RARE EARTH AND STRATEGIC METALS

Authored by: Chandan BR, Ashvin Patidar

Under the guidance of: **Manju Mastakar** (Managing Director)

Website
www.armstrong-cap.com

Address
A1 Tower, 5th Floor, Golden Enclave, Corporate Block, Old Airport Road, Bangalore 560017

Email address
chandan@armstrong-cap.com

RARE EARTH ELEMENTS ?

The 17 Rare Earth Elements include:

- Lanthanides:
- Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pm), Samarium (Sm), Europium (Eu), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Thulium (Tm), Ytterbium (Yb), Lutetium (Lu)
- Other REEs:
- Scandium (Sc), Yttrium (Y)

Where Are They Used?

- Neodymium and Dysprosium – used in powerful magnets for electric vehicles and wind turbines
- Terbium and Yttrium – used in lasers, LEDs, and displays
- Others are found in smartphones, batteries, military tech, and medical devices

Why They're Important?

- These metals have special powers – they can glow, carry electricity, and make strong magnets
- They help make devices faster, smaller, and more energy-efficient
- They support clean energy and improve electronics and defense systems

Are They Really Rare?

- Not really – they're fairly common in Earth's crust
- But they are not found in large deposits, so mining is difficult and expensive
- Their extraction causes environmental damage

Element	Symbol	Atomic number
Light REEs		
Lanthanum	La	57
Cerium	Ce	58
Praseodymium	Pr	59
Neodymium	Nd	60
Samarium	Sm	62
Europium	Eu	63
Gadolinium	Gd	64
Heavy REEs		
Terbium	Tb	65
Dysprosium	Dy	66
Holmium	Ho	67
Erbium	Er	68
Thulium	Tm	69
Ytterbium	Yb	70
Yttrium	Y	39

Key elements like **Neodymium and Dysprosium** are vital for permanent magnets in EVs and wind turbines, while **Terbium and Yttrium** are used in lasers and displays .

RARE EARTH ELEMENTS MARKET SIZE & TRENDS

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The global Rare Earth Elements (REEs) market is set to surge to **USD 6.28 billion by 2030**, clocking a strong **CAGR of 8.6% from 2025**. This growth is supercharged by the booming demand for **Electric Vehicles** (EVs) and **Clean Energy** tech—with Neodymium-Praseodymium (NdPr) magnets powering the heart of EV motors and batteries. The green revolution is officially magnetic.

Key Elements in Demand: Neodymium, Praseodymium, Dysprosium, Gadolinium, Terbium

Neodymium

Permanent magnets used in EV motors, wind turbines, and electronics

Valued at USD 2.07B in 2021, the Neodymium market is expected to grow at a robust CAGR of 15% through 2030

Praseodymium

High-strength magnesium alloys for aircraft engines and aerospace components.

Expceted to grow at a CAGR 10.7% (2025–2030)

Dysprosium

Alloying agent in neodymium-iron-boron (Neo) magnets for transport, power, defense, medical, industrial

Strong demand from industrial magnet use

Gadolinium

☢ Neutron absorber in nuclear reactors
💾 Also used in electronics and data storage

