



Authored by:
Madeline Ruid

Date: August 18, 2023
Topic: **Thematic**



Rare Earth Elements, Explained

Despite their name, rare earth elements (REEs) are a relatively abundant group of 17 metallic elements. In fact, the three most abundant REEs, cerium, lanthanum, and neodymium, are more plentiful than lead.¹ REEs' fluorescent, conductive, and magnetic properties make them an essential component in over 200 applications and products, including disruptive digital and clean technologies such as electric vehicles (EVs), robotics, and wind turbines.^{2,3} As these technologies become more widespread, we expect that demand for REEs is likely to increase significantly. And in our view, strong demand outlooks coupled with ongoing efforts to diversify the REE global supply chain can potentially create compelling investment opportunities over the coming years.

Key Takeaways

- Rare earth elements possess a unique set of properties that make them fundamental to hundreds of innovative technologies.
- Demand for REEs is forecast to reach nearly 240,000 tons by 2030, up from 171,300 tons in 2022, with key tailwinds from the digital and green transitions.⁴
- China currently dominates the REE supply chain, creating risks but also opportunities for companies in the rare earths industry.

Special Properties Make REEs Fundamental to Numerous Products

The 17 rare earth elements consist of the 15 lanthanide series on the periodic table as well as scandium and yttrium.⁵ These silver to silvery-white lustrous metals are often malleable and exhibit special properties, which helps to explain why they can be utilised in a range of industrial applications. For example, neodymium, dysprosium, terbium, and samarium can be used to create some of the strongest magnets possible. Called rare earth permanent magnets, they play a crucial role in the conversion of wind power to electricity.⁶ These magnets are also fundamental to the performance of most electric vehicle (EV) motors, robots, and factory automation equipment. Neodymium-iron-boron (NeFeB) magnets, the strongest commercially available rare earth magnets, are used the most in these technologies.⁷

Europium, yttrium, erbium, and neodymium are four REEs that have luminescent properties, which makes them useful for consumer technologies such as TVs and smartphones.^{8,9} Cerium and lanthanum have catalytic and electrical properties that make them useful in chemical processes, catalysts, and battery technologies.¹⁰ In short, most people use several technologies that contain REEs every single day.

INTENDED FOR ELECTRONIC USE ONLY



RARE EARTH ELEMENTS

Source: Global X ETFs with information derived from: Government of Canada. (2023, February 14). Rare earth elements facts.

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

Note: Upper left-hand number is the atomic number.

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

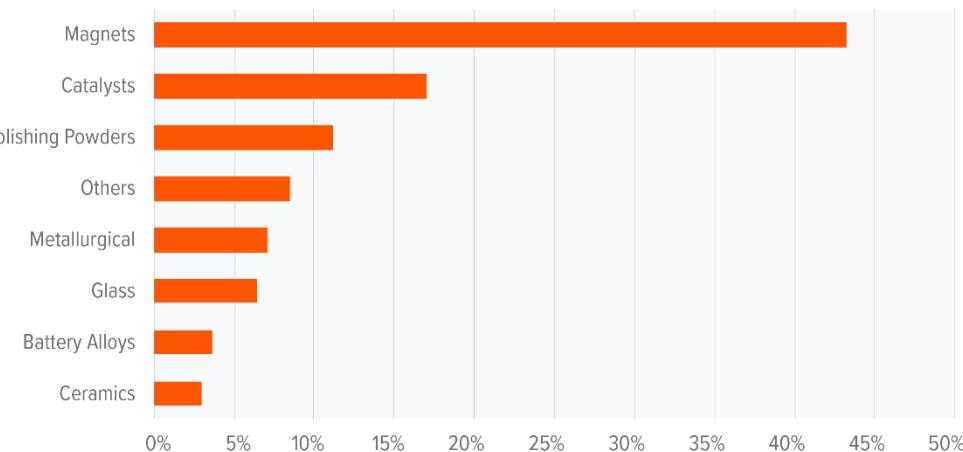
Long-Term Growth Outlook for REEs Is Strong

The use of rare earth elements in so many technologies and products creates a strong demand growth outlook for the industry, in our view. According to one estimate, demand for rare earth oxides is forecast to increase from 171,300 metric tons in 2022 to 238,700 metric tons by 2030.¹¹ The increased use of rare earth magnets as part of the ongoing digital and clean energy transitions create the most significant tailwinds for REE demand growth. In 2021, magnets accounted for 43.2% of global REE demand.¹² Demand for NdFeB magnets is forecast to grow at a compound annual growth rate of 7.5% between 2023 and 2040.¹³

These transitions are likely to continue the clear shift in the REEs demand profile. Demand is moving away from REEs such as lanthanum and cerium, which are used in more traditional use cases like chemical process, and moving towards REEs used in magnets, such as neodymium and dysprosium.

