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Skills shortage to restrict battery materials supply growth

I was quite surprised on last month's *Recharge* podcast to hear Suzanne Shaw, Roskill's graphite analyst, suggest that graphite demand was going to conservatively increase at a CAGR of 19% over the next several years and could grow by as much as 25-30% per

annum. Similar figures have been mooted for lithium, with several forecasters calling for demand growth in excess of 20% pa for over 10 years.

On the face of it, this sounds brilliant, but you have to wonder if it's actually attainable? These sort of numbers

sound like the ones we were hearing for bulk materials and base metals at the beginning of the China event 15 years ago. And, in that event, the industry singularly failed to make its supply growth targets. If we go back and analyse production growth over 2004-13, we find that copper managed an average of 3% pa and iron ore 8%.

Continued overleaf

Focus...Skills Shortage in Battery Materials

And, let's face it, producing iron ore isn't the toughest job in the world. For DSO, you just need to dig the stuff up, crush it and move it. It's more of an infrastructure play than a mining one. But once you get outside the realms of DSO, that's where the problems start. Because I can't name one project that started in the 2004-13 period that involved upgrading ore that was successful.

And much of the failure of those projects was down to a shortage of skills. The industry simply didn't have enough (or any) people who had the ability to bring on highly complex operations on time and on budget. And it was the same throughout the whole mining industry over that period.

In the same podcast last month, Suzanne Shaw said one of the largest risks she saw to an early stage graphite investment was the management team. She went on to mention that since graphite was such a small industry and that individual projects were unique, there was massive development risk in graphite.

That has indeed been a problem across the wider mining industry over a long period of time and is one of the key risks for battery materials going forward. During the China event we saw all sorts of failures. They might have been down to management teams assuming that since they had experience in other areas of mining they could build a project in a different segment (Northland Resources), people trying to bring skills learnt in a Developed Country project to an Emerging Country project (African Minerals, Anglo American), underestimating the complexity of the processing of an orebody (Northern Iron), trying to recycle another plant

(Kenmare Resources), assuming that because they had operating experience they would be able to develop a project (Mineral Deposits), and the list goes on.

What is well-known in this industry is that battery minerals projects are an order of complexity higher than a bog-standard mining project. What comes out the end of a battery minerals project has to have consistent chemistry over large volumes over a long period of time.

New projects so far in battery minerals have not really gone to plan. Orocobre (ASX:ORE) took years longer than expected to reach targeted production and Galaxy Resources (ASX:GXY) never has. Nemaska Lithium (TSX:NMX) might not make it into production at all, and all of the Australian hard-rock projects have struggled to hit their targeted recoveries over the long-run. In graphite, Syrah Resources (ASX:SYR) is struggling with a pricing structure for which the project was never designed and has its own problems with recovery.

On this month's *Recharge* Chris Evans, MD of Birimian Ltd (soon to be Mali Lithium – ASX:MLL), who was COO of Altura Mining (ASX:AJM) during the building of its project, highlights that a key issue in hard rock projects is the recovery of fines to the concentrate. This is one of the issues behind the lower than expected recoveries and the fixing of this impacts operating costs. He intends to apply his hard-won knowledge from the Pilgangoora project build to his current company.

So, do we really think that the battery materials industry will be able to make production growth rates of 15-20% y/y over the long run? It seems highly unlikely, not just from a practical point

of view because of the skills shortage, but also because of the current lack of capital available to the industry.

If the industry as a whole can't make its supply growth rates, and demand growth does hit forecast levels, it implies stronger for longer pricing, which will be a positive to investors. Investors, however, will need to be careful with regards to which projects they select to invest in. I can only recount one project from my coverage universe in the last cycle that came in on time, on budget. Here's hoping that there are more this time round...

Lithium clay: Desperation option?

When Bacanora Lithium (AIM:BCN) announced last month that it had partnered up with Ganfeng Lithium (SHE:002460) to advanced its Sonora lithium clay project in Mexico I must say that I came down with a bit of a twitch!

Clay was supposed to be the next big thing for lithium. We'd had hard rock but now we could develop clay deposits. Or so the story went. Until the middle of last year. That was when things started not to look so good for clay. That was when Bacanora started to try to put the funds together to develop Sonora, the first clay project out of the blocks.

The feasibility study for Sonora, released in December 2017, highlighted the project's resource of 8.7Mt of LCE, low stripping ratio and 19 year mine life which, for an upfront capex of US\$420m would allow production of 17.5Ktpa of Lithium Carbonate at close to best in class operating costs (net of a potassium sulphate credit) of US\$3418/tonne.

Focus...Lithium Clay: Desperation Option?

Sonora project FS key parameters

Initial capital cost	US\$m	420
Stage 2 capital cost	US\$m	380
Gross LoM op costs	US\$/t Li ₂ CO ₃	3910
Net LoM op costs	US\$/t Li ₂ CO ₃	3418
Stage 1 Li ₂ CO ₃ prodn	Ktpa	17.5
Stage 2 Li ₂ CO ₃ prodn	Ktpa	35.0
Stage 2 K ₂ SO ₄ prodn	Ktpa	30.0

Source: Bacanora Lithium

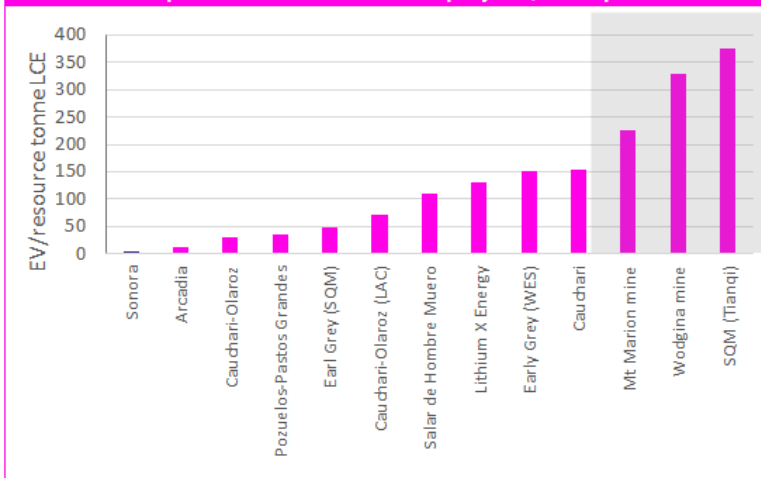
Contingent with the FS release a new Chinese investor came in to take a 19.9% interest in Bacanora for £31.2m (US\$42m). So, where did it all go wrong? Firstly, with lithium prices showing signs of topping out, Chinese investor NextView promptly disappeared. But all was not lost, as RK Mine Finance came up with a US\$150m debt facility and the company secured commitments for US\$65m from the State General Reserve Fund of Oman and US\$25m from offtake partner, Hanwa. It then embarked on a US\$100m equity raise in July 2018.

And *that* was where it all went wrong. Because the lithium market was turning over and suddenly an experimental clay project in a weakening market didn't look so attractive.

The thing about lithium clay deposits is that grades are low. Reserve grades of 3480ppm Li (0.75% Li₂O) don't compare too favourably with Australian hard rock projects at 1.2+% Li₂O and, given that clays and micas are really quite deleterious parts of hard rock processing, there is considerable scepticism in the industry about whether these projects can actually work.

Another key aspect here is that the lithium industry in general hasn't exactly covered itself in glory in bringing new projects into production on time and on budget. In hard rock, Galaxy (ASX:GXY) had a real 'mare at Mt Cattlin and in brine Orocobre (ASX:ORE) has failed to impress at Olaroz. Subsequent to the fundraising failure at Bacanora, Nemaska Lithium (TSX:NMX) experienced a budget blow-out.

Take-out multiples for lithium mines and projects, 2017-present



Source: Company data, BM Review

And all of these are existing technologies. So how would a small company do with an untested technology? That simply wasn't a chance that most financial investors were prepared to take. Certainly not at that point in time.

But it seems that it *is* a chance that Ganfeng is willing to take. Or is it? The answer is – it is, but at a price. For the 22.5% stake that Ganfeng is buying in Sonora it is paying c.US\$10m. That equates to an EV/resource value of US\$4.8/t of LCE for the whole deposit. That is the lowest take out multiple over the past two years. In fact, it's a fraction of the next lowest.

So, what does that say about where Bacanora is now? There's no doubt that they've got a powerful JV partner

and shareholder. But they've derived very little financial value from that deal. Ganfeng has spent tuppence and now effectively has an option on whether to develop that orebody. And we think that's what they're after.

Because at current lithium prices, why spend US\$420m on an experimental project? It's just not needed. As lithium bears have observed, there are plenty of projects out there in existing

technologies (hard rock, brine). They might as well get built first. It's only going to be if there is a massive lithium shortage and prices pop that people will start thinking about clay. So clay projects are really an option on the lithium price. At current levels, they're not in the money. But they might very well be again in a couple of years.

And there's lots of them out there. In the table below I've lumped Rio Tinto's (LSE/ASX:RIO) Jadar project in with the clay projects, because it might as well be. I would be very surprised if the project ever gets developed. A less RIO-like project it's difficult to envision – a large, high capex, experimental technology in a sector that might be oversupplied. Hmmm

Key sediment-hosted lithium projects

Project name	Location	Operator
Big Sandy	Arizona	Hawkstone Mining (ASX:HWK)
Clayton North	Nevada	Jindalee Resources (ASX:JRL)
Clayton Valley	Nevada	Cypress Development (TSXV:CYP)
Jadar	Serbia	Rio Tinto (LSE:RIO)
McDermitt	Nevada	Jindalee Resources (ASX:JRL)
Rhyolite Ridge	Nevada	Ioneer (ASX:INR)
Sonora	Mexico	Bacanora Lithium (AIM:BCN)
Thacker Pass	Nevada	Lithium Americas (TSX:LAC)
TLC	Nevada	American Lithium (TSXV:LJI)
Zeus	Nevada	Noram Ventures (TSXV:NRM)

Source: BM Review

US to streamline battery material permitting

The US Congress has moved closer to developing its national battery supply chain policy with the American Mineral Security Act, which is aimed at helping to streamline regulation and permitting requirements for lithium, graphite and other battery minerals.

As we observed in *Is self-sufficiency in battery materials a pipe dream for Europe & US?* (2019 Issue 4, p2-3) the US has got a lot of catching up to do when it comes to developing enough natural resources to supply its needs.

It seems to be more the threat of China, rather than a specific need to think ahead, that has stimulated lawmakers to move on this now. Whatever the reasons, it is likely to be a positive move, both for the nascent US battery supply chain and for President Donald Trump's key focus area of employment. It presumably won't have escaped lawmakers that primary industries such as mining can be extremely labour-intensive.

Of course, making it easier to mine doesn't address another of the US's major problems – that if they want to establish an EV manufacturing industry they will need to build battery plants. Currently there are only two Megafactories planned or under construction in the US. Maybe Congress needs to take a leaf out of Europe's book and encourage some more...

Musical chairs in cobalt

It seems to be musical chairs all round in the world of cobalt refineries this month. No sooner had news arrived that Freeport-McMoran (NYSE:FCX) and Lundin Mining (TSX:LUN) had

agreed to sell their Kokkola refinery in Finland to Umicore (EBR:UMI) for c.US\$150m, it was reported that Glencore (LSE:GLEN) and First Cobalt (TSXV:FCC) have signed an MOU whereby GLEN can “support” FCC in the restart of its refinery in Ontario, Canada.