Demand supported by nuclear reactor development

GLOBAL REE MARKET: REGIONAL POWERHOUSES & TRENDS

China

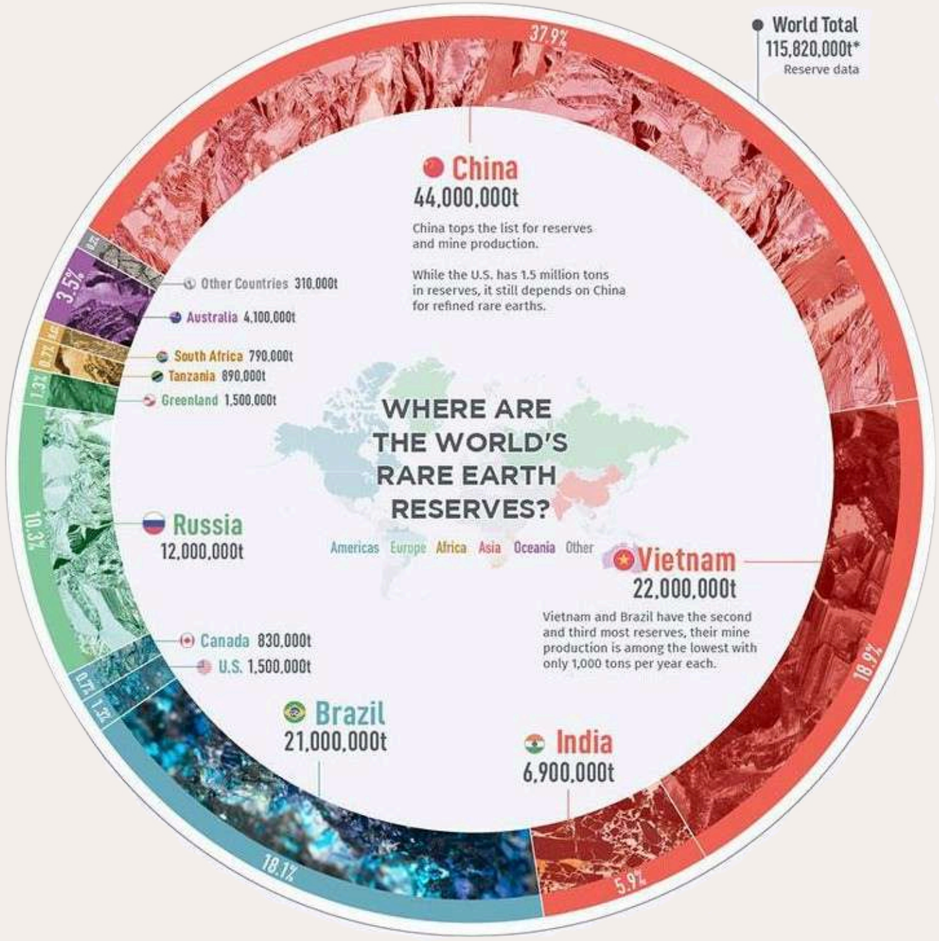
China dominates **REE supply: 85–90% refining, 65% production.**
Controls major shares of cobalt (68%), nickel (65%), and battery-grade lithium (60%).
Exports 75% of global EV batteries.
In Dec 2023, China restricted REE exports, triggering a global push for diversification.

Central & South America

Low production (0.2%), high potential.
Brazil underfunded: gets just 7% of global REE exploration budget.

Europe

Produces ~5% of global permanent magnets.
Dependent on China, now investing in sustainable sourcing and R&D to secure supply chains.



North America

Leading REE R&D and domestic mining.
EV surge driven by Tesla, Ford, BMW is boosting REE demand.
Aims to reduce China dependency.

Middle East & Africa

Estimated 4M tones of high-quality REE reserves.
Rich zones: Lofdal (Namibia), SKK (South Africa).
Growth held back by value chain gaps.

