***RARE eARTH mARKETS AND THEIR AFFECT ON SOLAR AND WIND POWER***

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## Overview

The rare earths consist of the 15 lanthanide elements – lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium. Researchers commonly add scandium and yttrium for a total of 17. Rare earths are desirable because they impart enhanced properties of magnetism, strength and luminescence. Rare earths are gaining in importance in the world economy because of their usefulness in technologically advanced products (e.g. hybrid electric vehicle motors, LEDs, mobile phones, mag-lev trains and lasers) and renewable energy technologies (e.g. wind turbines and photovoltaic films).

The reserves of rare earth ore around the world are China (33%), Russia (19%), United States (13%), Australia (5%), India (3%) and other - which includes South Africa and Canada - (22%). In the 1940’s India and Brazil dominated the rare earths production. They were followed by South Africa and in the 1980’s the United States held the lead. In the 1990’s China increased its production by over 450%. In the 2000’s China’s production increased another 77% to account for 129,000 tons in 2009. The rest of the world’s production slipped to only 3000 tons. According to the US Government Accounting Office, China produces 97% of the rare earth element raw materials, approximately 97% of rare earth oxides, and is the only exporter of commercial size amounts of rare earth metals. They captured the market by undercutting world market prices. This was accomplished, in part, by extracting rare earths from iron ore waste products (an inexpensive feedstock) and tolerating environmental consequences that would have been unacceptable by in western standards.

Given this level of control, economics tells us that China has an opportunity to exert market power. In December 2010, China announced a 35% cut in its export of rare earth oxides. In 2011, China increased their export taxes and rapidly escalated prices. For example, last year neodymium sold for $42 a kilogram, this year $283, while last year the price of cerium increased 1256%; this year it increased another 78%.

Former leader Deng Xiaoping said, “There is oil in the Middle East, but there is rare earth in China.”

It is ironic that the destiny of the solar and wind power markets could depend upon the actions of a communistic country; who is one of the world’s largest emitters of carbon dioxide.

## Methods

Rare earth elements are introduced and their properties discussed. The early development of the rare-earths market is presented and the economic tactics used to capture market power are examined. The current market state (and its implications on supply and price) is discussed. Rare-earths markets and their relationship to the renewable energy technologies (RETs) of solar photovoltaics and wind power are then introduced. The current and future markets for solar and wind powers are examined. China’s ability to expand its market power from rare-earth mineral market domination to increasing influence over RETs is examined within an economic framework and the resulting short run markets examined. Possible ramifications of the analysis into future RET markets are discussed. The ability to lessen the Chinese dominance in the rare-earth mineral market is analysed.

## Results/Conclusion

In the short run, China dominates the rare-earth market and will continue to do so for the near term. The dominance of the rare-earth market has been a part of the Chinese government’s plan dating back to the 1950’s. The US market will attempt to lessen China’s control of rare earths in the US market through the purchase of Silmet in Estonia (responsible for approximately 2% of the world’s output) and developing local resources. These efforts will be hampered by the refining process acidic effluent and its radioactive by-products (small amounts of uranium and thorium). These considerations will also affect Australian companies bid to build a refinery in Malaysia and other nation’s efforts to reduce China’s dominance. Moreover, the Chinese government is actively pursuing the relocation of high technological industries that use the rare-earth minerals to be sited within China. Economic analysis on electric cars, solar and wind power development that does not take into consideration the ability of the Chinese government to control a vital resource necessary to the production of these technologies are flawed and their estimates could be overstated.

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