

Artificial Intelligence

Cross Sector
Thematic



Tushar Chaudhari
tusharchaudhari@plindia.com | +91-22-663222391

Swarnendu Bhushan
swarnendubhushan@plindia.com | +91-22-66322260

Pranav Iyer
pranaviyer@plindia.com | +91-22-66322539

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March 19, 2026

Data centers – Next Lithium moment in strategic mining

Quick Pointers

- India's data center capacity is expected to rise by 4x from 1.5GW in 2025 to 7GW by 2035. This would generate domestic demand for critical minerals, also aided by our focus on defense, semiconductor manufacturing, aerospace and related sectors.
- Although meaningful revenue contribution may still be a few years away, long-term potential remains high for companies such as GMDC, Vedanta, HZL and NACL, who are starting to align with the potential.

Our [AI thematic](#) focuses on the upcoming tsunami in AI infrastructure. In our AI series, following the silica-services theme, this piece takes a deep dive into the opportunity that opens up for strategic metals for Indian companies. Strategic metals are critical to modern technology and industries, but their supply is limited or inflexible (being by-products). Strategic metals include technology metals such as gallium and germanium, and rare earth elements (REEs, total 17 such as dysprosium, scandium, etc.). India has significant REE resources concentrated in monazite minerals; however, extraction is relatively complex and expensive.

The next lithium moment? Lithium started as a novel mineral back in the early 2010s when electric vehicles (EVs) were just being rolled out. Since then, it has become the backbone of the energy transition – growing at a staggering +17% CAGR till 2025. The sharp rise in demand has led to emergence of new champions like Ganfeng Lithium and Tianqi Lithium, who have seen their market cap shoot 16x during 2010-23 before collapsing in 2024 along with commodity prices. *We believe a similar fate awaits for palladium (Pd, for hydrogen catalysts and EVs), gallium (Ga, for semiconductors and 5G), REEs (for magnets), silica (for solar panels and semiconductor chips), neodymium and praseodymium, as technological adoption accelerates.*

Global REEs may experience 15-20% demand growth, particularly due to magnet demand for EVs and wind turbines. India's INR72.8bn production-linked incentive (PLI) scheme would drive domestic demand for REEs. Gallium global demand could grow 7-10%, driven by AI infrastructure, semiconductor applications, and EV power electronics. Globally, palladium could see demand expanding at 4-5% CAGR. In India, demand would also get a boost from 5mmt hydrogen production target by 2030. Meanwhile, global silica demand could expand 6-9%, fueled by AI semiconductor fabs and solar manufacturing.

In this report, we dig deeper for the developments undertaken by Indian companies to explore this opportunity such as GMDC (REEs, silica) and Vedanta & Hindustan Zinc (REEs and palladium). Some of these companies are potentially positioned to benefit from a structural demand cycle for these minerals. As India develops REE industrial corridors and PLI schemes to build REE related infrastructure, we could significantly reduce our dependence on China across critical mineral supply chains while unlocking over \$10bn in domestic value by 2030. However, it would need further government support in terms of environmental clearances as monazite ore contains radioactive thorium, making extraction complex.

PL Capital Artificial Intelligence
PRABHUDAS LILLADHER
Cross Sector Thematic



The Chicxulub Impact

Swarnendu Bhushan swarnendubhushan@plindia.com | 91-22-6632 2260

Tushar Chaudhari
tusharchaudhari@plindia.com | +91-22-663222391

Swarnendu Bhushan
swarnendubhushan@plindia.com | +91-22-66322260

Pranav Iyer
pranaviyer@plindia.com | +91-22-66322539

Lithium: The blueprint for strategic metal cycles

The science: Lithium (Li), the lightest metal and a soft alkali metal, has evolved from a niche industrial commodity used primarily in ceramics, glass, and lubricants during the early 2010s, to the “white gold” of the energy transition over the past decade (2016-26).

Discovered in 1817, lithium possesses several key properties, including high electrochemical potential, low density, and exceptional energy storage capacity. These attributes make it indispensable for lithium-ion (Li-ion) batteries, which power EVs and energy storage systems. The key catalyst behind lithium’s transformation has been the global push toward electrification and renewable energy adoption.

During the mid-2010s, lithium remained a relatively small market valued at \$2-3bn, with annual demand of 100-150kt of lithium carbonate equivalent (LCE). At the time, EVs were still largely experimental, with global EV sales of roughly 130k units in 2013, while RE storage systems were still in their early stages.

By 2026, lithium has become the backbone of the electrification movement, with volumetric demand soaring at a CAGR of +17% since 2010. Today, it underpins nearly 90% of EV batteries and plays a crucial role in grid-scale energy storage, powering the global shift away from fossil fuels.

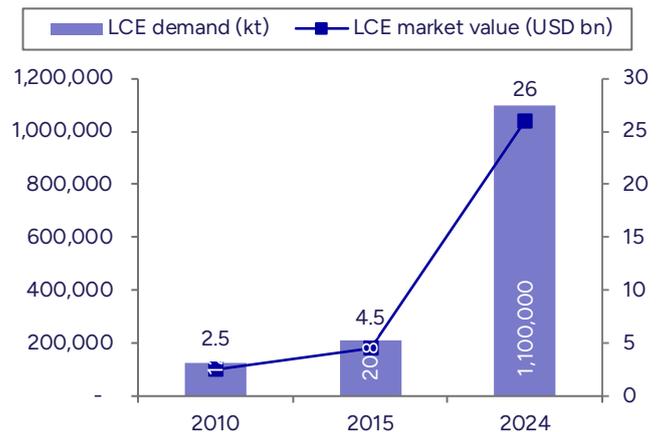
The adoption: The sharp rise in demand of lithium resulted in a whole lot of new players dominating the mining scene. Tianqi Lithium, a dominant Chinese lithium player, has seen its operating profit exploding by 40% CAGR during 2010-24. Similarly, Ganfeng Lithium saw its operating profit rise at a CAGR of 32% during 2010-23. As a result of the rise in operating profits, market cap of both the companies shot ~16x during 2010-23 before collapsing in 2024 along with commodity prices.

Exhibit 1: Historical prices of battery grade lithium (CNY/t)



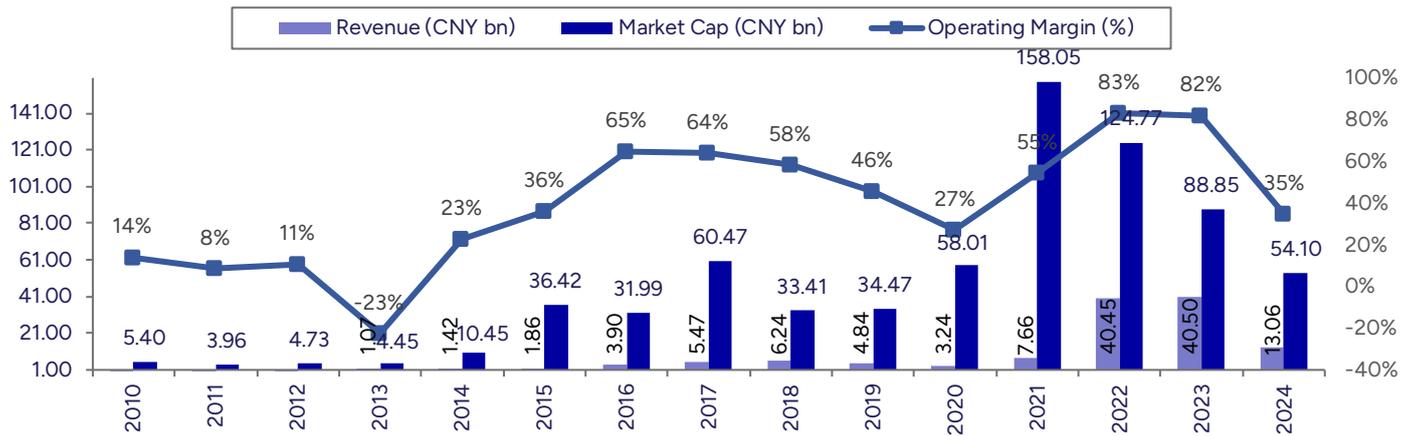
Source: Industry, PL

Exhibit 2: Global demand and market value for LCE



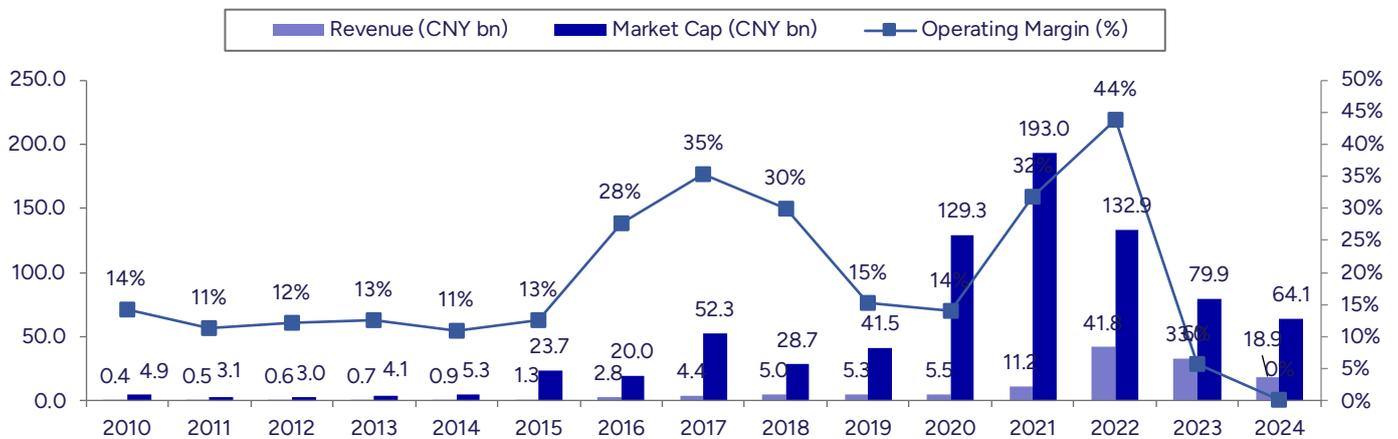
Source: Industry, PL

Exhibit 3: Tianqi Lithium financials



Source: Industry, PL

Exhibit 4: Ganfeng Lithium financials



Source: Industry, PL

Exhibit 5: Lithium – Historical relative price performance

Commodity	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Gold	-1%	-10%	8%	14%	-2%	18%	25%	-4%	0%	13%	1%
Silver	-19%	-12%	15%	6%	-9%	15%	48%	-12%	3%	-1%	-3%
Oil	-46%	-30%	45%	12%	-25%	34%	-21%	55%	7%	-11%	11%
Copper	-17%	-24%	17%	32%	-20%	6%	26%	27%	-15%	2%	-1%
Nickel	9%	-42%	14%	27%	-16%	31%	18%	25%	45%	-45%	8%
Uranium	7%	-5%	-43%	20%	19%	-13%	55%	9%	14%	91%	5%
Lithium	8%	200%	-2%	32%	-52%	-38%	6%	429%	87%	-81%	8%

Source: Industry

Critical minerals vs. legacy energy: Growth driving valuation re-rating

The comparative PE band charts (exhibit 6-15) highlight a clear divergence in earnings trajectory and market re-rating between global companies exposed to strategic minerals such as silica, palladium, and REEs and traditional thermal coal mining companies.