WHERE RARE EARTHS POWER THE WORLD

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	**Permanent Magnets**	Permanent magnets, made with rare earth elements, offer strong, lasting magnetic power without external energy. They're vital in compact, high-power applications like electronics, EVs, and wind turbines—driving growing demand as green technologies expand.	**Neodymium, Praseodymium, Dysprosium, Terbium, Samarium**
	**Batteries**	Used in hybrid batteries and small electronics. Key for the energy transition.	**Lanthanum, Neodymium**
	**Aviation**	Critical in fighter jets (e.g., F-35 with ~417 kg REEs): used in magnets, landing gear, and lightweight alloys.	**Neodymium, Samarium, Scandium, Europium**
	**Wind Power**	Modern wind turbines use rare earth magnets in generators to produce electricity efficiently and quietly, boosting REE demand alongside the rise of electromobility.	**Dysprosium, Neodymium, Praseodymium, Terbium**
	**Nuclear Power**	Used in control rods for regulation and shutdown in nuclear reactors. Demand rising with nuclear revival.	**Dysprosium, Europium, Samarium, Holmium, Gadolinium**
	**Water Electrolysis**	Green hydrogen, made via water electrolysis using clean energy, uses rare earths in some electrolyzers. As hydrogen adoption grows, REE demand may rise.	**Scandium, Yttrium, Cerium, Lanthanum, Gadolinium**
	**Semiconductors**	Improve electrical conductivity and doping in chips, lasers, LEDs, and solar cells.	**Terbium, Cerium, Erbium, Lanthanum, Neodymium, Praseodymium, Samarium, Scandium, Yttrium, Ytterbium**
	**Medical Technology**	Rare earths are vital in medicine, used in MRI magnets, X-ray imaging, contrast agents, cancer treatments, prosthetics, implants, and medical lasers.	**Gadolinium, Lutetium, Terbium, Yttrium, Neodymium, Erbium**
	**Electromobility**	Electric vehicles use rare earth magnets in drive motors for their strong, lightweight performance. Alongside wind power, EV growth is a major driver of rising REE demand.	**Dysprosium, Neodymium, Praseodymium, Terbium**

RARE EARTH ELEMENTS VALUE CHAIN

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Exploration And Development → Mining and Production of Rare Earth Concentration (65% china) → Separation into individual Rare Earth Oxidies (85% China) → Upgrading Rare Earth Metals (100% China) → Converting Metals into Alloy powders (80% China, 20% Japan) → Component Manufacturing (80% China,)

RARE EARTH MINERALS VALUE CHAIN

Upstream → Midstream → Downstream

	Mining	Separation	Refining	Forming	Manufacturing
					
	Ore, Concentrates	Oxides	Metal	Alloys,Compounds	Magnets, components
US capacity:	1 mine (Mountain Pass)	None	A few speciality producers (Materion, MMA(now Eutectrix), etc		1 Large-Scale manufacturer (Hitachi)
China Market Share:	65%	85%	90%	80 % to 90%	80% to 90%

The recent trade disputes and geopolitical dynamics have created a favorable opportunity for countries outside China to enter the rare earth industry. However, transitioning into this sector is neither swift nor straightforward. It involves a lengthy process of identifying and securing resources, developing the requisite technologies, and establishing the necessary infrastructure. Countries such as the U.S., Canada, and Australia face additional challenges due to stringent environmental regulations, which increase timelines and costs compared to regions with less stringent standards. Moreover, securing stakeholder consensus for these projects can be difficult.

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Advantage

- **Unique Properties:** REEs possess unique magnetic, phosphorescent, and catalytic properties essential for modern technology.
- **Enhanced Efficiency & Performance:** They enable miniaturization and higher performance, especially in electric motors for electric vehicles (EVs) and wind turbines.
- **Key Role in Green Technologies:** Critical for renewable energy applications like EVs, wind power, and solar panels, contributing to sustainability goals.
- **Versatile Applications:** Used in various industries, including electronics, medical technologies, and military equipment.
- **Future Potential:** Increasing demand for REEs in emerging fields like quantum computing, robotics, and advanced medical technologies.

Advantage & Disadvantage of REEs

Disadvantage

- **Supply Risks & Geopolitical Challenges:** REE supply is concentrated in a few countries, making them vulnerable to geopolitical instability and price volatility.
- **Environmental Impact of Extraction:** Mining and refining REEs can cause land degradation, water pollution, and toxic chemical release.
- **High Cost of Extraction & Processing:** The complex and expensive extraction process leads to higher production costs for products using REEs.
- **Limited Substitutes**: Many REE applications, such as in high-performance magnets, lack viable substitutes, increasing dependency.
- **Potential Supply Shortages:** Rising demand, especially with the growth of electric vehicles and renewable energy, could lead to supply shortages.

