Rare Earths: The New Commodity War

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Introduction

The consumer electronics industry is booming. Smart phones, laptops, tablets, video game consoles, and many more are constantly flooding the market, aiming to feed the growing appetite of a hungry society. According to Catherine Shu of *Tech Crunch*, in her article "China Says It Now Has 1.104B Mobile Users, While Mobile Communications Revenue Totaled $116.26B Over First 11 Months of 2012," roughly "82% of China's population currently uses a mobile phone," and 20% of them are smart phone users. The growth of global economies in the technology sector appears to have increased the quality of life for citizens in all countries. Where once Chinese citizens struggled to find working cars, today the populace enjoys many luxuries of the developed world. Indeed it appears that this is a golden age for technology production in the world.

Li Guirong would disagree with this characterization. Li is the secretary general of the local Communist Party in the town of Baotou, in Inner Mongolia. His village, like many others in this region, does not feel the growth of the electronics industry. His village does not have cell phone towers on every corner. His village does not have electric car charging stations. His village does not have video game consoles for every child. Li's village does have polluted water. Li's village does have high rates of cancer. Li's village does have barren, dead crop fields. Li's village of Baotou, like many others in the region, is a center for the mining of rare earth metals, and it is this integral industry that Li associates with the destruction of his home.

The mining of rare earth metals poses a growing threat to the sustainability of human life on this planet. Rare earth metals are an integral part of many electronics, and their necessity continues to grow exponentially as consumers demand more technology. However, like in Baotou, the effects of rare earth metal mining can be disastrous, and outweigh the costs of their

use. As our planet teeters on the edge of livability, it is more important than ever to implement sustainable solutions to the issue of rare earth metals. Positive steps have been made in the form of recycling and limitations on use; however, this raises concern as to the socio-political impacts of transitioning away from rare earth metals. In a world so dependent on technology, rare earth metals stand at the intersection of continued growth and sustainable living.

Impacts

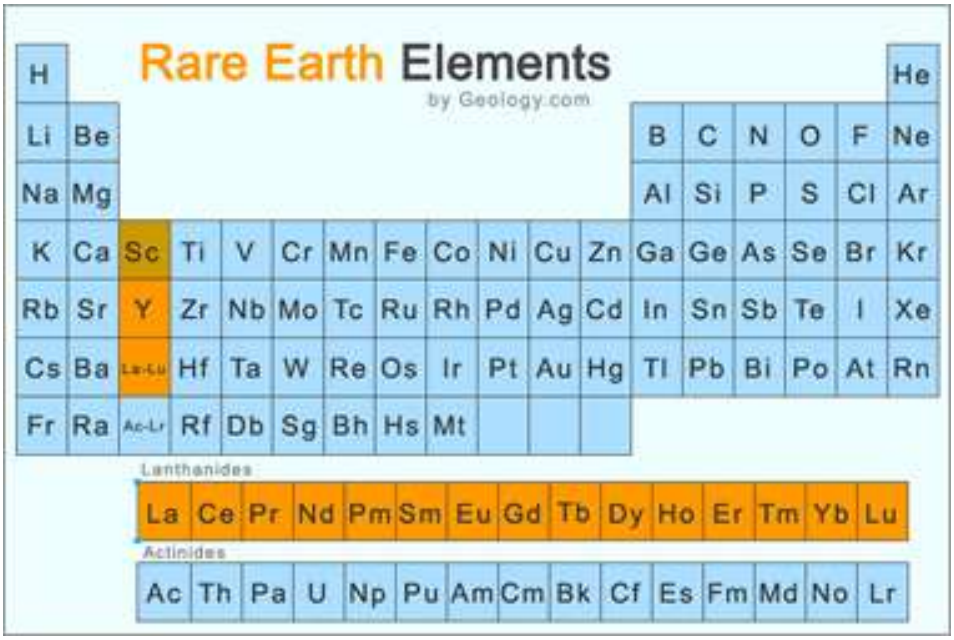

Figure 1. Distribution of rare earth elements on Periodic Table

Rare earth metals, also known as rare earth elements, are key elements for many of the earth's industries. The metals are a group of seventeen elements found together on the periodic table. Figure 1 above highlights the core elements in this group, which includes yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

James B. Hedrick of the *Center for Strategic and International Studies* explains in his presentation "Global Rare Earth Production: History and Outlook," that rare earths were first

used in the production of lamp mantles in 1884. He further explains that there are three methods for refining the metals:

1. Fractional crystallization- time consuming with thousands of steps to refine
2. Ion-exchange (IX)- low cost in short-term, but high continuous cost of operation
3. Solvent extraction (SX)- high cost to build, low cost to operate

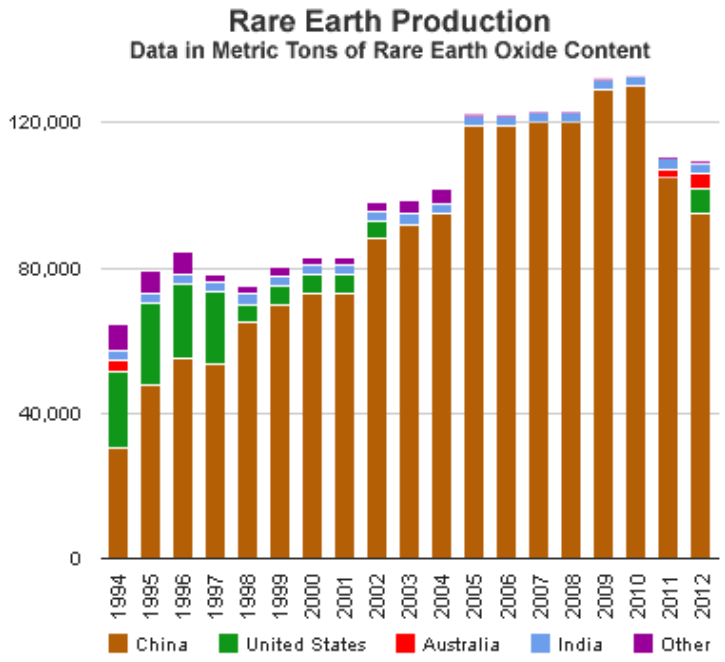

Figure 2. Production of rare earth metals around the world (1994-2012)

Unfortunately, all three refining methods involve chemical processes, and prove to be extremely dangerous for local ecosystems. The term "rare earth" describes not the scarcity of the resources, but the difficulty to refine the metals. Rare earth poses a global threat as many countries have historically been involved in the production and use. As figure 2 shows above, China has dominated the global production of rare earth metals in recent years. At its peak in 2010, China was producing 210,000 metric tons of rare earth metals per year. While the U.S. was

a major player at one point, it has since opted against the production for environmental and cost reasons.

The production of this precious resource has put China in a strong place economically, as the controller of global supply. The supply of this resource is necessary to the production of electronic goods around the world, and has positively impacted the growth of many industries. However, there is always a delicate interplay between the positive and negative impacts. The rare earth metals industries existence can play as much a negative impact on global economics as it does a positive, let alone on the environment.

Positive

According to geologist Hobart King of *Geology.com*, in his article "REE - Rare Earth Elements and their Uses," rare earth metals can be found in "computer memory, DVDs, rechargeable batteries, cell phones, catalytic converters, magnets, fluorescent lighting and much more." Demand for rare earth metals has exploded in the past 20 years as technologies such as cell phones have become more prolific. According to Dr. Ainissa Ramirez of *PBS*, in her article "Where to Find Rare Earth Elements," REEs are found in "the glass display, making it harder, to magnets in speakers, headphones, and vibrating motors, making them more powerful despite their small size." Rare earths have become an important aspect of many processes often taken for granted.