Support in this context apparently refers to supply of material (enough to support annual production of 2-2.5Ktpa of cobalt in sulfate) and possibly financing.

The FCX/Lundin-UMI deal seems a bit more complex with FCX due to separate its cobalt business to allow UMI to acquire the refinery and cathode precursor business while the miners retain the fine powder, chemicals, catalysts and ceramics and pigments businesses.

In terms of scale, the difference is significant. Benchmark estimates that Kokkola produced c.13Kt of cobalt in 2018 making it a strategic asset as the largest cobalt refinery business outside China. With UMI set to utilise the refinery to supply its new cathode plant in Nysa, Poland this looks like a great piece of business for the specialty chemicals producer.

It's not a bad bit of business for FCX/LUN either. The refinery was distinctly non-core, following FCX's sale of its share in Tenke Fungurume. The potential for the voiding of a long-term contract between the Tenke mine and the refinery for supply of raw material had previously been a stumbling block, but given the numerous supply additions in DRC this year this is unlikely to have such a significant impact and indeed Umicore has subsequently agreed a contract with Glencore for supply of raw materials.

DRC subcontracting limits to hit cobalt production?

In a raft of measures recently announced by the Government, companies in the DRC are being asked to ensure that subcontractors they hire are domestically-owned.

DRC's subcontracting regulator ARSP plans to launch a campaign in the near future to identify all subcontractors and make sure they are fully registered. Those that do not register will be “totally excluded from the market place”.

Mining companies run the risks of fines if they are found to be employing a non-eligible company.

China and Albemarle to revolutionise Li extraction

A number of reports suggest that a 15-year research program by the Chinese Academy of Sciences has resulted in a new technology for lithium extraction from brine. Details on the actual tech are extremely sparse however with only the soundbite that production costs could be as low as Rmb15,000/t (US\$2200/t). We assume it is a form of direct lithium extraction but pending further details, we're not holding our breaths!

But the Chinese aren't the only ones who are bringing through new technologies for lithium extraction. Albemarle (NYSE:ALB) is also in on the act.

CEO Luke Kissim revealed details of the plan which would involve a 30% increase in output from its Atacama operation without increasing the amount of brine extracted. Earthworks are due to commence in Q3/19 with commissioning of the project due by H2/21. While the company has kept

totally shunt about the technology involved with the increase, it has noted that it has successfully tested the process in the lab and in the field.

We'll take both claims with a pinch of salt until we see full evidence that they can work on a commercial scale...

Galaxy refocusing on hard rock/downstream?

We discussed last month Galaxy Resources' (ASX:GXY) travails at its Mt Cattlin mine in Western Australia. These look certain to have cost GXY's previous CEO, Anthony Tse, his job as the Board brought in Iluka's head of resource development, Simon Hay, to get the operation back on track.

However, GXY has now got its cheque book out and taken a A\$22.5m strategic stake in recently-merged peer Alliance Mineral Assets (ASX:A40), operator of the Bald Hill mine. Given its issues with finding a partner for its the Sal de Vida project in Argentina, it looks like GXY has decided to double down on WA.

The deal raises the potential for "cooperation" between the two companies. While this may include Galaxy's experiences at Mt Cattlin, might it also include Alliance's experiences at Bald Hill, given that that mine has already achieved recoveries in the March quarter of 68%, higher than Galaxy has ever achieved at Mt Cattlin!?

The deal is positive for Alliance as well, because it gives it the funds it needs to accelerate both its plant upgrade and exploration activities.

It's clear that many analysts feel that now that ex-CEO Anthony Tse has been relieved of his operational concerns, he's not going to be sitting on his hands, particularly with GXY all cashed up after the Posco deal. Towards the end of

May, GXY was forced to issue a response to media speculation that it planned to buy into a downstream project in China. Its denial was not exactly convincing!

Going downstream would likely be a good decision for GXY and it's a decision that many hard rock miners have already made. But I'm not convinced that investing in a Chinese project is the right way for them to go. Given current trade tensions maybe it would be better to invest in a domestic project? Out of left field, maybe the fact that most of GXY's production is already exposed to China would make it want to diversify its exposure. Maybe an investment in a plant in Europe or the US would be just as good an idea?

Livent to refocus on EVs

US lithium maker Livent (NYSE:LTHM) announced plans to shift its customer base over the next 12 months. Reporting poor Q1/19 results (see Company News) its CEO Paul Graves told Reuters that the company will shift away from its traditional markets of greases and other industrial products to focus on the growing EV market.

He also said that he regretted the Company's decision to move into hydroxide as fast as it has. Demand for hydroxide has been depressed in recent months suggesting slower than expected take-up of low cobalt battery chemistries.

The company had previously reported that it has shifted sales much more to Korea and Japan this year after failing to secure the prices it wanted in China.

Tesla warns of upcoming raw materials shortage

Tesla (NASDAQ:TSLA) got a lot of column inches this month with its

warning of looming supply challenges in battery minerals.

The company distanced itself from the remarks (attributed to Global Supply Manager Sarah Maryssael), suggesting that they referred to long-term expectation rather than an "immediate consequence".

Given the recent moves by automakers including VW, BMW and Toyota, it's probably fair to say that this is a widely shared view in the auto industry. Just not in the equity market...

REE prices go ballistic on China trade tensions

Pensana Metals (ASX:PM8) reported that Neodymium prices rose towards US\$50,000/t on the Shanghai Market following a visit by President Xi Jinping to a major REE maker.

The People's Daily said the answer to the question of whether rare earths could be a "counter weapon" for China to "hit back" against pressure from the US was "no mystery", implying that China is ready to use REEs as a weapon in its ongoing trade war with the US.



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It could be a “Trump card” [Ed: sorry, *couldn't resist*] for the Chinese. It's not like China doesn't have history for restricting rare earth exports when countries disappoint them. During a diplomatic stand-off after a Chinese trawler collided with Japanese patrol boats in 2010 China briefly limited exports of REEs to Japan.

Hopefully it's an important wake up call for governments. Trade restrictions or not, the Western World needs to invest in its own REE projects. While China still accounts for nearly 80% of global supply of REEs, it remains in the box seat and as the world grows more high-tech the reliance on these critical metals increases.

Malaysia backs down on Lynas plant

It seems that Malaysia has got what it wanted after Lynas Corp (ASX:LYC) announced plans to build a cracking and leaching plant in Australia to alleviate Malaysian regulators' concerns about waste disposal from its existing processing plant.

The plans were unveiled as part of A\$500m (US\$347m) expansion plans which should see the company's NdPr production grow to 10.5Ktpa.

In reaction to Lynas' plans, the Malaysian Prime Minister Mahathir Mohamad is reported to have said “we think we'll have to renew the licence”. So not exactly excited. But Malaysia does not want to lose such a large investment in the country and now that there are concrete plans in place to remove the waste, there is no reason for the country to continue the crack down.

Malaysia plans meetings this month to discuss with Lynas officials the removal of existing waste.

First Quantum to reopen Ravensthorpe; BHP keeps NiWest

The concerns about availability of Class I nickel have finally resulted in some movement among the majors but low nickel prices in the near-term may still affect what happens.

Roskill reports that First Quantum Minerals (TSX:FM) is investigating the possibility of re-starting the idled Ravensthorpe nickel operation which it acquired in 2010, started in 2011 and put under care and maintenance in 2017.

Restart costs are relatively low at US\$10m and operations could resume as early as Q1/20 if the company gets its skates on. In 2017, Ravensthorpe produced 17.8Kt of contained nickel.

It also looks like BHP Billiton (ASX:BHP/LSE:BLT) has done a swift *volte-face* on its Nickel West operations which it previously attempted to sell.

The company has now decided that its exposure to battery materials makes the business much more exciting than it had previously thought. With 70Ktpa of nickel production, a nickel sulphate plant under construction and the aspiration to get to 90Ktpa, you can follow BHP's thinking.

Australian Vanadium ties up with Ultra Power Systems

Australian Vanadium (ASX:AVL) reported that it entered into a JV with energy storage company Ultra Power

Systems (UPS) to develop the Coates vanadium project in Western Australia.

Although the value of the deal is not high, this is the first downstream collaboration that we are aware of in the vanadium space and could be relevant. UPS plans to evaluate the project with a view to producing a vanadium electrolyte for VRF batteries.

Given that AVL can elect to accept shares in UPS, if the project is successful, it would give Australian Vanadium shareholders a holding in an energy storage business which could be a unique asset.

Further moves into LIB recycling

Quebec recycling company Lithion reported that it has developed a process to recycle 95% of old lithium-ion batteries into new ones. It plans to open a pilot factory in Montreal later this year to process up to 200 tonnes of used batteries per year.

Canadian start-up Li-Cycle is also looking to get in on the act in LIB recycling. Its hydrometallurgical pilot plant currently processes up to one tonne of batteries per day but it's starting out on a global expansion to increase capacity to 17tpd. It can recover 80% of all materials included in a battery including lithium, nickel and cobalt.

The two join a number of other developers looking to get their technology into wider use as well as existing players in the industry such as Umicore (EBR:UMI) and GEM Company of China.

Raw & Intermediate Materials: Exploration Roundup

UEX continues strong results from West Bear

The month's standout results came from UEX Corporation (TSX:UEX), which regularly features in our Drill Bit segment, highlighting the best of the sector's exploration results. It continued its run of good exploration news from the West Bear project in Saskatchewan, Canada. The project boasts one of the shallowest cobalt resources in Canada and is open along strike.

Elsewhere there were strong results for Poseidon Nickel (ASX:POS) which is targeting brownfield exploration to assess the Black Swan and Silver Swan projects in Western Australia. It recorded a broad intercept below the existing open pit at Black Swan.

Frontier Lithium (TSX:FL), also a previous member of our Drill Bit segment, published the final results from its maiden pegmatite discovery at Spark, within its PAK project. All five holes had broad, high-grade intercepts. With a PFS for the project now complete and a pilot concentrator plant planned, FL is pushing forward rapidly with project development.