CHINA'S COMMAND OVER RARE EARTHS: TIMELINE OF EXPORT BANS AND GLOBAL MARKET TURBULENCE (2010 - 2025)

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September 2010

- Alleged Embargo Amidst Diplomatic Tensions
- China halted rare earth exports to Japan following a territorial dispute over the **Senkaku Islands.**
- All Chinese companies in the rare minerals industry ceased exports to Japan starting September 21, 2010
- Global rare earth prices surged, prompting countries to reassess their dependence on China's REE supply.

December 2023

- Export Ban on Magnet Tech
- China prohibited the export of technologies related to rare earth extraction and separation, crucial for manufacturing chips, EVs, and military equipment.
- China's ban included mining, processing, and extraction technologies to retain its advanced capabilities, making it harder for other countries to build independent REE supply chains.
- Countries reliant on Chinese technology faced challenges in establishing their own REE processing industries

December 2024

- Export Restrictions on Critical Minerals to the U.S (Round 1)
- In response to U.S. semiconductor restrictions, China banned exports of antimony, gallium, germanium, and superhard materials to the United States. Additionally, graphite exports faced stricter reviews.
- These materials are vital for electronics, defense, and battery technologies, and the restrictions intensified the trade conflict between the two nations US-China.
- Heightened market uncertainty; pressure on U.S. industries dependent on these materials; increased focus on domestic sourcing.

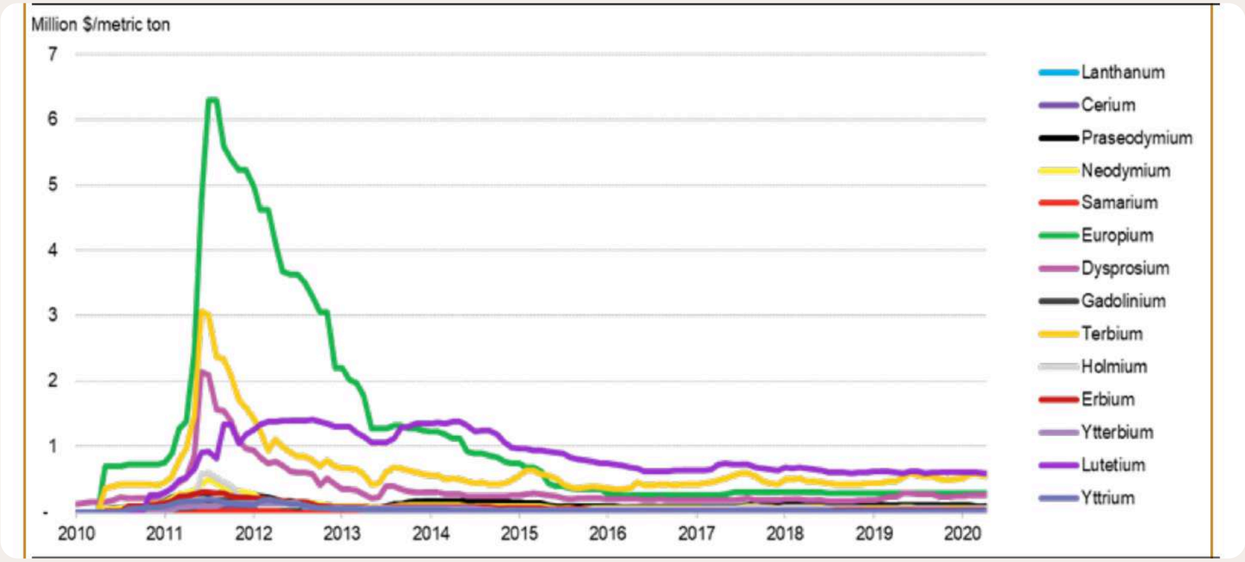
April 2025

- Export Restrictions on Specific Rare Earth Elements (Round 2)
- China imposed export controls on **7** medium and heavy rare earth elements: **samarium, gadolinium, terbium, dysprosium, lutetium, scandium, and yttrium.**
- These elements are essential for defense applications and high-tech industries, and the controls further escalated tensions with the U.S.
- Rare earth elements (REE) markets have exhibited divergent price trajectories, with selective upward adjustments and isolated downward corrections observed across the sector.