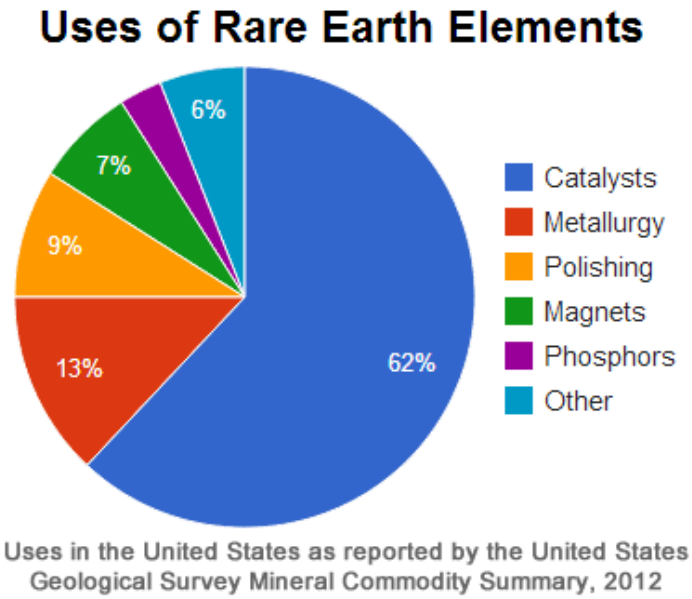

Figure 3. Uses of rare earth elements, 2012

As figure 3 shows above, the majority of the use for rare earth elements is as a catalyst for other reactions. King, in his article "REE - Rare Earth Elements and their Uses," explains that rare earth elements play a key role in the rechargeable batteries of cell phones and other devices. This key role has also helped to see the growth of the electric car industry, an industry often associated with environmental benefits. To quote King, "As concerns for energy independence, climate change and other issues drive the sale of electric and hybrid vehicles, the demand for batteries made with rare earth compounds will climb even faster." Rare earth elements play a key role in disseminating this technology.

Rare earth elements have also played a key role in advancing the technology we use today. According to Richard Tenaglia of *EWI*, in his report "A Q&A on the Rare Earth Material Situation in China and its Impact on US Manufacturing," the ultra-strong magnets within rare earth metals have "touched off a revolution in miniaturizing electronic devices." Rare earth elements have positively impacted the advancement of technology today, to the point that their

removal could jeopardize the future of technology. Tenaglia explains that the powerful rare earth magnets in wind turbines are essential to the growth of the clean energy industry.

Rare earths have also had a positive effect on the Chinese economy. According to Christopher Blakely of the *Gerald R. Ford School of Public Policy*, in his report "Rare Earth Metals and China," China produces a staggering "97.4 percent of the world's rare earths and contains over 50 percent of the world's rare earths reserves." The rare earth industry creates a significant economic advantage for any country involved. As the lifeblood of many vital industries, control over rare earths is a serious advantage in the global economic atmosphere. However, it is this exact positive impact that poses the greater threat to the future of the planet.

Negative

In September of 2010, China restricted the export of rare earth metals to Japan in a move to create leverage with the Japanese government. The move threatened to bring the Japanese electronics industry to a halt. According to Kharunya Paramaguru of *Time Magazine*, in her article "Rethinking Our Risky Reliance on Rare Earth Metals," China further cut production of rare earths by 40%, citing "concerns over how polluting the rare earth industry was." In fact, a growing need to clean up its land and consolidate control over the global market has seen the world's dominant producer of rare earth metals make heavy restrictions in recent years.

In his article "China Tries to Clean Up Toxic Legacy of Its Rare Earth Riches," Keith Bradsher of *The New York Times* explains that China "quietly and unilaterally imposed taxes and annual tonnage limits on its rare earth exports seven years ago," and has proceeded to increase the taxes, while lowering the tonnage limits. While the Chinese government contends that this is an attempt to clean the environment, western officials argue the move is a way for China to

exploit the global rare earth market, noting that the super-power has done little to curb metal use within their own borders.

Thus enters the danger of rare earth metal use from a socio-economic standpoint. While harmful for the environment, the global rare earth metal trade threatens to unsettle global economies so heavily built on raw materials, as well as economies built on finer forms of manufacturing. Meanwhile, as global superpowers argue over the price of raw materials, local communities and environments continue to be destroyed as the long-standing effects of rare earth metal mining further infects the earth.

The mining of rare earth metals has been an explosive growth industry from their very beginning. King explains in "REE - Rare Earth Elements and their Uses," that demand for rare earths grew as the color television entered the market in the mid-1960s. Europium, an essential ingredient in color televisions, was found in bastnasite in the Mountain Pass, California mine; each piece of bastnasite "contained about 0.1% europium." Like this, Mountain Pass became the largest producer of rare earths in the world, and put the U.S. at the forefront of the industry.

However, the global economy quickly changed as China entered the mining industry in the 1990s. The Chinese were able to undercut all other producers because they had both cheap labor and little environmental regulation, thus driving mines such as Mountain Pass out of business and destroying the U.S. rare earth industry. However, what happens when the world's foremost producer of rare earths is also its foremost user of rare earths? The entire global economy is put in jeopardy.

