

Industrial Technology

Highlights From Battery Materials 2018

Unless otherwise denoted, all figures shown in US\$

Highlights:

Last week, we attended Battery Materials 2018, a conference co-hosted by Metal Bulletin, Industrial Minerals and MinMetals, held in Shanghai April 18-19. We also had the opportunity to meet with producers and developers in the lithium and cobalt spaces and the managements of several downstream battery materials processors. We toured a hard rock conversion facility under construction, which we shall report on separately. In today's note we provide a summary of what we learned, which leaves us confident that the rapid pace of downstream project development is likely to keep prices of lithium and cobalt high over the coming year.

- **Battery Technology:** While the transition to nickel-rich cathodes remains a closely watched development, all signs are for a more modest penetration of 811 chemistry than previously expected. Challenges with stability as well as declining power density with cycling remain significant enough to curb adoption. Solid-state electrolytes continue to see major R&D efforts, but commercialization remains in the future.
- **Lithium Market:** Lithium demand is on pace to continue to double every five years, as battery costs decline and battery size per vehicle grows. Meanwhile despite announcement of many projects new supplies of lithium chemicals are expected to be at lower volume and quality and higher costs than planned. \$10 BB in investment is needed to bring capacity in line with expected demand over the next decade. Pricing is likely to remain high, as DSO is making no progress in the market and marginal cost of new supply that makes its way into batteries is greater than \$10,000 / t.
- **Cobalt Market:** Despite the promise of nickel-rich technology, adoption remains slow because of safety and performance. Meanwhile, new supply from existing miners is not impacting prices, as much of the material is not hitting the metal market as it is an intermediate salt form. The necessary level of incentive pricing for new supply still remains unclear, and financing of new cobalt-dominant resources remains in its infancy. Pricing is expected to remain high.

Conference Overview: Metal Bulletin organized a comprehensive conference that included perspectives on the critical raw materials for the battery industry, bringing together stakeholders in the lithium, cobalt, nickel, and graphite world. Battery Minerals 2018 was held at the Marriott in Shanghai on April 18 and 19, with nearly 200 participants by our count of the pre-registration list. Apart from the individual one-on-one meetings we participated in, we found the panel sessions for each material most insightful and provide our highlights in today's note. If there was a single conclusion to be drawn, it would be that the markets for lithium and cobalt remain tight and will do so for some time, a positive backdrop for the stocks in the sector.

Battery Technology: On the battery technology front, there are two main themes that are being closely watched, both promising to cut costs of batteries for EV applications significantly as well as reduce the per kWh usage of materials.

- **Nickel-Rich Cathodes:** The outlook for a limited increase in the near term for new supplies of cobalt is driving a push to use the metal more efficiently. As is widely known for those following battery technology closely, the so-called 811 cathode chemistry uses significantly less Co than the older 111 chemistry and additionally boosts the energy density. However, the pace of adoption remains an important question. While using less cobalt is a key driver for the transition to 811, performance declines at a faster rate with cycling than for the older technology where the cobalt acts as a stabilizer. This continues to limit the applications for 811, and raises safety concerns.
- **Solid-state Electrolytes:** R&D is being conducted worldwide within government-funded labs as well as leading battery makers to bring solid state electrolyte technology into broad commercial adoption. Noting how long such development takes, one presenter pointed out that the second generation solid-state technology was introduced as early as 2000, but later generations remain far from commercialization.
- **Longer Range Battery Packs:** Chinese regulations and subsidies aimed to boost range and quality have resulted in automakers installing more kWh of batteries per vehicle. Along with rising EV sales, this is cutting the advantages of a transition to Nickel-rich chemistries, as aggregate demand for both lithium and cobalt continues to grow faster than supply despite an increasingly efficient use of both materials.

Lithium Market Overview: Analysts from both Industrial Minerals and Metal Bulletin provided reviews of supply, demand and pricing in the lithium segment. However, outside of presentations from specific project developers, we found the update by SQM's Senior Commercial VP, Daniel Jimenez, and the panel moderated by Chris Berry, founder of House Mountain Partners, which included Jingwen Sun analyst at Changjiang Securities, David Deak CTO and SVP at Lithium Americas, Joe Lowry, President, Global Lithium LLC, and Anthony Tse, Managing Director of Galaxy Resources, provided the most detailed summary of the current state of the lithium market. Below is a summary of our takeaways from the panel and presentations.

Lithium demand is on pace to continue to double every five years, as battery costs decline and battery size per vehicle grows. Meanwhile despite announcement of many projects actual supply of lithium chemicals is expected to face lower than expected volumes and higher costs. \$10 BB in investment is needed to bring capacity in line with expected demand over the next decade. Pricing is likely to remain high, as DSO is making no progress in the market.

