Two main procedures for this include molten salt electrolysis and metallothermic reduction.

The concentration in the midstream segment is due to several factors.

- The primary factor is the technical complexity, which creates strong barriers to entry. A separation facility requires a deep understanding of this REE chemistry, processing engineering, and waste management. Very few organizations own such capabilities.
- Moreover,r such capacities require huge capital, constituting the largest investment in the value chain. This capital is committed way before the facility starts yielding revenues, posing a significant financial risk.

- Environmental scrutiny is also high at this stage as large volumes of acid are involved in the process,s and separation facilities generate substantial wastewater, er which requires proper treatment. Similarly, radioactive materials produced during the process need to be handled as per special guidelines.
- Another significant moat is the deposit-specific knowledge required for the separation of different elements. Since each REE deposit has a unique elemental distribution, one technology for a type of ore cannot be replicated for another ore project.
- The final downstream product specifications are determined by quality control at the midstream stage. The smallest variations in the separation process can cause major issues thatare passeds on to downstream manufacturing.

Chemical separation is the key to structural power in this value chain. However, gaining supply chain independence demands a huge capital influx along with strong technical capability, which can take decades or longer to build.

3.3. Downstream:

Rare earth oxides that are separated are then given a metallic form and alloyed for various downstream applications, of which permanent magnet production is the most important.

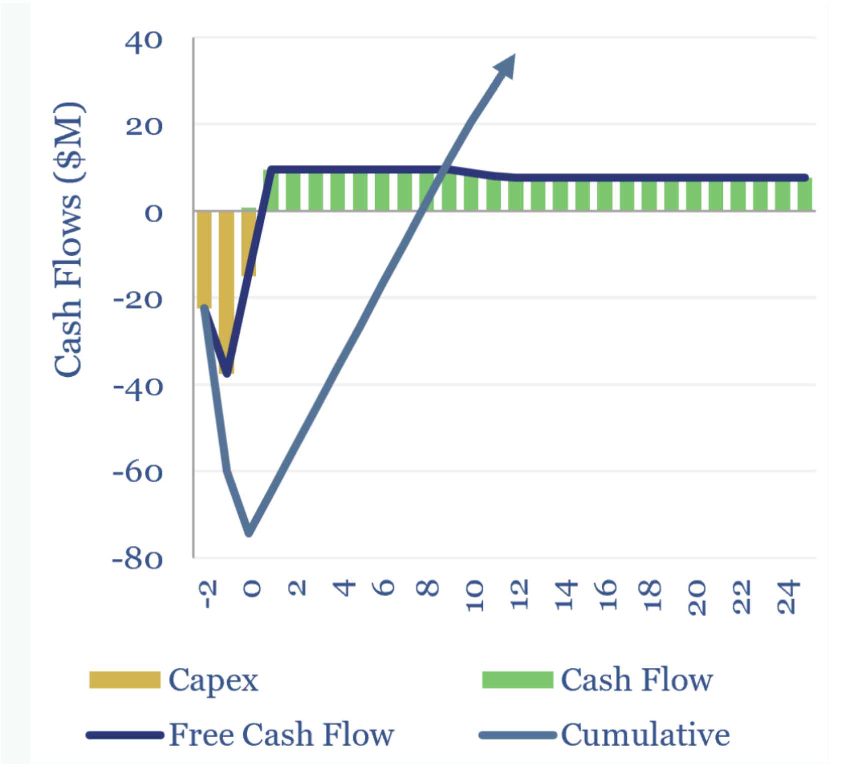
- Alloy Production: Neodymium, when combined with Iron and Boron,n creates Neodymium-Iron-Boron (NdFeB), which is one of the strongest REE-based permanent magnet alloys. It delivers exceptionally high magnetic strength and efficiency.
- Magnet Manufacturing: this step requires high precision as the process involves steps like powder metallurgy, magnetic alignment, sintering, machining, and protective coating. The quality of the product at this stage is determined by characteristics like tight control over composition, microstructure, and impurities.