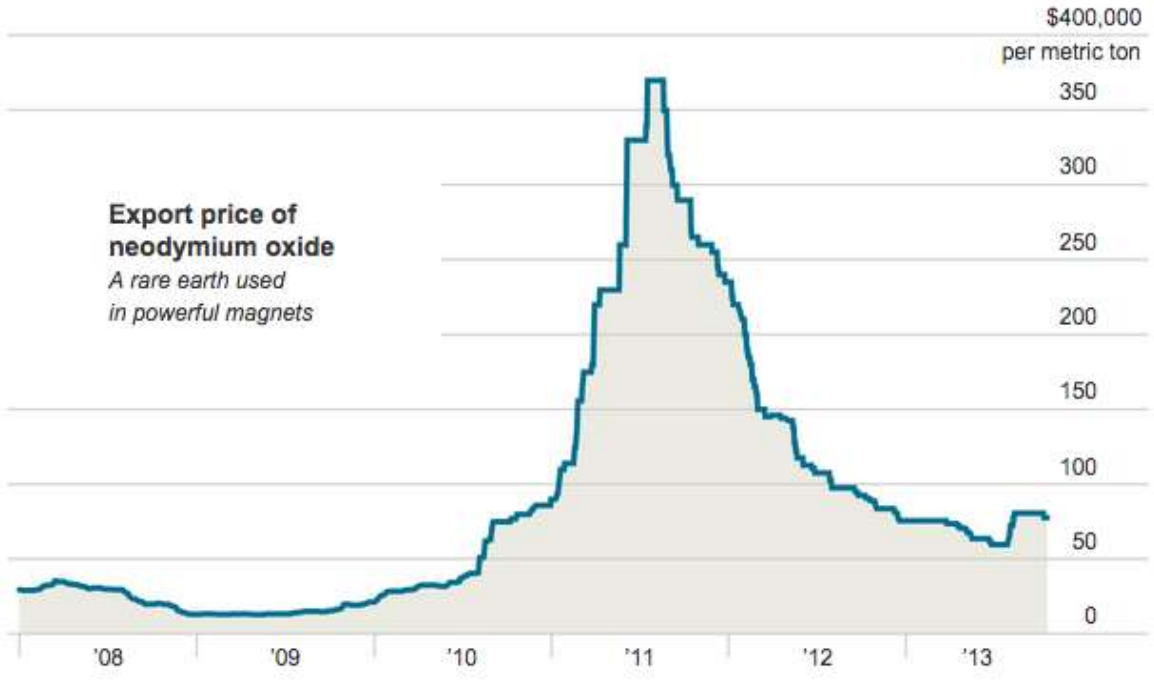

Figure 4. Export price of rare earths from China

The rare earth market is constantly in flux because of the dangerous monopoly in China and the competing global powers. Figure 4, found in Keith Bradsher of *The New York Times*'s article "China Tries to Clean Up Toxic Legacy of Its Rare Earth Riches," shows the change in price of a rare earth metal commonly used in everything from headphones to advanced magnetic telescopes. After a two-month embargo on the metal in 2010, China forced the price to skyrocket. However, after World Trade Organization pressure, the embargo was lifted and the price plummeted. This type of volatility in the market is highly dangerous for a healthy market, let alone a market in the midst of a recession.

The danger exists for a global market collapse if supplies become further ensnared and demand continues to rise. The world stands at the nascence of another commodities war, similar to that of the oil wars. Furthermore, as industries begin to move away from using rare earth metals for cost reasons, desperation to keep the industry alive will begin to set in. Wars to fund

the continued use of weapons that use rare earth metals, and the possible collapse of an industry are not unheard of. In the case of rare earth metals, the oil industry has already made moves to reduce the amount of lanthanum in gasoline, according to Keith Bradsher of *The New York Times.* "Only 1.5 percent of the latest catalyst formulations for oil refining are now lanthanum, down from 4 or 5 percent three years ago," says Bradsher in his article "China Tries to Clean Up Toxic Legacy of Its Rare Earth Riches." The reduction could set back the entire industry, and economy of China if left unregulated and unchecked.

