



## Key Takeaways

- While several countries export Rare Earth Element (REE) end-use products to the US, the lion's share of volume imported is from China.
- On one hand, China's production allows the US to offshore a chemical processing industry that is harmful to the environment and worker health. However, **China's current dominant market position poses global economic risks** similar to the market power exercised by the OPEC cartel for decades over oil.
- **The US and its allies can act now to reduce this economic and strategic risk** through coordinated efforts to shore up and diversify the international supply of REE, with multiple sources of raw and processed materials produced to agreed environmental and labor standards.

## RARE EARTH ELEMENT MARKETS

Jill Welch<sup>1</sup>, Charles Sims<sup>1</sup>, Prabuddha Prakash<sup>2</sup>, Scott Gilpatric<sup>2</sup>, and Scott Holladay<sup>2</sup>

The rare earth elements market is really a chain of interconnected markets starting from the mining of the rare earth raw materials (commonly referred to as rare earth oxides or REO) and ending with several end-use applications including permanent magnets, alloy steel powders, ferro-alloys, and inorganic products used as luminophores. These markets span multiple countries with production in one link of the chain using inputs from production in another country. In total, \$540.6 million in REE end-use applications were imported to the US in 2019. [Figure 1](#) demonstrates the volume of rare earth elements (REE) that were imported to the US in 2019 by major end-use application. The majority of volume imported (74.2%) were magnets, which totaled \$401.1 million. Permanent magnets, which are used for wind turbines and electric vehicle motors in addition to other applications, not only have the highest value in terms of trade volume but are also critical for future supply chains given their high energy-producing capabilities relative to their weight. Alloy steel powders, ferro-alloys and inorganic products used as luminophores make up 16%, 7%, and 2% of U.S. imports, respectively.

**Should the U.S. be concerned about China's dominance in the rare earth element market?**

While several countries export REE end-use products to the US, the lion's share of volume imported is from China, and the majority of China's exports are permanent magnets (see Figure 1). China's exports totaled \$292.5 million and made up over half of U.S. imports for REE end-use applications. Over two-thirds of China's REE exports to the U.S. were permanent magnets (\$271.4 million). Japan, Germany, and Canada are also important trading partners in REE end-use applications.

Given China's dominance in REE end-use imports to the US, where does China get the REE raw materials used in the production of these goods? According to the U.S. Geological Survey's Mineral Commodity Summary, China's rare earth mining accounted for about 63% of estimated, total world-wide production in 2019. China then supplements its domestic supplies of REE raw materials through international trade. Globally, over \$2.1 billion of REE raw materials are exported, and imports to China account