Dominance in this stage directly translates into influence over end-use industries like EVs, wind turbines, and defence. This stage is characterised by several factors:

- The entire magnet manufacturing process involves substantial patented processes and trade secrets regarding alloy composition, microstructure control, and coating techniques. Companies trying to replicate this process cannot just reverse engineer and gain similar performance. The Intellectual Property creates significant entry barriers in this stage.
- Industries like automotive and aerospace demand stringent testing andqualifications processes. Therefore Quality certifications protect already

established players in this domain, as OEMs do not change suppliers easily once they have been qualified.

- Suppliers who hold the power and capability to rapidly develop customised magnets for various applications demanding different magnetic properties, shapes, and coatings can demand premium pricing.
- What separates successful manufacturers from failures is manufacturing efficiency. Losses borne during machining, coating,n g, and magnetization phases directly have an impact on profitability. New entrants may struggle to reach this efficiency.
- Lastly, magnets are critical,l but motors and generators are the end products that these magnets are used for. Rather than selling magnets to manufacturers of the end product, integration witend productsts can generate higher value.



Source: Thunder Said

Vertical integration across the value chain, from mine to magnet, is significantly more advantageous. They provide improved supply stability and security, tighter quality control, and lower dependence on third-party processors. Vertically integrated firms can capture a larger share while also reducing price volatility exposure and supply instability.

4. Porter’s Five Forces: Rare Earth Midstream & Magnet Manufacturing:

4.1. Threat of New Entrants- Low

Midstream and magnet manufacturing stages arhighly capital-intensiveee, require complex technical expertise, environmental compliance, and long commissioning timelines. This makes entry for new players tough in an industry where established players have decades of expertise and process optimisation.

4.2. Bargaining Power of Suppliers- Moderate

Though rare earth ores are available globally, their usable concentrates are controlled by very few players. Vertically integrated firms can reduce this risk. However, China’s dominant control over both mining and processing weakens the supplier’s power in this system.

4.3. Bargaining Powers of Buyers- Low to Moderate

End product buyers such as EV manufacturers and wind turbine companies rely heavily on the quality and reliability of the magnets. Therefore, it is not easy for such firms to switch suppliers, as it involves long qualification cycles and performance risks. Pricing power lies in the hands of established magnet producers.

4.4. Threat of Substitutes- Low

Substitutes for rare-earth permanent magnets are very few. Even if the alternatives exist, they result in heavier, less efficient, or more expensive systems, making substitution unattractive for most industrial uses.

