Gray gold

China's rare earth power play, impacts, and suggested consumer responses

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Tighter export quotas for rare earth elements (REEs) from China and the recent embargo on exports to Japan are driven primarily by the desire to support domestic manufacturing and promote technology transfer to China, with consolidating the REE industry and strengthening environmental protection as secondary objectives.

The frantic response and sharp price increases for REEs highlights how the hand-to-mouth supply policies of many industrial consumers have left them highly exposed to disruptions in supplies of critical mineral inputs. The uses of REEs—17 elements vital to producing a range of essential commercial and military products, from smart phones to fiber optics—are shown in **Exhibit 1**. Meanwhile, demand for higher purity mixed and separated inputs for green technologies and electronics seems poised to rise for the foreseeable future. It also shows how China's focused national industrial policies have given it a hammerlock on supplies of rare earths, tungsten, and other key inputs whose markets are small in value terms relative to commodities like crude oil, but which are nevertheless irreplaceable in many industrial processes and therefore have immense strategic value. Today, China produces 97% of the world's REEs, the US none.

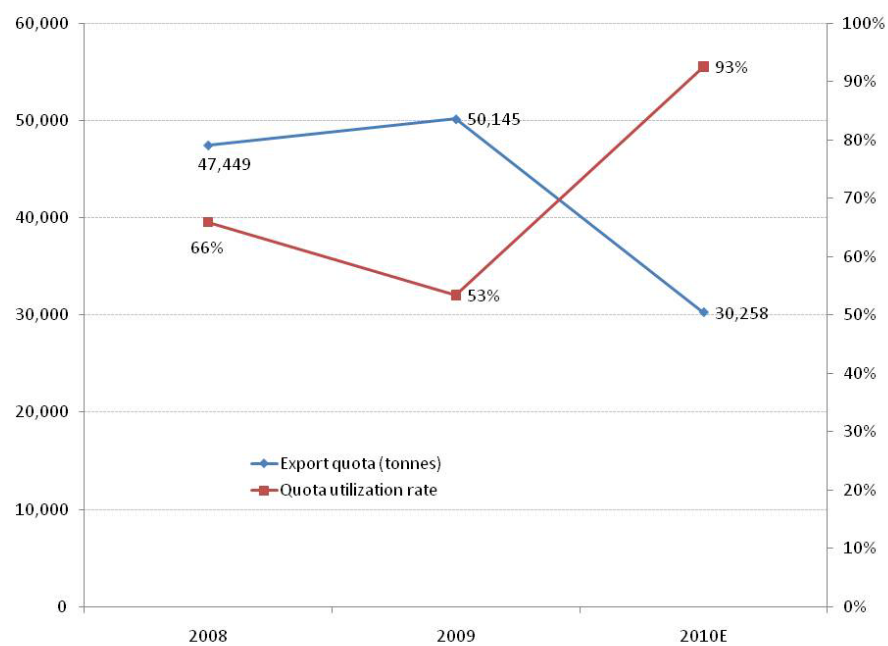
Exhibit 1: Rare earths and selected end uses

Light rare earths (more abundant)	Major end uses	Heavy rare earths (less abundant)	Major end uses
Lanthanum	hybrid auto engines, metal alloys, catalysts	Terbium	phospors, permanent magnets
Cerium	auto catalysts, petroleum refining, metal alloys	Dysprosium	permanent magnets, hybrid engines
Praseodymium	magnets	Erbium	phosphors
Neodymium	auto catalysts, petroleum refining, laptop hard drives, headphones, hybrid car engines	Yttrium	red color, fluorescent lamps, ceramics, metal alloy agents
Samarium	magnets	Holmium	glass coloring, lasers
Europium	red color for TV and computer screens	Thulium	medical x-ray machines
Gadolinium	magnets	Lutetium	petroleum refining catalysts
		Ytterbium	lasers, steel alloys

