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U.S. Rare Earth Policy Needs Short-Term Focus

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China produces 97 percent of all rare earth elements (REEs) consumed in the world today,[1] and it continues to restrict the export of these materials.[2] Given that these materials are critical inputs to many important technologies, should U.S. policymakers be concerned?

Yes and no. On the positive side, Congress is now paying attention, recently introducing the Rare Earth Supply-Chain Technology and Resource Transformation (RESTART) Act of 2011. RESTART is still under committee consideration in the House, and the United States has not yet adopted a specific and actionable REE policy.[3] That may be changing with the U.S. Department of Energy (DOE) December 2010 release of a *Critical Materials Strategy*,[4] which quantifies potential REE supply disruptions and lays out a broad slate of general program and policy recommendations for the consideration of policymakers.

Two urgent questions continue to face U.S. policymakers today:

- In the short term, what can the United States do to reduce the risk of supply disruptions of these critical materials?

continued on inside...

1 U.S. Geological Survey (USGS), *Mineral Commodity Summaries,* January 2010.

2 Helen Sun, "China Cuts Export Quotas for Rare Earths by 35%," Bloomberg, December 28, 2010 (http://www.bloomberg.com/news/2010-12-28/china-cuts-first-round-rare-earth-export-quotas-by-11-correct-.html).

3 In April 2011, Representative Mike Coffman introduced the *Rare Earth Supply Technology and Resources Transformation (RESTART) Act* (H.R.1388). The stated purpose of the bill is 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 Defense Logistics Agency of the Department of Defense."

4 U.S. Department of Energy (DOE), *Critical Materials Strategy,* Washington, D.C., December 2010.

About the Authors

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- In the long term, how should the United States ensure a stable supply of sufficient REE inputs for the clean technology industries critical to the future of America's green economy?

Background

REEs consist of a group of 17 elements including scandium, yttrium, and the 15 lanthanide elements located at the bottom of the periodic table. REEs are critical inputs to many important clean technologies, from wind turbines to electric vehicle batteries, efficient lighting technologies to fuel cells (Table 1).[5] President Obama and other top U.S. policymakers have set high goals for the adoption of many of these clean technologies in the hope of boosting our nation's economy and environmental sustainability. To meet the targets for clean technology adoption over the next decade, U.S. demand for REEs will increase significantly.

The United States once possessed a significant REE mining industry and was a world leader in the production of certain types of REEs, but by the early 1990s this dominance had ended.[6] Instead, China currently dominates all levels of the global REE supply chain, accounting for 120,000 out of 124,000 metric tons of REEs produced globally in 2009.[7] Given this geographic concentration of REE production, China's recent tightening of export quotas on REEs threatens the growth of the cleantech economy by increasing the prices and reducing the availability of these materials.

Annual global demand for REEs is currently estimated at 134,000 metric tons; by 2014, demand could potentially exceed 200,000 metric tons per year.[9] Much of this growth will be

Table 1. Summary of REE Applications in Selected Technologies[8]

Technology	Key REEs	Role in Technology	Future Concerns
Electric Vehicles	Lanthanum, neodymium, dysprosium	Batteries, magnets in electric motors	Significant REE use, but potential substitutes for REEs in electric motors under development; lithium ion battery technology also under development
Wind Turbines	Neodymium, praseodymium	Permanent magnets for next generation wind turbines (> 3 MW)	No known substitutes for neodymium magnets and large quantities are needed; shortages likely in the future
Fuel Cells	Lanthanum, yttrium	Provides conductivity, used as stabilizing dopant	No significant REE supply issues predicted, and technology advancements expected to reduce need for REEs in fuel cells
Efficient Lighting	Yttrium, europium, terbium	Used in rare earth phosphor powders, which allow CFLs and LEDs to achieve high levels of efficiency	No known substitutes for yttrium; significant demand growth expected for yttrium, europium, and terbium, and shortages are likely

Sources: DOE, *Critical Materials Strategy,* December 2010, and National Energy Technology Laboratory (NETL), *Fuel Cell Handbook* (Seventh Edition), November 2004.

5 The four technologies listed do not represent the entire scope of REE applications. Nevertheless, they deserve emphasis because of their dependence on REEs as key inputs and their projected growth in the short term.