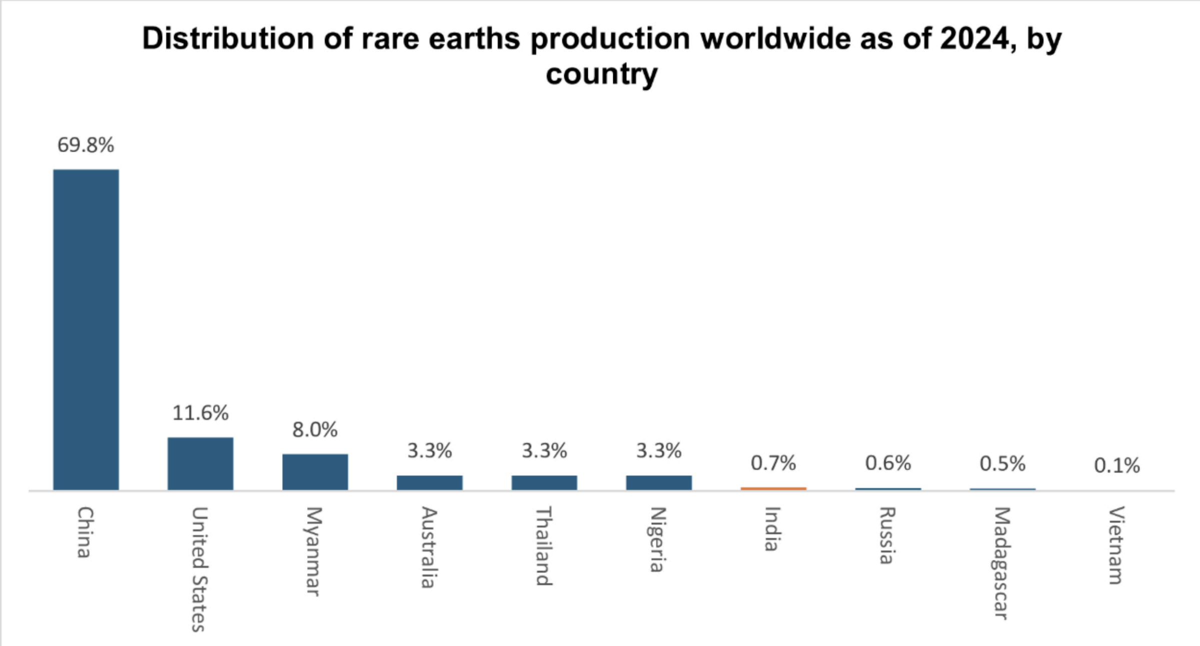
4.5. Industry Rivalry- Moderate

Competition within this industry is minimal, as very few established players exist, and the barriers to entry are high for new players to enter the market. Capacity expansion is expensive and slow, which keeps rivalry disciplined. Chinese players benefit from scale and state support, making competition tougher for new non-Chinese entrants.

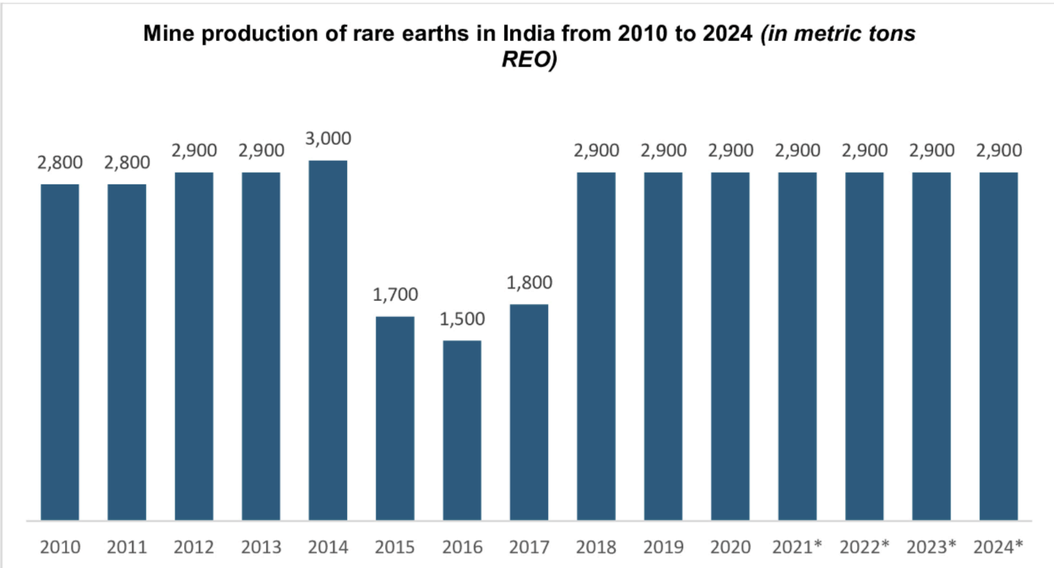
5. Indian Industry Landscape:

India is the third largest rare earth resource holder behind China and Brazil, adding up to almost 6-7% of the world’s total reserves. This vast resource base is primarily in the form of monazite heavy mineral sands along the coasts. India’s beach sand deposits account for almost 35% of the world’s deposits. The Press Information Bureau identified several resources,s including ~6.9 Mt REO resources; 13.07 Mt in-situ monazite in beach placers containing ~55–60% rare-earth oxides. However, India contributes less than 1% to the total global supply of rare earth oxides.

Currently, we import 93% of rare earths from China between 20 and 4-2025. India is absent in most parts of the value chain, not utilising the resources it holds, therefore being vulnerable to geopolitical changes.



Source: IBEF



Source: IBEF

There are several reasons explaining this production gap:

Government regulation has locked up most of India's REE-bearing monazite. As the monazite reserves have high thorium content, which is a radioactive material, it is classified as an atomic mineral that needs to be regulated. For long, it has been exclusively under the control of government-owned entities as per the Atomic Energy Act. Therefore, until very recently, Indian Rare Earths Ltd (IREL), a PSU, was the only entity permitted to mine and process monazite for REEs. However, this was done to supply thorium for India's nuclear program rather than process REEs to generate magnets or other applications. Restrictions on private miners have led to decades of under-utilisation.