Source: Congressional Research Service

While the recent embargo on REE exports to Japan is truly problematic, the situation concerning export quotas—at least thus far—is more complex. Data from **Dacha Capital** show that Chinese REE exporters used only 66% of the rare earth export quota available in 2008 and 53% in 2009, suggesting that the significant export quota reductions implemented in July 2010 aim to align quotas more closely with actual overall export demand (**Exhibit 2**). The major cuts undertaken in 2010 bring the quota usage rate to 93% in Dacha's estimate. The quota usage rate is the percentage of the quota that is actually exported in a given year. Dacha analysis suggests that a key risk comes from rare earth suppliers choosing to use their smaller quota allotments to ship more valuable heavy rare earths first, potentially engendering shortages to exportable supplies of lighter REEs like cerium. Dacha tells us non-Japanese buyers are actually being offered discounts in some cases as Chinese REE exporters scramble to use up the remainder of their 2010 quotas.

Exhibit 2: China rare earth quota usage rate



Source: Dacha Capital

Why are REEs so important?

Rare earths are special in that while only small amounts of them are needed in most applications, they are typically irreplaceable as substitutes are nonexistent, inferior, or even more expensive. The users are typically relatively price insensitive, although the small portion of rare earths in many products and their small portion of total raw material costs make manufacturers' product price increases deceptive in terms of how they reflect the minerals' strategic value.

For example, rare earth investors tell us refinery catalyst makers such as W.R. Grace and Albemarle have faced a roughly 700% increase in the price of lanthanum (a critical input for catalytic converters) in the past year, but have only increased final product prices by about 5% as they pass higher input prices along to consumers. Although lanthanum represents only a small portion of the companies' raw material costs (hence the small product price increase), they could not manufacture the catalysts without it. As such, industrial consumers' REE stockpiles are not a matter of buffering against price shocks (as is the case with oil or copper), but rather, a matter of competitive survival.

Dacha Capital tells us at the beginning of 2010, Japanese REE users likely had six-to-nine months of stocks on hand, while consumers in the US and Europe had less. Since then, the firm tells us all three consuming regions have seen stock draws and that inventory levels in some areas may now be closer to two months' of consumption. **Alkane Resources** also believes that Japanese consumers likely now have around 6 months worth of REE inventory, while it thinks some European users may be nearly out. Alkane also tells us China is rumored to have large stocks of light REEs, but little in the way of heavy REE inventories.

The likelihood that non-Japanese REE users have even lower inventories than their Japanese competitors leads us to conclude that China's motives for delaying raw REE exports extend beyond the stated objective of "counter smuggling." The critical nature of REEs for industrial processes make it unlikely that other users would sell to embargoed Japanese firms that probably still have larger stockpiles, since making a few million USD in profit from liquidating REE inventories is simply not worth the production halt that lack of REE supply would cause.

