NEWSLETTER
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STORMCROW

Still Not Gettin' that Rare Earth Jive…

October 27 2020

Good News on NEV Sales in China!

In this issue we discuss:

- **Best NEV Sales Ever in China** With a provincial push on new energy vehicle (NEV) subsidies post the COVID-19 slowdown, September sales of NEVs in China hit an all-time record. That helps the yearly total, draws down on critical material stockpiles faster and should help keep companies afloat.

- **Prices Remain Stagnant** Prices for lithium chemicals and spodumene concentrate are still stuck in the mud. We remain hopeful, though. Selling big numbers of batteries means that, sometime soon, someone is going to need to order some new feedstock.

- **A Rare Look at the Rare Earths** Rare earths are getting a lot of press. The only problem we have with that is that we can't think of a good reason why they should. Even the magnet material to end all magnet materials, neodymium, is not showing much life, so we feel it's a lot of smoke and mirrors right now.

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See the end of report for important disclosures

As a Matter of Introduction…

This is our thirteenth (semi)monthly newsletter (fourteenth? maybe?)! Time flies when you are having fun, and critical materials and the connected industries are, at least to us, fun. While we never produced a newsletter filled with cautions about the "best cure for high prices being high prices " during the lithium heyday that extended through the middle of 2017, those who sat in on Stormcrow talks at conferences know that we were out there saying it. However, we feel even more strongly that the old maxim about the "best cure for low prices being low prices" is every bit as true, and given some pessimism around the battery materials market now, we believe that some realism (along with a little hope) is required.

First, for those who don't know, Stormcrow deals with the markets for critical materials. Generally speaking, what amounts to a critical material is in the eye of the beholder, but we think of them as materials that are essential to making a product with the properties intended by its designers, even if those materials are not anything like the highest-cost item on a bill of materials. As an example, think about lithium in the battery of your cell phone. That lithium costs pennies as a raw material, but if your cell phone manufacturer was forced to do without it then the resulting cell phone would bring with it a very, very different operating experience than it currently does.

Over the coming months, we are going to deal with our views of the market prospects for some critical materials, and interesting facts about others. We will talk a little about technology and the impact, both good and bad, that it can have on demand for critical materials. We hope you find this interesting and worthwhile! Note that when not writing newsletters like this one, Stormcrow Capital functions as a corporate adviser (capital markets / financing / M&A) in the critical materials sector. We are registered as an Exempt Market Dealer in Canada *(additional disclosures included at the end of this note, for those who need help getting to sleep).*

Still Going Nowhere Fast

A whole lot of nothing happened in September with respect to the prices for battery materials, except for cobalt sulfate which was sharply higher (following metal prices) but has since rolled over a bit. While we hoped things were on the verge of turning around, and we still think that happens within what is left of 2020, things remain slow:

Battery-grade $LiOH \bullet H_2O$ down 1.2%

Battery-grade Li_2CO_3 UP 1.0%

Battery-grade $CoSO_4 \bullet 7\ H_2O$ down 2.3%

Battery-grade $NiSO_4 \bullet 6\ H_2O$ UP 2.5%

That $CoSO_4$ prices have relaxed a bit is not shocking, given what the metal is doing and the fact that cobalt sulfate appreciated more than 20% in August. Nickel sulfate has been on a steady climb for a couple of months, which suggests that restocking of this feedstock is already occurring. It is also encouraging to see lithium carbonate prices fighting back in China as the price of lithium carbonate being as low as it is has left the industry walking around on its elbows, as the saying goes.

Since the end of September, lithium carbonate prices have edged up, lithium hydroxide prices have edged down and spodumene prices are flat and lousy. We continue to believe that the bellwether, the indicator that something is seriously up, will be spodumene prices. While those prices remain flat and below USD$400 a tonne when shipped into China, we expect positive movement before the end of the year. Most especially given what we will discuss below with respect to NEV sales in China.

The Subsidies Worked!!!