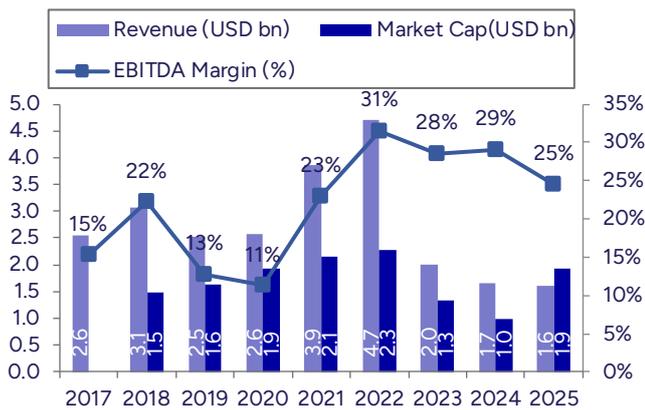
Over the past decade, global companies operating in silica, palladium, and rare earth value chains have demonstrated stronger earnings growth and superior stock price appreciation relative to coal miners. This reflects the rising demand for these minerals given their increasing use in several high-growth industries.

Silica forms the backbone of the semiconductor, solar PV, and electronics ecosystem, while palladium remains a key component in automotive catalytic converters and emerging hydrogen technologies. REEs are indispensable for permanent magnets used in EVs, wind turbines, defense electronics, and advanced consumer devices. As these industries expand globally, demand for such minerals continues to accelerate, leading to earnings upgrades and valuation re-rating for producers of these elements.

In contrast, coal mining companies are largely mature and cyclical, where earnings are primarily influenced by regulatory pressures, supply disruptions and the gradual global shift toward cleaner and greener energy sources. While coal producers may experience periodic profitability during supply shortages or price spikes, their long-term growth outlook remains relatively constrained compared to companies linked to critical minerals.

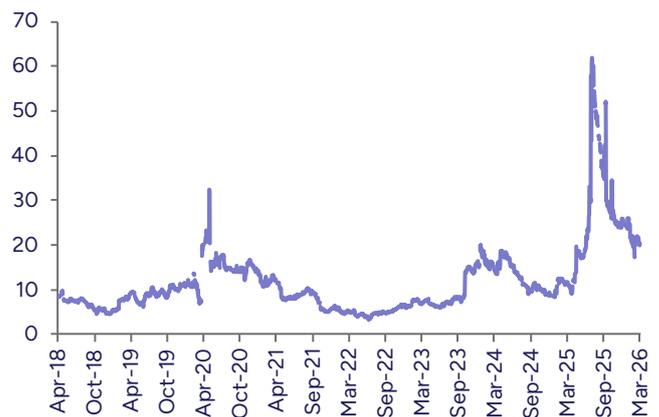
Looking ahead, the gap between the two segments is likely to widen as semiconductor demand, RE expansion, and defense technology investments continue to accelerate the need for critical minerals, increasing their importance in global supply chains. We believe, as Indian companies ramp up the strategic minerals capex, similar movement in equity value could be seen over the next few years.