Specific impacts of an REE supply crunch

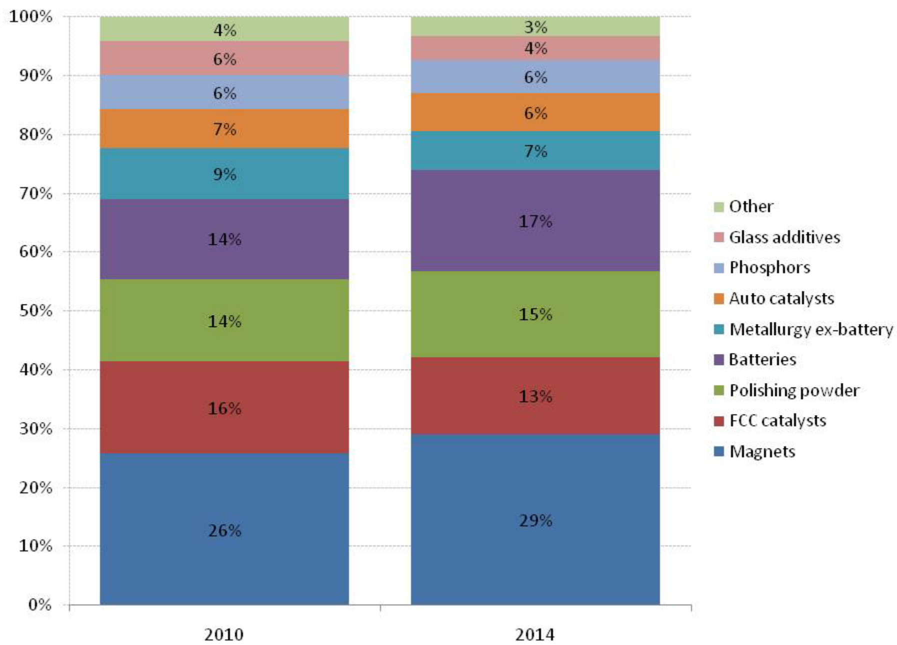
Alkane Resources tells us "*the industries that will be most impacted will be magnets (Nd, Dy) and phosphors (Y, Tb). NiMH* [nickel metal hydride] *batteries will also be impacted to some degree (Nd). There will also be some flow on effect to catalysts and special ceramics (Y).*" Dacha Capital concurs, telling us supplies of neodymium, a key input for making magnets that already costs $80,000/ton in Japan, will likely be impacted in the next six months.

Lynas Corp. estimates that magnets will account for 26% of total rare earth demand volume in 2010 and 29% in 2014 (**Exhibit 3**). Rare earth magnets are valued for their high power-to-size ratio, which makes them valuable for applications including hybrid car electric motors, jet engines, smart bomb and missile guidance systems, satellite power and communications systems, lasers, and computer hard drives.

Fluidized cat cracker catalysts, which are used in oil refining, are the next largest source of REE demand (16% in 2010 and 13% in 2014). If catalyst makers outside China cannot obtain sufficient raw materials, Chinese manufacturers will have a window of opportunity to grab market share before alternative supplies come online.

Dacha also tells us that supplies of ytterbium, yttrium, and europium to the lighting industry are likely to be pinch points over the next 12-to-18 months, particularly since a number of countries are presently seeking to phase out incandescent bulbs and replace them with more efficient bulb types that also happen to require REEs. The company believes there will be little to no supply-side response to a supply crunch or higher prices since the elements' concentrations in their ores are so low.

Exhibit 3: Rare earth element demand by sector in 2010 and 2014
(percentage of total demand)



Source: Lynas

The supply/demand balances as measured by the deficit or surplus as a percentage of demand for some of the most heavily used REEs, including neodymium and lanthanum, are expected to be meaningfully negative for at least several more years (**Exhibit 4**). Continuing deficits for many key REEs is driving heavy investment in new producing projects to tap the estimated 64% of REE reserves outside China, such as Mt. Weld in Australia (forecast to account for 13% of global supply in 2014) and revival of mothballed mines like MolyCorp's Mountain Pass project, formerly the world's leading producer (nearly 12% of global supply in 2014). Significant untapped and underutilized reserves are also present in Canada, India, Brazil, Russia, South Africa, Malaysia, and Malawi.