Most troubling are the environmental dangers that stem from rare earth metals. In an article from *The Guardian* titled "Rare-earth mining in China comes at a heavy cost for local villages," Li Guirong describes the change that the mining of rare earth metals has done to his home. His home village, once filled with "fields here as far as the eye can see," has been replaced with lakes of radioactive sludge, byproducts of the mining and refining of rare earth metals. Rare earth metals pose a grave threat to the environment because of the toxic chemicals and fossil fuel needed to mine and refine them.

In the Li's village, the ground no longer supports any life, thus destroying the mainly agrarian society of the area. The toxic chemical water waste that pools in lakes, as pictured above, has seeped into the local ground and water supply. Furthermore, local studies have shown

that the fossil fuels burned by the refineries have released toxins into the air. According to *The Guardian,* it was found that residents were inhaling "solvent vapour, particularly sulphuric acid, as well as coal dust," and has attributed to high rates of cancer amongst the people.

The people are in jeopardy as rare earth metals continue to destroy the environment. Christopher Blakely of the *Gerald R. Ford School of Public Policy,* in his report "Rare Earth Metals and China," explains that the U.S. closed its final rare earth mine in 2002 partly due to the pressures of mining on the environment. China used its lax environmental standards to its advantage; however, Chinese officials are now faced with the degradation the mining has caused on the environment. As Keith Bradsher of *The New York Times* explains, two decades of mining has caused toxic chemicals to flow into the Yellow River, a water source that supports 150 million people.

With land no longer suitable for farming, clean water sources dwindling, and now a rare earth industry that itself may be in jeopardy, China is realizing it has ensured its own destruction both as a country and a land. A war threatens to loom on all ends as an enraged populace is encouraged to protect their land from government interests.

Solutions

The goal, then, is to find a solution that can support both the environment and a volatile global economy. However, how does one appease industries and markets, while cutting back on the physical mining that is causing the problem? Certain radical approaches have been taken on a technological end, while many analysts argue that the real change must come from the society.

Technological

The most promising solution to the rare earth metals mining problem is recycling. A growing trend has emerged promoting the recycling of electronics, as consumers have come into the habit of dumping and upgrading their gadgets every few years. However, even though our iPads may look obsolete, their core elements are not. According to Jessica Marshall of *GreenBiz*, in her article "Why rare earth recycling is rare and what we can do about it," a Yale study showed that recycling neodymium magnets had an 80 percent lower human toxicity factor, and used 60 percent less energy. The typical process involves shredding the electronics down to a fine powder. From there, the elements can be separated and then reused. Thus, every iPhone that is no longer used can have some of the basic neodymium elements recycled to produce new phones.

The amount of rare earths mined is easily lower than the amount in local trash centers. The difficulty in this technology is cost-benefit. According to Marshall, every smartphone has 65 different elements to rifle through to find the tiny amounts of ground up rare earths. The amount of money and energy to accomplish this, some argue, could ultimately remove any environmental benefit. As a solution to this, so as to avoid further mining, some argue to create an industry out of the recycling. Vice President Al Gore, through his venture capital support, agrees with this action.

In his article "BlueOak Raises $35 Million For Its Factory That Mines Electronics," *Techcrunch's* Jonathan Shieber explains that BlueOak Resources, a company that recycles electronic waste (e-waste), is extracting gold, silver, and copper, as well as rare earth elements from electronics. This gold, silver, and copper, can then be sold for separate profits, according to

Jessica Marshall of *GreenBiz.* With the U.S. producing 3.2 million tons of e-waste each year, according to Shieber, the business of electronic recycling has taken on an entirely new face. As a result, top investors such as Al Gore are looking to build more e-waste plants across America, to feed one industry using an entirely new one, and help the environment. Other companies, such as Honda, have begun reusing elements found within car batteries, thus focusing on a future of reuse and recycle, rather than solid production. The one thing all of this technology hinges upon is the acceptance by society.

Social

Simon Hadlington of *Chemistry World* argues, in his article "Rare element substitution a tricky proposition," that rather than try to recreate the exact same product. He argues that the product uses the elements that it uses because it is at the height of existence. Instead, he argues that we should move to replace certain technology, rather than their core elements and expect the same product. This has resulted in the push to replace indium tin oxide in touchscreens, using alternatives based on carbon nanotubes or graphene. However, the change that Hadlington is proposing hinges on humans being willing to compromise.