Exhibit 5: Elkem Asa (silica) – Financials



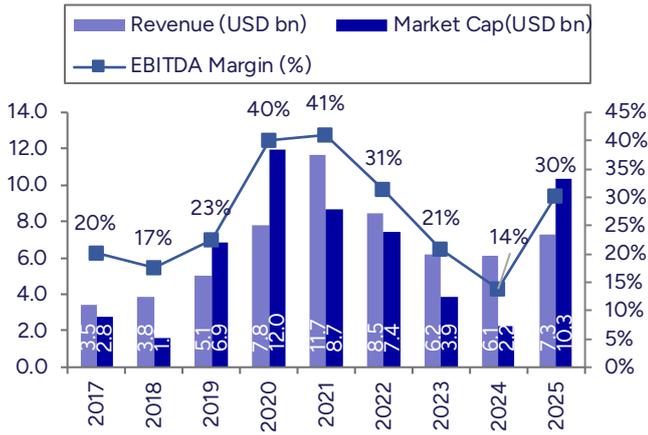
Source: Company, PL

Exhibit 6: 1-year forward PE band chart



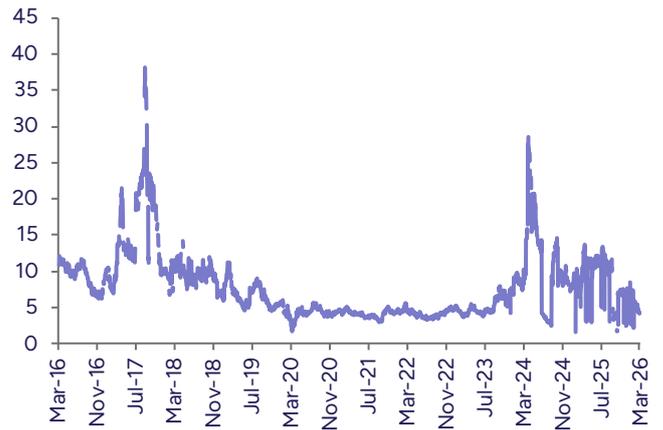
Source: Company, PL

Exhibit 7: Sibanye Stillwater (palladium) – Financials



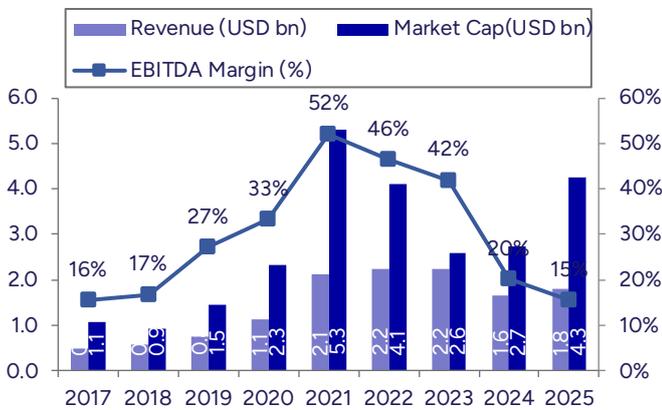
Source: Company, PL

Exhibit 8: 1-year forward PE band chart



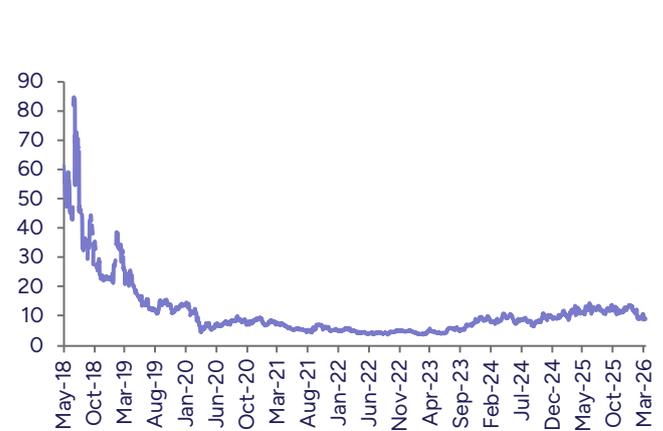
Source: Company, PL

Exhibit 9: Northam Platinum Holdings (palladium) – Financials



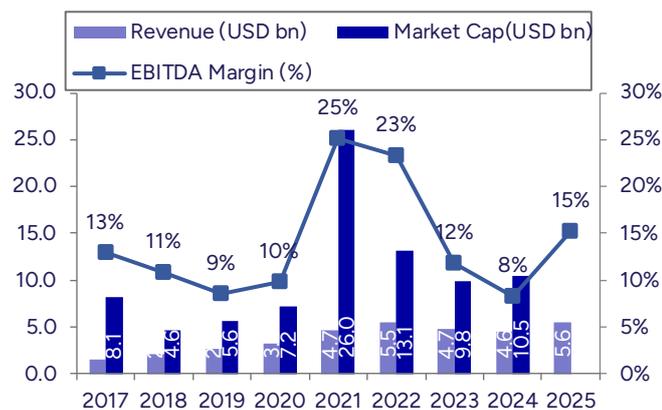
Source: Company, PL

Exhibit 10: 1-year forward PE band chart



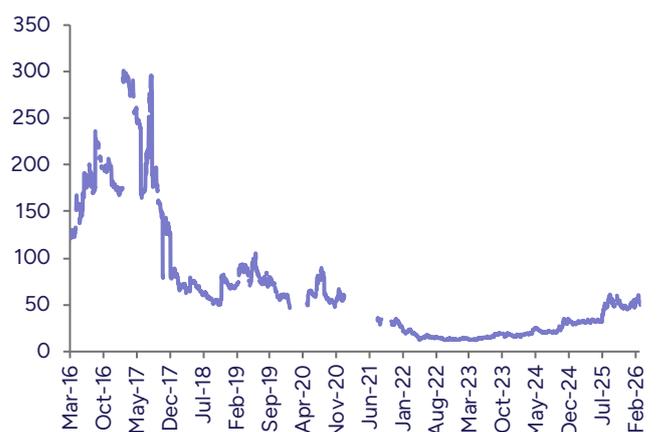
Source: Company, PL

Exhibit 11: China Northern Rare Earth Group – Financials



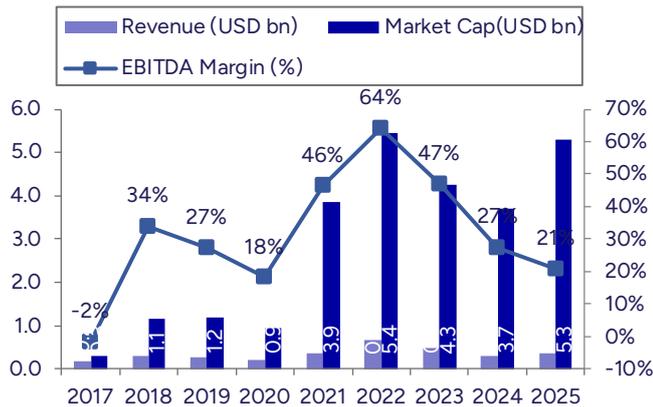
Source: Company, PL

Exhibit 12: 1-year forward PE band chart



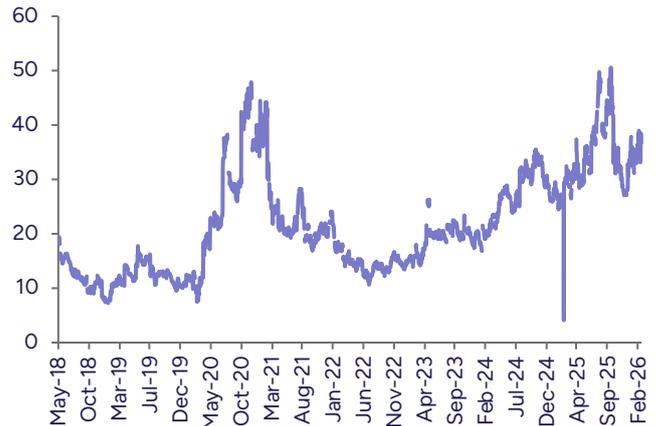
Source: Company, PL

Exhibit 13: Lynas Rare Earth – Financials



Source: Company, PL

Exhibit 14: 1-year forward PE band chart



Source: Company, PL

Gallium: A critical mineral for advanced technologies

Gallium is a soft, silvery metal with strategic importance in both civilian and defense applications. It is not mined directly, but is primarily recovered as a **byproduct of bauxite processing** during alumina refining, linking the aluminum industry to a range of high-value technology sectors.

Gallium plays a crucial role in modern electronics and advanced materials. Its key applications include semiconductors, LEDs, lasers, and specialized electronic components, while it is also used in medical imaging, high-performance alloys, and temperature measurement devices as a substitute for mercury.

Gallium has emerged as an important material for semiconductors, optoelectronics, power electronics, and advanced defense technologies. As demand for advanced electronics and renewable energy systems increases, gallium's strategic importance continues to rise.

Strategic importance of gallium

Gallium has been classified as a critical mineral due to its essential role in emerging technologies and the high concentration of its global supply chain. It is a key enabling material for AI infrastructure, electrification, RE systems, and defense electronics.

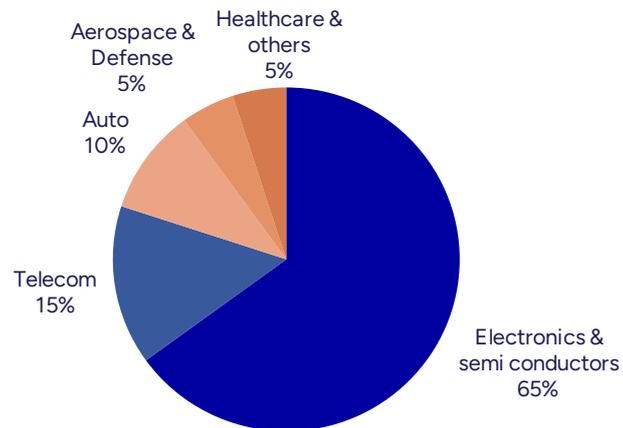
Key areas where gallium is indispensable include:

- Semiconductors: Gallium arsenide (GaAs) and gallium nitride (GaN) used in high-performance chips
- Telecommunications: RF chips used in 5G and emerging 6G infrastructure.
- Power electronics: Applications in EVs, fast chargers, and energy conversion systems
- Optoelectronics: LEDs, lasers, and high-efficiency display technologies
- Defense systems: Radar technologies, satellite communications, and advanced aerospace electronics
- Renewable energy: Thin-film solar technologies such as copper indium gallium selenide solar cells

Global demand outlook

Gallium demand is heavily driven by high-technology applications, which account for ~95% of total consumption.

Exhibit 15: Global gallium demand by end-user industry

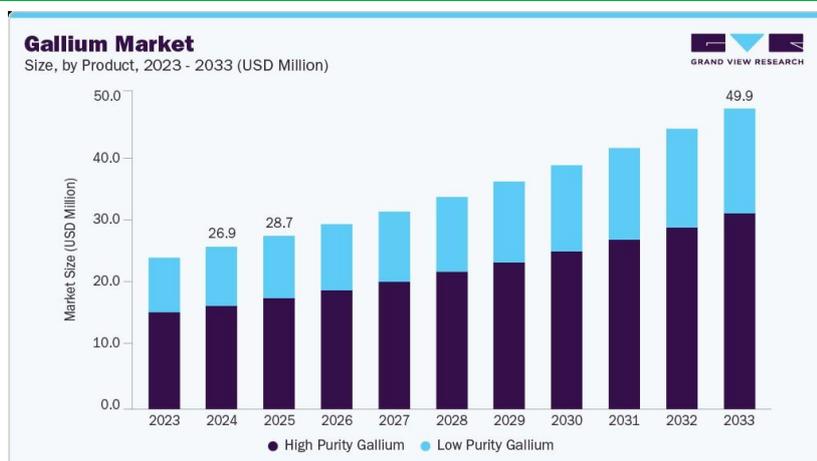


Source: Industry

Demand growth

- Global consumption of high-purity gallium was ~550t in 2025 and is projected to grow at a CAGR of 6.5-7% over 2025-30E to 750-800t. Market value growth is expected to be significantly higher due to premium pricing for high-purity gallium products. In addition, the broader gallium-enabled semiconductors and optoelectronics markets are projected to grow at over 20% CAGR, driven by AI infrastructure, electrification of transportation, RE technologies, and expansion of advanced telecommunications networks.

Exhibit 16: Gallium market is expected to grow at a strong 20% CAGR over CY25-30 (in \$ mn)



Source: Industry

Global gallium supply scenario

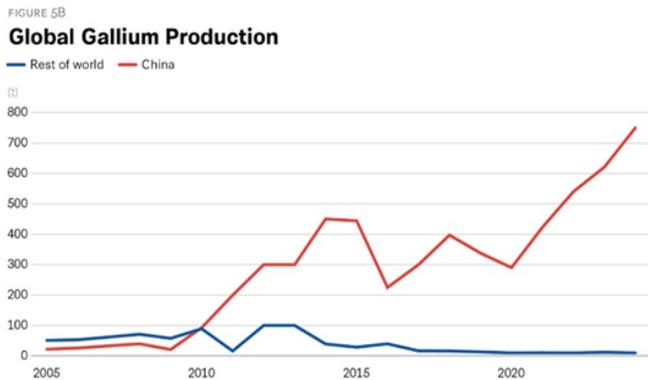
Gallium is almost entirely produced as a by-product of aluminum refining, with minor quantities recovered from zinc ores. The global supply chain is highly concentrated, China accounts for over 90% of global primary production, producing nearly 900t in 2025. Other producers such as Japan and Russia contribute only a few tons each. There is no meaningful gallium production in the US, Europe or most other regions.

This extreme concentration has created significant geopolitical risks for global supply chains. China's dominance in gallium production has led to several supply disruptions in recent years; Export licensing restrictions introduced in Aug'23, a complete export ban to the US in Dec'24, while the ban was temporarily lifted for 1 year in Nov'25.

These restrictions have triggered sharp price spikes, inventory drawdowns, and supply chain stress across global semiconductor industries.

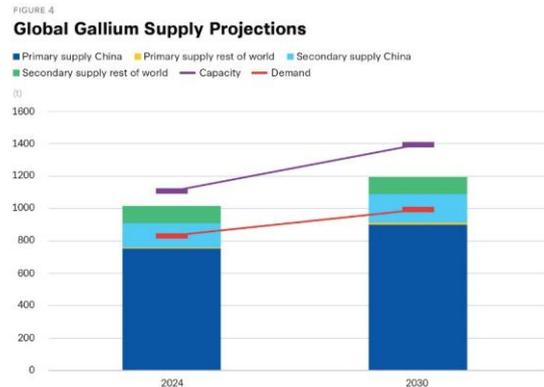
Several countries, including Australia, Canada, Greece, India and South Korea, have announced projects aimed at diversifying gallium supply. However, most of these projects are expected to begin contributing meaningfully only after 2027-28.

Exhibit 17: China controls over 90% gallium production (metric tons)



Source: Industry

Exhibit 18: Projected global gallium supply growth (metric tons)



Source: Industry

Market pricing and economics

The gallium market is currently characterized by tight supply conditions and structural imbalances.

Recent price movements highlight scarcity of the metal:

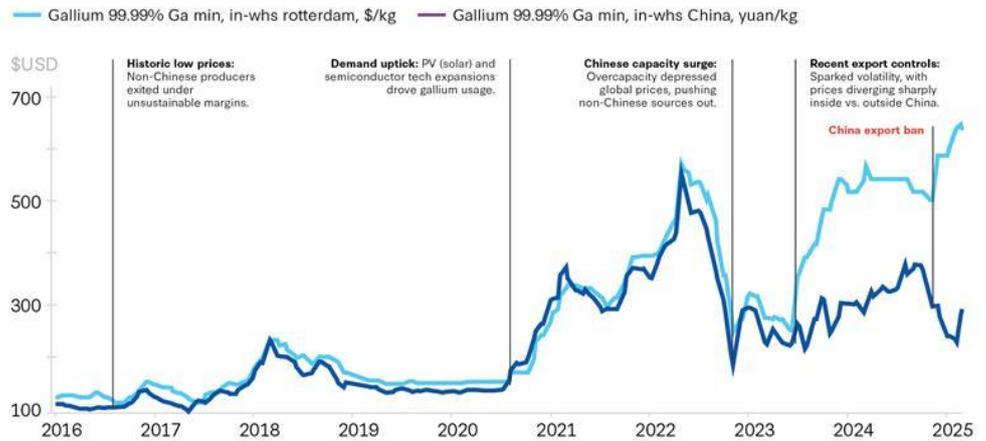
- US import price: ~\$580/kg in 2025, up 30% YoY
- Spot prices: have periodically traded significantly higher
- Long-term trend: prices increased from \$274/kg in 2018 to ~\$2,101/kg by 2026

Semiconductor-grade gallium requires purity levels of 99.99% (4N+), which commands premium pricing. Recovery efficiency during alumina refining typically ranges at 60-80%, meaning that large alumina refineries can potentially produce 10-20tpa of gallium. NACL has announced a pilot project of 10tpa in the first phase of gallium extraction.

