

Rare Earth Elements - Key Facts

- Rare Earth Elements (REEs) consist of 17 elements with unique physical and chemical properties..
- REEs mined: Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pm), Samarium (Sm), Europium (Eu), Scandium (Sc), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Thulium (Tm), Ytterbium (Yb), Lutetium (Lu), Yttrium (Y).
- China dominates the global REE market, accounting for ~70% of global rare earth ore extraction and 90% of rare earth processing (2023).
- The largest use of REEs is the production of permanent magnets, a critical component of clean energy applications EVs, wind turbines, defence and electronics. China produces ~90% of permanent magnets globally.
- Recycling plays an important role – global REE recycling market size is expected to reach US\$ 422m by 2026E.
- ACF Equity Research forecasts that the REE market could touch US\$ 7.4bn by 2030E.

Rare Earths Elements Mining Methods



Open-Pit and Underground Mining: Open pit is the most common method of mining REEs. It involves removing large quantities of overburden (layer of soil above mineral deposit) to access the REE-bearing ore. For deeper REE deposits underground mining creates tunnels and shafts to access the ore.



Leaching (In-situ and Heap): In-situ (ISL) involves pumping a leaching solution (often acid) into the ore to dissolve REEs, which are then pumped back to the surface and processed. Heap leaching crushes the ore, piles it into large heaps, which are then sprayed over by a leaching solution to extract the REEs.



Placer and byproduct mining: The placer method is used for REEs found in alluvial deposits (sediment carried and deposited by moving water). It involves dredging / panning to separate REE minerals from sand and gravel.

Applications of Rare Earth Elements



Advanced electronics: REEs are used in computers, laptops, smartphones, televisions, batteries, defence and aerospace electronics, and LED light bulbs.



Medicine: REEs are used in magnetic resonance imaging (MRIs), X-rays, radiation, laser scalpels, dental and bone repair and even cancer treatments.

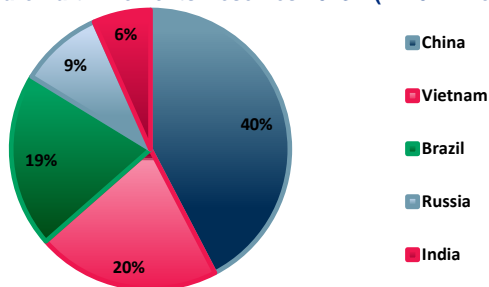


Industrials: REEs are used in magnets, catalyst, glass and polishing, electronics and lighting, metallurgy and alloys, manufacturing, energy storage and batteries, defence and aerospace.



Defence technologies: REE are used in jet engines, sonar and radar systems, space exploration (e.g. satellites), night-vision goggles, missile defence and advanced communication.

Top 5 Countries - Rare Earth Elements Reserves 2023A (~110 million tons globally)

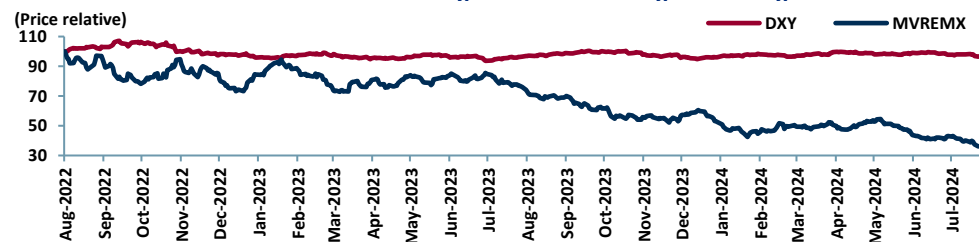


Source: USGS 2024.