RARE EARTH ELEMENTS DEMAND BY USE, SHARE OF 2021 DEMAND

Sources: Global X ETFs with information derived from: Natural Resources Canada. (2023, February 14). Rare earth element facts.



INTENDED FOR ELECTRONIC USE ONLY

Some cleantech companies, particularly EV and wind power equipment producers, are looking for ways to reduce or even fully eliminate REEs due to their potential environmental impacts and volatile pricing. Notably, during Tesla's annual Investor Day in March 2023, Colin Campbell, Tesla's VP of Powertrain Engineering, announced that the company's future drive unit uses a next-generation permanent magnet motor that will not use any rare earth materials.¹⁴ Campbell offered no further details or timetables for the phaseout.

In our view, if efforts to reduce REEs by Tesla and other cleantech companies prove successful, we believe it should still have a relatively limited impact on REE demand for at least the next several years. First, it is projected that reductions in the use of rare earths in wind power systems on a per megawatt of capacity basis should be outpaced by growth in overall wind power capacity through 2030.¹⁵

Second, we believe that growth in EVs could also outpace diminishing REE use in the EV industry. Non-rare earth magnets for EVs are not yet widely commercially available and generally still come at a sizeable cost in terms of weight and efficiency.¹⁶

And third, we expect that REEs' importance in everyday electronics and other clean and digital technologies should amount to strong and diversified demand for many years to come. Currently, the entire EV industry accounts for around 12% of rare earth magnet demand, with Tesla responsible for a little over 2%.¹⁷

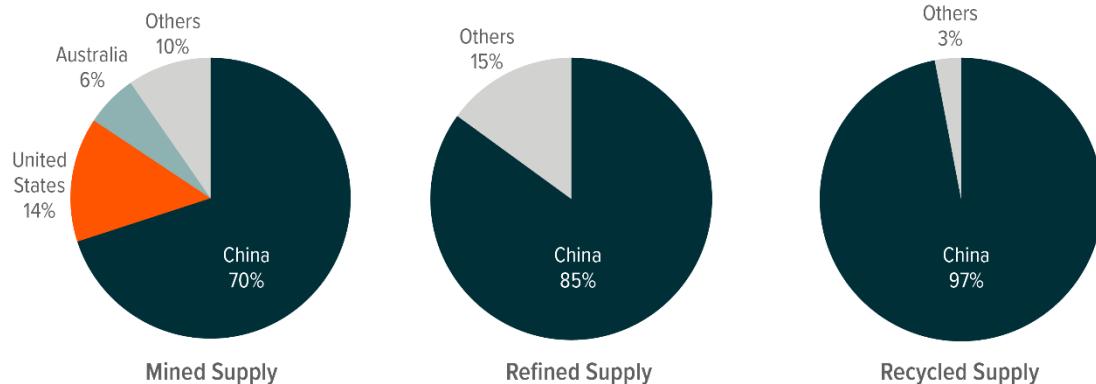
REE Supply Chain Dynamics Present Risks but Also Opportunities

While REEs are relatively abundant in the earth's crust, they are often not found in large enough quantities for cost-effective mining operations. In addition, separating and processing REEs can be challenging and costly. These dynamics make the supply chain highly concentrated to only a handful of countries.

China dominates the REE supply chain, accounting for 70% of REE mining, 85% of processing, and 92% of rare earth magnet production.^{18,19} China is also responsible for 97% of the recycled REE supply.²⁰ Therefore, many of the largest REE companies are China-based, including China Northern Rare Earth Group, China Rare Earths & Technology Co., and Shenghe Resources Co.

RARE EARTH ELEMENTS SUPPLY CHAIN, % SHARE BY COUNTRY

Sources: Global X ETFs with information derived from: Wood Mackenzie. (2022, March 23). Rare earths: vital elements of the energy transition.; Politico. (2022, December 14). China Dominates the Rare Earths Market. This U.S. Mine Is Trying To Change That.; United States Geological Survey (USGS). Mineral Commodity Summaries: Rare Earths 2023.