Exhibit 19: Gallium – Historical price trends & global supply dynamics

FIGURE 2

Gallium Price Shocks and Supply Shortages



Source: Industry

Domestic gallium supply scenario

India currently does not have commercial gallium production and remains 100% dependent on imports, largely from China. This dependence exposes the country to global supply disruptions and export restrictions. However, domestic production initiatives are now underway.

NACL’s gallium extraction initiative

NACL is developing India’s first gallium extraction facility, which will recover gallium as a by-product of its alumina operations. Odisha bauxite deposits contain relatively high gallium concentrations (30-80ppm), making extraction commercially viable.

Project overview

NACL is setting up a pilot-scale demonstration facility at its Damanjodi refinery plant for gallium recovery from Bayer liquor. The project is being implemented under an MoU with the Bhabha Atomic Research Centre (BARC) and the Heavy Water Board. Through these collaborations, the company has developed indigenous technology to extract gallium during the alumina production process.

Project capacity and timeline

Initial capacity: ~10tpa and potential expansion: 10-20tpa with full-scale deployment. A prototype facility is under development, and is expected to be ready within 8-9 months, followed by ~1 year of testing.

Commercial production is expected to commence around 2027-28. Once operational, NALCO will become the first and only gallium producer in India.

Demand outlook in India

Although India’s gallium market remains small in absolute terms, demand is expected to grow rapidly due to the India Semiconductor Mission, expansion of electronics manufacturing, growth in EVs and power electronics, deployment of 5G infrastructure, increasing use of LED lighting, solar power expansion, including thin-film solar technologies.

Indian high-purity gallium market was valued at approximately \$0.8mn in 2024 and is expected to reach \$1.5mn by 2033, representing a CAGR of ~6.8%.

As India scales its semiconductor, EV, and solar industries, domestic demand for gallium is expected to increase significantly beyond current supply projections.

Financial potential of gallium production

Although gallium production volumes are relatively small compared to primary aluminum output, the high price of gallium provides attractive economic returns. At current market prices, 20tpa gallium project could generate ~INR4bn in revenue. More than the value, it is of strategic importance for the nation.

Silica – The invisible backbone of the digital and solar economy

Silica, chemically known as silicon dioxide (SiO₂), is one of the most abundant minerals on Earth, comprising ~59% of the planet's crust. It occurs naturally in crystalline forms such as quartz and in amorphous forms such as sand and diatomaceous earth.

Industrial silica, particularly high-purity silica sand (95%+ SiO₂), is the primary focus of commercial extraction due to its wide range of applications. Silica possesses several key properties, including high hardness, chemical inertness, thermal stability, and optical clarity, making it indispensable across multiple manufacturing sectors.

Major applications of silica

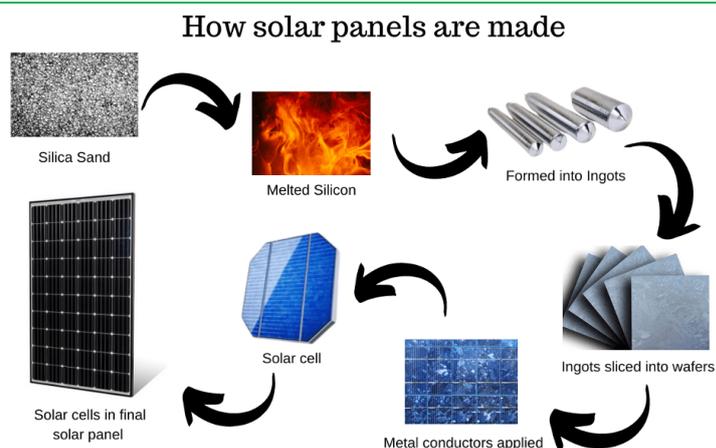
Silica is used across several sectors:

- Glass manufacturing (50-60% of demand)- Flat glass for buildings and windows, container glass, specialty glass for solar panels and fiber optics
- Foundry and metal casting (15-20%)- Refractory sands used in metal casting for automotive and machinery industries
- Construction (10-15%)- Filler material in concrete and mortar and hydraulic fracturing (fracking) proppants in the oil and gas industry
- Electronics and high-tech applications (5-10%)- Silicon wafers used in semiconductors and solar cells, components used in AI and data center chips, and precipitated silica used in tires, coatings, and specialty materials
- Other applications- Chemicals and silicones, ceramics, water filtration systems

Silica has been designated a "critical mineral" by the US and several allied nations, including India through its recent Pax Silica alignment. The mineral plays an important role in AI infrastructure, renewable energy systems, and large-scale infrastructure development.

Prices for high-purity silica sand typically range at \$50-150 /t, while ultra-high-grade silica used in semiconductor manufacturing can command prices exceeding \$200/t.

Exhibit 20: Silica plays critical role in solar panel manufacturing



Source: Industry

Global supply dynamics

Production

- Global silica production reached ~479mmt in 2024, with an estimated market value of \$36.5bn.
- Major producing countries include the US (major exporter), China (primarily domestic consumption) and the Netherlands (processing and trading hub).
- Significant silica deposits are located in the US (Wisconsin and Illinois), Australia and Brazil.
- Supply growth has remained steady but faces challenges from environmental regulations, high water usage in washing processes, and stringent sustainability standards.
- The washed silica sand segment, which represents the high-purity market, produced roughly 100-150mmt in 2024, with capacity expansions underway across Asia and North America.

Supply outlook

Global silica supply is expected to range from 391-500mmt, representing 5-6% growth, driven by new mining projects, including expansions by US Silica. However, export controls from China on high-tech silica materials could create regional supply bottlenecks.

Global demand trends

Global silica demand is estimated at ~372mmt in 2025, driven by urbanization, renewable energy installations, EVs, and AI infrastructure development. The market was valued at \$21.2-27.8bn in 2024, supported by a recovery in automotive foundry demand and glass manufacturing after the pandemic.

Regional demand breakdown

- Asia-Pacific: ~50% market share (driven by China and India's construction and manufacturing sectors)
- North America: ~25% (fracking and solar installations)
- Europe: ~15% (glass manufacturing and electronics)

Long-term demand outlook

Global silica demand is expected to reach 501-554mmt by 2032, representing a CAGR of 5-6.5%. Market value is projected to increase to \$37-47bn by 2034.

Key high-growth segments include:

- **Precipitated silica:** Expected to grow at 5.8% CAGR, reaching \$5.9bn by 2030, driven by demand from EV tires and specialty rubber
- **Spherical silica:** Used in semiconductor packaging and AI chips, with demand closely tied to global semiconductor capacity expansion

Market trends

- High-purity silica shortages: 10-15% deficit is projected by 2027, primarily driven by semiconductor demand.
- Energy price volatility: Production costs remain sensitive to energy and logistics costs.

- Sustainability initiatives: Recycling of glass waste could add 20-30mmt of silica supply by 2030.
- Supply chain diversification: India's Pax Silica initiative (Feb'26) aims to diversify supply chains currently dominated by the US.

Major global producers

Key companies involved in silica mining and processing include:

- US Silica Holdings (US)- Production: 20-25mmt annually. Focus: Industrial sand for glass and hydraulic fracturing
- SCR-Sibelco (Belgium/Netherlands)- Production: 15-20mmt. Specializes in high-purity quartz for electronics and solar applications
- Covia Holdings (US)- Production: 10-15mmt. Strong presence in foundry and glass-grade sands
- Mitsubishi Corporation (Japan/Australia)- Operates Cape Flattery Silica Mine (~5mmt). Major exporter of semiconductor-grade silica
- Badger Mining Corporation (US)- Production: 5-10mmt. Specializes in resin-coated foundry sands
- Hi-Crush Inc (US)- Production: ~8mmt. Traditionally focused on fracking sands
- Mangal Minerals (India/UAE)- Production: 2-3mmt. Exporter of high-purity silica

Downstream and refining companies

- Evonik Industries (Germany): Fumed silica (Aerosil) for coatings and specialty materials
- Cabot Corporation (US): Precipitated silica used in rubber and tire manufacturing
- PPG Industries (US): Divested its silica business in Q4 2024

Exhibit 21: Financial overview of major players

Company	Revenue (2024)	EBITDA	Silica contribution
US Silica Holdings	\$900mn	\$150mn	80-90%
SCR-Sibelco	\$3.5bn	\$600mn	60-70%
Covia Holdings	\$2bn	\$300mn	~70%
Mitsubishi Corp	\$140bn	\$12bn	<1%
Wacker Chemie	\$7.7bn	\$1.3bn	Silicones: EUR2.81bn
Evonik Industries	\$16.6bn	\$2.3bn	~EUR1bn
Cabot Corp	\$3.6bn	\$650mn	EUR1.2bn

Source: Industry, PL

Indian silica market

India is among the top 10 silica producers globally, producing 10-15mmt annually. However, India remains import-dependent for high-purity silica grades. Domestic demand stands at 12-15mmt, with the market valued at ~\$1.7bn in 2025. Major reserves are located in Rajasthan and Gujarat.

Growth potential of silica in India

India's silica market is expected to grow rapidly, reaching \$3.5bn by 2033, representing a CAGR of ~9.5%, significantly above the global average.

Key demand drivers: Infrastructure growth under PM Gati Shakti, solar capacity target of 100GW by 2030, and semiconductor ecosystem development (3 planned fabrication plants). These factors could add ~7mmt of additional silica demand.

Key investments in India

India has more than 200mmt of untapped silica reserves. Expansion by companies such as GMDC and NACL could add 5-10mmt of production capacity annually. Government initiatives under the National Critical Mineral Mission (NCMM) could drive investments of up to INR50bn in the sector.

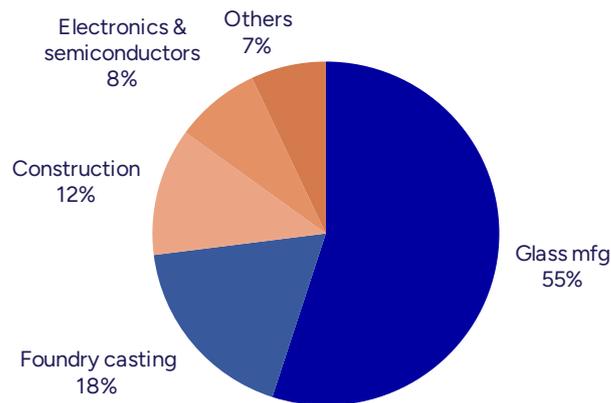
GMDC is the primary public-sector silica producer in India. Key operations include Rajpardi silica sand mine (Surat) and Bhuj deposits (Kutch). Total reserves are estimated at ~50mmt, with annual production of 0.5-1mmt. Following its entry into the Pax Silica alliance in Feb'26, GMDC announced plans to invest INR1-2bn to expand production targeting semiconductor and AI-related supply chains.