Elsewhere in Lithium, the standout was Galan Lithium (ASX:GLN) which reported strong results from the Candelas brine project in Argentina. It has now confirmed the existence of brine in holes 5 and 6 of its current drill

May 2019 drilling news

Date	Operator	Project	Location	Status	Depth	Key intercept	Hot or not?
Cobalt							
22-May-19	UEX Corporation (TSX:UEX)	West Bear	Canada	PR	55.5m	8.3m @ 0.33% Co & 0.75% Ni	🔥🔥🔥
Graphite							
06-May-19	Comet Resources (ASX:CRL)	Springdale	Western Australia	R	32m	7m @ 18.4% TGC	🔥
06-May-19	Lomiko Metals (TSXV:LMR)	La Loutre	Quebec	PR	51m	116.9m @ 4.8% TGC	🔥
Lithium							
06-May-19	Hawkstone Mining (ASX:HWK)	Big Sandy	Arizona	PR	12m	44m @ 2040ppm Li	
09-May-19	Liontown Resources (ASX:LTR)	Kathleen Valley	Western Australia	PEA	277m	48m @ 1.5% Li2O	🔥
15-May-19	Savannah Resources (AIM:SAV)	Mina do Barroso	Portugal	PEA	89m	45m @ 1.67% Li2O	🔥
20-May-19	Liontown Resources (ASX:LTR)	Kathleen Valley	Western Australia	PEA	209m	90m @ 1.3% Li2O	🔥
22-May-19	American Lithium (TSXV:LI)	TLC	US (Nevada)	PR	27m	57.9m @ 1194ppm Li	
29-May-19	Piedmont Lithium (ASX:PLL)	Piedmont	US (N. Carolina)	PEA	27m	14.9m @ 1.76% Li2O	🔥
29-May-19	Galan Lithium (ASX:GLN)	Candelas	Argentina	PR	220m	160m @ 491-856 mg/L	🔥🔥
30-May-19	Frontier Lithium (TSX:FL)	PAK	Canada	PFS	66m	58.7m @ 1.58% Li2O	🔥🔥
Nickel							
06-May-19	Poseidon Nickel (ASX:POS)	Black Swan	Western Australia	RS	900m	223.1m @ 1.02% Ni	🔥🔥
27-May-19	Poseidon Nickel (ASX:POS)	Silver Swan	Western Australia	RS	131.5m	7.48m @ 10.89% Ni, 0.17% Co	🔥🔥
Vanadium							
21-May-19	Vanadian Energy Corp (TSXV:VEC)	Huzyk Creek	Canada	PR	300m	13.77m @ 0.18% V2O5	

Source: Company data, BM Review. Status: PR: pre-resource; R: resource evaluation; RS: Re-start

program and has recently received stage 2 drill permits for the project.

A tale of two scales in lithium

Sorry for the awful pun, but it really is a men vs boys scenario in lithium this month. On one hand is the gargantuan Manono project in DRC with a resource of 400Mt and a high resource grade as well, and then you have the Finniss project in Australia's Northern Territory which is eking out monthly resource upgrades with an aim to reach 10Mt.

If you just look at resources, you would suggest that Savannah Resources' (AIM:SAV) Mina do Barroso project is closer to Finniss than Manono in terms of its developability, but you would be wrong.

Because Mina do Barroso has a massive infrastructure advantage over

Manono. Located just 138km from the port of Mai Leixoes, with the Portuguese government keen to promote development of a lithium hydroxide plant in the country, and the EU sinking millions of dollars into developing a battery value chain in Europe, we believe that Mina do Barroso has a better chance of being built than either of the other projects.

Which is not to say that Manono is not world-class. Because it is. But with a 2000km trucking distance (or potentially trucking, rail, barging) there are a lot more moving parts to deal with than there are Mina do Barroso which, although smaller and lower grade, is likely to be considerably simpler.

While Finniss is closer to the coast even than Mina do Barroso, I do worry about its small size and not particularly high grade. The defined resources so far are

Last month resource roundup

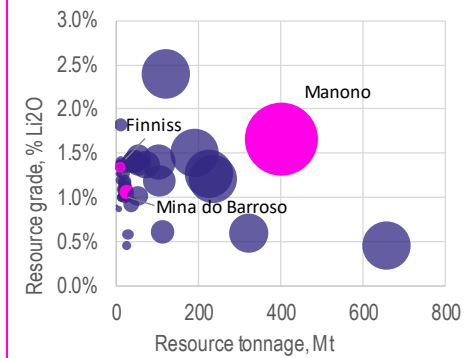
Date	Company	Ticker	Main commodity	Project	Location	Country	Status	P&P Reserve Mt	MII Resource Grade %	MII Resource Mt	MII Resource Grade %	By-product	BMR
06-May-19	Core Lithium	ASX:CXO	Lithium	Finniss	NT	Australia	Upgrade	-	-	9.63	1.3% Li2O	-	Jun-19
07-May-19	Artemis Resources	ASX:ARV	Nickel	Ruth Well	WA	Australia	Maiden	-	-	0.152	0.63% Ni	Cu	Jun-19
08-May-19	AVZ Minerals	ASX:AVZ	Lithium	Manono	-	DRC	Upgrade	-	-	400	1.65% Li2O	Sn, Ta	Jun-19
22-May-19	Lithium Australia	ASX:LIT	Vanadium	Youanmi	WA	Australia	Maiden	-	-	185	0.33% V2O5	-	Jun-19
22-May-19	Bushveld Minerals	AIM:BMN	Vanadium	Vameto	Bushveld	South Africa	Upgrade	48.4	0.62% V2O5	186.7	0.78% V2O5	-	Jun-19
31-May-19	Savannah Resources	AIM:SAV	Lithium	Mina do Barroso	-	Portugal	Upgrade	-	-	27.0	1.06% Li2O	Ind mins	Jun-19

Source: Company data, BM Review

Raw & Intermediate Materials: Exploration round-up... / Development news

spread over a number of small and geographically discrete pegmatite occurrences and its size and grade doesn't benchmark well against its peers. I always say to developers 20Mt at in excess of 1% Li₂O is a minimum for a hard rock project. Finnis has some way to go to get to that level.

Featured projects vs BMR HR lithium universe



Source: Company data, BMR

Vametco a tier 1 resource

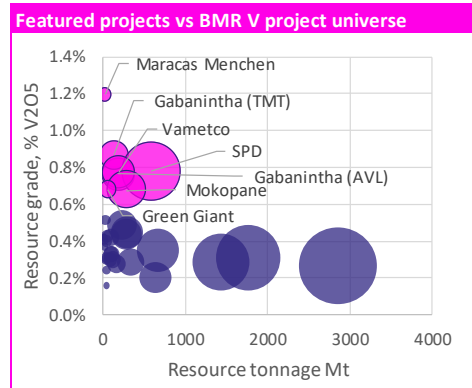
Bushveld Minerals' (AIM:BMN) updated resource and reserve estimate for the Vametco mine emphasises once again the gulf in class between existing vanadium producers and many of those developers which want to become producers.

Vametco, one of BMN's three assets has an updated resource of 186.7Mt @ 0.78% V₂O₅ (138Mt attributable to Bushveld) and a whole rock grade of 0.62% V₂O₅ for its reserve.

This is actually quite a lot lower grade than Largo Resources' (TSX:LGO) Maracas Menchen, but that is a substantially smaller orebody with a significantly smaller contained tonnage.

We are tracking 51 vanadium exploration and development projects globally currently. Only Tando Resources' (ASX:TNO) SPD project as well as Australian Vanadium's (ASX:AVL) and Technology Metals Australia's Gabanintha projects have

comparable tonnage and grade to Vametco.



Source: Company data, BMR

The rest of the Vanadium project universe has an average in-ground V₂O₅ grade of 0.36%, not really comparable

Development news

Cobalt

First Cobalt Corp (ASX:FCC) reported that it signed a MOU with **Glencore** (LSE:GLEN) to supply cobalt feedstock (sufficient to produce 2-2.5Ktpa of cobalt in sulfate) and financing to recommission the First Cobalt refinery in Ontario, Canada.

Global Energy Metals (TSXV:GEMC) reported that it entered into a strategic technological initiative with **Canada Cobalt Works** (CVE:CCW) to utilise the Re-2OX process to advance GEMC's projects. The deal was to have involved CCW taking a 2m unit position in GEMC at C\$0.075/sh but this was subsequently pulled.

Graphite

Black Rock Mining (ASX:BKT) gave details on its price framework in offtake agreements which has been agreed by four out of five offtake partners. Benchmark pricing varies between US\$1117/t for regular 94.5-95.5% concentrate up to US\$2161/t for ultra high grade (>99%) concentrate on a CIF China basis. It has also signed two

new offtake agreements with Qingdao Yujinxi and Yantai Jinyun for three years of supply up to 50Ktpa.

Gratomic (TSXV:GRAT) reported it entered into a definitive offtake agreement with Phu Sumika for 7.5Ktpa of graphite concentrate from its Aukam mine in Namibia, to be sold into Europe. The product would range from 80-99.9% carbon with prices ranging from US\$500-2800/t depending on grade and moisture content.

Hexagon Resources (ASX:HXG) released a scoping study for Advanced Graphite Processing which would allow it to capture significant downstream margins. The study envisages building a 1Ktpa Qualification plant and a commercial plant with initial capacity of 20Ktpa with capital costs of A\$23-27m for the pilot (depending on site) and A\$118-135m for the commercial plant, with operating costs of A\$2248-2618/t and weighted average basket selling price of A\$8487/t. The company hopes to commence development of the plant in H1/20 and has suggested that a US site is preferable.

Renascor Resources (ASX:RNU) published an optimised development plan for its Siviour project in South Australia, which more than quadrupled the stage 1 processing capacity described in the PFS, raising stage 1 graphite concentrate production to 83.4Ktpa for upfront capex of US\$78m and at opex of US\$344/t. Stage 2 (years 4-40) would raise production to 145Ktpa at an additional capital cost of US\$56m and opex of US\$367/t (years 4-10). It is currently finalising a DFS for the project.

Talga Resources (ASX:TLG) published a PFS for its Vittangi project in Sweden

which supports a 22-year LoM project producing 19Ktpa of Talnode-C anode product (5Ktpa stage 1) for upfront capex of US\$27m (stage 2: US\$147m) and opex of US\$1852/t.

Triton Minerals (ASX:TON) has received formal approval from the Mozambique government for the 60Ktpa Ancuabe project over a 25-year life of mine.

Lithium

AVZ Minerals (ASX:AVZ) published an upsized scoping study for its Manono project in DRC for a 5Mtpa throughput operation producing 1.1Mtpa of 5.8% spodumene concentrate at an FOB opex of US\$323/tonne FOB Dar es Salaam and for a capex of US\$380-400m.

IronRidge Resources (AIM:IRR) published metallurgical test results from its Ewoyaa project in Ghana which support production of a 6% concentrate with recoveries up to 85% using Heavy Liquid Separation at a coarse 6.3mm crush.

Lithium Australia (ASX:LIT) has signed a LOI with Chinese battery manufacturer DLG, one of China's top-10 battery manufacturers, to provide the Australian market with lithium batteries and cooperate on future technologies.

NRG Metals (TSXV:NGZ) signed a strategic alliance with Lilac Solutions to gain access to its new ion exchange technology (IX Process) for lithium extraction which can result in a 90% lithium recovery from brine, double that of evaporative technology. The partnership will commence with pilot plant work at the Hombre Muerto North project in Argentina.

Pure Energy Minerals (TSXV:PE) agreed an earn-in agreement with Schlumberger (NYSE:SLB) whereby the services company can acquire up to 100% of PE's Clayton Valley project in Nevada, US. PE would be entitled to a residual 3% NSR on the project.

Other materials

Neometals (ASX:NMT) published a revised DFS on a vanadium production pathway for the Barrambie VTM project which would produce 6.3Ktpa of FeV over a 15 year LoM for a capex of A\$692m (US\$484m) and operating costs of US\$26/kg of V in FeV.

Pursuit Minerals (ASX:PUR) published scoping studies for its Airijoki (Sweden) and Koitelainen (Finland) V projects targeting production of vanadium-rich magnetite concentrates. The Airijoki study envisaged production of 1.6% V2O5 concentrate with the Koitelainen study targeting 2.5%. No capex and opex estimates were published.

RNC (TSX:RNX) published an updated FS for the Dumont Ni-Co project in Quebec, Canada, which supports a 30 year project producing 39Ktpa of nickel and 1.2Ktpa of cobalt for a capital cost of US\$1.02bn and AISC of US\$3.80/lb (net of bpcs).