WHEN THE REE SUPPLY CHAIN BREAKS, PRICES EXPLODE

THE RIPPLE EFFECT OF EXPORT CURBS AND GLOBAL DISRUPTIONS ON RARE EARTH MARKETS

REE prices surged following China's export quotas in 2010–11



In **2010**, China slashed rare earth exports by **40%**, cutting annual supply from **50,000** to **30,000** tons. Just a year later, another **20% quota reduction** followed, as China prioritized its domestic tech and energy needs.

This **chain reaction** triggered a **global supply crunch**, sparking a rare earth price explosion. Between 2010 **and** 2020, prices skyrocketed—some by **over 400%**—reshaping market dynamics and exposing the world's deep dependency on fragile REE supply chains.

The table below compares current market performance with the Rare Earth Elements (REEs) surge during the 2010–2011 Senkaku Islands dispute, emphasizing the impact of China's export restrictions on global prices and supply dynamics.

RaRe Metal Elements	**6 Month** (Aug 2010- Jan 2011)	**1 Year** (Current)	**5 Year** (Current)
China Northern Rare Earth Group High-Tech	150%	13.38%	21.53%
Lynas Rare Earths Limited	119.4%	36.84%	42.21%
MP Materials Corp	-	65.52%	21.53%
Jinduicheng Molybdenum Co Ltd	37%	-14.63%	10.90%
Baoji Titanium Industry Co Ltd	34%	27.34%	6.19%
Xiamen Tungsten Co Ltd	95%	-3.48%	10.78%
AMG Critical Materials NV	74%	-37.84%	0.46%
Eramet SA	5%	-38.66%	-9.41%
Shenghe Resources Holding Co Ltd	22%	2.18%	7.85%
ILUKA Resources Ltd	220%	-47.71%	1.27%
TRONOX HOLDINGS PLC**	59%	-68.01%	-3.90%

Sources: Rare Earth Elements (REE) - Value Chain Analysis for Mineral Based Industrialization in Africa

POST-TRUMP TARIFFS SPARKED A GLOBAL SHIFT

Trade tensions and tariffs from the US—combined with global political uncertainty—have triggered a seismic shift in the Rare Earth Elements (REE) market. Nations are racing to cut dependence on China, pushing for diversified sourcing, localized mining, and strategic partnerships worldwide.

- **Global Diversification and Strategic Alliances:** The risks of overdependence on China for rare earth elements (REEs), intensified by tariffs and export controls, have driven countries to diversify supply chains. This shift has led to strengthened international collaborations—such as between the US, Australia, and India—to build more secure and resilient REE networks.
- **Emergence of New Mining Hubs:** Nations like Vietnam, Brazil, and parts of Africa are emerging as potential new sources for REEs, attracting foreign investment and technology transfers to develop their mining and refining capabilities.
- **Government Initiatives and Innovation:** Governments across the US, Australia, and Canada are actively supporting the rare earth sector through funding, incentives, and regulatory support. Simultaneously, investments in R&D are advancing alternatives to REEs and improving recycling technologies to reduce reliance on new extractions and enhance supply stability.
- **Environmental and ESG Concerns:**

Producing 1 ton of REEs consumes large volumes of chemicals—including 4.41 tons of sulfuric acid, 12.32 tons of sodium chloride, and 1.17 tons of hydrochloric acid.
This results in massive toxic output:
~2,000 tons of hazardous waste, 75 cubic meters of acidic wastewater, and 1 ton of radioactive residue.
Pollution threats include radioactive elements (like thorium and uranium), heavy metals (arsenic, lead), and airborne particulate matter—posing serious environmental and health risks.
A major example is Bukit Merah (Malaysia), where poor radioactive waste handling led to leukemia and birth defects—highlighting the dangers of unregulated REE processing.
These risks make ESG compliance and waste management essential for any nation entering the REE race.