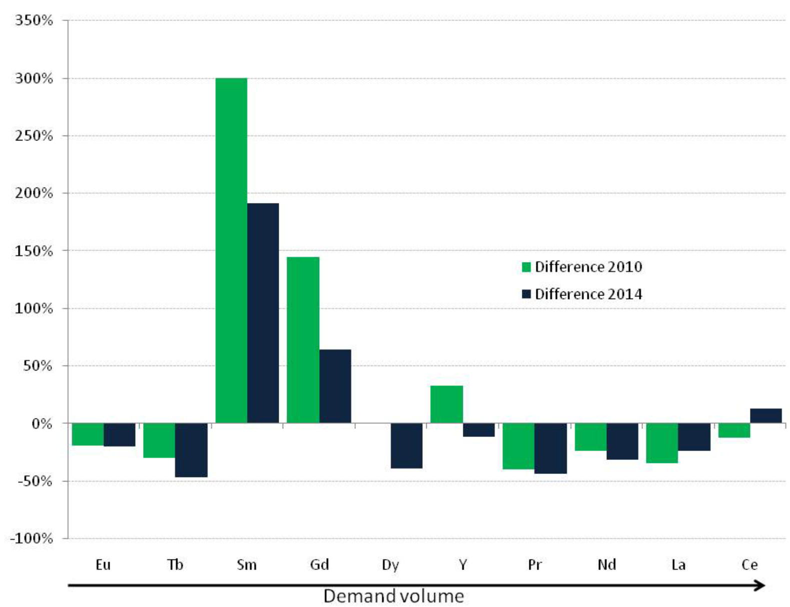
Yet even with new mines coming online, China will still account for more than 2/3 of global REE supply in 2014 (**Exhibit 5**). Some commentators advocating recycling as a source of REE elements to offset restriction in exports of raw materials from China. However, we believe the economic costs and environmental regulations associated with "urban mining" (electronic recycling) will be prohibitively high in many cases and thus will prevent this channel from making a substantial impact on global supplies. This view is borne out by Lynas's estimates, with recycling accounting for only 3.5% of the REE supply in 2014.

China currently produces more than 95% of the global REE supply (**Exhibit 6**), will retain significant global REE market influence, and in the face of rising foreign production may further tighten export quotas. The reason for this is that the ultimate rationale for the REE power play is not simply a desire to protect the environment or rationalize the structure of the industry (e.g., consolidating firms and reducing smuggling).

Rather, it stems from at least three additional factors. First, Chinese manufacturers need sufficient inputs, and already consume more REEs than the rest of the world's combined. To a lesser degree, the coincidence of REE export interruptions with key Chinese policy statements—such as opposing a WTO challenge on market access for REE-reliant solar and wind power technologies manufactured in China—and conspicuous absence of detailed explanation on Beijing's part—suggests some effort to influence foreign governments, particularly that of Japan (itself a major supplier of REE products to the US).

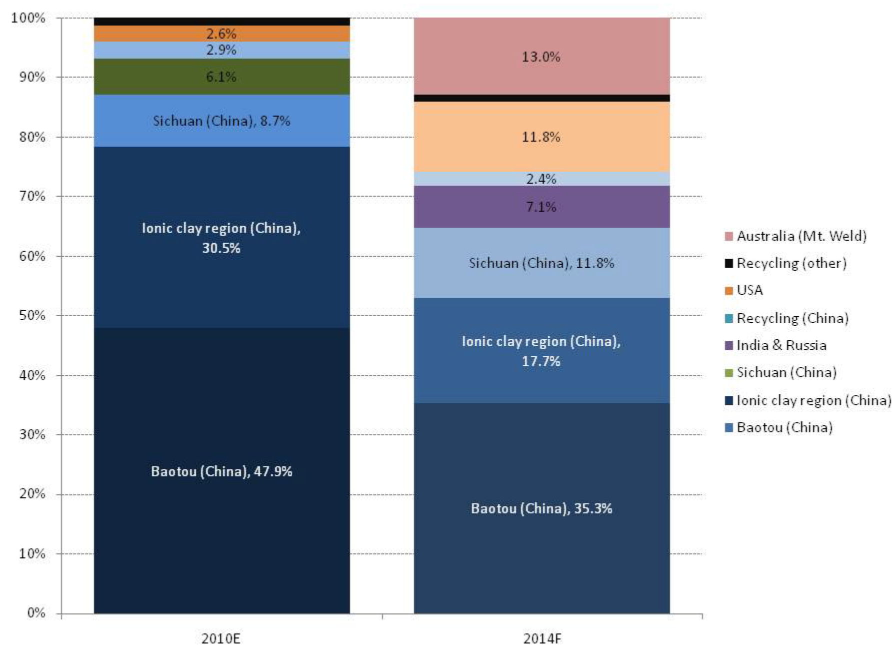
Beijing may be increasingly cautious about using this blunt instrument, which has already catalyzed foreign REE supply diversification efforts in Japan, the US, and other consumer nations. Most importantly from a foreign perspective, forcing more REE-containing components to be manufactured in China can help promote technology transfer and further the government's objective of moving Chinese economic activity higher up on the industrial value-added chain. We believe Beijing is honest in citing the environmental and industrial structure motives—with the caveat that they are secondary in importance to incentivizing tech transfer, a consequence that seems increasingly likely as more foreign companies move REE-dependent operations to China.