Tando Resources (ASX:TNO) published a scoping study for the early stage of its SPD vanadium project in South Africa which would involve production of 0.79Mtpa of 2% V2O5 concentrate over 25 years LoM for upfront capex of US\$18.8-20m and opex of US\$11.7/t of concentrate, at mine gate.

Technology Metals Australia (ASX:TMT) entered a non-binding MOU with NMC Ningxia Orient Group Company Ltd (CNMNC) to buy 2Ktpa of V2O5 from the Gabanintha project for a minimum of three years with a three year option, on a take-or-pay basis.

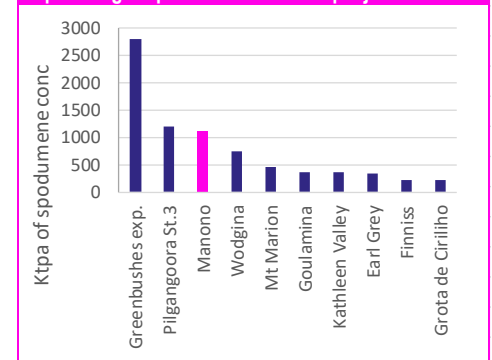
VanadiumCorp Resources (TSXV:VRB) agreed an earn-in agreement with an unnamed private company whereby the PC can earn a 75% interest in the Iron-T VTM project in Quebec, Canada by spending US\$5m on exploration and US\$1m in cash and stock payments to VRB within 4 years and earn an additional 10% by completion of a PEA and 15% by completion of a positive PFS leaving VRB with an offtake of 200Ktpa of VTM concentrate for 15 years.

Development round-up

Manono turning into a "monster"

AVZ Minerals' (ASX:AVZ) upscaled scoping study for the Manono project suggests that a 1.1Mtpa production level for spodumene concentrate is possible for the project over an extended life. That would make it one of the world's largest HR lithium mines. Only Pilbara Minerals' Pilgangoora stage 3 expansion at 1.2Mtpa and Talison's Greenbushes expansion to 2.8Mtpa would surpass it.

Top 10 largest planned HR lithium projects



Source: Company data, BMR

So Manono is a real project. But the bottleneck is, and continues to be, infrastructure. There are a number of landlocked African projects with eye-catching resource potential, but the issue is getting it out of the region.

When we interviewed Nigel Ferguson, AVZ's MD, for the **Recharge** podcast in

Raw & Intermediate Materials: Development round-up... / Financing round-up

April, we specifically asked about this, given AVZ's stated need to move its product 2,000km to get to port. For the 450Ktpa production target they were then targeting he was suggesting that 25 trucks per day would be needed, so for 1.1Mtpa that figure would be more than doubled. That's a lot of trucks, and on public roads as well.

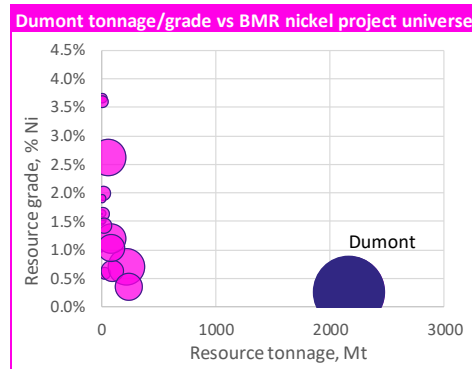
I would suggest that a more reasonable solution for AVZ would be to find a partner to build a lithium hydroxide plant adjacent to the mine. We discussed this solution also and Nigel confirmed that all the key raw material prerequisites for a hydroxide plant (sulphur, electricity) are available.

Converting to lithium hydroxide near the mine site would reduce transportation tonnages by c.85%, making road transfer of material much more viable. In addition, transportation costs would be a significantly lower percentage of total costs and, indeed, likely selling prices of lithium hydroxide than spodumene concentrates. Currently concentrate prices of c.US\$620/tonne compared with hydroxide prices of c.US\$14000/tonne.

Dumont FS underwhelms

RNC (TSX:RNX) published its long-awaited update of the Feasibility for

the Dumont project in Quebec this month. While the company highlights that its production forecasts make it one of the largest nickel projects in the world, it has to be. Because it's uber low grade.



Source: Company data, BMR

The project has a total resource grade of 0.26% nickel (and 0.01% Co) and a reserve grade of 0.27%. So, while it's planned to have c.50Ktpa of nickel production by year 8, this comes at the cost of very high upfront capex of US\$1018m and LoM capex of US\$2230m and LoM AISC of US\$8,280/t or US\$3.80/lb) and given that current LME nickel prices are of the order of US\$11,860/tonne that doesn't leave too much breathing space. Which explains the project's low IRR of 15.4% after tax.

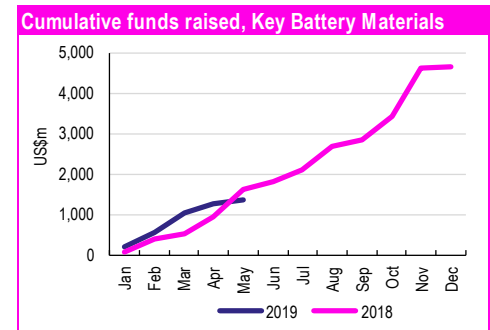
There's no doubt that this can be a world-class project, but not realistically

at current nickel prices. Given that the industry historically underestimates capex, one has to assume that the cost will be higher than expected and, with nickel prices where they are, that leaves very little breathing room. Nickel prices would need to be closer to US\$15,000/t before the numbers are likely to stack up on this project, in our view.

Financing/M&A round-up

Lacklustre month for financings

It wasn't a great month for financings in the battery material space in May, with only US\$75.6m raised and 13 deals in all. The Lithium sector dominated once again, but cumulative activity has now moved below 2018 levels, highlighting the ongoing malaise in the capital markets.



Source: Company data, BM Review

Last month financing round-up

Date	Company	Ticker	Commodity	Amt raised local CCY	Unit	Placing price local CCY	Use of funds
02-May-19	American Pacific Borate & Lithium	ASX:ABR	Lithium	A\$3.1m	Shares + 1/2 option	A¢18	Fort Cady project
07-May-19	Walkabout Resources	ASX:WKT	Graphite	A\$3.1m	Placement	A¢23	Lindi Jumbo project
10-May-19	European Lithium	ASX:EUR	Lithium	€1.5m	Placement	A¢9	Wolfsberg DFS
13-May-19	Tando Resources	ASX:TNO	Vanadium	A\$1.7m	Placement	A¢8.5	SPD project
14-May-19	NRG Metals Inc	TSXV:NGZ	Lithium	C\$4.5m	Shares + warrant	C\$0.225	Hombre Muerto North project
15-May-19	Ultra Lithium	TSXV:ULI	Lithium	C\$1.4m	Shares + 1/2 warrant	C\$0.06	Argentine exploration
16-May-19	Alliance Mineral Assets Ltd	ASX:A40	Lithium	A\$32.5m	Strat placement	A¢20	Bald Hill mine upgrades
20-May-19	Anson Resources	ASX:ASN	Lithium	A\$15m	Equity facility	2D VWAP	Paradox project
20-May-19	Bacanora Lithium	AIM:BCN	Lithium	£14.4m	Strategic investment	25p	Sonora project
21-May-19	Gratomic	TSXV:GRAT	Graphite	C\$1.5m	Shares + warrant	C\$0.05	Graphene projects
24-May-19	Mincor Resources	ASX:MCR	Nickel	A\$23m	Placement	A¢40	Kambalda project
24-May-19	Mincor Resources	ASX:MNC	Nickel	A\$23m	Placement	A¢40	Accelerate Kambalda re-start
29-May-19	Hawkstone Mining	ASX:HWK	Lithium	A\$2.4m	Placement	A¢2.0	Big Sandy project
30-May-19	Pure Energy Minerals	TSXV:PE	Lithium	US\$1.5m	Strategic investment	C\$0.0615	Clayton Valley project

Source: Company data, BM Review

With equity raisings and strategic sales still dominating, and representing 82% of funds raised so far in 2019 the current weakness in the equity markets could impact ability to raise funds into the second half of 2019, which could have material impacts on supply growth in critical materials. Given the need for this to accelerate in coming years if a large deficit is to be avoided, this could be very significant for supply/demand balances.

Other news

Artemis Resources (ASX:ARV) restructured its funding package with Riverfort Global Capital, extending the maturity date on its convertible debt to 31 January 2020, but agreeing to redeem 2.1m securities by 30 September 2019. In exchange it agreed a US\$500,000 cash payment and the issue of 18.7m options at A\$0.08 and a further 100,000 convertible notes.

First Cobalt Corp (ASX:FCC) announced that it acquired 9.64m shares representing c.6% of the share capital of **eCobalt Solutions** (TSX:ECS) via a private share purchase agreement at a price of C\$0.375/sh. It suggested that the acquisition was for investment purposes.

Lepidico (ASX:LPD) and **Desert Lion Energy** (CVE:DLI) announced plans to merge via the acquisition of all DLI's shares by LPD. The combination of 5.4 LPD shares per DLI will combine DLI's exploration assets in Namibia with LPD's processing technologies. The deal was approved by DLI shareholders.

Production/Earnings News

Albemarle (NYSE:ALB) reported Q1/19 lithium net sales of US\$292m, down 2.1% y/y due to rain disruptions which it believes will shift sales to later in the year and qualification delays at the

Xinyu II expansion program. Unlike Livent, ALB's clients continue to meet their offtake commitments so demand is robust. It warned that it will stockpile Wodgina material if market demand and prices do not justify selling it.

Livent (NYSE:LTHM) cut its 2019 EPS forecasts to US\$56-66 from US\$92-98 due to weaker near-term demand for lithium hydroxide as "several" customers announced delays to the commercial launches of high nickel cathode chemistries. It also lost about 1Kt of lithium carbonate production in Argentina due to heavy rains but production has now normalised.

SQM (NYSE:SQM) reported Q1/19 EPS of US\$0.31, down 18% y/y due to lower margins in lithium, impacted by lower realised prices and higher costs related to the new lease payment structure with Corfo. Its average selling price was US\$14,600/t for the quarter. It forecasts 17% lithium demand growth in 2019. It delayed its Atacama 50Ktpa expansion plans to 2021 from 2020.

Bushveld Minerals (AIM:BMN) announced plans from 2019 to establish a dividend policy to reflect its development from a junior developer into a significant vanadium producer.

Largo Resources (TSX:LGO) reported Q1/19 financial results which had already been guided down on low vanadium prices. It made a net loss of C\$2.2m for the quarter despite recording record recoveries and cash op costs down 4% y/y at C\$4.54/lb. Results were impacted by provisional pricing adjustments.

People Moves

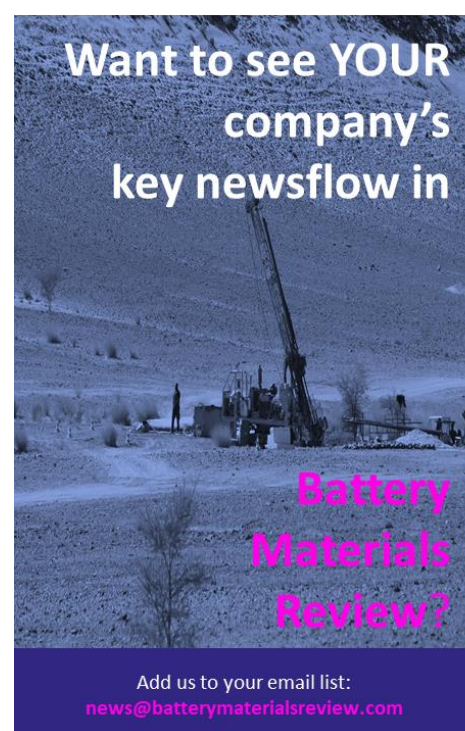
Comet Resources (ASX:CRL) has appointed Philippa Leggat as CEO, replacing Tony Cooper, who will stay on as a consultant. CRL is looking to

develop the Springdale graphite project in Western Australia.