Production guidance: FY24 production: ~0.8mmt; FY26 target: 1-1.5mmt silica, expected to contribute 10-15% of GMDC revenue, or INR1-1.5bn. Long-term strategy targets 15-20% CAGR growth in silica production, supported by partnerships under the Pax Silica framework.

Long-term outlook

India's silica production is projected to increase from ~15mmt currently to 25-30mmt by 2030, with total industry revenue potentially reaching \$2-3bn. For GMDC specifically, silica revenue could reach INR3-5bn by FY30, with EBITDA margin of ~20%. Strategically, domestic silica production will reduce imports of ~\$200mn annually and support India's Atmanirbhar Bharat initiative. However, environmental regulations remain a key risk, while global partnerships, particularly with the US, could allow Indian producers to command 10-15% premium pricing for high-purity grades.

Exhibit 22: Global silica usage by user industries



Source: Industry, PL

Palladium – Powering the hydrogen and clean mobility economy

Palladium (Pd) is a rare, lustrous, silvery-white transition metal belonging to the platinum group metals (PGMs). Discovered in 1803 and named after the asteroid Pallas, it is one of the scarcest elements in the Earth's crust (about 15 parts per trillion). Key properties include a high melting point (1,555°C), excellent corrosion resistance, ductility, and superior catalytic activity – making it ideal for chemical reactions without being consumed. Palladium is primarily a byproduct of nickel and copper mining, with global reserves estimated at 100,000mt, concentrated in Russia (41%) and South Africa (38%).

Designated a "critical mineral" by the EU, US and India due to supply risks (geopolitical tensions in Russia), palladium's market is volatile, with prices fluctuating from \$866/oz in early 2024 to over \$2,100/oz by late 2025 amid deficits. As of early 2026, prices have stabilized at \$2,000-2,200/oz, influenced by ongoing substitution trends and hydrogen tech demand. Palladium prices are up 4% in 2026 and are up 83.5% YoY as of Feb'26. The global market, valued at \$11.65bn in 2024, is projected to reach \$16.07bn by 2030 (CAGR 8.2%), driven by automotive recovery, electronics, and green technologies like fuel cells.

Major uses:

- Automotive catalysts (70-80% of demand): Essential in catalytic converters to reduce emissions in gasoline vehicles, capturing pollutants like hydrocarbons and carbon monoxide
- Electronics (10-15%): In multilayer ceramic capacitors (MLCCs) for smartphones, computers, and EVs
- Chemical and hydrogen applications (5-10%): Hydrogen purification membranes, fuel cells, and hydrogenation processes
- Other: Dentistry (alloys), jewelry, and medical devices

Global demand-supply dynamics

Supply:

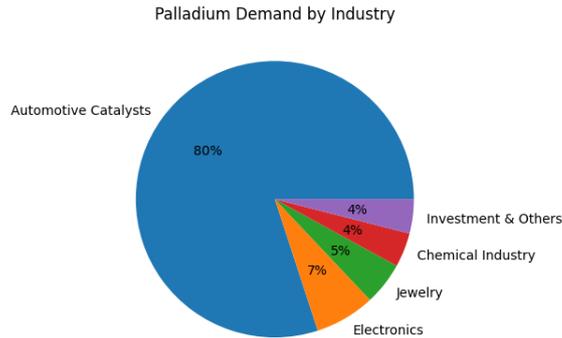
- Primary production is tied to nickel/copper mining, with total output at ~9.59mn ounces (Moz) in 2024, down slightly from 2023 due to Russian sanctions and South African operational challenges (e.g., power outages, labor issues). Recycling supplies ~30% (2.8-3Moz annually), but declined 15% in 2024 due to lower auto catalyst scrap.
- Russia (Norilsk Nickel) and South Africa dominate (~80% share), followed by Canada, Zimbabwe, and the US.
- 2025-2026 Outlook: Supply: ~9.7Moz in 2025, with early 2026 estimates at ~9.8Moz, as deficits narrow but persist (forecast surplus delayed to late 2026 or 2027). Geopolitical risks (e.g., US/EU bans on Russian Pd) could tighten further, pushing prices to \$2,100-2,500/oz. Emerging supplies from recycling tech and minor expansions in Canada/Zimbabwe may add 0.2-0.3Moz by end-2026.

Demand:

- Total demand: 10.10Moz in 2024 (up 2% YoY), led by automotives (7.5Moz, resilient despite EV shift) and electronics (1.2 Moz, boosted by 5G/AI)
- Substitution trend: Platinum replacing Pd in catalysts (640koz in 2024, rising to 700koz in 2025 and ~800koz in 2026) due to Pd's higher cost, potentially easing deficits but pressuring prices short-term

- 2025-2030 projections: Demand to grow 3-5% CAGR to 11-12Moz by 2030, fueled by hydrogen economy (fuel cells, projected +15% YoY in 2026) and jewelry (Asia-Pacific surge). Market value: \$20.37bn in 2025 to reach \$24.59bn by 2034 (CAGR 2.1%), with Asia-Pacific (40% share) driving growth

Exhibit 23: Global palladium demand by user industries



Source: Industry, PL

Market trends:

- Deficits: ~500koz in 2024, reduced ~5% in 2025, but prolonged by supply disruptions; early 2026 shows ~300koz deficit. Prices are volatile (up 83% in 2025 YTD, +10% in Q1 2026).
- Risks: EV adoption caps auto demand (2-3% annual decline post-2026); opportunities in clean energy (Pd membranes for H2 purification, potential +20% demand by 2030)

Key global players: Research, mining, production and involvement

The Pd value chain involves miners (extraction as byproduct), refiners (processing), and end-users (catalysts/electronics). 90% of mining happens in Russia and South Africa ; research focuses on catalysis, recycling, and H2 applications. Over 20 major firms are involved, with top miners controlling ~80% output.

Major mining and production players:

- Norilsk Nickel (Nornickel, Russia): World's largest (~40% global Pd); integrated nickel/Pd producer. 2024 output: ~2.4Moz Pd; 2025: ~2.3Moz (sanctions impact); 2026 guidance: Stable at 2.3-2.4Moz
- Anglo American Platinum (Amplats, South Africa): 15-20%; major PGM refiner. Output: ~1.5Moz Pd equivalent in 2024; 2025: ~1.6Moz; 2026: Targeting 1.7Moz with cost optimizations
- Impala Platinum (Implats, South Africa): 10-15%; focuses on Rustenburg operations. Output: ~1Moz Pd in 2024; 2025: ~1.05Moz; 2026: ~1.1Moz led by volume growth
- Sibanye-Stillwater (South Africa/US): ~10%; diversified PGM/nickel. Output: ~0.8Moz Pd in 2024; 2025: ~0.85Moz; 2026: ~0.9Moz with US expansions
- Northam Platinum (South Africa): 5-7%; high-grade Booyendal mine. Output: ~0.4Moz Pd in 2024; 2025: ~0.45Moz; 2026: ~0.5Moz

Refiners and downstream:

- Johnson Matthey (UK): Leading catalyst producer; processes ~30% global Pd; 2026: R&D focus on low-Pd formulations

- Umicore (Belgium): Recycling and catalysts; ~20% market share in auto applications; expanding Pd recovery tech
- BASF (Germany): Chemical catalysts with Pd tech; invests in H2 purification

Exhibit 24: Financial overview of major players

Company	Revenue (2024)	EBITDA (2024)	YoY Change	Pd-Specific Notes (2024-2026)
Norilsk Nickel	\$12.5bn	\$5.2bn	Rev: -13% EBITDA: -25%	Pd: \$3-4bn revenue (30% of total); 2025 EBITDA: ~\$4.8bn; 2026 guidance: +5% on stable output. Margin: 41%
Anglo American Platinum	~\$3.5bn (est., group contrib.)	\$1.1bn (R19.8bn)	EBITDA: -19%	Pd: ~\$1bn revenue; 2025 EBITDA: \$1.2bn; 2026: \$1.3bn with AISC \$986/oz
Impala Platinum	~\$2.8bn (est.)	\$0.7bn (R12.4bn)	EBITDA: -65% (from peak)	Pd ~\$0.8bn; 2025 EBITDA: \$0.75bn; 2026: \$0.8bn, volumes: +4%
Sibanye-Stillwater	\$6.2bn (R112B)	\$0.9bn (R16bn est, adj)	Rev: -1%	Pd ~\$1.2bn; 2025 EBITDA \$1bn; 2026: \$1.1bn, US credits boost
Northam Platinum	\$1.7bn (R30.8bn)	\$0.35 bn (R6.3bn)	Rev: -22%	Pd ~\$0.5bn; 2025 EBITDA \$0.4bn; 2026: \$0.45bn; capex: R4.9bn
Johnson Matthey	\$15.2bn (group)	\$1.1bn	EBITDA: -10%	Catalysts (Pd: ~40%): \$2bn revenue; 2025: \$1.2bn EBITDA; 2026 R&D spend: +15%
Umicore	\$20.5bn (EUR18.9bn)	\$1.4bn (EUR1.3bn)	EBITDA: -5%	Recycling/catalysts (Pd: ~25%): \$1.5bn; 2026: \$1.6bn on auto recovery

Source: Industry, PL

Palladium in India: Investments, involvement, and guidance

India is a net importer of Pd (~90% reliance), with negligible domestic production (no significant reserves; small quantity as byproduct from copper/zinc mines). Demand is 0.2-0.3Moz annually (2024-2025), mainly auto catalysts (80%) and electronics; total market size was ~\$1.39bn/\$1.5bn in 2024/25 respectively.

Key Indian involvement:

- No major mining/production investments yet: Focus on exploration under NCMM (launched 2025). Vedanta/Hindustan Zinc (HZL) expanding zinc/silver (INR120bn plan, Jun'25), but no Pd-specific plans; minor PGM traces in Rajasthan copper ops yield <1% Pd byproduct (negligible revenue)
- Emerging player: Deccan Gold Mines Ltd (DGML): Primary Indian firm in Pd exploration. Won Bhalukona-Jamnidih block (Chhattisgarh, Apr'25) under NCMM auctions; first-ever Ni-Cu-PGE (platinum group elements, incl Pd/Pt) sulfide discovery in India (announced Oct'25). Reserves: early estimates 5-10mt ore with 0.5-1g/t PGEs

Revenue/EBITDA due to palladium:

- Indian: DGML - Zero (pre-production); HZL/Vedanta - minor byproduct (~INR0.15bn revenue)
- Global: Wheaton Precious Metals (streaming, Pd exposure via Sibanye): 2025 GEO production exceeded guidance; Pd-attributable ~\$200mn revenue, \$150mn EBITDA. Clean Air Metals (Canada, exploration): 2026 objectives include Pd in Thunder Bay project; negligible revenue yet

Growth potential of palladium in India

India's Pd market holds strong promise, aligned with Atmanirbhar Bharat and green transition, potentially capturing 2-3% global value by 2030 (~\$300-500mn revenue).