Moreover, monazite is relatively low in REE and contains several harmful by-products. This increased the complexity and cost of extracting and processing REEs as compared to importing from China, which is abundant in rich bastnasite reserves.

However, as global supply chain issues rise, given the geopolitical events in the last few years, including China's restrictions on REEs in 2025 and rising demand for clean energy, India has noted the strategic need to develop domestic REE mining and production. India has introduced atwo-foltop-downn strategy: Accelerate domestic mining and production and build refining and magnet-making facilities. To facilitate these strategies, there have been several policy shifts and reforms.

- National Critical Mineral Mission 2025: develop a self-reliant critical minerals sector, prioritising rare earths. By 2031, the Geological Survey of India (GSI) will undertake 1200 exploration projects. The government will now auction exploration rights, too, under this mission. India has recognized 130 deposits, of which coastal states such as Tamil Nadu, Kerala, Andhra Pradesh, and Odisha have the most deposits.

- Sector Liberalisation 2025: Ending decades of state monopoly in the exploration of rare earths, 13 exploration blocks were auctioned, inviting private sector participation and foreign investment into a government-only domain. As of 2025, five auction rounds have been conducted, where 34 of 35 blocks have been allocated. Multiple auction tranches since late 2023 have been launched for critical mineral blocks. The second tranche (2024) targeted blocks worth ~USD 362bn; bidders included Vedanta, Coal India, Ola Electric, Dalmia, etc. However, India also cancelled 14 of 18 blocks in that tranche due to insufficient bids or no bids, underlining early-stage interest, price uncertainty, and regulatory risk.

- Production Linked Incentives (PLI): The government has introduced PLI schemes for manufacturers of rare-earth-based components, to fuel building supply chains in India to increase downstream usage of REEs in areas like EVs and clean technology. A ₹72.8 billion program was approved by the cabinet to initiate domestic manufacturing of rare-earth permanent magnets. The aim is to establish 6000 tonnes per annum of NdFeB by 2032, which meets around 90% of projected domestic demand. This will encourage bids from private players for setting up facilities.

- Infrastructure and R&D Projects:
    a. One of the major projects is the Rare Earth Theme Park initiative. Various plants and facilities across the value chain will be developed.
    b. IREL, which controls major mineral sands in India, is expanding through its flagship unit, Odisha Sands Complex (OSCOM). It is expanding its processing capacity, and the mineral handling infrastructure is being upgraded. It is estimated that the planned rare earth magnet plant will produce 3000 kgs of magnets for various applications in clean energy and defence.
    c. Several notable joint ventures like IREL-IDCOL have plans to build new mining and separation plants to mine deposits in Odisha.
    d. IREL is also seeking international partnerships and funding with countries like South Korea and Japan to access advanced processing and magnet-making technology.
    e. Lastly, a Rare Earth and Titanium Theme Park has been proposed to commercialise laboratory-scale technology for extraction and processing.

With these capacities built, the government seeks to triple rare earth oxide production in India by 2032. This will help reduce major dependency on imports, vertically integrate the process, stabilise the supply chain, and position India as a global Rare Earth Permanent Magnet (REPM) player.

6. Key Players across the Value Chain:

India’s rare earth value chain can be mapped out into three segments:

6.1. Upstream: Mining and Mineral Separation

IREL Ltd, under the Department of Atomic Energy, has historically been the major player in upstream operations. This government-owned miner operates mineral sand separation plants at locations such as Chavara (Kerala) and Manavalakurichi (Tamil Nadu), and the large OSCOM facility in Odisha. Annually, altogether, they process ~6–10 lakh tonnes of mineral sands to produce monazite and other resources. However, it currently only produces about 400–500 tonnes of neodymium oxide annually, with expansion dependent on strategic partnerships and government policy support.

Another public entity, Kerala Minerals & Metals Ltd (KMML), also mines beach sands mainly for titanium minerals and has historically generated monazite as a by-product. KMML works closely with IREL, transferring monazite to the latter for the extraction of REEs and thorium.