China's REE dominance creates risks for supply disruptions and price volatility. In 2010, for example, China banned REE exports to Japan for two months and prices spiked amid the supply disruption.²¹ In



April 2023, it was reported that China might prohibit exports of specific rare earth magnet technology, which could be highly disruptive over the short-term to the myriad industries that use REE magnets.²²

However, these risks also create expansion opportunities for the REE industry. For example, U.S.-based MP Materials is expanding its operations to become the only fully integrated rare earths company in North America. The company, which accounted for about 15% of the global REE supply in 2021, is investing \$700 million to streamline its REE processing operations and construct a rare earth metal, alloy, and magnet manufacturing facility.^{23,24} Once complete, MP Materials should have the capacity to produce enough magnets for at least 500,000 EV traction motors annually, of which General Motors is an offtaker.²⁵ Elsewhere, Australia-based Lynas Rare Earths is expanding its processing efforts in the United States, Australia, and Japan to meet future demand for REEs.^{26,27,28}

In the public sector, recent government initiatives aim to support the buildout of domestic REE supplies. In April 2023, the European Commission passed a Critical Raw Materials Act that aims to secure the EU's future supply of 34 critical raw materials, including rare earths.²⁹ Projects that qualify can benefit from access to financing and accelerated permitting timelines.³⁰ In December 2022, the Canadian government published a strategy that aims to increase the supply of 31 critical minerals, also including REEs.³¹

In September 2022, the Biden Administration announced \$156 million in funding from the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) to support the U.S.' development of a first-of-its-kind facility for extracting and separating REEs and critical minerals from unconventional sources such as mining waste.³² In early 2022, the U.S. Department of Defense (DoD) awarded MP Materials with \$35 million in funding to design and build a heavy REE processing facility at MP Materials' California production site.³³ At the time of the announcement, the DoD had invested over \$100 million in enhancing domestic REE supply chain.³⁴ The IRA also includes incentives to build out domestic rare earth element supply chains.

Conclusion: Exposure to REEs Means Exposure to Innovation

Expected growth in technologies such as wind turbines, robotics, and EVs is likely to lead to strong demand growth for rare earth elements over the coming years. This demand, combined with current supply dynamics and growing support from the public sector, can benefit companies across the entire REE value chain. In the process, we believe investors can find compelling opportunities in an industry that is fundamental to the ongoing clean energy and digital transitions.

Footnotes

1. Brunel (2022, September 13). Five fascinating facts about rare earth metals.
2. American Geosciences Institute. (n.d.). What are rare earth elements, and why are they important? Accessed on May 25, 2023.
3. Science History Institute. (2020). Science Matters: The Case of Rare Earth Elements.
4. WSJ. (2023, April 25). The U.S. Wants a Rare-Earths Supply Chain. Here's Why It Won't Come Easily.
5. United States Geological Survey (USGS). (n.d.). Rare Earths Statistics and Information. Accessed on May 25, 2023.
6. Science History Institute. (2020). Science Matters: The Case of Rare Earth Elements.
7. Advanced Magnet Source. (n.d.). Neodymium NdFeB Magnets. Accessed on May 25, 2023.
8. Science History Institute. (2020). Science Matters: The Case of Rare Earth Elements.
9. Visual Capitalist. (2021, August 25). Visualizing the Critical Metals in a Smartphone.
10. Science History Institute. (2020). Science Matters: The Case of Rare Earth Elements.