6 Cindy Hurst, *China's Rare Earth Elements Industry: What Can the West Learn?,* Institute for the Analysis of Global Security, March 2010.

7 USGS 2010.

8 Rare earth elements are also widely used in consumer electronics, mobile phones, missile guidance systems, and a host of other non-clean technologies.

9 Marc Humphries, *Rare Earth Elements: The Global Supply Chain*, Congressional Research Service, September 2010.

driven by increasing demand for magnets and battery alloys through 2014, at rates of 12 percent and 15 percent growth per annum, respectively.[10] While China's output is also expected to rise over this time period, it is not expected to be sufficient to meet the growing global demand for REEs. As a result, supply shortages are anticipated over the next 5 to 10 years.[11] By 2015, many experts believe there will be an annual shortage of approximately 40,000 metric tons of REEs overall, although the shortfall of individual REEs will vary considerably.[12]

U.S. DOE Policy Recommendations

The DOE's *Critical Materials Strategy* assessed both the short-term (0 to 5 years) and medium-term (5 to 15 years) outlook for REEs based on their usage in a number of cleantech applications.[13] The report concludes the following:

- **REE supply shortages are most likely a short-run risk.** Many clean technologies (including wind turbines, EVs, photovoltaic cells, and florescent lighting) use materials at risk of short-term supply shortages, and these risks will decrease in the medium to long term.[14]
- **Dysprosium, neodymium, terbium, europium, and yttrium are the most critical REEs in the short term.**[15] "Criticality" is measured based on an index that combines risk of supply disruption and importance to the clean energy economy.
- **Clean technologies will consume an increasing share of global critical materials.** Clean technologies currently are responsible for 20 percent of global critical materials demand, but the need for additional supplies of REEs will grow in proportion to the growth of global demand for cleantech applications.
- **Policy and investment can reduce risk of supply disruption.** This is particularly true in the medium to long term, as many policies such as research and development or educational programs experience a lag in impact.
- **Data gaps exist in a number of key areas and, thus, comprehensive analysis of potential market shortfalls is challenging.** The U.S. Geological Survey currently provides supply data for REEs, but a broader data collection effort across agencies is necessary to better inform policy. For example, improvements in annual production and consumption data or the materials intensity of various energy technologies would lead to more precise analysis and aid policymakers.

In addition to these conclusions, the DOE report proposes eight policy interventions to address risks, constraints, and opportunities in the REE supply chain (Table 2).

While concluding that supply disruption is primarily a short-term concern, most DOE recommendations are medium- and long-term solutions. For example, increased R&D, the institution of a recycling policy, and investment in education and training will have little impact on supply concerns in the short run.

10 Lynas Corporation, "Will there be sufficient rare earths to meet demand from clean energy technology?, presented at the International Minor Metals Conference, London, April 2010 (www.lynascorp.com/content/upload/files/Presentations/MMTA_APRIL_2010.pdf).

11 Lynas Corporation, "Will there be sufficient rare earths to meet demand from clean energy technology?, presented at the International Minor Metals Conference, London, April 2010 (www.lynascorp.com/content/upload/files/Presentations/MMTA_APRIL_2010.pdf).

12 Hurst 2010.

13 The DOE *Critical Materials Strategy* does not include detailed long-term (beyond 15 years) assessments, but it does offer general conclusions regarding long-term risks and outcomes.

14 In both the DOE report and our own analysis, short run is used to refer to the next 5 years, medium term refers to 5 to 15 years into the future, and long run refers to a time frame beyond 15 years.

15 See Table 1 for specific cleantech applications.

Two policies merit further analysis because of their potential for short-run impact and ability to address supply shortages: permitting for domestic production and diplomacy (which we henceforth term "strategic cooperation" for descriptive clarity). An analysis of permitting and strategic cooperation is particularly critical, given the fact that the DOE does not have jurisdiction over these policy directions and the report provides insufficient detail to evaluate each option.

Options with Short-Term Impact: Strategic Cooperation and Permitting

Strategic Cooperation

REE-consuming firms and their respective governments have adopted a variety of strategies in response to Chinese export restrictions, particularly over the past several months. Based on the positive experiences of key REE-importing nations (e.g., Japan) and future REE-producing nations (e.g., Australia) in forming strategic agreements on which to cooperate, we evaluate a range of potential actions that the United States might undertake within the sphere of strategic cooperation.