Of late, private participation in this sector was negligible, given legal restrictions. However, the landscape is now shifting as the government auctions critical blocks to private entities. Hindustan Zinc Ltd (HZL), a Vedanta Group company, secured a composite license for the Nawatola-Laband rare earth block in Uttar Pradesh, which is a monazite-bearing deposit. This was the first time a private Indian company gained rights over a monazite resource. The CEO indicated they plan to mine and process neodymium from this deposit, but production may take about 5 years, given 3–4 years of exploration and the need for regulatory clearances.

Coal India Ltd (CIL), a PSU traditionally known for mining coal, is leveraging its exploration expertise to diversify into REEs. Recently, in 2025, CIL was awarded a 209 sq km rare earth exploration license in Andhra Pradesh and is also investigating coal ash and overburden in its coalfields for REE extraction potential. They have successfully found traces of 250–400 ppm REE in some samples and are at early stages, but signal a strategic broadening of upstream resource assessment beyond coastal sands.

Several smaller private players, too, have entered upstream via critical mineral auctions. Vinmir Resources and R.K. Minerals won graphite blocks that may have associated vanadium/REE occurrences. Ramgad Minerals & Mining Ltd won the Dombarahalli REE and phosphate block in Karnataka. These smaller entrants may seek technical collaborations given the specialized nature of rare earth extraction. However, under current regulations, even private license holders might need to partner with or sell monazite-derived products to IREL, since monazite handling remains sensitive. Upstream projects will therefore likely be developed either as joint ventures with PSUs or under close regulatory supervision.

Without the Atomic Energy Act restrictions, upstream mining could scale up significantly, feeding midstream processing facilities with local feedstock.

6.2. Midstream: Processing, Refining, and Magnet Production

At present, India's midstream capacity is very limited. IREL does produce some refined oxides like neodymium-praseodymium oxide, cerium oxide, etc., but volumes are small and aimed toward specialty applications or export in semi-processed form. India lacks commercial facilities for full-spectrum separation of all 17 REEs to high purity, as well as plants for converting oxides to alloys and magnets at scale. As a result, India remains concentrated at the upstream end of the value chain, with limited midstream and downstream capabilities.

Bridging this gap is a main focus of recent government schemes. The rare earth magnet PLI program (₹7,280 crore) was introduced as we lack domestic magnet makers. The goal is to establish 5 new facilities that integrate the midstream steps from purified Nd-Pr oxide to Nd-Fe-B alloy smelting, powder production, and magnet shaping by 2030. Achieving 6,000 TPA magnet output would make India self-sufficient as its EV and wind industries grow. The technical requirements span solvent extraction expertise, metallothermic reduction, inert atmosphere alloy casting, and precision sintering. Indian entities will likely need to license or partner for technology. Encouragingly, there are signs of movement: multiple conglomerates have expressed interest in building REE processing and magnet facilities under the incentive scheme. Several industrial groups, including Vedanta, JSW Group, and Sona BLW Precision Forgings, have publicly indicated interest in rare earth processing or magnet manufacturing under the PLI framework.

On a smaller scale, Trafalgar Engineering, a private firm, announced in late 2024 plans to establish India's first integrated rare earth metal, alloy, and magnet plant. This would be a groundbreaking project, supporting and filling critical links in the chain. Although details are inadequate, it shows entrepreneurial interest in midstream opportunities outside of the big industrial houses.

Foreign capacity can be leveraged as well. Reuters reported that IREL is prepared to supply neodymium oxide to a foreign technology partner who would manufacture magnets and send them back. This essentially outsources the midstream until domestic facilities develop, ensuring critical end-users are not starved of magnets in the meantime. India also suspended a long-term REE export agreement with Japan in 2025 to keep more raw material for use within the country and support local processing industries.

In short, India has just started building its rare-earth processing capabilities. Government incentives, combined with rising demand. The magnet use in India is forecast to triple from ~2,000 tons in FY25 to ~6,000 tons by FY30, creating a strong business case. Challenges remain in acquiring technology and achieving cost competitiveness. China benefits from decades of scaled infrastructure, constant development of technology, and relaxed regulations. Indian producers will need to optimize processes and possibly accept lower margins initially to establish credibility. Companies that can manage REE refining successfully in India, or form alliances to do so, stand to become a keystone in the future supply chain.