Exhibit 4: Estimated supply/demand imbalances for rare earths in 2010 and 2014, by element (shortfall or surplus as a percentage of demand)



Source: Lynas, China SignPost™

Exhibit 5: Rare earth supplies by source in 2010 and 2014
(% of global supply)



Source: Lynas

Exhibit 6: Global rare earth magnet supply chain
Note: “Sintered” means made from a metallic powder heated until particles adhere to each other

Step	% of process controlled by key nations
Mining, concentration, separation, and firing to high purity rare earth oxides	97% Chinese
↓	
Electrolytic reduction to convert high purity rare earth oxides into metals	100% Chinese
↓	
Production of alloy powders suitable for making sintered magnets	75% Chinese, 25% Japanese (from Chinese feedstock)
↓	
Production of sintered magnet parts	75% Chinese, 25% Japanese (from Chinese feedstock)
↓	
Assembly of sintered magnet parts into electric traction drives and other components	diversified
↓	
Assembly of electric traction drives and other components into finished vehicles	diversified

Source: Molycorp

Policy recommendations

1) **Work to establish common global REE processing facilities in a third country such as Indonesia, the Philippines, or Singapore that is not a major producer or consumer, but lies near major users and producers.** China currently hosts most global REE processing capacity, particularly for the heavy REEs. Experts tell us that if each aspiring producer also builds processing facilities, the right-sizing process could be very chaotic and possibly disruptive to the market. A common, independently-run facility would reduce this problem and also alleviate concerns that any one company would have with processing its ores as a competitor's facility.

2) **Build a US strategic REE stockpile. Consider also establishing a global common stockpile managed by a body created by key consumer governments including China, Japan, and the US.** The US government sold the last of its strategic rare earth inventory in 1998, but the House of Representatives recently passed (by a margin of 325 to 98) H.R. 6160, the Rare Earths and Critical Materials Revitalization Act of 2010, for the creation of a US rare earth supply chain. The bill's full text is available at http://www.govtrack.us/congress/bill.xpd?bill=h111-6160. The Congressional Research Service lists four other pieces of REE-related legislation that members may consider, including the following (*italicized* wording derived from CRS):
   - **H.R. 4866, the Rare Earths Supply-Chain Technology and Resources Transformation Act of 2010.** *The bill aims to "reestablish a competitive domestic rare earths minerals production industry; a domestic rare earth processing, refining, purification, and metals production industry; a domestic rare earth metals alloying industry; and a domestic rare earth based magnet production industry and supply chain in the United States."*
   - **S. 3521, Rare Earths Supply Technology and Resources Transformation Act of 2010.** *The bill would expedite permitting for exploration and development of REE deposits in the US.*
   - **H.R. 5136, the Fiscal Year 2011 National Defense Authorization Act.** *This measure would require the Secretary of Defense to assess the rare earth material supply chain to determine what, if any, of the materials are of strategic importance to the US If the material is determined to be strategic, the Secretary would be required to develop a plan to ensure long-term availability by 31 December 2015. The legislation calls for the Secretary to submit a report to Congress on the assessment and plan no later than 180 days after enactment of the legislation.*
   - **P.L. 111-84, the Fiscal Year 2010 National Defense Authorization Act.** *In the proposed House and Senate (H.R. 2647/S. 1390) versions of the defense authorization bill for 2010, Representative Mike Coffman and Senator Evan Bayh introduced legislation to direct the Comptroller General to determine the extent to*

which specific military weapons systems are currently dependent upon rare-earth materials and the degree to which the United States is dependent upon sources that could be interrupted or disrupted.