WTO Litigation

There is increasing momentum in Washington for the United States to join with other countries in filing a formal WTO complaint against China's export restrictions on REEs. Much of this momentum is attributable to a recent WTO ruling that rejected China's defense of decreasing export quotas on strategic materials such as

Table 2. DOE Policy Options

Policy Options	Summary	Timeframe*
Increase Research and Development (R&D)	Priority areas include magnets, motors, and generators; batteries, photovoltaics, and lighting; environmentally sound mining; materials processing; recycling.	Medium to long term
Improve Data Collection	Work with government agencies and other stakeholders to fill in data gaps, particularly on annual production and consumption of individual REEs; prices at which REEs trade; materials intensity of different energy technologies; potential substitutes for critical materials in these technologies.	Short, medium and long term
Invest in Education and Workforce Training	Objective is to support a growing manufacturing base and encourage innovation. Special attention given to materials sciences in internships, fellowships, and scholarships; coordinate with other agencies to further opportunities in these sectors.	Medium to long term
Provide Financial Assistance for Domestic Production and Processing	Loan guarantees and price supports. (However, the DOE cannot currently provide loan guarantees in this sector, and it is unclear how price supports would be implemented.)	Short and medium term
Increase Stockpiles	U.S. stockpiles could "diminish the leverage of monopoly suppliers in crisis situations," as well as promote domestic investment in new mines. The DOE does not recommend this strategy.	Short term
Institute Recycling Policy	Policies that encourage higher rates of recovery of critical materials, as well as additional R&D dedicated to recycling (noted above).	Medium to long term
Streamline Permitting for Domestic Production	Additional coordination between state and federal agencies and industry education on best practices.	Short, medium and long term
Engage in Diplomacy	Cooperation with other countries either facing similar challenges or with access to critical materials.	Short, medium and long term

Source: DOE, *Critical Materials Strategy*, December 2010
*Time frame assessment is based on our own research and analysis.

coke and bauxite for the same justifications used to impose export restrictions on REEs.[16] Challenging Chinese trade policy in the WTO poses the most aggressive policy available to the United States because it threatens to further exacerbate Chinese-U.S. bilateral relations. Diplomatic relations between Beijing and Washington are currently characterized by tense negotiations over military and economic cooperation, such as currency appreciation and the recent delivery of more than $6 billion in military aid to Taiwan.[17] Given the broader strategic framework vis-à-vis China, it may be advisable for the Obama administration to elect to address shortages of REEs through other diplomatic initiatives, especially the three policy options detailed below.

Pursue Diplomatic Agreements For Bilateral Cooperation

Engaging in bilateral negotiations with REE-supplier countries to reach cooperative agreements can be an effective strategy for diversifying future supply. One of Japan's most successful strategies in the wake of China's block on REEs to Japan in late 2010 has been to incorporate cooperation on REE supply into high-level bilateral diplomatic meetings (often between heads of state).[18] For example, Japan engaged diplomatic counterparts in Vietnam and Mongolia to secure bilateral agreements to cooperate on REEs.[19] In many cases, the agreements that have stemmed from these meetings have also prompted parallel strategic alliances in the private sector, as discussed in more depth below.

Cooperate Within Existing Multilateral Organizations and Free Trade Frameworks

For many other countries, including Australia, Vietnam, and Mongolia, as well as the European Union, cooperation on REEs represents more than a single-issue discussion. Often, agreements to cooperate on REEs are held out as a bargaining chip in general trade negotiations; India hopes that its cooperation with Japan on REEs will lead to further cooperation on nuclear power.[20] Additionally, Australia emphasized its REE resources in diplomatic meetings with Japan, successfully incentivizing Japan to re-open bilateral free trade talks that had long been stalled due to Japan's refusal to adopt a less protectionist stance on other trade issues.[21] As the U.S. government considers cooperating with other states to prevent a short-run supply disruption, it will be important to consider the extent to which the United States can garner gains on REEs in exchange for concessions, including but not limited to relaxing U.S. trade protections on other goods.