Projected Market Growth

🟢 **Demand Surge:**
REE demand set to grow 8–12% CAGR till 2030, fueled by:

- 30M EVs annually by 2030
- Rapid wind energy expansion

🔴 **Supply Gap:**
Only 40% of non-China demand can be met by existing projects—
⚡ Huge opportunity for new miners and investors

PUBLIC TRADED COMPANIES IN RARE EARTH ELEMENTS

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Company	Sector	Specialty	Rare Metals	Finished Products
China Northern Rare Earth Group High-Tech	Rare Earth Mining and Processing	Polishing powder, rare earth oxides, metals, hydrogen storage materials	Neodymium, praseodymium, other rare earths	Aerospace communication materials, high-tech rare earth products
Sociedad Quimica y Minera de Chile SA	Non-metallic mining	Lithium derivatives, potassium nitrate, iodine, industrial chemicals.	Lithium and iodine	Specialty plant nutrients, solar salts, industrial nitrates
Albemarle Corporation	Specialty Chemicals	Lithium-based products for EV batteries, pharmaceuticals, bromine specialties	Lithium and bromine	Battery materials, flame retardants, industrial chemicals
Lynas Rare Earths Limited	Rare Earth Mining and Processing	Sustainable rare earth materials for magnets and green technologies	Neodymium (Nd), praseodymium (Pr), lanthanum (La), cerium (Ce)	Magnets for EVs, wind turbines, and electronics
MP Materials Corporation	Rare Earth Mining and Magnet Manufacturing	NdPr metal production and sintered NdFeB magnets	Neodymium-praseodymium (NdPr)	Automotive-grade magnets for EVs, drones, robotics
Pilbara Minerals Limited	Lithium Mining	Spodumene concentrate production for battery materials	Lithium and tantalum	Spodumene and tantalite concentrates

HOW & WHERE TO INVEST IN RARE EARTH ELEMENTS?

Challenges in the Rare Earth Elements (REE) sector:

1. China's dominance: China controls 65-90% of the REE value chain.
2. Environmental regulations: Stringent regulations can hinder development.
3. High costs: Establishing infrastructure and processing facilities is expensive.
4. Lack of expertise: Global scarcity of specialized knowledge in REE processing.
5. Long timelines: Exploration to full-scale mining and refining takes significant time.

Risks and implications:

1. Supply disruptions: Temporary disruptions can trigger significant price movements.
2. Barriers to entry: New entrants face substantial hurdles to break into the market.
3. Dependence on China: China's near-monopoly poses risks for global demand, particularly for clean energy, electronics, and defense technologies.

These very factors may create a scenario where supply disruptions, even temporary ones, can trigger significant price movements. The historical precedent of the 2010 embargo vividly illustrates this potential.

RARE EARTH AND STRATEGIC METALS ETFS (EXCHANGE TRADED FUNDS):

VanEck Rare Earth and Strategic Metals ETF

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ETFs pool investments in a basket of stocks, offering diversification. The **VanEck Rare Earth/Strategic Metals ETF (REMX)** and the Rare Earths and Critical Materials ETF (CRIT) invests in this sector.

↓

The REMX ETF's composition reveals a significant exposure to the rare metals and elements sector, with **56.70%** of its portfolio dedicated to companies involved in their extraction and processing. This includes essential materials such as **neodymium, praseodymium, and cerium, alongside a 30% concentration in China-based firms**, which provides a strategic investment opportunity to gain exposure to the Chinese REE space.