6.3. Downstream: Applications in EVs, Electronics, Defense, and Energy

India's downstream industries consuming REEs are growing day by day, with the government encouraging the Make in India campaign. It's a green step taken towards clean mobility and the environment. As India is the world's third-largest auto market and has a target to cover about 30% of the EV segment by 2030, there's a huge demand and scarcity for NdFeB magnets, which are used in motors. Other RE materials are utilized in manufacturing batteries and electronics. India, unfortunately, imports 100% of rare earth magnets to fulfill the requirements. In 2024, India had imported 2,300 tonnes of REPMs (rare earth permanent magnets), majorly NdFeB, with ~65% coming from China and ~15% from Japan. Disruptions in the supply chain could significantly impact EV production, wind energy projects, or electronics manufacturing. Indeed, Indian EV makers raised alarms about potential production slowdowns when China announced export restrictions on certain RE products in mid-2025.

Due to this drawback, many downstream firms have started taking proactive measures. The automotive OEMs and Tier-1 suppliers are researching and exploring ways to secure their magnet supply and reduce dependence. A remarkable example is OLA Electric, India's largest electric 2-wheeler manufacturer, which innovated a new design for a motor using ferrite (iron-based) magnets instead of rare-earth magnets. It also received government certification in October 2025, proving performance comparable to traditional RE magnet motors. With this, OLA aims to not only cut the costs across its scooter lineup but also avoid supply chain risks associated with neodymium and RE materials externally. TVS Motor, too, has indicated interest in ferrite magnet motors. Such developments resemble downstream firms that are hedging against REE scarcity either by material innovation or by investing upstream. On the other hand, India is boosting electronics manufacturing, which uses small quantities of REEs in components like LEDs, displays, etc.

Defence, being one of the most critical downstream sectors, uses REEs in sensors, precision-guided munitions, and communication systems. The government places strong emphasis on ensuring that these materials are available domestically to meet defence requirements because of their importance to national security. IREL's mandate is to supply special REE materials for strategic sectors under DAE oversight.

Renewable energy is another huge consumer. As India expands wind capacity, it will need magnets or alternatives. Wind turbine manufacturers demand large NdFeB magnet arrays for direct-drive turbine designs. Wind OEMs like Suzlon and similar international players can source magnets locally if domestic magnet production becomes operational

The downstream is what steers the demand for rare earths. Indian companies in EVs like Ola, Tata Motors' EV unit, Mahindra Electric, Sona Comstar for EV drivetrains, Dixon, Bharat Electronics for defence, all gain from a strong domestic rare earth supply chain. They are exposed to risks if the chain isn't developed, and it could lead to cost spikes and shortages of imported REEs.

Company	Role in Value Chain	Key Initiatives / Involvement
IREL (India) Ltd	Upstream	Sole miner of monazite; operates mineral sands plants; expanding capacity; pilot magnet plant at Vizag; seeking Japan/Korea tech tie-ups
KMML (Kerala Minerals)	Upstream	Mines beach sand in Kerala (ilmenite, etc.), produces monazite by-product (supplied to IREL). No direct REE products.
Hindustan Zinc (Vedanta)	Upstream	Won first private monazite block (UP); plans to mine & process neodymium (magnets) – production ~5 years out; advocates opening monazite to private sector
Vedanta Ltd	Upstream & potential midstream	Secured 10 critical mineral blocks (incl. REE); pursuing "mine-to-magnet" strategy – expressed interest in RE magnet manufacturing. May leverage Hindustan Zinc & global partnerships for REEs.
Coal India Ltd	Upstream	Got 209 km² REE exploration license (AP); sampling coal ash for REEs (250–400 ppm found); developing extraction tech in-house. Backed by National Critical Mineral Mission funding.
Dalmia Bharat (DBRL)	Upstream	Won graphite block in TN auctions; sees critical minerals as new business after exiting refractories. No rare earth block yet, but likely to participate in future auctions/JVs.
Ramgad Minerals	Upstream	Part of Baldota Group; won Karnataka phosphate-REE block. Will explore REE extraction alongside phosphate – likely needs tech partnership.
JSW Group (Jindal)	Midstream	Shown interest in setting up REPM plants under incentive scheme. Could invest via JSW Steel/Energy in magnet manufacturing to support EV and renewable ventures. No official project yet.
Sona BLW (Comstar)	Midstream & downstream	Major EV motor maker reliant on magnets; keen to secure magnets locally – may partner to produce NdFeB magnets. Stands to benefit from magnet PLI; exploring tech collaborations.
Trafalgar Engineering	Midstream	Announced plan for India's first integrated RE metals–alloys–magnets facility (late 2024). Aims to fill value chain gap. Progress TBD; private initiative aligning with government push.
Ola Electric	Downstream	Developed rare-earth-free ferrite motor for its EVs, reducing Nd magnet use. Mitigating REE supply risk; will integrate ferrite motors across products. May still require REEs for higher-performance needs.
Others (PSUs & JVs)	Upstream/All	NLC India (PSU) took phosphorite blocks; Oil India (PSU) took potash block – indicating cross-sector interest. Quad nations collaboration could bring foreign JV projects. Defense R&D labs providing magnet tech for scale-up (IREL partnering).

