

Rare Earth Minerals and Products

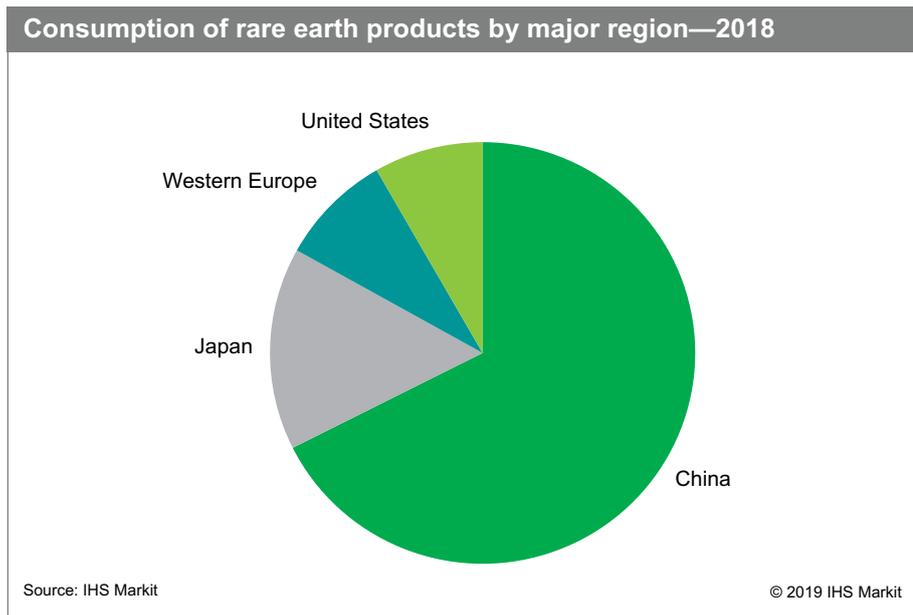
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Abstract

The various markets for rare earths—as mixtures, individual elements, or compounds—have developed in a very sporadic manner. Several markets that initially promised to consume major amounts of rare earths were developed, only to have the rare earths displaced by less costly alternatives. Rare earth-exchanged FCC catalysts continue to be a major market for rare earths with the introduction of reformulated gasolines. Newer markets are growing for individual high-purity rare earths, particularly for neodymium for use in high-performance permanent magnets. As a result of these changes, the REO industry has developed into a two-tiered industry. Mixed REOs, which formerly constituted the bulk of the business, show stagnant demand, while purified, specialized REOs show strength and good prospects. Special, relatively small-volume applications have shown positive growth over the last 10 years, with corresponding price fluctuations.

China was the largest consumer of rare earths, followed by Japan, in 2018. China's largest domestic rare earth-consuming market is permanent magnets, followed by catalysts, polishing powders, glass-ceramics, metallurgy, NiMH batteries, phosphors, and other new materials markets. All of these markets are growing faster in China than comparable markets in the United States, Western Europe, and Japan.

The following pie chart shows consumption of rare earth products by major region:



In 2011 and 2012, world consumption of rare earths decreased as supplies from China were restricted by export and production quotas. The prices for rare earths peaked in 2011, prompting many rare earth product manufacturers to seek ways to reduce the amount of rare earths in their applications in order to save costs and limit supply risks. Between 2013

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and 2015, prices for all rare earth oxides (REOs) have continued to decline by as much as 90% compared with the price levels observed in 2011. Demand remained weak for certain REOs between 2013 and 2015, and new production in Australia and the United States caused a further decrease in prices in early 2016. Prices for most rare earths remained steady between 2016 and 2018, with the exception of neodymium oxide and yttrium oxide which have increased slightly between 2017 and 2018.

The world's leading producer is Solvay. A large share of its production is at the La Rochelle, Poitou, France facility, with additional production capacity located in Baotou, China at the Baotou Solvay Rare Earths subsidiary, and in the United States. Solvay is forward-integrated, producing final goods such as catalysts, fuel additives, phosphors for lighting and electronics, and pigments, and is also one of the world's largest glass-polishing compound suppliers. Additional leading rare earth refiners/product manufacturers include BASF SE, Johnson Matthey, and W.R. Grace & Co. They are forward-integrated producers of final goods, including catalysts. Inner Mongolia Baotou Steel Rare-Earth (Group) Hi-Tech Co., Ltd. in China is the leading rare earth mining company, and over the last decade has also increased its forward-integrated production to include polishing powders, magnets, and phosphors.

There are more producers of downstream products derived from rare earth minerals than mineral producers and they are also more global in scope; however, the industry is dominated by only a few large firms. The industry has various levels of integration, ranging from the mining and refining of the whole spectrum of marketable rare earth elements, to niche players that produce finished industrial or consumer goods incorporating a single rare earth element.

Environmental issues are having an impact on US rare earth production. In 1998, Molycorp's rare earth output slowed to half the production level of previous years. Substantial loss of output also occurred in the first half of 1999 as the company experienced delays in obtaining permits from environmental regulatory agencies to make the repairs required to continue operations at its California mining facility.

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