By Ian London, Vice President of Market Development • Avalon Rare Metals, Inc.

Going Forward: The Delicate Supply Balance and the Growing Demand for Rare Earths

It really doesn't matter what business, technical or news journal you peruse these days; you are bound to come across several articles on rare earths or the technologies that the rare earths make possible. Hybrid and pure electric vehicles are expected to drive the Green Energy Economy. Newer and larger wind power developments are in the air. Smaller and energy-efficient motors are humming quietly, and personal electronics devices like Blackberries and iPhones are sending a very clear message: there is a new materials and green technology renaissance underway. And, as we know, rare earths and magnets are playing a key role in this rebirth.

These two new sectors in the economy however, will continue to face delicate imbalances in the supply and demand for raw materials for both home-grown technologies and for job creation. This will be especially so in the Western world.

Underlying some of the market dynamics are geopolitical imbalances as the different economies emerge from the economic downturn of 2008/2009. China continues to supply about 97 percent of the world's current demand for rare earths, although there are increasing pressures to satisfy its own domestic demand for products. As for exports, China is aligning its efforts to produce more value-added products, effectively saying "Why export raw materials when we could export magnets?" It is only natural then for China to further ask "Why just magnets? Why not complete motor assemblies or complete automobiles?"

To counter a dwindling supply of rare earths and grow our technologies and economies we will need a new, perhaps international in scope, resource development and process facilities to move forward. But, will we have the full spectrum of soup-to-nuts solutions to meet North American, Asian and European needs?

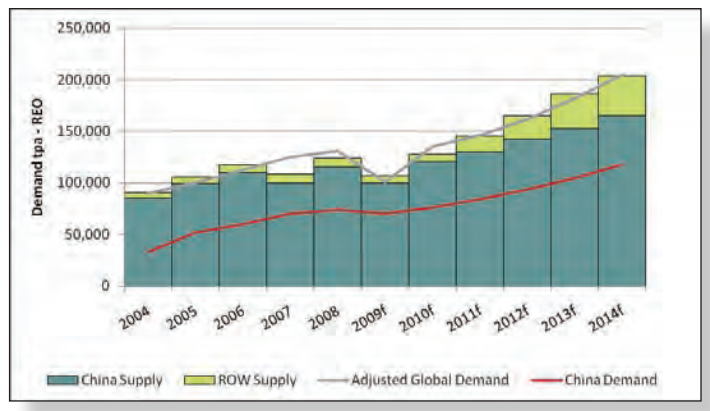
Overall REE Supply and Demand

In October 2009, the US Geological Survey (USGS) announced that "All metals have sufficient resources to last mankind well into the 21st Century." I do not intend to be critical, but our success in going forward, will be driven by a balance between production and consumption, not by whether adequate resources or mineable "reserves" exist. Production is driven partly by price, partly by factors such as capital and operating costs, and perhaps community support or opposition. Consumption is driven by growth of industrial production and technology demands, both of which can be influenced by government policy. Please note that I highlighted the term "reserves" above, in quotation marks. A reserve is a quantified resource in terms of its economic exploitation and it may be measured and reported differently in differing jurisdictions. Accordingly, I tend to be a bit cautious when considering what is described. In Canada, regulatory authorities require that reserves have a mine plan demonstrating financial viability. Furthermore, rare earth elements (REEs) production is as much dependent upon form as content, that is while the assay results may indicate the ultimate elemental content, recoveries are dependent upon the minerals which carry these elements as the mineralogy strongly influences recovery rates.

Dudley Kingsnorth, a noted Australian-based rare earth market analyst and managing director of Industrial Minerals Co. of Australia, recently commented that the consumption of REEs decreased by 10.3 percent in 2009 because of the economic downturn. He also forecasts that global REE demand is set to grow to 180,000 tonnes (t) of rare earth oxides (REO) by 2014 (or 205,000 t REO if industry aligns the supply/demand balance for the individual oxides, but more on that later) and anticipates that consumption will exceed 200,000 t REO for the first time in 2016.

Based on his analysis, Kingsnorth further notes that the West (i.e. non-Chinese world) will need to produce and supply approximately 40,000 t of REOs in 2014 and thereafter, the Western supply will have to grow at about 5,000 to 10,000 tonnes per annum (tpa) of REOs.

The following chart, presented by Kingsnorth at the *Managing Supply Chain Risks for Critical & Strategic Metals Conference* in October, in Washington D.C., clearly illustrates this growth, the changing sources of supply, and the delicate balance in aggregate supply and demand.