Congressional support should be enhanced by the presence of REE reserves in states in every major region of the country.

3) **Establish a detailed set of guidelines to advise private sector firms and support their efforts to source and stockpile rare earths and other strategic metals more strategically.** Free markets are generally the best solution, but the REE market is disproportionately small (only ~$2 billion annual global value) and strategic (significant price fluctuations have driven key sources, e.g. Mountain Pass, out of business—and may do so again absent government support). We therefore believe that for certain irreplaceable inputs such as REEs, it is appropriate to have a higher level of government guidance for sourcing and stockpiling practices. To date, Washington's level of engagement with the issue has been very low. Experts in the US national laboratory system tell us they currently "*don't track this particular issue on an ongoing basis*" and that in order for them to study REE-related questions, they would need a request for analysis from the Department of Homeland Security. Such a request should be issued without delay.

4) Create a national strategic mineral inventory reporting system similar to Energy Information Administration (EIA) weekly petroleum inventory data reporting. This would help prioritize measures to avoid bottlenecks regarding supplies of critical resources. Given the importance of REEs to the production of critical military systems, the US Defense Department should track REE use in all major US military systems—something neither it nor its contractors do thoroughly at present.

5) Provide financial incentives such as subsidized storage to encourage commercial REE users to hold larger inventories. Policymakers would need to determine what a "minimum acceptable" level is, perhaps six months' worth of consumption. The Defense Department should provide financial support in relevant areas.

6) Consider recycling more electronics within the US and using old electronic goods to create a strategic reserve of REE magnets. Sourcing this way reduces market disruption relative to buying raw REEs and during a time of economic difficulty, is likely to gain Congressional support for its job creation potential. A major US rare earth magnet dealer tells us its cost of obtaining magnets has "*almost doubled*" in 2010 and that its magnets come from China, a situation broadly repeated across the industry.

7) **Increase stockpile holdings of REEs, tungsten, cobalt, and other strategic metals that come from monopoly or near-monopoly suppliers.** This will help to hedge against supply interruptions and help undercut efforts at monopoly pricing.

8) **Support establishing a global REE pricing system, especially for the more commonly used elements such as lanthanum, cerium, and neodymium.** The London Metals Exchange now has a contract for cobalt, another strategic metal with a global trade level of roughly 55,000 tonnes per year (less than half that of REEs combined volume), and it is likely that an REE contract might be feasible as well.

9) **Create an "equal access" framework agreement with China stipulating that raw material supply disruptions of one month or longer not caused by accidents or natural disasters or other conditions clearly beyond the control of the producers or institutions of the exporting country's government can lead to punitive tariffs on goods from the country that supplies these raw materials.** One possible approach would be to develop rules that enable a panel of other World Trade Organization (WTO) members voting by a 2/3 or greater majority to support a claim that the disruption is politically motivated or otherwise designed to promote unfair trade conditions. Already, the US, Japan, and EU may be preparing to file a WTO complaint against China for its restriction of REE exports.

10) **Increase federal R&D funding for investigating ways to improve efficiency of REE use as well as identify potential substitutes.** China already has a major REE research effort underway. MolyCorp estimates that China's research establishment currently employs more than 1,000 PhD level scientists who are conducting government-sponsored rare-earth-related research efforts ranging from making extraction and separation more efficient for producing better magnets and other end products.

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