↓

Vested is a user-friendly investment platform that enables Indian investors to access and invest in **U.S. stocks and ETFs**. Through Vested, you can invest in the **VanEck Rare Earth and Strategic Metals ETF (REMX)**,
In addition to **REMX**, Vested offers a wide range of other U.S.-based ETFs and stocks, allowing you to diversify your portfolio across various sectors and investment themes

HOLDING OF REMX IN REES

VanEck Rare Earth and Strategic Metals ETF

RaRe metal Elements	Weights
China Northern Rare Earth Group High-Tech	8.45%
Lynas Rare Earths Limited	6.68%
MP Materials Corp	6.57%
Jinduicheng Molybdenum Co Ltd	5.14%
Baoji Titanium Industry Co Ltd	5.03%
Xiamen Tungsten Co Ltd	4.69%
AMG Critical Materials NV	4.02%
Eramet SA	3.93%
ILUKA RESOURCES LIMITED	3.69%
Avz Minerals Ltd	0.94%

TOP 10 HOLDING OF REMX

RaRe metal Elements	Weights
China Northern Rare Earth Group High-Tech	8.45%
Sociedad Quimica y Minera de Chile SA	7.44%
Albemarle Corporation	6.79%
Lynas Rare Earths Limited	6.68%
MP Materials Corp	6.57%
Pilbara Minerals Limited	5.86%
Jinduicheng Molybdenum Co Ltd	5.14%
Baoji Titanium Industry Co Ltd	5.03%
Shenghe Resources Holding Co Ltd	4.70%
Xiamen Tungsten Co Ltd	4.69%

CONCLUSION

The Rare Earth Element (REE) market stands at a pivotal turning point, fueled by the relentless global demand for clean energy technologies, electric mobility, and advanced electronics. Rare earths like **neodymium, dysprosium, and terbium** are vital for the manufacturing of **electric vehicle (EV) motors, wind turbines, defense system**s, and a broad range of consumer electronics.

For years, China has held a near-monopoly, controlling over **65-90% of the global supply chain**, from mining to refining and magnet production. While this dominance ensured affordability and availability, it created strategic vulnerability for countries dependent on Chinese exports.

The Trump-era tariffs marked a major inflection point. In response to U.S. trade measures, China imposed export restrictions on **7 Elements** key **REEs–samarium, gadolinium, terbium, dysprosium, lutetium, scandium, and yttrium**–may lead to price volatility.

These tensions exposed the fragility of the REE supply chain and catalyzed a global shift toward reducing reliance on China. Major economies including the United States, Canada, Australia, the European Union, and Japan have accelerated efforts to:

- Unlock new reserves and expand domestic mining and refining capacity. Example: The U.S. restarted operations at the **Mountain Pass Mine (California)**, one of the few REE sources outside China.
- Australia's Lynas Rare Earths is developing new processing hubs in Texas and Malaysia.
- Invest in R&D for recycling REEs and substitutes via material innovation.
- Forge international partnerships to build a diversified and resilient REE supply network.

This disruption has opened vast opportunities across exploration, refining, rare earth magnet production, and supply chain innovation. Countries are now actively unlocking resource corridors and creating favorable policies and incentives to attract capital and technological collaboration in this space.

HOW TO INVEST IN RARE EARTH ELEMENTS?

- One of the most effective and diversified ways to gain exposure to this fast-evolving sector is through the **VanEck Rare Earth/Strategic Metals ETF (Ticker: REMX).**
- REMX holds **56.70%** of its portfolio in companies directly involved in **mining and processing rare earth elements.**
- Top holdings include global leaders like **Lynas Rare Earths (Australia), MP Materials (USA), Iluka Resources, and China Northern Rare Earth Group.**
- REMX has outperformed broader metals indexes during periods of trade tension and clean energy booms, with strong historic returns during supply shocks and technology cycles.

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Phone
+91 8008253510

Website
www.armstrong-cap.com

Address
A1 Tower, 5th Floor, Golden Enclave, Corporate Block, Old Airport Road, Bangalore 560017

Email address
chandan@armstrong-cap.com