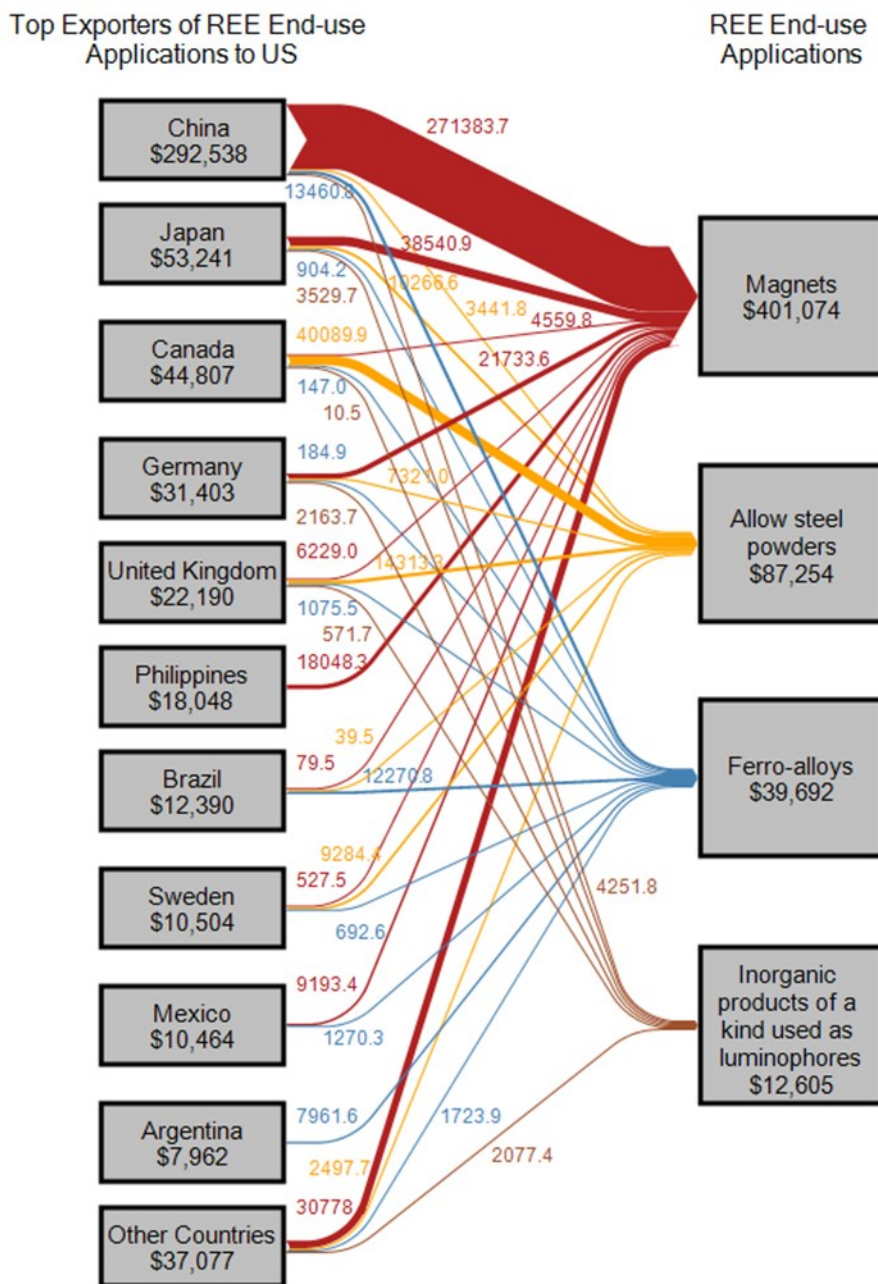
<sup>1</sup> Center for Energy, Transportation, and Environmental Policy at the Baker School of Public Policy and Public Affairs at the University of Tennessee, Knoxville

<sup>2</sup> Department of Economics, University of Tennessee, Knoxville

**Figure 1. Rare Earth Elements End-Use Applications and Top Exporters to the U.S., 2019**

Source: CEPII-BACI international trade database, 2019

**REE End-Use Applications, 2019**  
**Trade Volume**  
**Total Imported to US - \$540,625 (USD thousands)**



**Table 1. Top Exporters of Rare Earth Elements Raw Materials to China, 2019**

*Source: CEPII-BACI international trade database, 2019*

Top Exporters of REE Raw Material to China	Volume Imported (USD thousands)	Percent of Total Imported
Australia	\$903,411	87.41
Vietnam	\$22,047	2.13
Brazil	\$13,706	1.33
Iran	\$10,323	1.00
Russia	\$9,957	0.96
Thailand	\$9,948	0.96
United Arab Emirates	\$8,507	0.82
Myanmar	\$7,421	0.72
United States	\$7,181	0.69
Turkmenistan	\$6,243	0.60
Other Countries	\$34,741	3.36
<b>Total Imported</b>	<b>\$1,033,486</b>	<b>100.00</b>

*(continued from Page 1)*

for almost half (47.6%) of imports. In 2019, 203 countries received imports of REE raw materials, but no country other than China accounted for more than five percent of total, world-wide imports of REE raw material. China’s dominance in REE raw material imports stems from its dominance in the processing of these raw materials into intermediate products such as rare earth metals.