Source: IMCOA

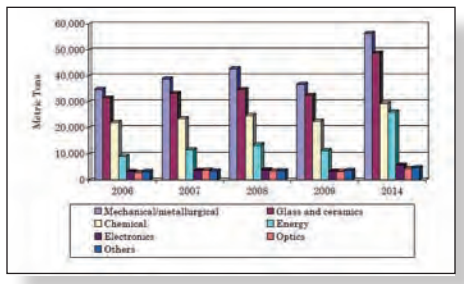
Kingsnorth's projections effectively show growth in China at 10 to 15 percent per annum and 4 to 8 percent in the rest of the world (ROW).

Furthermore, while China continues to promote value adding in export products (i.e., with REEs built into final products) and strives to meet its internal demand, its share of consumption of REOs and metals will rise from 60 percent to 65 percent over the next five years. The West will also

increasingly consume more REEs in end products; a result of importing more motors or assemblies utilizing REEs.

REEs and Permanent Magnets

Rare earths are found in many advanced products across a broad range of industry sectors including mechanical/metallurgical, glass and ceramics, electronics, chemical, optical, energy and others such as life sciences, sensors and instrumentation. As illustrated in the following chart shown in BCC Research's *Report on Rare Earths of June, 2009*, Mechanical/Metallurgical applications currently account for the largest share of the market (36,770 t or 32 percent of the total), followed by Glass & Ceramics (28.6 percent). The REEs used primarily in the fabrication of permanent magnets are reported within the Mechanical/Metallurgical sector.



Source: BCC Research

From the BCC Research chart, it is also evident that there are clearly competing demands for REEs by significant industrial sectors. While some sectors may be smaller than others, their relative growth rates may be significantly higher. I'm not sure as to how sensitive these numbers are to the more recent announcements around the development of large scale wind farms and other new technology applications such as high luminescence phosphors, optically detectable security markers, phosphors emitting blue light or magnetic recording media, which might materially skew the chart. These applications could certainly test the demand/supply balance available to the magnet sector. Please note that I also believe new and more reliable supplies will unleash much new demand.

Not all sectors require the same individual REEs. The permanent magnet business is primarily interested in five of the 16 elements: neodymium (Nd), dysprosium (Dy), praseodymium (Pr), samarium (Sm) and terbium (Tb).

According to BCC Research the anticipated overall annual growth in the demand for permanent magnets, is of the order of 8 to 9 percent from now through 2014. There have been other estimates prior to the economic turmoil of 2008/2009 that the anticipated growth could have been in the range of 11 to 15 percent.

BCC currently projects that rare earth demand for permanent magnets, reported in rare earth oxide form, will increase from 23,290 t in 2009 to approximately 34,220 t in 2014. This annual demand would translate into the following demand for the individual REEs:

Rare Earth Oxide	2009 tpa	2014 tpa	GAGR %
Nd	16,571	24,635	8.3
Pr	3,338	4,963	8.3
Dy	2,225	3,310	8.3
Sm	990	1,065	1.5
Tb	166	247	8.3
Total	23,290	34,220	8.0

Source: BCC Research

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While in aggregate, total production of all 16 REOs will increase from approximately 107,500 t in 2009 to 180,000 t in 2014, there is the question as to whether there will be an adequate proportion of specific elements to satisfy the permanent magnet demand. Many of the proposed new producers tend to be heavier on the light rare earth elements (LREEs – Nd, Pr, Sm) and light on the heavy rare earth elements (HREEs – Dy, Tb); the latter being the real vitamins for high performance magnets. The following table illustrates the expected overall output for the magnet REEs (recognizing that these elements are also used in other technologies). The magnet sector consumes a significant proportion of the available Nd, Dy and Tb, however these materials are in very tight or in deficit situations (shown in red).

Rare Earth Oxide	Overall Demand[1] 180,000 tpa	Magnet Metal Demand[2]	Overall Supply[1] 180,000 tpa	Magnet Proportion of Supply
Nd	34,900	24,635	33,300	74.0%
Dy	2,040	4,963	1,800	247.7%
Pr	7,900	3,310	10,000	33.1%
Sm	1,390	1,065	4,000	26.6%
Tb	590	247	400	61.8%
Total	46,820	34,220	49,500	69.1%

Sources: [1]IMCOA, [2]BCC Research

Supply Going Forward

It is generally believed that currently operating and nearer-term development projects could meet the expected ROW demand in 2014. However, as some observers have noted, a number of projects still need to better define their resources, develop and prove metallurgical processes, obtain environmental, operating and community support, secure sales contracts (a necessity in today's equity and debt financing world), obtain funding, and then construct and start-up what will be a sophisticated chemical facility before attaining full production. This is neither a short nor streamlined To-Do-List. However, as I mentioned, experts believe the targets are achievable.