Hawkstone Mining (ASX:HWK) appointed Barnaby Egerton-Warburton as Non-Executive Chairman. He is currently CIO of BXW Venture Capital Fund and has been a senior investment banker. He was a NED at Loneer Ltd (ASX:INR) which is also developing a clay project in the US.

Lithium Americas (TSX:LAC) appointed Jonathan Evans to succeed retiring CEO Tom Hodgson. Evans has been the company's President and COO since September 2018.

Artemis Resources (ASX:ARV) appointed Ed Mead as Interim CEO after Wayne Bramwell resigned to "pursue other professional opportunities". He is currently an Executive Director.



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EIB finances Northvolt with €350m

Swedish battery start-up Northvolt has secured a €350m (US\$395m) loan from the European Investment Bank to build its first battery plant at Skellefteå in Sweden.

The loan, which was applied for in September, is part of a €1.5bn fundraising split 50/50 between debt and equity intended to build 16GWh of capacity by 2023. Final capacity of the plant is planned to be 32GWh pa.

Many industry players have been waiting for EIB approval before pulling the trigger on funding. IKEA has said it is in the final stages of talks about participating in the project.

Northvolt is already supplying LIBs for Epiroc's underground mining vehicles and batteries from the plant are expected to be low cobalt chemistries.

Farasis to build German LIB plant

Chinese LIB maker Farasis Energy is to spend €600m (US\$674m) to build a battery plant in Germany. The plant is expected to start in 2020 with capacity of 6GWh pa, rising to a maximum capacity of 10GWh. Farasis had previously agreed with Daimler to supply 140GWh of batteries between 2021-27.

France and Germany to set up €6bn battery initiative

France and Germany have established a cross-border battery cell consortium with the aim of developing next-gen EV batteries and have announced a joint investment of €5-6bn (US\$5.6-6.7bn).

Funding consists of €1.2bn in state subsidies as well as €4bn in investment from European private companies.

While every little helps, we still see little evidence of Central Government appreciation that investment in raw materials will be vital if the EU is to meet its self-sufficiency targets in the supply chain.

Governments seem happy to let the mining industry go on its own and don't seem to appreciate how closed traditional funding sources are currently. Given the time it takes to explore and develop a mine is currently three times what it takes to develop and build a battery plant, Europe still runs the risk of having no raw materials to supply any plants it builds.

VW goes "large" on lithium and batteries

Volkswagen (ETR:VOW3) has announced plans to invest c.€1bn (US\$1.1bn) in battery cell production at Lower Saxony in Western Germany.

In a briefing document on its website VW flags that it sees lithium as the "irreplaceable" material of electrification and that's why it has locked in a long-term supply agreement with Ganfeng Lithium (SHE:002460/HKX:1772) for at least 10 years.

It has also flagged the importance of solid-state batteries and hopes to start producing those from its operations by 2025.

The company also flagged that it is working on its own recycling technology and plans to set up its own plant in Salzgitter by the end of 2019.

Last but certainly not least, VW has "set itself the goal" of promoting

lithium production in Europe in the medium term. Good news for Europe's two most advanced hard-rock projects, particularly given the Group's stated preference for lithium derived from mining rather than from brine.

The Company plans divestments to allow it to refocus on the core battery value chain.

Tesla comes back to the market for funds

While VW benefits from other businesses that it can divest to raise funds, Tesla (NASDAQ:TSLA) has no such advantage, which in May left it doing what most of the market knew it would have to and Elon Musk has denied for many months – namely coming back to the market for more funds.

At the beginning of May Tesla announced plans to raise US\$2bn, quickly upping its target to US\$2.7bn. The raising consisted of US\$737-848m in stock and US\$1.6-1.84bn in convertibles.

While, initially the company suggested that this was effectively only a cash buffer, by the middle of May when Musk emailed his employees, Tesla's POV had changed, with Musk stating "It is important to bear in mind that we lost US\$700m in the first quarter this year, which is over US\$200m per month" and that the raisings had only given c.10 months' of funding at Q1 burn rates. He went on to exhort employees to cut spending as much as possible.

As we flagged in the May issue, everything does not look rosy in Tesla-land at the moment. Caught up in the US/China trade war, not hitting its Model 3 production targets and with

Downstream: News and Views...

cash flying out the door faster than sales, there must be material concerns about the near future for Tesla.

The problem is that Gigafactory is a huge fixed cost base and, as anyone who's invested in an iron ore project knows, if you don't hit your production targets, then you're likely to haemorrhage cash.

It's imperative that Panasonic (TYO:6752) hits its battery output targets and that Tesla starts hitting its own production targets if the company is to be viable as a going concern. Cost cutting is a positive move but it can only go so far.

Tesla, as a kind of flagship of the EV revolution remains important to the sector for now. In a few years time when the BigAuto companies have fully caught up on EVs maybe it won't be so important but for now when people think of EVs they think of Tesla and with Tesla not doing well that makes people a lot less confident on the outlook for EVs as a whole.

Volvo signs battery deals

Volvo has signed 10-year battery supply agreements with CATL (SHZ:300750) and LG Chem (KRX:051910) to supply its planned Polestar fleet of EVs, which is expected to launch in 2020.

Deals with both companies cover the global supply of battery modules for all models on the upcoming SPA2 and CMA modular vehicle platforms.

The "multi-billion dollar supply deals" will cover the company's global plans. Its first battery assembly line is already under construction at its plant in Ghent, Belgium and its first EV is due to launch at its plant in China, a JV with Geely (HKX:0175), its parent company.

Siemens plans electric highways

The first test route for electric hybrid trucks powered by overhead lines opened in Hesse, Germany in May.

Siemens (ETR:SIE) is part of a consortium testing out the same catenary technology that powers public transit bus trolley lines or light-rail train cars. The overhead line powers the electric motor and charges onboard batteries when the truck is connected to the line. When the truck leaves the overhead line, it can operate on battery power or with its diesel engine.

The test will extend until 2022 and there is significant interest from other countries as well as other applications such as shuttles.

Utah plans record 1GW ESS plant

Utah's Advanced Clean Energy Storage project is making lots of column inches. The 1GW project would use a bunch of exotic technologies including CAES, renewable hydrogen and solid-oxide fuels cells, as well as flow batteries. With such a mish-mash of technologies the jury's still out on how viable the project is.

Sonnen's new homebuilder strategy

The US arm of Sonnen, recently acquired by Shell (LSE:RDSA), is to enter the Illinois newbuild home market with high-end energy storage systems. Sonnen will outfit each house in a 28-home test development with a 20kWh ecoLinx battery, perhaps in a sign of things to come.

Sonnen's batteries in Germany operate within a network of thousands of residential batteries that function as a

distributed power plant. That approach is not viable in the US so Sonnen is moving downscale to put batteries in each unit of neighbourhood developments.

The combined storage capacity for the homes will exceed 0.5MW which could have a substantial impact on local grid balancing during peak events.

Downstream: Tech news

Samsung SDI develops new EV battery

Samsung SDI (KRX:006400) is negotiating with automakers after developing a new battery which is 30% more energy efficient than existing batteries. Energy density of the new battery cell is 500Wh/L and of a module is 369Wh/L and the new battery could be in mass-production by the end of the year.

New flexible lithium battery

A team from PolyU have developed a novel lightweight Textile LIB which has an energy density of 450Wh/L and a bending radius of less than 1mm. It also possesses fast charging/discharging capacity and a long life cycle.

The battery is expected to provide a solution for the wearables market, which is expected to reach US\$100bn by 2024. It applies PolyU's patented Polymer-Assisted Metal Deposition (PAMD) technology.

New polymer could benefit NMC batteries

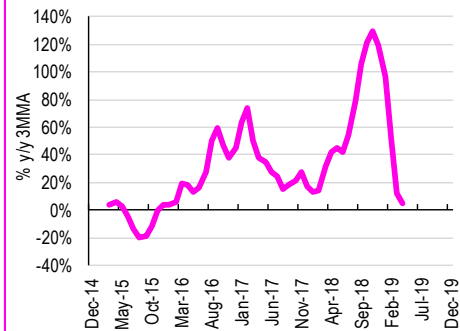
A team at the DOE's Argonne National Laboratory believe that a new cathode coating consisting of a sulphur-rich polymer called PEDOT could allow NMC batteries to run at higher voltages, thus increasing their energy output or lifetime, or both.

Trade & Demand: Batteries & End-use markets

EV sales growth falling

With the bulk of the Model 3 backlog now appearing to be out of the door, the overarching theme in the EV market at the moment seems to be the slowdown in activity caused by withdrawal of subsidies, be this in China or the US.

US EV sales growth

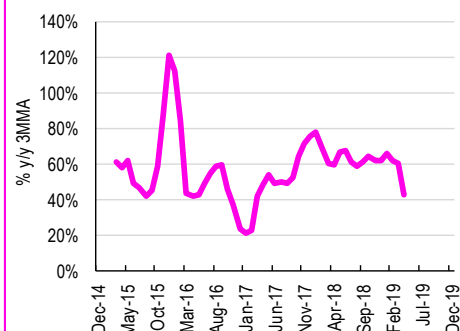


Source: BM Review, EVvolumes.com

Chinese registration were up “only” 36% y/y. While in the rest of the world that would be a reasonable growth rate, it happens to be the slowest growth rate in China since July 2017 and highlights the significant slowdown caused by the changes to the subsidy regime.

However, within that it should be noted that wider auto sales in China are still in decline, so the relative outperformance of the EV sector is still pretty significant. The EV market share hit 5.4% YTD, above the 4.2% for the whole of 2018, and on course to reach c.7% by the end of the year.

Global EV sales growth



Source: BM Review, EVvolumes.com

In Europe, auto sales were down 1% y/y

in April so while the 30% increase in EV sales doesn't look like an exciting growth rate, it's still beating the wider market.

In the US, registrations rose only 8% y/y and sales continue to suffer from the concentration of the Tesla Model 3 on overseas markets. The success of the Model 3 has reduced sales in the Model S and Model X, implying that a re-boot is likely necessary in the near future.

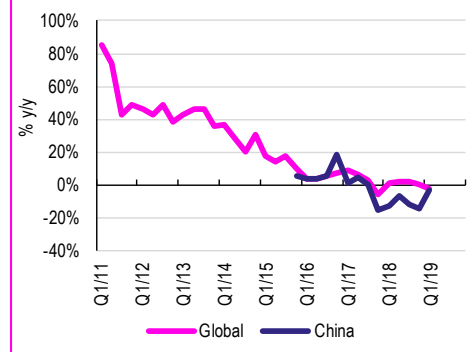
Smartphone sales falling

Global smartphone sales were down 2.7% y/y in Q1/19 to 373m units, their lowest level since Q2/17, according to Gartner Inc.

Demand for premium models continued to be lower than that for basic models, as slowing innovation and rising prices continued to extend replacement cycles.