Not that the existence of what are labelled temporary subsidies goosing the sale of new energy vehicles should be a surprise, nor is the removal and absence of subsidies negatively impacting sales. But, man, it did work in September! Reports by the CAAM tell us that overall automobile sales jumped nearly 13% last month, to 2.57 million units. What concerns us the most, obviously, are the sales of NEVs, and this jumped to a record of 138,000 units in September. That doesn't reverse my thinking that NEV sales are heavily dependent on subsidies, unfortunately, but it's positive for our industries of interest.

Rare Earth Ruminations and Rationalization

The press has, for some reason, been beating a rare earth drum for a while, now. For those that missed this, and you didn't miss much, the prices of rare earths were unexciting for years until, in 2010, the Chinese authorities decided to significantly restrict the exports of rare earths from China. Then there might or might not have been an unofficial embargo on shipments of these materials from China to Japan due to a maritime incident, and prices went crazy. Some rare earths saw their prices jump to 50x their starting point because no material can be instantly substituted for another.

Then the inevitable happened. While many pundits and instant experts jumped in to "explain" that the rare earths were "irreplaceable", they aren't. The use of lanthanum in catalysts in the petroleum industry is a great thing when lanthanum is $2 a kilogram, it's a lousy option when lanthanum is $100 a kilogram and so the industry switches to using other metals such as nickel. Rare earth magnets containing neodymium work fine in offshore, direct-drive wind turbines when neodymium is $20 a kilogram, but they are uneconomic when neodymium is $400 a kilogram and so you use regular wind turbines that contain a transmission and break down more often. Cerium oxide was widely used as a polishing powder in the processing of glass for LCD and OLED screens, but when the polishing powder went from $2 a kilogram to $120 a kilogram then, instead of simply adding a new bag of cerium oxide for each run you vacuum up the powder, clean the glass dust out of it, re-sieve the material and add maybe 1/20th of a new bag. In other words, downstream industry relied on material and technological substitutions, along with conservation. Demand for the rare earths collapsed, prices followed, and this brings us up to date.

Lately, we have been hearing a lot about rare earths. Politicians like Donald Trump and Ted Cruz are making hay out of describing how China can't wait to restrict sales of rare earths to the United States again. This will apparently cripple the Americans both technologically and militarily. One wonders why China hasn't done this yet, with the answer being that such action wouldn't cripple either the US technology or armaments industries, and that it would also have some significant detrimental effects on China's economy.

First, what is the US supposed to be worrying about? Well, the US Geological Survey publicly tells us that global mine production of all rare earths in 2019 was about 210,000 tonnes, of which 132,000 came from Chinese mines. That understates the actual importance of China, because the rare earths are difficult to separate from one another and China does most of that, even for materials mined in the USA and Russia. So the

Chinese are an outsized supplier. But the US only has an apparent consumption of about 13,000 tonnes a year, and much of this is in the form of finished products. So US consumption isn't a huge amount as things go, and that consumption is in the form of finished chemicals or products coming largely from China. If China cuts off the rare earths to the US then they are curtailing downstream processing in China as a result.

Now, let's look at what rare earths go where and why. The story told by an uneducated (or, maybe, ill-advised) press is that the rare earths are "essential" to technology. Can't make a cell phone without 'em, so the story goes. And it is true, they are used in technology devices. In your cell phone, there are a couple of speakers, and they are typically made using small rare earth magnets made from a compound of neodymium, iron and boron (usually referred to as NdFeB). There is another magnet that can vibrate when you get a message or call, also typically NdFeB. And if the screen is LCD then the backlight for the display contains one or more light emitting diodes that produce their light courtesy of a phosphor that contains a tiny amount of rare earths.

If you want to get rid of the rare earth magnets in the phone, you can. They can be replaced with ferrite magnets, made of iron. Now, the magnets will be larger and the phone will need to use more power to get the same volume or the same vibration out of them, but it won't be an appreciably larger amount of electrical energy being used. There is enough volume, weight and power saving to want to use rare earth magnets, if those rare earths stay inexpensive, but if you can't get them then you can't use them.