The world's major supplier of rare earth metals, China, is increasingly withholding rare earth metals for its own needs and reducing export quotas, with rumored or planned reductions and even complete sale restrictions of dysprosium and terbium.

In this light, it seems the US Administration has now recognized that the sourcing, processing capability, reliability and security of its REE supply chain may undermine its economic recovery, national security and green economy targets. It is understood that the last of US Government's holdings of rare earths in the National Defence Stockpile (NDS) was apparently depleted in 1998. The USGS advised that national defence material requirements "may necessitate the inclusion of rare earths, including scandium and yttrium, in the NDS at a future date." Accordingly, in early October, the US Congress effectively approved the *National Defense Authorization Act for Fiscal Year 2010,* in which *Section 843: Report on rare earth materials in the defence supply chain* requires the Armed Services Committees of the Senate and House of Representatives to receive a report on the Department of Defense's REE supply chain by April 1, 2010. The report is expected to provide an analysis of the current and projected domestic and worldwide availability of rare earths (as required by defence), the risks that could restrict the access to rare earth materials, a determination as to the current and anticipated dependencies on rare earth materials, particularly neodymium iron boron magnets, and steps that have or plan to be taken to address any such risk.

So where are the current mine developers and operators at, as they prepare to meet the demand? While it is difficult to put hard numbers on their mineral deposits, recent press releases and web-available information can be summarized as follows:

	TREO Output (tpa)	HREE Content (% TREO)	Start Date (pre-2014)
Mountain Pass (USA)	10,000 - 20,000	1%	2011 - 2013
Nechalacho (Canada)	5,000 - 10,000	20%	2013 - 2014
Mt. Weld (Australia)	10,000 - 20,000	3%	2011 - 2013
Nolans (Australia)	10,000 - 20,000	4%	2011 - 2013
Hoidas Lake (Canada)	?	7%	-
Bear Lodge (Wyoming)	?	n/a	-
Dong Pao (Vietnam)	?	n/a	-
Kvanefjeld (Greenland)	?	14%	-

There are also daily announcements as to new REE mineral discoveries or of projects designed for other primary products such as uranium that also contain REEs as a possible by-product. This level of mineral exploration activity only tends to confirm the pending imbalances and shortfalls. The real challenge is to manage the buzz, and focus on getting economical projects and supply chain processing into service.

Closing Remarks

I am reasonably confident that raw material producers, alloy processors and industrial manufacturers will find reasonable balances in REE supply and demand. An alternate supply chain capacity outside of China can be established and secured, but I'm not saying it will be easy. It will probably require project and industry developers, trade policy makers and academia to coordinate their strategies and priorities. It may also require some form of economic and financial support in the nearer term to ensure that raw material development projects and recycling capacity are fully implemented in light of some of the steps that need to complete.

At the same time, I wouldn't be surprised that as some of these projects come into service, there will be a slew of new applications for rare earths, as demonstrated by an ever increasing number of patents, which will further continue to challenge the supply/demand balances.

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MAGNETICS 2010

Growing Demands and the Delicate Balance for Rare Earth Supply

Forecasts for the demand of rare earths continue to rise with the anticipated recovery based on a green energy economy through renewable energy technologies, many of which are built upon the efficiencies using magnets. China remains the pre-eminent supplier of rare earth oxides, producing upwards of 97 percent of today's supply, and its domestic demand for rare earths is estimated to exceed its production in 2011. This presentation will provide an update on the major sources and continuing balance and supply chain issues faced by sources outside China's control.

Ian London, vice president of Market Development for Avalon Rare Metals, Inc., is responsible for supply chain development and industry group relations. Avalon is a Canadian junior mineral exploration and development company with a primary focus on the rare metals and minerals, including the rare earth elements. Ian brings more than 30 years of business experience, including terms as CEO of Process Products Limited, a supplier of engineered machined components in the construction of power turbines, rail cars and MRI machines, and as CEO of Ontario Hydro International Inc, a consulting and operating services provider to the utility sectors in over 60 countries. He earned his engineering degree at McGill University and a MBA at the Schulich School of Business. He can be reached at ilondon@avalonraremetals.com.