Thomas Gradael, a professor of geology and geophysics at the Yale School of Forestry & Environmental Studies, hopes product designers will begin to design products that avoid these precious and useful materials in *Time's* article "Rethinking Our Risky Reliance on Rare Earth Metals." Others hope that people will begin to use their gadgets longer, rather than constantly upgrading and demanding new production. These social solutions ask for quite a bit from people who do not typically care where their food comes from, let alone their technology. However, as political turmoil rises, social change may be the only true hope. Villagers in China, their lives

destroyed by rare earth metal mining, have banded together to demand their local leaders force change. The Chinese central government has responded by undergoing massive reforms to their mining standards, and instituting quotas on the amount of metals exported.

Conclusion

Throughout the second-half of the 20th century, and most of the 21st century, the world has seen the growth of the military-industrial complex. War has been waged to perpetuate the existence of certain industries, and certain industries have gone to war to acquire precious resources. Here plays out the same scenario on a global scale not seen since the Cold War.

However, in this scenario, we are also racing the clock of our dying planet. As technology advances, and we begin to solve our greatest problems such as information and energy, the cost of solving these problems begins to show elsewhere. Rare earth metals are the cost of a high-technology society. Even today, it is impossible to create a solar panel with the use of one of the seventeen rare earth metals. We have so entangled ourselves in a system of mining and production, that the global economy is threatened if it is not perpetuated or dramatically changed.

As humans of the modern age, we are subject to the belief that technology will ultimately come with a solution. For a long time, that solution has involved some sort of rare earth metal. For a long time to come, this very well may be the case. However, as we keep our eye towards a cleaner planet, we must recognize the technological and economic advantages to methods such as recycling and substitution. The real solution to the problem of rare earth metals can never be removing them, or having all countries produce them. Instead, it must be accepted that they are a fact of our system, and we must find whatever way to use them that does not harm our planet.

On certain levels, this requires governments to ignore strictly their own profit, and focus on the lives of the human race. This may become an absolute necessity as the fight over rare earths has taken to the citizenry. Populaces are demanding change, and political turmoil domestically and internationally can spell the end of any government. Thus, the imperative is clear that rare earth metals demand social and technological change for the good of the planet, and our society.

References

Blakely, Christopher, Joseph Cooter, Ashu Kaitan, Iclal Sincer, and Ross Williams. "Rare Earth Metals & China." *Gerald R. Ford School of Public Policy*. n.d. Web. 12 Nov. 2014.

Bradsher, Keith. "China Tries to Clean Up Toxic Legacy of Its Rare Earth Riches." *The New York Times.* The New York Times Company, 22 Oct. 2013. Web. 11 Nov. 2014

Hadlington, Simon. "Rare element substitution a tricky proposition." *Chemistry World.* Royal Society of Chemistry, 6 Jan. 2014. Web. 13 Nov. 2014.

Hedrick, James B. "Global Rare-Earth Production: History and Outlook." *Center for Strategic and International Studies Rare Earth Elements: Geology, Geography, and Geopolitics.* 15 Dec. 2010. Web. 11 Nov. 2014.

King, Hobart, ed. "REE - Rare Earth Elements and their Uses." *Geology.com*. n.d. Web. 11 Nov. 2014.

Marshall, Jessica. "Why rare earth recycling is rare and what we can do about it." *GreenBiz.* GreenBiz Group, 14 Apr. 2014. Web. 13 Nov. 2014.

Paramaguru, Kharunya. "Rethinking Our Risky Reliance on Rare Earth Metals." *Time.* Time Inc., 20 Dec. 2013. Web. 11 Nov. 2014.

Ramirez, Ainissa. "Where to Find Rare Earth Elements." *PBS.org.* WGBH Educational Foundation, 2 Apr. 2013. Web. 11 Nov. 2014.

Shieber, Jonathan. "BlueOak Raises $35 Million For Its Factory That Mines Electronics." *TechCrunch.* AOL Inc., 10 Jun. 2014. Web. 13 Nov. 2014.

Shu, Catherine. "China Says It Now Has 1.104B Mobile Users, While Mobile Communications Revenue Totaled $116.26B Over First 11 Months of 2012." *TechCrunch.* AOL Inc., 24 Dec. 2012. Web. 11 Nov. 2014.

Tenaglia, Richard. "Rare Earth Materials: A Q&A on the Rare Earth Material Situation in China and its Impact on US Manufacturing." *EWI Energy Center.* EWI Inc., Feb. 2011. Web. 12 Nov. 2014.