Facilitate Private Trade Agreements Between Suppliers and Consumers

Cooperative efforts by governments and private groups to diversify REE supply must be designed with the features of the REE market in mind. Due to the highly specific compositional nature of REE inputs for clean technologies, REEs are not

16 Juliane Von Reppert-Bismarck, "WTO opens China to rare earth challenge," Reuters, March 1, 2001 (http://af.reuters.com/article/metalsNews/idAFLDE72029E20110301).

17 David Shambaugh, "Stabilizing Unstable U.S.-China Relations? Prospects for the Hu Jintao Visit," *The Brookings Institution,* January 2011 (http://www.brookings.edu/papers/2011/01_us_china_shambaugh.aspx).

18 Jiji Press, "Japan, Vietnam to jointly develop rare earths," October 22, 2010 (http://www.mcot.net/cfcustom/cache_page/118976.html).

19 Agence France-Presse, "Japan, Mongolia to launch talks on free trade, rare earths," November 12, 2010 (http://www.bilaterals.org/spip.php?article18469).

20 Minu Jain, "Trade pact great but civil nuclear pact delicate issue, says Japanese media," *Headlines India,* October 26, 2010 (http://headlinesindia.mapsofindia.com/india-and-world/japan/trade-pact-great-but-civil-nuclear-pact-delicate-issue-says-japanese-media-66511.html). It is unclear whether Japan's recent nuclear accident has affected or will affect this cooperation.

21 Rod McGuirk, "Japan, Australia to restart free trade talks," *Associated Press,* November 23, 2010 (http://abcnews.go.com/Business/wireStory?id=12220760).

traded on exchanges. Instead, REEs change hands from producers to users on contracts negotiated by the two parties, sometimes years in advance. As exemplified by the Japanese government's recent pursuit of diplomatic agreements for REE cooperation with various countries, followed almost immediately by the signing of contracts between Japanese REE-consuming firms and foreign REE-mining ventures, government can play a key role in this process.[22] In a market characterized by specific contracts between REE suppliers and consumers, high-level government diplomacy should focus on the development of strategic agreements that will facilitate private-sector action. Specific actions the United States may consider include bringing industry representatives to the table in government negotiations on REEs, as well as encouraging investment in joint mining ventures abroad by incorporating REE discussions into multi-issue negotiations.

Streamlining the U.S. Permitting Process

The United States is currently ranked first in the world for the longest mine permitting delays.[23] Based on our review of U.S. regulations, the primary sources of permitting delay result from the intertwined bureaucratic layers at the federal and state levels that govern the mining permit process and the persistent litigation brought by groups opposed to the mining activity. In a sample of U.S. metal mines, locations with litigation reported took more than nine years on average to obtain permits; in contrast, in locations without litigation, the average permitting time was six and a half years.[24] While these locations represent just a sample of U.S. mines, there does seem to be evidence that litigation coincides with many of the longer permitting timelines.

Legitimate environmental concerns may underlie these cases, but based on observed differences between the permitting experience in the United States and other countries, there appear to be other important factors as well. In the case of Australia, permitting is completed in a much shorter time frame. Australia has well-defined rights for indigenous populations and active dialogue between the mining industry and environmentalists on voluntary industry standards, which could serve to reduce the instances of litigation and general opposition to projects. Given this analysis, there are two key recommendations that may reduce permitting time, corresponding to near-term actions and longer-term strategic dialogue.

Improved Coordination Between Federal and State Agencies

Proposed congressional legislation—the RESTART Act—recommends a task force created to evaluate the nature of procedural delays and provide recommendations for expediting the permitting process.[25] In particular, this task force should focus on reviewing the source of past delays in issuing permits to determine whether the majority were due to legitimate environmental concerns, litigation, process delays, or some combination of those factors. Should litigation and process delays prove to be the cause in a significant number of cases, then further work could be done to ascertain the nature of the litigation and to identify whether specific parts of the approval process are common roadblocks. In the case of common sources of litigation, if

22 AAP, with Reuters, "Lynas signs rare earths supply deal," November 24, 2010 (http://www.raremetalblog.com/2010/11/lynas-signs-rare-earths-supply-deal.html).

23 Behre Dolbear Group, Inc., *2010 Ranking of Countries for Mining Investment.*

24 K. Long, Van Gosen, B., Foley, N., and Cordier, D., *The Principal Rare Earth Elements Deposits of the United States—A Summary of Domestic Deposits and a Global Perspective,* U.S. Geological Survey Scientific Investigations Report 2010–5220, 2010.