Huawei was the only producer to see growth out of the top three, but the decision by Google not to support Huawei smartphones may dent that in the next few quarters.

Global vs Chinese smartphone sales growth



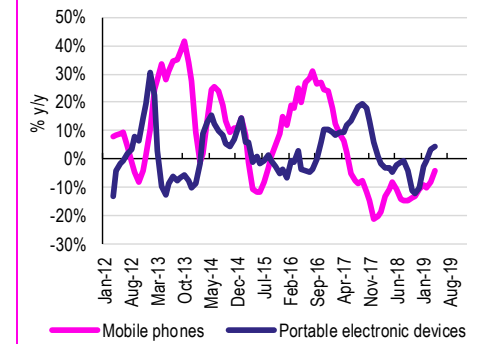
Source: BM Review, Gartner Inc., Canalys

Signs of life in device markets

However it's not all bad in consumer products with signs of positive growth momentum in Chinese electronic devices where output growth has turned positive. This, even though

mobile phone output continues to shrink, with Chinese mobile phone shipments hitting their lowest level since 2013 in Q1/19.

China electronic device output growth

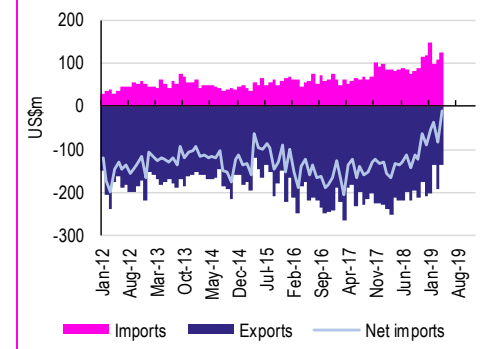


Source: BM Review, China NBS

Japan moving to net import position in LIBs

Japan had its lowest-ever net export level for LIBs in value terms in April and could very well move to a net import position over the next few months.

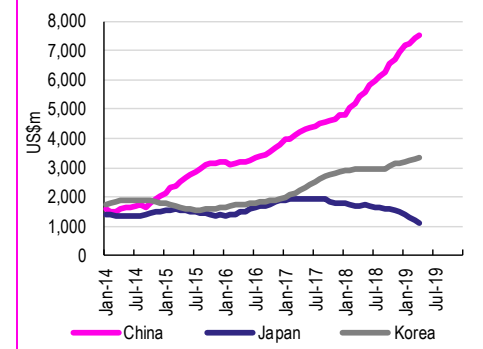
Japanese LIB trade



Source: BM Review, Global Trade Tracker

Net exports from Korea and Japan remain robust, however.

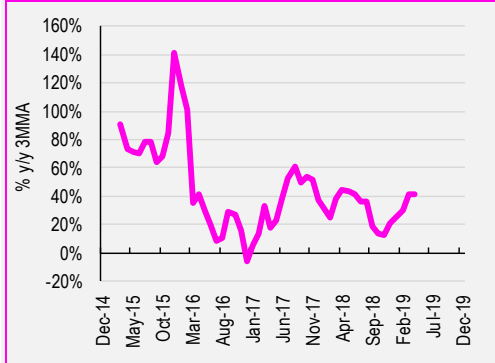
12M rolling Asian LIB net exports



Source: BM Review, Global Trade Tracker

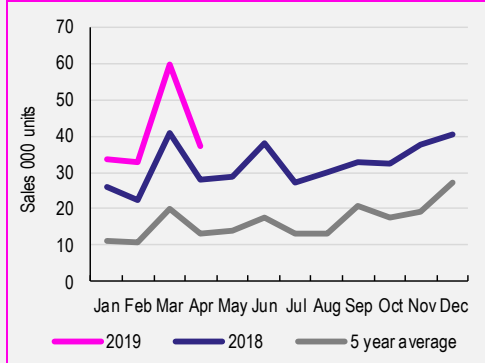
Trade & Demand: EVs and Consumer Products

European EV sales growth



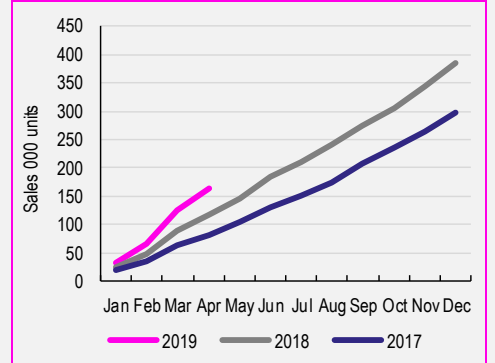
Source: EVvolumes.com

Seasonality of European EV sales



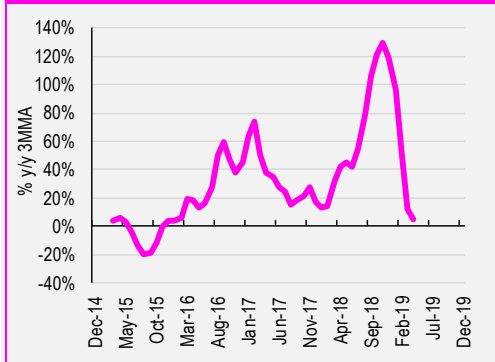
Source: EVvolumes.com

Cumulative European EV sales



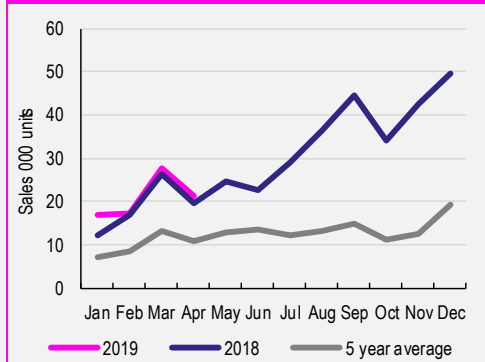
Source: EVvolumes.com

US EV sales growth



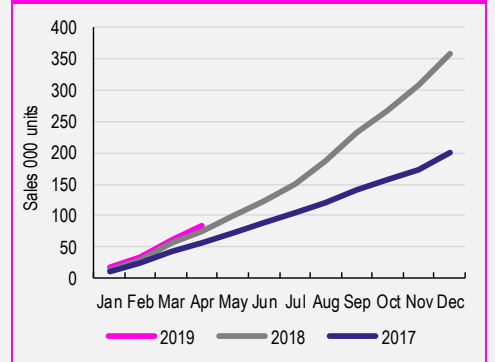
Source: EVvolumes.com

Seasonality of US EV sales



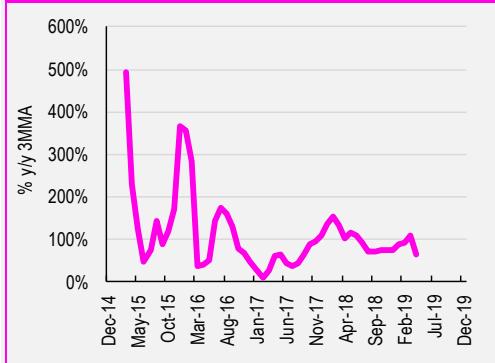
Source: EVvolumes.com

Cumulative US EV sales



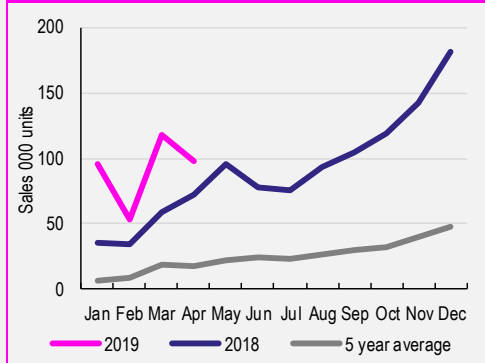
Source: China National Bureau of Statistics

Chinese EV sales growth



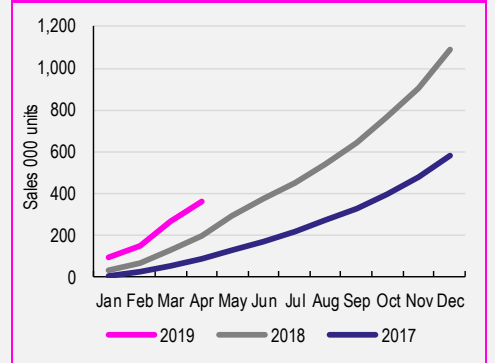
Source: EVvolumes.com

Seasonality of Chinese EV sales



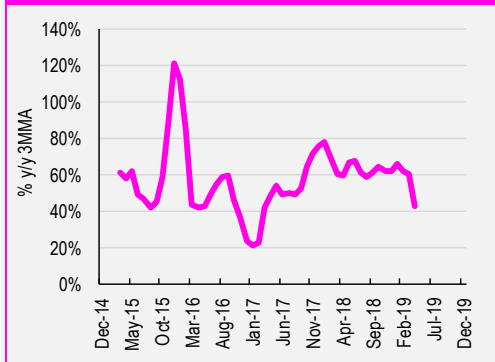
Source: EVvolumes.com

Cumulative Chinese EV sales



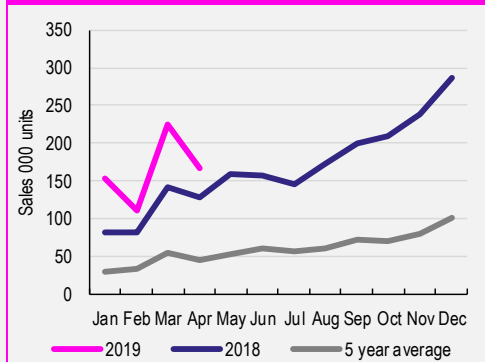
Source: China National Bureau of Statistics

Global EV sales growth



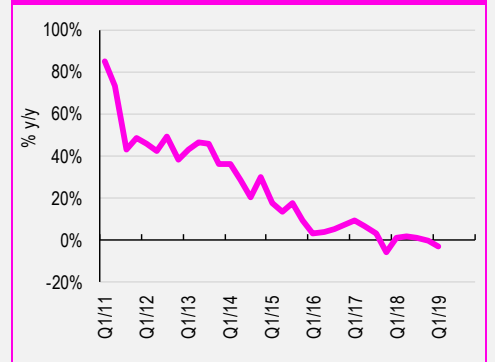
Source: EVvolumes.com

Seasonality of Global EV sales



Source: EVvolumes.com

Global smartphone sales growth

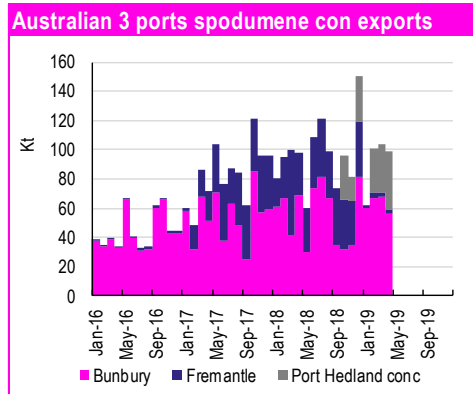


Source: Gartner Inc.

Trade & Demand: Commodities

3 Ports spodumene exports flat

Spodumene exports from the ports of Bunbury, Fremantle and Port Hedland were flat in April, with no bulk shipments from Fremantle for the fourth month in succession.