- Demand drivers: Auto sector (5mn+ vehicles/year) needs ~0.4Moz by 2030; the National Green Hydrogen Mission (5mmt green H2 by 2030) favors Pd membranes (+20-30% demand). Electronics (Make in India, 3 fabs) adds 20-30% growth; jewelry: ~10%

- Projections: Market to reach \$1.88bn by 2030 (CAGR 5.9% for PGMs, Pd: ~60% share). ; India's share to increase from 1% to 3% via NCMM
- Supply opportunities: Recycling from auto scrap (0.1Moz/year by 2030, INR20bn potential); DGML's Chhattisgarh project (0.05-0.1Moz Pd by 2028). Investments: INR73bn in rare earths/magnets (2025 budget) extends to PGMs; 100% FDI allowed
- Challenges: Import dependence (Russia/SA bans add 10-15% premiums); tech gaps in refining/exploration. Upside: Exports to US/EU amid diversification (\$50-100mn); DGML could add INR5-10bn revenue by 2030
- Strategic value: Reduces forex outflow (~\$200mn/year); supports EV/H2 goals. With NCMM auctions (230 blocks, 2025-26), India eyes 5-10% Asia-Pacific Pd supply by 2035

REEs – The magnetic backbone of energy transition

Rare earths refer to a group of 17 naturally occurring metallic elements with unique properties and a wide range of industrial applications. These are critical inputs for the global transition to a low-carbon economy, particularly in the production of clean energy technologies. Their critical role in the advancement of technology and sustainable development underscores the importance of securing a stable supply of these elements. REEs are divided into 2 categories: **light REEs (LREEs)**: These include elements like lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd) and samarium (Sm), which are more abundant and generally have a lower atomic weight. **Heavy REEs (HREEs)**: These consist of elements such as terbium (Tb), dysprosium (Dy), and yttrium (Y). They are less abundant and have a higher atomic weight.

Exhibit 25: 17 REEs

21 Sc Scandium 44.956 $3d^1 4s^2$	39 Y Yttrium 88.906 $4d^1 5s^2$	57 La Lanthanum 138.91 $5d^1 6s^2$	58 Ce Cerium 140.12 $4f^1 5d^1 6s^2$	59 Pr Praseodymium 140.91 $4f^3 6s^2$	60 Nd Neodymium 144.21 $4f^4 6s^2$
61 Pm Promethium 144.913 $4f^5 6s^2$	62 Sm Samarium 150.36 $4f^6 6s^2$	63 Eu Europium 150.69 $4f^7 6s^2$	64 Gd Gadolinium 157.25 $4f^7 5d^1 6s^2$	65 Tb Terbium 158.93 $4f^9 6s^2$	66 Dy Dysprosium 162.50 $4f^{10} 6s^2$
67 Ho Holmium 164.93 $4f^{11} 6s^2$	68 Er Erbium 167.26 $4f^{12} 6s^2$	69 Tm Thulium 168.93 $4f^{13} 6s^2$	70 Yb Ytterbium 173.05 $4f^{14} 6s^2$	71 Lu Lutetium 174.97 $4f^{14} 5d^1 6s^2$	17 Rare earth elements

Source: Industry

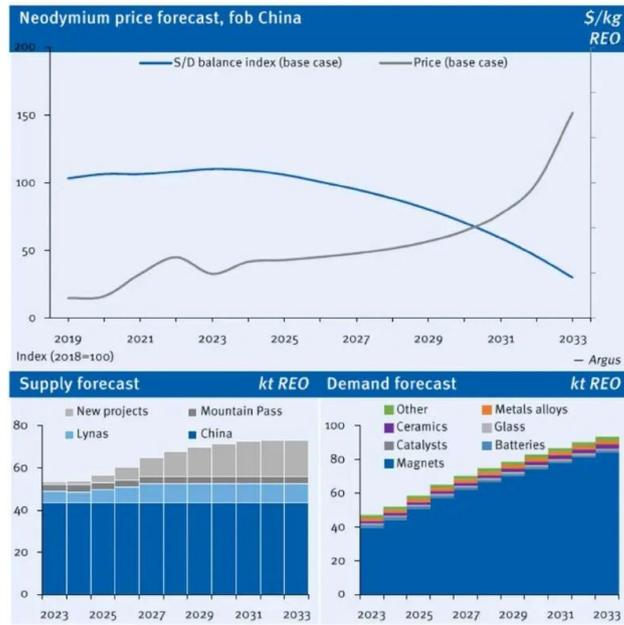
GMDC's portfolio includes high-purity light rare earth oxides: Neodymium and praseodymium are integral to the production of the strongest magnets – permanent magnets, critical for motors in EVs and wind turbines.

In electronics, neodymium magnets enable data storage in computer hard drives and deliver clear sound in mobile phone speakers and microphones – key innovations that have made today's lightweight devices possible. Demand from renewable energy and electric mobility continues to rise. Neodymium-iron-boron magnets power wind turbines, hybrid vehicles, and electric cars, making them the largest users of high-performance neodymium magnets worldwide. The element is also gaining traction in next-generation medical devices, such as wearable sensors and magnetically guided therapies, alongside its established uses in MRI machines, surgical lasers, and pacemakers.

Neodymium also has decorative applications, being one of the components used to make beautiful glass with hues ranging from yellow green to deep violet. It can also be combined with other elements to create items, such as glasses that block infrared radiation, and goggles for welding and cutting operations. Its wide range of applications and versatility make neodymium one of the most effective REEs available commercially today.

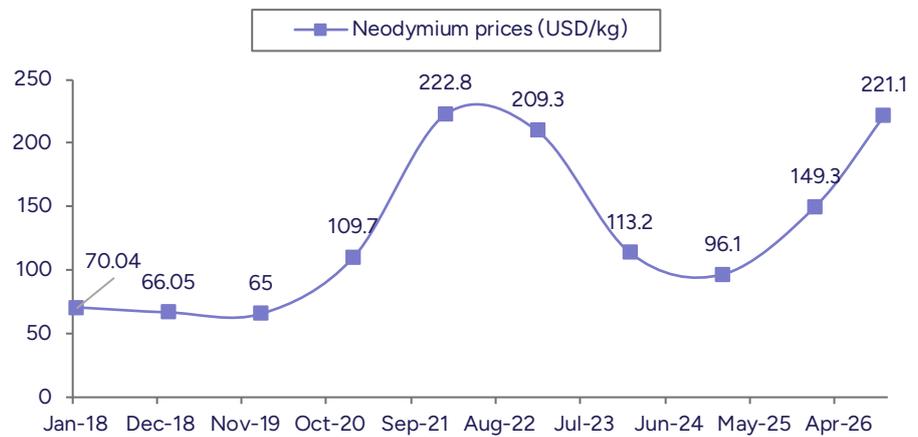
The main mining regions include China, the US, Brazil, Russia, Sri Lanka, India, and Australia. However, China dominates production, accounting for roughly 85% of global output, largely due to its advanced refining and separation capacity, rather than mining volume alone. The bulk of the global supply still comes from China, which controls roughly 85% of the refining capacity. Beijing's strategic management of its rare-earth industry, including export quotas and environmental regulations, has historically led to sharp price fluctuations. In 2010, for instance, China restricted rare-earth exports and temporarily halted shipments to Japan following a diplomatic dispute, sending prices soaring. **Neodymium price rose sharply in 2025, up 55%.**

Exhibit 26: Neodymium price, demand and supply – Historical and outlook



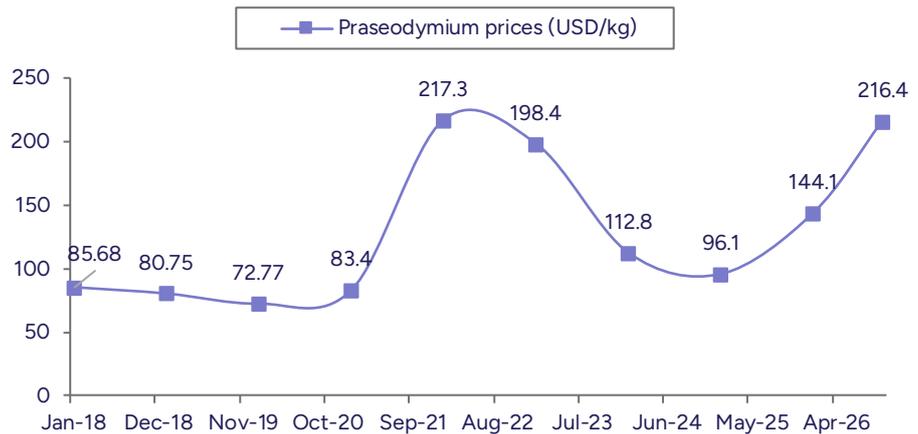
Source: Industry

Exhibit 27: Neodymium prices (\$/kg)



Source: Industry, PL

Exhibit 28: Praseodymium prices (\$/kg)



Source: Industry, PL

Praseodymium’s unique properties make it indispensable across various modern industries. For decades, it has been used as an alloying agent with softer metals such as aluminum and magnesium to strengthen them without reducing flexibility, particularly in aircraft engines and turbine components.

Its most important role today is in the production of neodymium-praseodymium (NdPr) permanent magnets, which are essential for EV motors, wind turbines, and precision electronics. These magnets are prized for their combination of strength, heat resistance, and low weight, characteristics that have made them critical to the green energy transition.

Beyond magnets, praseodymium serves as a neutron absorber in nuclear reactors and plays a role in glass manufacturing, high-intensity lighting, and lasers. Certain praseodymium compounds emit vivid red and green light, making them valuable in TV and smartphone displays.

Praseodymium is not mined on its own. It occurs alongside other LREEs, particularly neodymium, within bastnäsite and monazite ores. Globally, China remains the dominant producer, accounting for roughly 69% of rare earth ore output in 2024 and an even larger share once separation and refining are included. Outside China, the US, Myanmar, and Australia contribute to global supply, although each operates at a far smaller scale.