- **Lithium Demand:** Demand for lithium in 2017 was 212,000 t LCE with 23% hydroxide and 60% carbonate. Consistent with our view, SQM expects the market to double every 5 years reaching 475,000 t LCE in 2022 and 900,000 t LCE in 2027, driven rapid growth in EVs. This will drive the growth in hydroxide at a faster pace than carbonate. SQM highlighted that despite years of participation in the lithium market that since 2009 SQM has consistently underestimated demand. On the panel, an earlier presentation about battery technology was echoed: demand is not simply a question of EV growth, but regulations to increase range and quality mean that kWh per vehicle is rising. Interestingly, the Morgan Stanley that called for falling prices assumed 42 kW per vehicle in 2025, yet the current average in China is 45 kWh/vehicle and that includes buses that have much large amounts. This transition in China to longer range and larger vehicles has compounding effect.
- **Lithium Supply:** On the supply of lithium, last year Australia grew to 38% market share, surpassing Chile at 37%. Given the outlook for consensus EV sales, the market will need an additional 600,000 t LCE to 800,000 t additional supply by 2027. This represents a \$10 BB investment, based on a capex intensity from \$13-20,000 per tpa LCE. However, the track record of the industry in bringing on new supply is poor. The lithium panel reiterated the disappointment in Chinese brines, the ramp up at Mt Cattlin, and Olaroz and the failure of RB Energy. Historically, SQM noted that it consistently overestimated the addition of new supply since before 2009. The lithium panel participants all expected the new projects to hit problems associated with cost, yield and volume.
- **Lithium Pricing:** The panel participants agreed that prices would remain high for the foreseeable future, noting that fundamentals have not changed: it remains difficult to build projects and bring them online at design capacity. Since 2015, there was a rapid expansion in the price differential between prices inside China and those for the rest of the world. SQM and ALB have been reporting marked increases and the gap is all but closed. Although softer in recent months, prices are still high and with the RMB down versus the USD the price decline has not been strong outside of China.
- **Marginal Pricing:** Anthony Tse, Managing Director of Galaxy Resources, made the point that approximately half of the global production of lithium chemicals from spodumene now ends up in batteries, which is being produced, including a margin for the players in the supply chain, at \$10,000 / t to \$12,000 / t. That is now the marginal cost for the supply into the battery value chain and should continue to put a floor on pricing should EV demand persist. As a result, in the next 3-5 years 60 to 70% of the demand growth will be supplied by hard rock resources, not brines, which will keep prices high.
- **Project Finance:** There was a lot of discussion of the progress on ♦Nemaska's financing for its Whabouchi/Shawinigan project. The panel viewed the need to reach a streaming deal, and the fact that strategic investors are acting as lead equity orders points to lack of understanding of lithium space and project finance by the investment community. Participants viewed this to be a reflection of "bad info and bad interpretation" by buy and sell side analysts, a relatively unveiled reference to the infamous Morgan Stanley report from Q1/18. It was felt that the streaming deal with Orion Mine Finance reflects a high cost of capital, reflecting the unique development risk related to Nemaska's proprietary technology.
- **Direct Shipment Of Ore (DSO):** DSO remains a recurring theme, but as one participant put it, "LCE out of ground does not equal LCE in a bag." Another participant pointed out that 2 MM t DSO has been imported into China, but only "tens of thousands of t" has been made into concentrate, most of which is poor grade, has high iron and moisture content, and is unsuitable for cathodes. There are large volumes of DSO sitting at ports, and the biggest user is rumoured to have used only 30-40% of it and is reportedly trying to sell the remainder. Questioned why suppliers continue to sell and ship

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DSO, the panel argued that there are many entities in China that try to convert DSO once or twice, and then the shipments to particular buyers, as recorded by publicly available state records, stop. The consensus is that for cathodes, DSO is a stop gap measure as there are 60-80 t of waste for every t of output product, which means DSO is completely unsustainable long term, essentially bringing a huge waste liability into country. Bottom line, DSO has “bad environmental impact, poor recovery levels, and low economics.” Sounds like a “case-closed” situation.

Cobalt Market Overview: The cobalt panel included, Anthony Milewski, Chairman, ♦Cobalt 27, Tony Southgate, Head of Cobalt Marketing at ERG, Simon Bao GM Marketing at Jinchuan Group and Zong Shaoxing, president RamuNiCo Management. The focus on this panel was largely on the impact of a shift to nickel-rich cathodes and near term pricing trends. The shift to a higher percentage nickel-rich batteries (i.e. to 811 chemistries) is ongoing, but as noted above because of both safety (cobalt stabilizes the battery charge/recharge stability) and declining power storage capacity with cycling, the adoption of 811 chemistry is likely to be slower than anticipated. There was general agreement that there would be no outright replacement of cobalt for at least a decade.

- **Cobalt Demand:** In questioning how customers will respond to high prices, one participant pointed out that the response will be limited as doping of the nickel cathode with cobalt in the 811 chemistry means that the savings is closer to a reduction by 10% rather than what is more widely thought of as a 60% reduction. Mirroring what was said in the lithium session, growth of EVs along with growth in the kWh per EV means that even using Co more sparingly suggests large growth in demand ahead. One estimate was that the shift to 811 will result in the CAGR in demand to fall to 18% from 25%, which is still a higher rate than can be met by supply.
- **Cobalt Pricing:** Although the audience gave a collective audible laugh when it was suggested that the cobalt price wasn't high, it was noted that the average price over the long term is \$20/lb and that the more recent \$10 /lb low was artificial. At only \$100 / vehicle, one panel member suggested the market can continue to pay more for cobalt. One panel member noted that the incremental cobalt being produced out of the DRC by large scale producers is in the form of cobalt hydroxide, which goes straight into processing for cobalt sulphate, the feedstock to cathodes, because recovery on this conversion is 90%. As this adds no new cobalt metal, the metal market, where demand is strongest, will likely remain strong and pricing high.
- **Cobalt Supply:** When asked if new cobalt mine projects or existing miners help to cut the deficit, the panel noted that existing nickel miners do not optimize for cobalt production because it wastes nickel units and sometimes PGMs, resulting in lower overall economics. As for new projects, one participant pointed to the most advanced project, eCobalt's Idaho Cobalt Project, still needs to complete financing. Noting that cobalt purchased today eventually makes its way into a vehicle approximately 12 months from now means that today's purchases reflect pent up demand. As a result, expectations are for even larger deficits looming out to 2022.

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