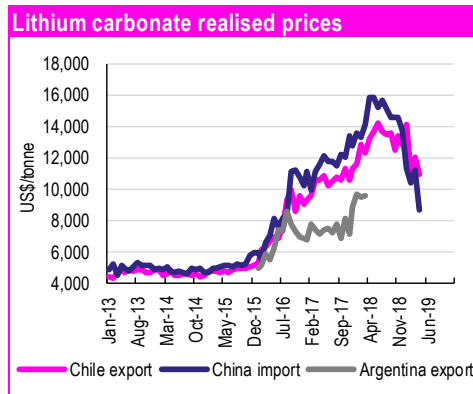


Source: Pilbara Port Authority, Southern Ports

Spodumene concentrate prices continued to decline through the month with some bid prices falling below US\$600/t for the first time. With further weakness in hydroxide prices it's likely that prices will remain pressured but new converting capacity opening around the end of the year could give some support.

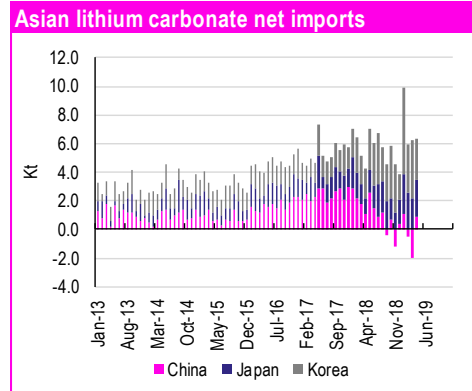
Lithium carbonate prices down again

Spot lithium carbonate prices were down again in April and May and this was mirrored in trade data, with both Chilean export prices and Chinese import prices falling.



Source: Chilean Central Bank, GlobalTradeTracker

China returned to a net import position in April, although at very low levels, and Japanese and Korean demand was robust.

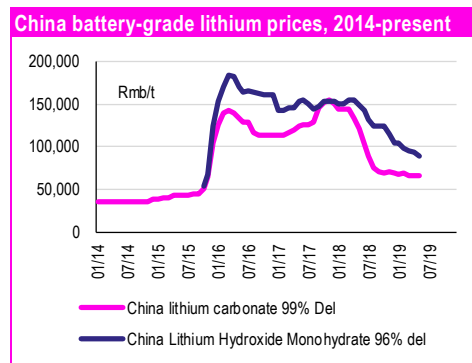


Source: BM Review, GlobalTradeTracker

Brine ramp ups into the summer months could pressure supply but demand is expected to benefit from the slower than expected take-up of low cobalt technologies.

Pressure on hydroxide

The slower than expected take-up of low cobalt battery chemistries has continued to pressure the hydroxide market in recent months and the hydroxide premium over lithium continues to close. New supply in H2/19, coupled with weaker than expected demand, is likely to further pressure prices.

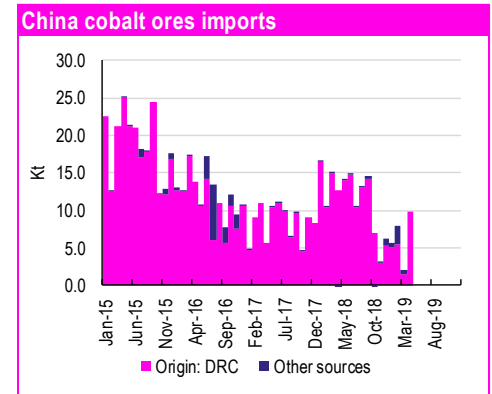


Source: BM Review

Chinese cobalt imports bounce back

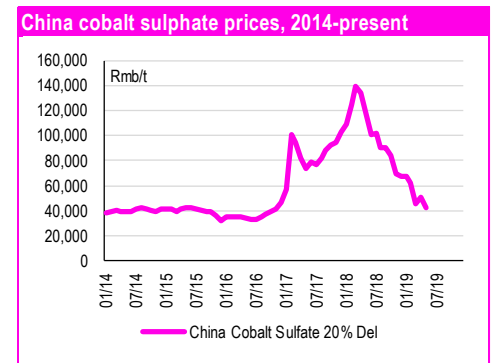
China imports of cobalt ores from DRC bounced back in April after Katanga resumed limited exports. 100% of

China's April imports were derived from the DRC.



Source: BM Review, GlobalTradeTracker

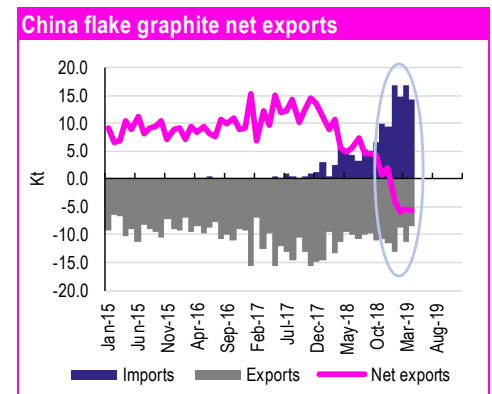
Cobalt intermediate prices continued their decline in May, suggesting that the market remains oversupplied.



Source: BM Review

Graphite prices under pressure

China remained a net importer of flake graphite in April with net imports stabilizing at around 5Kt/month.



Source: BM Review, GlobalTradeTracker

Import prices ticked up slightly but still remain below US\$550/t suggesting that

Focus...Nickel Inventories

Syrah Resources (ASX:SYR) is still not getting pricing power.

Market prices in key battery grades weakened again in May suggesting that near-term oversupply is tempered but a robust demand outlook.

Vanadium prices down again

Vanadium pentoxide prices hit their lowest level since November 2017 in May as carnage in the ferrovanadium market spilled over. We highlighted in May that much of the price weakness seems to be down to substitution of ferro-niobium for vanadium, leading to weaker than expected demand. The carnage must end soon however with prices within touching distance of marginal costs of production.

LME prices hit by trade concerns

LME prices were weaker across the board in May as global trade concerns led to a risk-off situation.

Copper and zinc were the worst performers, down 10% and 9% respectively and, given the continued fall in exchange inventories, we can't say that the weakness was down to any fundamental driver.

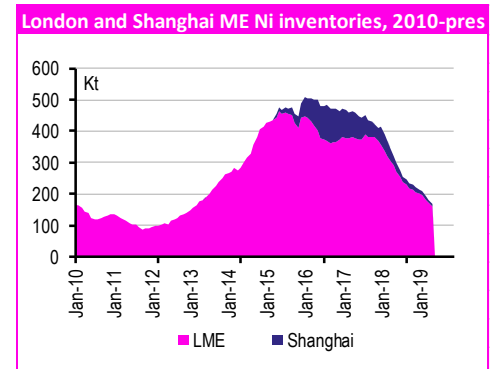
Take Nickel inventory drop with a pinch of salt

We all know that nickel as a commodity is one of the big winners of the battery story. We've all seen the Benchmark Minerals chart that shows annual nickel demand in batteries rising by a factor of 15x over the next 10-15 years, we know about the changes in battery chemistry that are likely to see nickel demand per kWh increase substantially and most of us are aware of the fact that there is a shortage of class 1 nickel development projects and that class 2 nickel simply isn't suitable for use in batteries.

Everybody is excited about the outlook for nickel and there's been a fall of over 150Kt in combined LME and Shanghai nickel inventories over the past year. Surely this must be down to stronger demand for nickel in batteries and the shortage of class 1 nickel, which means that the industry is utilising nickel metal from exchange inventories to turn into sulphate for use in batteries?

Well, let's think about that statement in more detail, shall we? If we think about current battery chemistries in use in 2018 about 40% was NMC111,

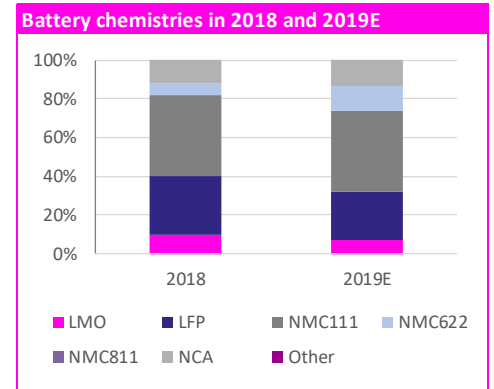
30% LFP, 12% NCA and only 6% high nickel (ie NCM523 and 622) batteries.



Source: Bloomberg, BM Review

NCM811 hasn't yet taken off as a chemistry and isn't likely to in any volume over the course of this year. While we should see NCM523 and NCM622 growing traction, we are probably only talking about maybe a 10-15% combined market share in 2019.

In 2018 roughly 4% of total nickel consumption went into batteries, about 90Kt of material. So, we are seeing an increase in nickel-rich battery chemistries and we are forecasting an increase in EV production.



Source: BM Review

But realistically how much are EV volumes likely to increase in 2019? We've seen the best-case forecasts, with Posco calling for a 100% y/y increase but, based on current growth rates, probably an increase of c.60% is more likely. So maybe, in an absolute best-case scenario, we could see a nickel consumption increase in

Monthly performance of key commodities						
US\$		Current	1M	3M	12M	YTD
Spodumene concentrate (CIF China)	US\$/t	620	-3%	-8%	-33%	-14%
Lithium carbonate China (99% del)	US\$/kg	9.4	1%	-1%	-46%	-4%
Lithium hydroxide China (96% del)	US\$/kg	13.8	-8%	-14%	-35%	-19%
Cobalt LME	US\$/t	33,000	-4%	0%	-63%	-40%
Cobalt sulphate China (20% Del)	US\$/kg	6.5	-17%	-31%	-63%	-26%
Graphite, China flake 190	US\$/t	390	-5%	-13%	-17%	-13%
Vanadium pentoxide, China 98% FOB	US\$/lb	8.0	-32%	-54%	-44%	-60%
Aluminium, LME	US\$/t	1,761	-3%	-7%	-23%	-6%
Copper, LME	US\$/t	5,781	-10%	-12%	-15%	-3%
Lead, LME	US\$/t	1,783	-8%	-17%	-27%	-11%
Nickel, LME	US\$/t	12,040	-3%	-8%	-21%	14%
Zinc, LME	US\$/t	2,685	-9%	-4%	-13%	7%

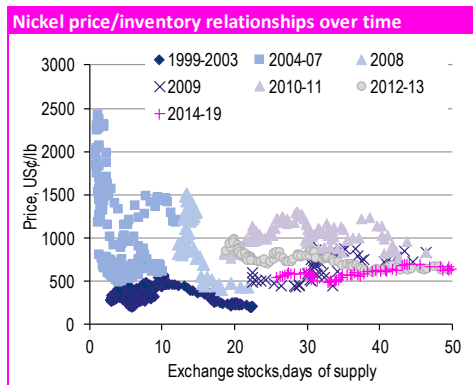
Source: BM Review

Focus...Nickel Inventories...

batteries of 80-90%, call it 76Kt, over the course of 2019. But the inventory de-stock is considerably more than that. So where's it all going?

We would suggest that a large amount of this material is going to off-exchange inventories. As recently as October 2018, BMO's commodity analyst Colin Hamilton estimated that there was as much as 465Kt of nickel stored in off-exchange stocks. Bonded warehouse inventories in Shanghai are of the order of 38Kt and China's State Reserve Bureau (SRB) has also been a large buyer of nickel in recent years and its holdings are included in the 465Kt estimate.