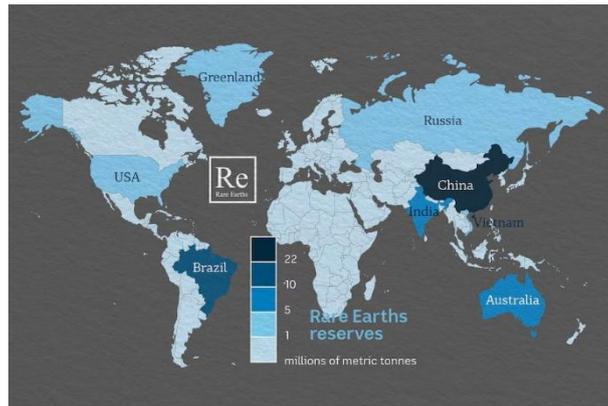
Outside China, a number of countries are working to expand or establish rare earth production, although most projects remain in early stages. Australia continues to scale output through companies like Lynas, while the US and Canada are investing in domestic mining, separation, and magnet production to reduce their reliance on Chinese processing. Exploration and development efforts in Brazil, Vietnam, and Greenland have also accelerated, reflecting broader geopolitical interest in diversifying supply chains.

After a three-digit price increase in 2021 (+161%), praseodymium saw a 55% decrease in its value from 2022 to 2024.

Between 2019-20 and 2023-24, India imported a total of 9,728t of REEs, averaging ~1,946t/yr, government data shows. Most of these imports came from China, followed by Japan, Russia, South Korea, the US, Austria, France, Hong Kong, and other countries. Despite ongoing efforts, India continues to depend heavily on imports, particularly from China, to meet its REE requirements. This import dependence leaves Indian industries vulnerable to supply shocks and geopolitical risks.

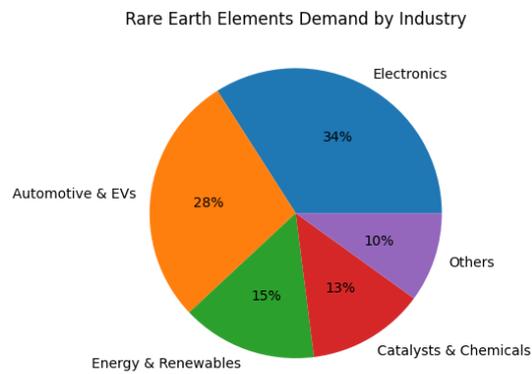
As of Mar’21, India held an estimated 12.73mmt of monazite, mostly found in beach sand in Kerala, Tamil Nadu, Andhra Pradesh, and Odisha, according to the Indian Mineral Yearbook (2023).

Exhibit 29: Region-wise rare earth reserves globally



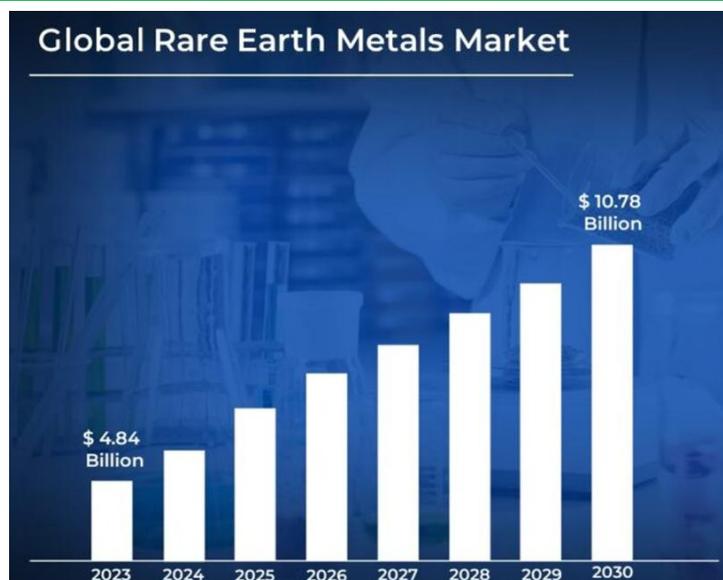
Source: Industry

Exhibit 30: Industry-wise RRE demand



Source: Industry, PL

Exhibit 31: Global RRE projected market in \$ bn (2023-30E)



Source: Industry

HZL is diversifying into critical minerals, such as rare earths, to reduce its reliance on imports. The miner recently secured a monazite-rich rare earth mining block in Uttar Pradesh – a first for India’s private sector. **Monazite ore** is rich in neodymium, but it also contains radioactive thorium, making extraction complex. It could take up to 4-5 years before HZL begins producing **rare earth** minerals, underscoring the long road ahead for India’s domestic REE ambitions. HZL aims to mine and process neodymium, a critical REE used in permanent magnets for EVs, wind turbines, and various electronic devices.

- **Slow exploration & setup:** Securing a mining block is just the start. Surveys, permitting, and plant construction can take 4-5 years, with no guarantee of commercial success until production ramps.
- **High technical complexity:** Rare earth processing involves low-grade ores, radiation hazards, and intricate chemical separation. Most Indian firms lack the advanced capabilities and safety systems required.
- **Costly infrastructure & clearances:** Separation plants are capital-intensive and face prolonged delays in environmental and radiation safety approvals due to bureaucratic red tape.
- **Reducing reliance on China for critical minerals:** REEs are vital for high-tech manufacturing – from EV motors and wind turbines to smartphones and missile systems. Yet India depends almost entirely on imports to meet demand. These risks are not theoretical. China dominates the global rare earth supply chain, accounting for *~70% of world output* and an outsized share of processing capacity. Beijing has leveraged this position by tightening export controls on certain rare earth products. In fact, China recently cracked down on exports of specialized REE magnets and materials (like terbium and dysprosium used in neodymium magnets), citing strategic concerns.

With ambitions to generate 30% of its revenue from minerals like potash, halite, tungsten, and rare earths within 5 years, HZL is aligning itself with India’s broader strategic pivot to secure inputs for clean energy and defense. However, there are structural roadblocks such as glacial permitting, outdated restrictions on monazite, limited processing infrastructure, and dependency on foreign tech.

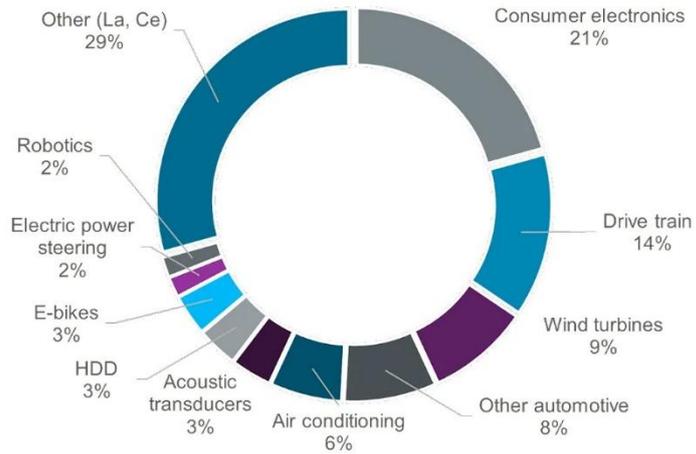
Gujarat Mineral Development Corporation (GMDC) is actively advancing in REEs, with notable progress in 2025-2026, particularly around its flagship Ambadungar Rare Earth Project in Chhota Udepur, Gujarat.

Ambadungar project: This region has one of the world’s largest known hard-rock REE deposits (primarily LREEs, including neodymium for magnets, praseodymium, etc.). GMDC describes it as a world-class asset and is developing an end-to-end value chain: open-pit mining, processing plants, tailings management, infrastructure (water/power supply, workshops, residential facilities), and eventual separation/refining. The goal is to produce mixed rare earth concentrate (MREC) initially, supporting India’s clean energy transition (e.g., NdFeB magnets for EVs, wind turbines, electric motors).

In Jan’26, BARC transferred a fully indigenous technology titled “Process for the Recovery of Rare Earth Values from Ankeritic Ore Body of Ambadungar, Gujarat, India (CH48MinD)” to GMDC.

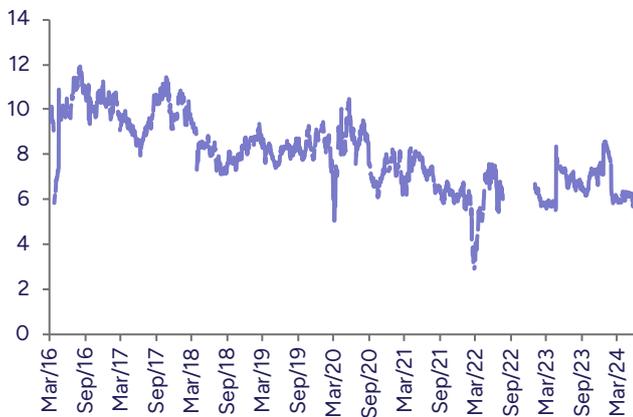
- This tech enables recovery of MREC from the site’s hard-rock ankeritic ore, addressing ore-specific challenges.
- GMDC plans pilot-scale deployment first, with ongoing BARC technical support for process validation, recovery optimization, and environmental assessment.
- This is a big step toward self-reliance (Atmanirbhar Bharat), reducing dependence on foreign processing tech (mostly China-dominated).