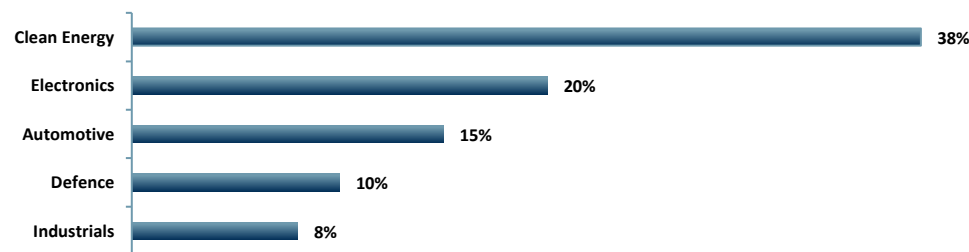
Rare Earth Elements - Value Chain

- Mining & Extraction:** REE ores are located and extracted via open-pit or underground mining. Mining is often complex and expensive because REE ores are usually found in small economic concentrations (ore bodies).
- Processing & Refining:** Once extracted, the ores are crushed and processed to concentrate REEs and remove impurities through advanced techniques of separation/flotation, purification and final preparation.
- Logistics & Transportation:** Moving REEs from mining sites to refineries, and then to manufacturing hubs, often involves complex global supply chains. Transport can be via road, rail, sea, or air, depending on the material's value and urgency.
- Trading & Distribution:** REEs are not traded on open commodity exchanges, but rather through direct contracts between producers and consumers, or private negotiations with specialised traders. Pricing is opaque. See IRESM
- End Users:** Renewable Energy demand - Separated REEs (NdPr) are transformed into permanent magnets (essential for EVs, wind turbines and other electronic devices) and alloys (which enhance strength and durability).

US Dollar Index vs. Global Rare Earth/Strategic Metals Index Aug 2022 – Aug 2024

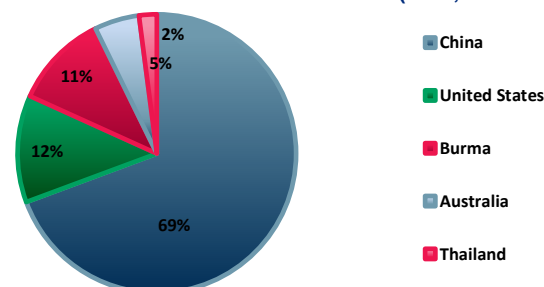


Top 5 Rare Earth Elements Usage by Sector Application



Source: USGS, IEA 2024.

Top 5 Countries - Rare Earth Elements Production 2023A (~350,000 tons globally)



Source: USGS 2024.

RARE EARTH ELEMENTS VALUE CHAIN

A Top 5 of Rare Earth Elements Mining Small/Mid-cap co.s

- Australian Strategic Mater. (ASX: ASM)
- Texas Mineral Resources (OTC: TMRC)
- Ionic Rare Earths (ASX: IXR)
- Rare Element Resources (OTC: REEMF)
- Rainbow Rare Earths (LON: RBW)

A Top 5 of Countries - Rare Earth Elements Reserves

- China (40%)
- Vietnam (20%)
- Brazil (19%)
- Russia (9%)
- India (6%)

A Top 5 of Rare Earth Elements Users co.s

- Apple Inc. (NASDAQ: AAPL)
- Tesla, Inc. (NASDAQ: TSLA)
- Samsung Electronics Co., Ltd. (KRX: 005930)
- Volkswagen AG (FRA: VOW)
- General Electric Company (NYSE: GE)



Sources: ACF Equity Research Graphics; Image generated by OpenAI's DALL-E.

A Top 5 of Rare Earth Elements Processing & Refining co.s

- Lynas Rare Earths Ltd. (ASX: LYC)
- MP Materials Corp. (NYSE: MP)
- Iluka Resources Limited (ASX: ILU)
- Neo Performance Materials Inc. (TSX: NEO)
- Arafura Rare Earths Limited (ASX: ARU)

A Top 5 of Rare Earth Elements Logistics & Transportation co.s

- AP Moller-Maersk (CPH: MAERSK-B)
- Deutsche Post AG (FRA: DPW)
- DSV A/S (CPH: DSV)
- Kuehne + Nagel International (SWX: KNIN)
- Nippon Yusen Kabushiki Kaisha (TSE: 9101)

A Top 5 of Rare Earth Elements Trading & Distribution co.s

- Materion Corporation (NYSE: MTRN)
- Lynas Rare Earths Ltd. (ASX: LYC)
- Arafura Rare Earths Limited (ASX: ARU)
- Sumitomo Corporation (TSE: 8053)
- Glencore plc (LSE: GLEN)