11. WSJ. (2023, April 25). The U.S. Wants a Rare-Earths Supply Chain. Here's Why It Won't Come Easily.
12. Natural Resources Canada. (2023, February 14). Rare earth elements facts.
13. Adamas Intelligence. (2023, May 2). NEW REPORT: Rare Earth Magnet Market Outlook to 2040.
14. Bloomberg. (2023, March 20). Tesla's Vision of EVs Without Rare Earths Will Spur Magnet Race.
15. Wood Mackenzie. (2022, March 23). Rare earths: vital elements of the energy transition.
16. Bloomberg. (2023, March 20). Tesla's Vision of EVs Without Rare Earths Will Spur Magnet Race.
17. Adamas Intelligence. (2023, March 2). Implications: Tesla Announces Next Generation Rare-Earth-Free PMSM.
18. United States Geological Survey (USGS). Mineral Commodity Summaries: Rare Earths 2023.
19. Politico. (2022, December 14). China Dominates the Rare Earths Market. This U.S. Mine Is Trying To Change That.
20. Wood Mackenzie. (2022, March 23). Rare earths: vital elements of the energy transition.
21. Science History Institute. (2020). Science Matters: The Case of Rare Earth Elements.
22. Nikkei Asia. (2023, April 6). China weighs export ban for rare-earth magnet tech.
23. Politico. (2022, December 14). China Dominates the Rare Earths Market. This U.S. Mine Is Trying To Change That.
24. MP Materials. (2022, April 21). MP Materials Begins Construction on Texas Rare Earth Magnetics Factory to Restore Full U.S. Supply Chain.
25. Ibid.
26. Bloomberg. (2023, May 3). Lynas Eyes More Rare Earths Capacity if Malaysia Plant Shuts.
27. Reuters. (2022, June 14). Australia's Lynas gets \$120 mln Pentagon contract for U.S. rare earths project.
28. Lynas Rare Earths. (n.d.). Kalgoorlie Rare Earths Processing Facility Project FAQs. Accessed on June 12, 2023.
29. Economist Intelligence. (2023, April 17). EU acts to secure access to critical raw materials.
30. Ibid.
31. PV Magazine. (2023, March 7). North America's bid to onshore rare earth supply.
32. U.S. Department of Energy. (2022, September 19). Biden-Harris Administration Announces \$156 Million for America's First-of-a-Kind Critical Minerals Refinery.
33. U.S. Department of Defense (DoD). (2022, February 2022). DoD Awards \$35 Million to MP Materials to Build U.S. Heavy Rare Earth Separation Capacity.
34. Ibid.

The value of an investment may go down as well as up and past performance is not a reliable indicator of future performance.

Trading may not be suitable for all types of investors as they carry a high degree of risk. You may lose all of your initial investment. Only speculate with money you can afford to lose.

Changes in exchange rates may also cause your investment to go up or down in value.

Tax treatment depends on the individual circumstances of each client and may be subject to change in the future.

INTENDED FOR ELECTRONIC USE ONLY



Please ensure that you fully understand the risks involved. If in any doubt, please seek independent financial advice. Investors should refer to the section entitled "Risk Factors" in the relevant prospectus for further details of these and other risks associated with an investment in the securities offered by the Issuer.

This document is not intended to be, or does not constitute, investment research.

These insights are strictly for general information purposes provided at the date of publication and may change without notice and are not a recommendation, solicitation or offer to buy or sell any financial products or to adopt any approach to investment. There is no guarantee that any matter discussed will be successful. Reliance on any part of this information is at your own discretion.

This information may provide estimates and future forecasts and are not a representation of any future performance. This information is not complete or exhaustive and we make no representations or warranties, express or implied, concerning the accuracy or comprehensiveness of these insights.

These insights do not take into account a person's own financial position or circumstances of any person or entity in any region or jurisdiction. This information should not be relied upon as a primary basis for any investment decision. Its applicability will depend on the particular circumstances of each investor.

It does not constitute tax advice and investors and potential investors are advised to consult their professional advisors concerning possible taxation or other consequences of purchasing, holding, selling, converting or otherwise disposing of any investments under the laws of the relevant region and/or their country of incorporation, establishment, citizenship, residence or domicile, or other liability to tax and in light of their particular circumstances.

The prospectus, the key information documents or the key investor information documents, the articles of association as well as the annual and semi-annual reports may be obtained free of charge from the representative.

Past performance is no indication of current or future performance. The performance data do not take account of the commissions and costs incurred on the issue and redemption of units.

Information for Investors in Switzerland

This is an advertising document. The state of the origin of the fund is Ireland. In Switzerland, the representative is 1741 Fund Solutions AG, Burggraben 16, CH-9000 St.Gallen. The paying agent is Tellico AG, Bahnhofstrasse 4, 6430 Schwyz.

The prospectus, the key information documents or the key investor information documents, the articles of association as well as the annual and semi-annual reports may be obtained free of charge from the representative.

Past performance is no indication of current or future performance. The performance data do not take account of the commissions and costs incurred on the issue and redemption of units.

INTENDED FOR ELECTRONIC USE ONLY