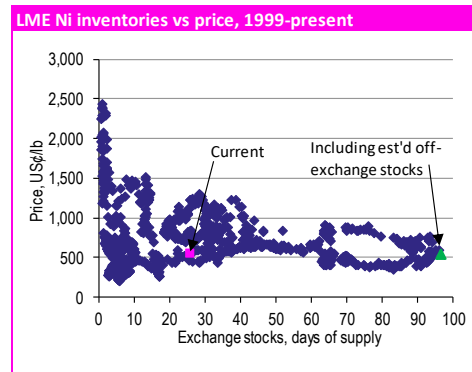
The reason for the excitement in the inventory draw is that there's been a long-term relationship between metal prices and inventories. While this relationship varies over time, there is definitely a correlation there. We prefer to plot metal inventories in days of consumption terms rather than in absolute terms to take account of the significant changes in consumption over the past 10-15 years and our chart, showing the different relationships over time, is below.



Source: LME, Shanghai Futures Exchange, BM Review

While at the current time, inventories seem to be heading in the right direction for a rapid increase in prices, if we lump the 465Kt off exchange inventory number in with the current exchange inventory levels that takes us

to a higher absolute level than we have ever been and in days of consumption terms up to 96, nearly off the scale of our chart. The story isn't quite so attractive now, is it?



Source: LME, Shanghai Futures Exchange, BM Review

But, maybe it's not so bad. We need to think a little bit about what this off-exchange inventory is for and how sticky it is. After all, 5-10 years ago there was lots of off-exchange inventory in copper and it didn't necessarily impact what copper prices did. At least it didn't until the end of the copper price event when all of the inventory came back onto exchange and prices collapsed!

A lot of this nickel is being used as collateral for financings. That means it's not accessible to be used for, in many cases, years. That means that consumers of nickel are stuck with using what's currently available on exchange and that the environment may actually be as tight as it's starting to seem.

But not all of this is being used for financings, so maybe let's suggest 50% of it is. Then we've still potentially got as much as 230Kt of off-exchange inventories. Perhaps 100Kt of that could be SRB stocks. We know from experience of what happened in copper that China will deploy that metal if it sees prices going too high, so it's not sticky, and we assume much of the rest of that material would be sold to consumers at higher prices as well.

So, we would suggest that maybe the environment is not as outright bad as it could be, but there's still a lot of material sitting off exchange, which could be deployed if prices spike.

While the demand situation has positive momentum this is probably not a major problem (it wasn't in copper for many years) but since commodities (demand and pricing) are cyclical, there is the risk for substantial cyclical corrections during the secular trend, so market participants need to be wary about putting on long-term trades. Investors need to keep an eye on what's going on off the metal exchanges as well as on...

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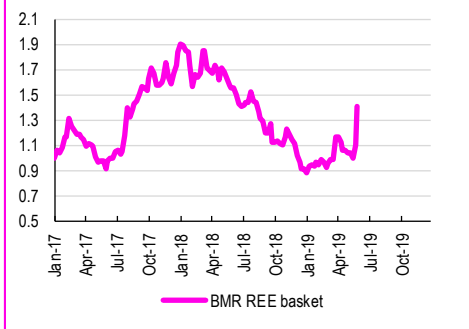
Equity round-up

Equity markets in general were weak in May as trade war concerns sapped risk appetite, and the battery chain was no exception, with all of the ETFs underperforming the wider equity markets. The battery materials stocks were, however, the largest underperformers within the battery space.

Trade concerns put REEs in focus

Rare Earth element producers and developers were back in focus in May as concerns about China withholding REEs led to a spike in prices and a focus on ex-China equities.

BMR REE basket performance



Source: BM Review

Pretty much every man and his dog with an REE project came under focus from the market, but the big winner was Ucore Rare Metals (TSXV:UCU) which is looking to develop a project in Alaska. The stock was up 134% in US\$ terms, although has given up some of that performance in June.

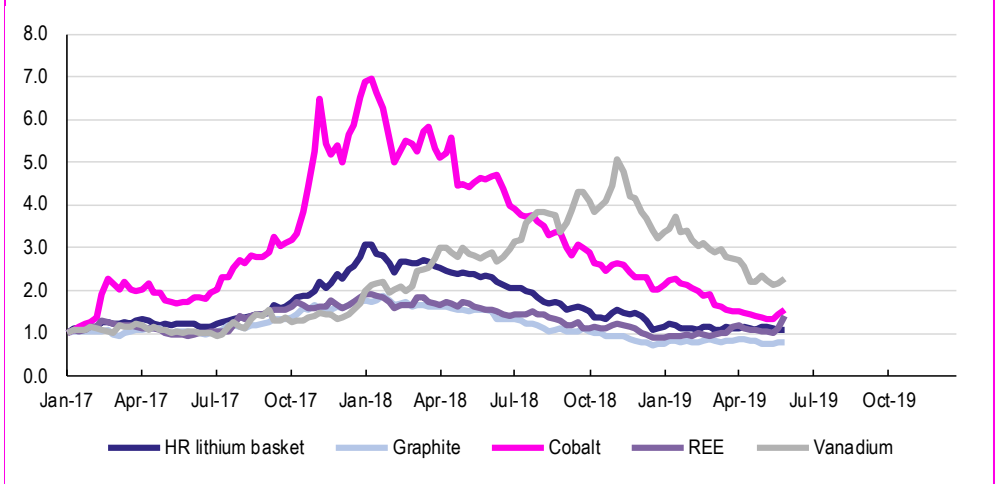
Cobalt basket shrugs off cobalt price weakness

While most of our basket constituents were down for the month, in line with the continuing malaise in cobalt and cobalt intermediate prices, Celsius Resources (ASX:CLA) was up a cracking 152% on no news and Australian Mines (ASX:AUZ) 40% as its management presented to investors in Europe.

Monthly performance of key equities

US\$	Current	1M	3M	12M	YTD
Equity baskets					
Cobalt	1.53	13%	-20%	-67%	-28%
Graphite	0.78	3%	-7%	-50%	5%
HR Lithium	1.08	-6%	-7%	-54%	-7%
Brine Lithium	0.76	-6%	-7%	-40%	0%
REE	1.40	35%	51%	-10%	59%
Vanadium	2.28	-3%	-23%	-19%	-32%
Other indices, stocks and funds					
S&P Global 1200 index	2299	-5%	-1%	-1%	9%
S&P Global 1200 Materials index	2450	-8%	-5%	-12%	4%
Global X Lithium & Battery Tech ETF	24.6	-11%	-18%	-26%	-9%
Solactive Battery Value-Chain index	201.2	-9%	-8%	-14%	0%
Cobalt 27 Capital Corp	4.0	-10%	-8%	-67%	20%

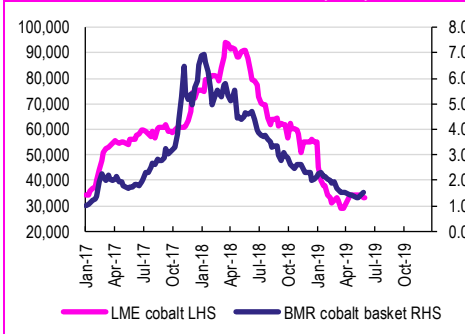
BMR Equity basket performance (US\$), Jan 2017-present



Source: BM Review

Artemis Resources (ASX:ARV) was the worst performer in our basket.

LME cobalt vs BMR cobalt basket (US\$)



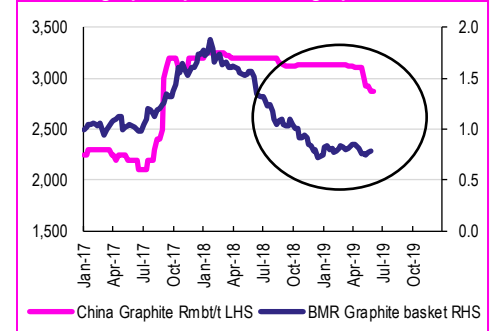
Source: BM Review

Graphite basket shrugs off weakness

Triton Minerals (ASX:TON) was the biggest outperformer in our graphite

basket, up 60%, after the granting of the mining concession for the Ancuabe project by the Mozambique government.

Chinese graphite price vs BMR graphite basket



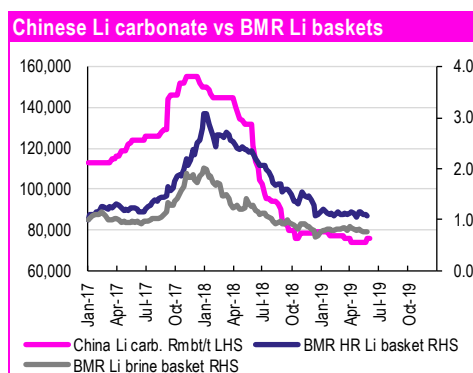
Source: BM Review

Despite the recent weakness in flake prices, there continues to be a material

disconnect between commodity and equity prices in graphite.

Lithium baskets fall again despite KDR bid

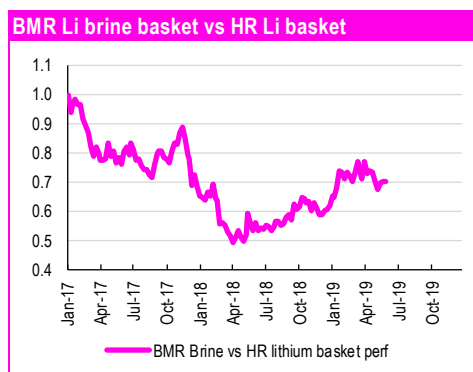
Lithium stocks resumed their decline in the second half of May after the initial excitement following the Wesfarmers (ASX:WES)/Kidman (ASX:KDR) bid. Weak operating results from SQM (NYSE:SQM), Livent (NYSE:LTHM) and Albemarle (NYSE:ALB) offset positive performance from basket constituents including Kidman, Pure Energy (TSXV:PE) and Alliance Mineral Assets (ASX:A40).



Source: BM Review

While there was some excitement about the possibility of counterbids for KDR, that now looks substantially less likely with KDR management having entered a Scheme Implementation Deed with WES.

With hard rock seemingly very much in focus for M&A, it is perhaps not a surprise that the brine basket has started to underperform again, since the end of March.



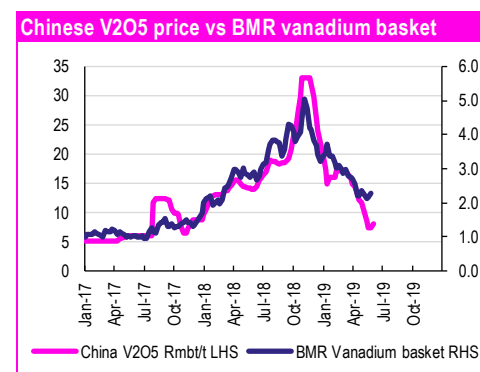
Source: BM Review

Company news holds up Vanadium basket

Positive company-specific news was enough to allow our Vanadium equities basket to offset further weak vanadium price behavior in May.

With the V2O5 price down 32% m/m, pure play Largo Resources (TSX:LGO) was down 8% in US\$ terms but positive newsflow from Bushveld Minerals (AIM:BMN) and Technology Metals Australia (ASX:TMT) was enough to leave these stocks up 12% and 22% respectively, leaving our Vanadium equity basket in positive territory for the month.

However, with V2O5 prices showing few signs of recovering in the near-term we wouldn't be surprised if the basket plays catch-up in June.



Source: BM Review

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