The LEDs in an LCD backlight are more problematic. There are replacements for the rare earth phosphors, but they don't work as well or we'd be using them today. However, it isn't clear that we'd have to replace them at all. First, LEDs use much less rare earth than fluorescent bulbs for the same amount of produced light. A 2015 paper by Ku, Selter and Loudis from GE Lighting tell us that a single compact fluorescent lightbulb (remember those?) used 340,000 µg of yttrium oxide, 18,000 µg of europium oxide and as much as 30,000 µg of terbium oxide. But a 1 watt "power package" LED bulb, not an uncommon configuration today, uses only 6,300 µg of yttrium oxide, 100 µg of europium oxide and an insignificant amount of terbium oxide. The potential 50-fold decline in demand for yttrium oxide in lighting has led to a very significant decline in demand for yttrium overall, and a serious decline in its pricing. But second, if you don't want to use rare earth phosphors at all, there are options. For example, the organic light emitting diode, or OLED, displays used in Samsung and Apple cellular handsets (among many others) uses no rare earth phosphors, at all.

As for defense, yes, there are rare earths used. The predominant use for rare earths in defense is in small and powerful magnets that, in turn, result in very small and very powerful electric motors. These motors can do things such as move the steering vanes

on smart bombs. But if the supply of the materials to make such motors dried up, and recycling these materials from cell phones and other sources couldn't be arranged, then the end products would need to be redesigned to use iron magnets again, and while this might mean the payload of such a bomb would need to drop by a fraction, it is not the catastrophe that commentators would make it out to be. Again, this is only assuming that recycling can't provide the required materials.

To put it mildly, there is no current evidence that rare earth supply is being stretched. The pre-eminent magnet material of the rare earths is neodymium oxide. So, going back to 2009 and including the "Rare Earth Crisis" of 2010-2012, here is the price of high-purity neodymium oxide from China, in USD/tonne. Next to that, we will put a view of pricing since the start of 2013, just to make the trend more clear.

Exhibit 1 – Neodymium Oxide Pricing (USD/t, 2009-present and 2013-present)

Source: Asian Metal

While the neodymium oxide price is better than it was in 2009, it isn't exactly surging as if there was a secular shortage of material. Over the last seven years it's traded between USD$35 and USD$80 a kg, and if we squint and look for a trend then it is probably down. Nor do we expect a secular shortage of neodymium to get dropped on us soon. And why would that be our conclusion? Because when we walk into Costco or Walmart, we can go and buy a number of toys such as drones and R/C vehicles that contain small and powerful rare earth motors. If there is enough to go around for cheap toys, we can't imagine that we are on the verge of running out.

Want another reason, backed by an industry heavyweight? On 8 October 2020 it was revealed that one of the largest producers of high-quality rare earth magnets in the world, with one of the most important patent portfolios out there, Hitachi Metals, is being sold

by its parent company, Hitachi. You'd think if there was an opportunity sometime soon to have rare earth prices moving sky high, because demand for rare earth magnets from the automotive industry was going to rocket upward, a company as acquisitive as Hitachi would be looking to take advantage. As recently as November 2017, Hitachi purchased Santoku, a well-known company in the rare earth arena that processed and produced finished rare earth chemicals and materials as its main business. Today, Hitachi looks to be leaving the space entirely, and at least one of the rumored buyers is a Chinese company. So much for keeping the best magnet-making technology out of China!

Finally, if you need another reason for being a little less optimistic about rare earth demand and pricing than some breathless reports have suggested, take a look at Tesla. All of their early vehicles, from the Roadster to the Model S to the Model X all used an induction motor that did not contain rare earths. Sure, some of the latest designs from Tesla now use rare earth magnets because such motors give you a small boost in efficiency and thus distance per charge, but at increased price (we presume it's cheaper than truing to add battery capacity). Tesla is working to try to eke out every advantage for an expensive line of vehicles, but this doesn't in any way mean that economy cars and pickup trucks will do the same.

Don't get me wrong, Stormcrow published an analysis of the rare earth sector, pre-COVID, and what we predict is a slow and steady improvement in the industry as demand is boosted by the automotive sector and demand growth continues in other industries. But this will likely provide modest improvements over the next 5-10 years. Companies that are already profitable will likely become more profitable but barring some sort of investor frenzy we don't feel it's likely that a large number of new projects will, or even should, get off the ground.

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