Note: Several initiatives listed above remain at early or pilot stages and are subject to regulatory approvals, technology partnerships, and multi-year development timelines. Listed companies represent optional exposure to India's rare earth ecosystem rather than near-term revenue drivers.

7. Key Risks:

While the rare earth sector in India presents long-term potential, investors must consider several challenges and risks that could impact project timelines and returns:

- **Regulatory and Policy Hurdles:** Despite changes in reforms, regulatory complexity remains one of the biggest challenges. As of 2025, private firms can bid for REE blocks, but operationalizing them might require collaboration with IREL. The timeline could also be affected by any delays in policy liberalization, particularly limiting monazite handling only for PSUs.

- **Environmental and Social Concerns:** In the extraction of REE, especially from monazite, hazardous chemicals like thorium and uranium are the byproducts. Transporting and disposing of this radioactive waste safely requires secure storage and sophisticated disposal facilities. Beach sand mining, too, can impact the coastal ecosystem and local communities. Failure on this front is enough to cause project shutdowns or litigation.

- **Technological Gaps:** The midstream technology deficit is a significant risk. Obtaining high-purity separation of all the rare earths would need immense expertise in solvent extraction. India lacks commercial magnet-making facilities and depends almost completely on imports, mostly from China. Recent Chinese restrictions on magnet manufacturing equipment and technology could add further challenges for Indian firms.

- **Execution and Timeline Risks:** Building an integrated rare earth supply chain requires more than a decade to be fully functional. Mining projects alone can take up to 5 to 7 years from exploration to production, as indicated by HZL's CEO for their REE project. Delays in environmental clearance for a magnet factory and slower uptake of incentives by industry could push the timeline. If the mines don't produce enough oxide, the magnet plants could face difficulties running, and vice versa.

- **Market and Price Risks:** Rare earth projects are subject to global commodity price swings and demand fluctuations. Prices for elements like neodymium or dysprosium can be volatile as the export policy of China plays a significant role and global supply-demand balance. If prices drop too low due to a global oversupply or recycling uptick, some Indian projects might turn unviable.

  Currency risk is another consideration, as REEs are traded globally, often in USD. A weakening rupee could raise import costs, which is beneficial for domestic producers' appeal, but detrimental for those importing technology. For downstream companies, reliance on imports until local supply is ready is a risk.

- **Infrastructure and Logistics:** Infrastructure upgrades are needed to support refining plants. Transportation of heavy mineral concentrate from coasts to inland refineries or hazardous chemicals could pose challenges. Any limitation in infrastructure would directly increase the operating costs or cause bottlenecks.

8. Conclusion

India's rare earth challenge is not resource availability, but capability creation. While policy reforms and incentives have initiated a shift toward domestic mining, processing, and magnet manufacturing, the true bottleneck remains midstream chemical separation and downstream scale execution. Building a competitive mine-to-magnet ecosystem will require sustained capital, technology partnerships, and regulatory clarity over a long time horizon. If executed well, this transition can materially strengthen India’s strategic autonomy in clean energy, mobility, and defence; if not, dependence on imports will persist despite abundant reserves.

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