25 RESTART (H.R.1388) includes a provision to establish a "Rare Earth Policy Task Force" in order to "monitor and assist Federal agencies in expediting the review and approval of permits or other actions, as necessary, to accelerate the completion of projects that will increase investment in, exploration for, and development of domestic rare earths." More specifically, the bill directs the task force to explore options to expedite the permitting process pursuant to the Federal Land Policy and Management Act of 1976 (FLPMA); the Act of June 4, 1897 (the Organic Act of 1897); and the National Forest Management Act of 1976.

resolutions were reached, these findings could serve as a guide for future engagement between opposition stakeholders and the mining industry, both with respect to the issues of concern as well as means of resolving conflicts in the future.

Improved Industry Engagement With Concerned Stakeholders

Although it may require a shift in the engagement strategy of the U.S. mining industry, there could be significant longer-term benefits from directly engaging concerned stakeholders as the Australian industry has done, potentially reducing the frequency of litigation. These engagements can be guided by the results of the task force noted above. In addition to the growing focus by NGOs on the mining sector, financial institutions are also increasingly focused on social and environmental risks, which can ultimately impact access to capital for mining companies.[26] Therefore, embracing a transparent and widely accepted set of standards may even enhance the U.S. mining industry's competitive positioning over time.

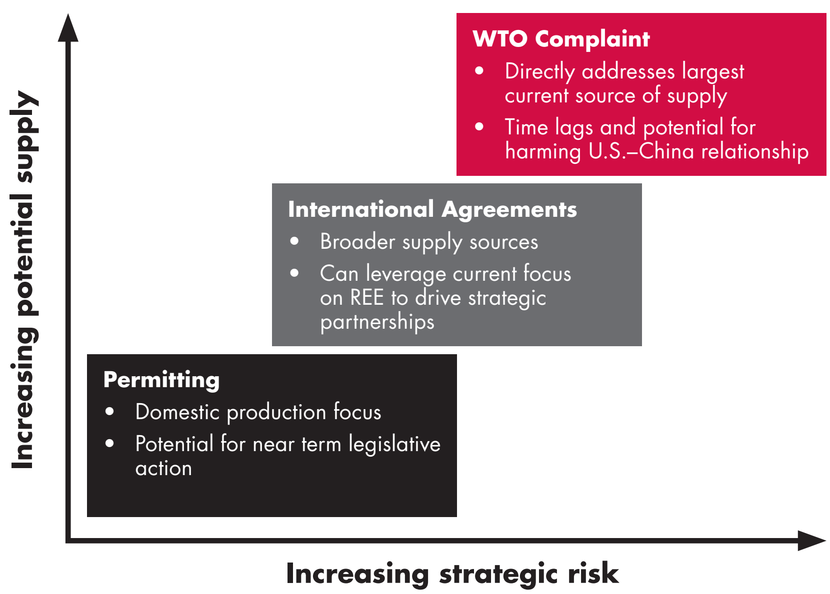
Summary of Recommendations

Given the range of policy recommendations that arise from our analysis, it is informative to evaluate these short-term options in the context of their strategic risk and the potential size of the REE supply they may secure. Figure 1 below provides an assessment of these trade-offs.

Based on the three strategies depicted above, we ultimately recommend that the United States pursue a twofold policy of permitting and international agreements. Simply put, the strategic risk of pursuing a WTO complaint against China, further exacerbating existing tensions, is quite high. Moreover, in the event of a favorable ruling, the time lag associated with a WTO dispute settlement process would do little to solve the U.S. short-term supply shortages of REEs.

Permitting and international agreements, on the other hand, represent a more moderate policy approach for the United States. Both policies can be implemented domestically with less risk of jeopardizing our relationship with China. Meanwhile, the United States can continue bilateral negotiations with Beijing in an effort to reverse Chinese export restrictions. Permitting and international agreements thus provide policymakers with actionable policies to achieve a desired solution to near-term REE supply concerns.

Figure 1.
Policy Option Trade-Offs



26 David Brereton, *The Role of Self-Regulation in Improving Corporate Social Performance: The Case of the Mining Industry,* revised version of paper presented to the Australian Institute of Criminology Conference on Current Issues in Regulation: Enforcement and Compliance, Melbourne, September 2002.

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