Exhibit 32: NdFeB magnets –Industry-wise end users



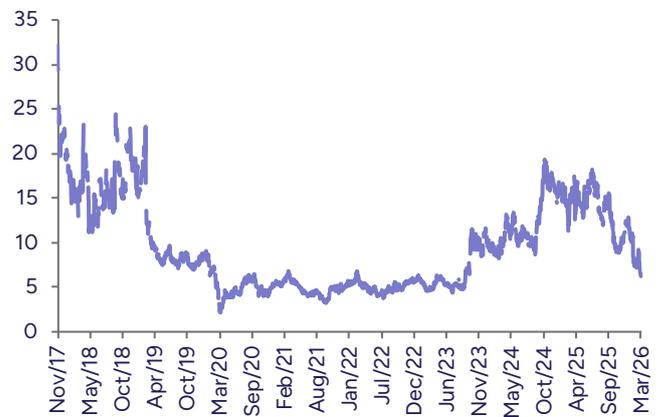
Source: Industry, PL

Exhibit 33: Nornickel 1-year forward PE band chart



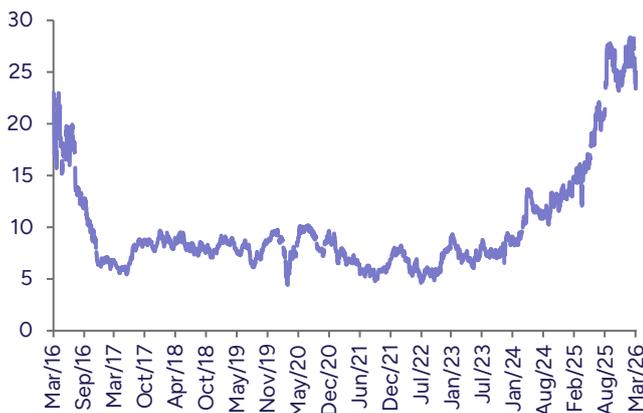
Source: Industry, PL

Exhibit 34: Impala Platinum holdings 1-year forward PE band chart



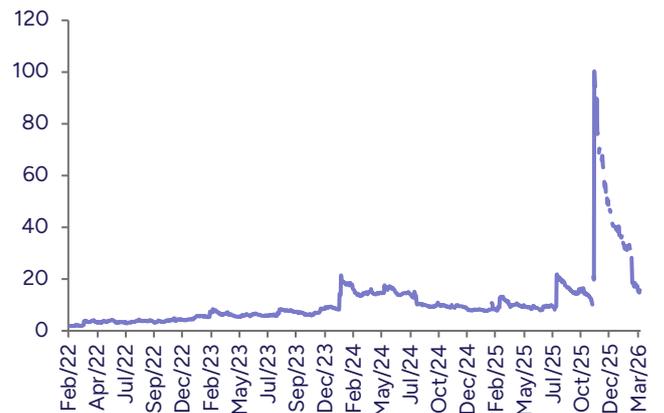
Source: Industry, PL

Exhibit 35: Anglo American 1-year forward PE band chart



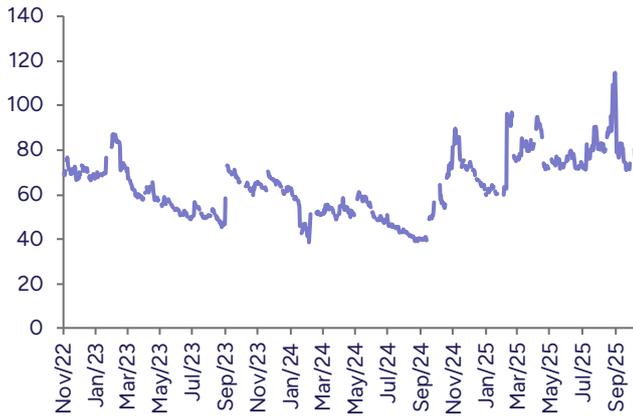
Source: Industry, PL

Exhibit 36: Ferroglobe 1-year forward PE band chart



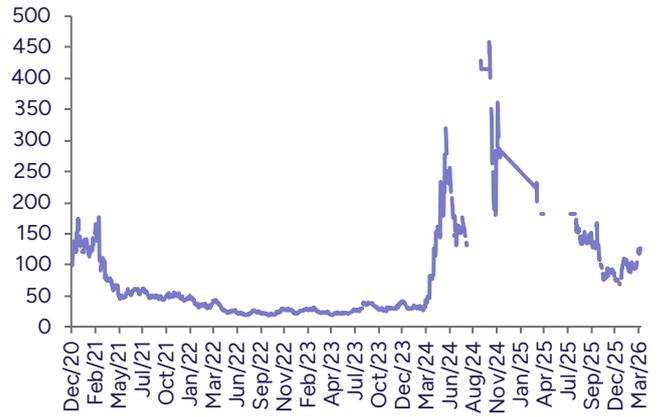
Source: Industry, PL

Exhibit 37: China Minmetals Rare earth 1-year forward PE band chart



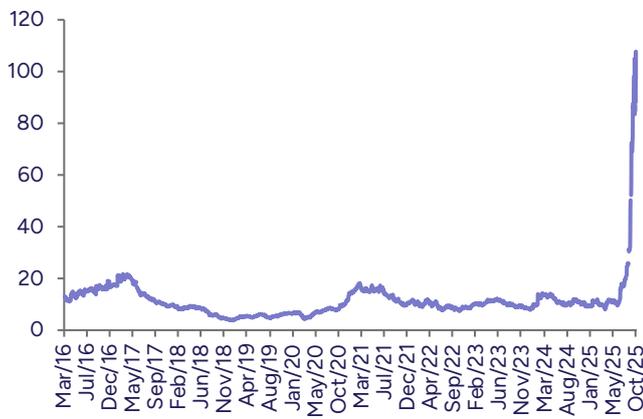
Source: Industry, PL

Exhibit 38: MP Materials 1-year forward PE band chart



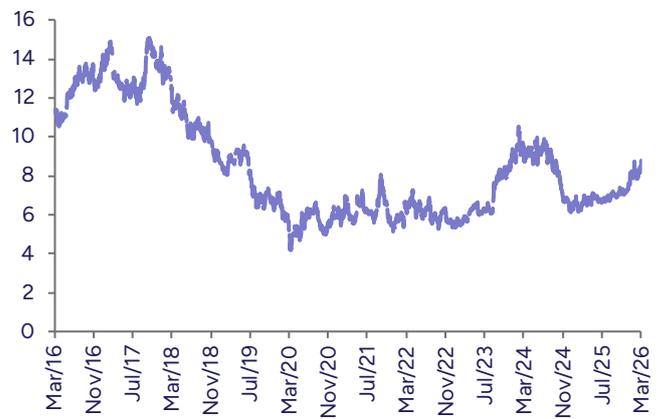
Source: Industry, PL

Exhibit 39: Iluka 1-year forward PE band chart



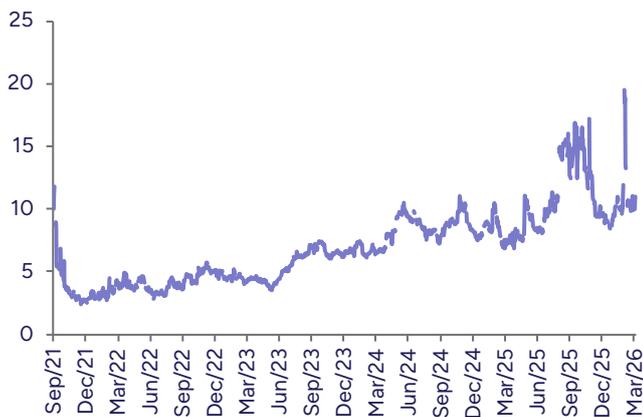
Source: Industry, PL

Exhibit 40: Coal India 1-year forward PE band chart



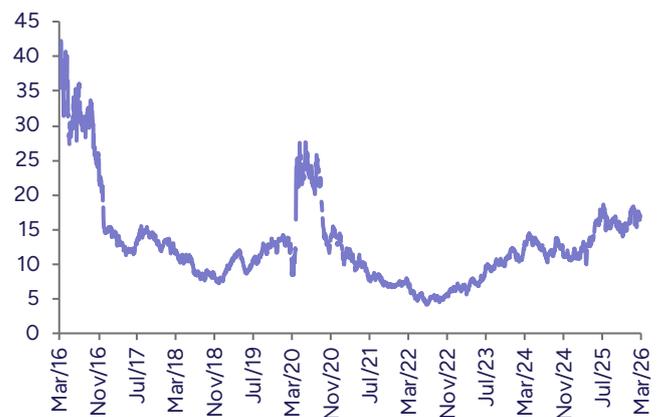
Source: Industry, PL

Exhibit 41: Peabody 1-year forward PE band chart



Source: Industry, PL

Exhibit 42: Glencore 1-year forward PE band chart



Source: Industry, PL

Exhibit 43: Indian Companies Valuation Summary

Company Name	Rating	Price (Rs)	Target (Rs)	Mcap (Rs bn)	Revenues (Rs m)				EBITDA (Rs m)				EPS (Rs)				PER (x)				EV/EBITDA (x)		
					FY25	FY26E	FY27E	FY28E	FY25	FY26E	FY27E	FY28E	FY25	FY26E	FY27E	FY28E	FY26E	FY27E	FY28E	FY26E	FY27E	FY28E	
National Aluminium Co.	Hold	387	356	711	1,67,876	1,74,058	2,02,780	2,18,377	75,074	75,708	97,235	1,02,119	28.7	29.3	38.2	40.9	13.5	10.4	9.7	8.5	6.2	5.5	
Gujarat Mineral Development Corp Ltd	NR	559	NA	178	28,508	26,986	35,659	42,939	6,407	5,949	9,011	12,281	21.6	21.0	22.9	28.0	26.63	24.42	19.97	29.4	19.41	14.24	
Hindustan Zinc	NR	538	NA	2,271	3,40,830	3,92,665	4,58,476	4,79,180	1,73,880	2,11,893	2,65,087	2,76,166	24.5	30.638	39.388	41.163	17.55	13.65	13.06	10.87	8.69	8.34	
Vedanta Ltd	NR	679	NA	2,656	15,29,680	16,99,000	19,53,000	2,01,41,000	4,23,440	5,49,509	7,12,165	7,38,621	38.65	53.336	76.157	79.617	12.73	8.92	8.53	6.24	4.81	4.64	

Source: Company, PL

Analyst Coverage Universe

Sr. No.	Company Name	Rating	TP (INR)	Share Price (INR)
1	ACC	BUY	2163	1755
2	Adani Port & SEZ	BUY	1900	1531
3	Ambuja Cement	BUY	640	452
4	Dalmia Bharat	Hold	2302	2232
5	Hindalco Industries	Hold	907	964
6	Jindal Stainless	Hold	784	756
7	Jindal Steel	Accumulate	1171	1102
8	JK Cement	Accumulate	6199	5790
9	JK Lakshmi Cement	BUY	881	761
10	JSW Cement	BUY	142	124
11	JSW Infrastructure	BUY	339	273
12	JSW Steel	Accumulate	1292	1170
13	National Aluminium Co.	Hold	356	385
14	NMDC	Hold	87	86
15	Nuvoco Vistas Corporation	BUY	443	350
16	Shree Cement	Hold	27770	27350
17	Steel Authority of India	Hold	151	149
18	Tata Steel	Accumulate	226	197
19	Ultratech Cement	BUY	14168	12369

PL's Recommendation Nomenclature (Absolute Performance)

BUY	: > 15%
Accumulate	: 5% to 15%
Hold	: +5% to -5%
Reduce	: -5% to -15%
Sell	: < -15%
Not Rated (NR)	: No specific call on the stock
Under Review (UR)	: Rating likely to change shortly

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Corporate Office: 6th Floor, Tower 2B South Annex, One World Centre, 841, Senapati Bapat Marg, Lower Parel, Mumbai - 400013

Registered Office: 3rd Floor, Sadhana House, 570, P. B. Marg, Worli, Mumbai-400 018

Tel: (91 22) 6632 2222 Fax: (91 22) 6632 2209

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