Table 1 illustrates the top ten exporters of REE raw materials to China. The vast majority of China’s REE raw material imports (over 87%) come from Australia and amounted to \$903.4 million. Other top exporters included Vietnam, Brazil, Iran, and Russia. However, with the exception of Australia, the other countries in the top ten (for example Vietnam, Brazil, Iran, and Russia) individually accounted for two percent or less of China’s total REE raw material imports. Eighty-nine countries fell outside of the top ten, and together these countries (i.e., “other

countries” in Table 1) accounted for 3.4% of the total REE raw materials that were exported to China.

Should the U.S. be concerned about China’s dominance in the rare earth element market? On the one hand, China’s production allows the U.S. to off-shore a chemical processing industry that is harmful to the environment and to U.S. worker health. The U.S. has off-shored other dirty industries with little concern about losing domestic market share. On the other hand, production of processed minerals is currently dominated by Chinese producers to such an extent that Chinese government policy can effectively foster a cartel exercising a high degree of market power over these commodities. Much as the Organization of the Petroleum Exporting Countries (OPEC)’s market power over oil posed an ongoing risk to the global economy for decades after the cartel’s emergence, Chinese market power poses an emerging threat.



If China were to create REE supply disruptions comparable to the size and frequency of disruptions historically seen in the OPEC-controlled oil market, Chinese market power would generate over \$200 million in transfers from the U.S. to China in 2022 – a 32% increase over the past decade. The magnitude of these transfers depends on three things:

- ❑ **The importance of REE end-use applications to the U.S. economy.** While REE end-use applications are an increasingly important part of the U.S. economy, they remain small relative to oil. These losses will increase as the importance of REE in the U.S. economy grows.
- ❑ **The Chinese government’s willingness to exert market power by intentionally manipulating global supplies.** To date, China has largely been content to use its market power to maintain its dominant position in REE markets by depressing prices for REE raw materials and metals. This behavior has made it difficult for domestic producers to enter the REE market. As the importance of REE in the U.S. economy grows, China may begin to behave more like OPEC and boost prices by restricting supplies. This strategy of restricting supplies would be financially

beneficial to China since world REE demand is insensitive to price increases. Historically, a 1% increase in REE prices only triggers a 0.07% decrease in REE demand.

- ❑ **The responsiveness of producers in other countries to these supply disruptions.** Several countries currently export REE raw materials and metals. The ability of countries other than China to ramp up production in response to rising prices curtails China’s ability to restrict supplies and raise prices. However, the responsiveness of these other countries is in question. A 1% increase in REE prices triggered a 0.88% increase in REE supplies in China but only a 0.33% increase in the rest of the world.

The U.S. and allies can take actions now to reduce the economic and strategic risk present in the status quo. These actions should involve a coordinated effort to foster a robust and diversified international supply of these commodities with multiple sources of raw and processed minerals produced to agreed environmental and labor standards. These actions would help ensure non-Chinese producers are willing and able to respond to possible supply disruptions originating in China.

## About the Authors

**Jill Welch** is a senior research associate at the Center for Energy, Transportation and Environmental Policy at the Baker School of Public Policy and Public Affairs at the University of Tennessee, Knoxville (UTK).

**Charles Sims** is director of the Center for Energy, Transportation and Environmental Policy and TVA Distinguished Professor of Energy and Environmental Policy at the Baker School.

**Prabuddha Prakash** is a third-year graduate student in the UTK Department of Economics.

**Scott Gilpatric** is Department Head and Professor in the UTK Department of Economics.

**Scott Holladay** is associate professor and John Wisecarver Faculty Research Fellow in the UTK Department of Economics.

**For more information, contact the Center for Energy, Transportation and Environmental Policy at [CETEP@utk.edu](mailto:CETEP@utk.edu).**