Critical Metals
For a Sustainable World

Capitalight Research Inc.

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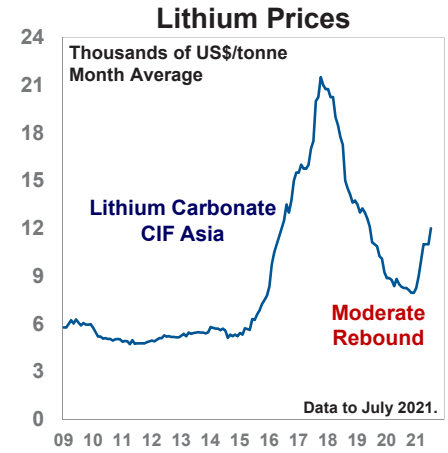
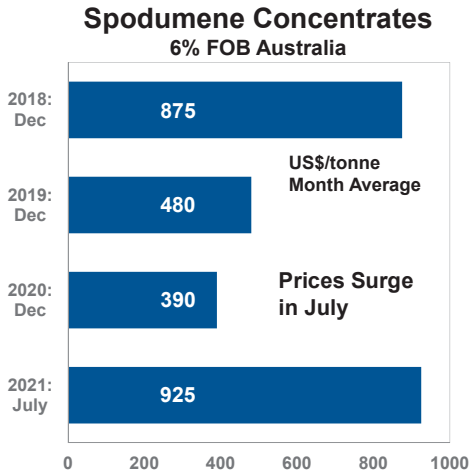


Source: BMI, Bloomberg, Capitalight Research.



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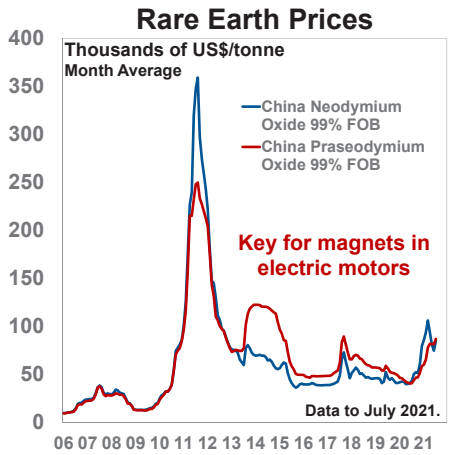


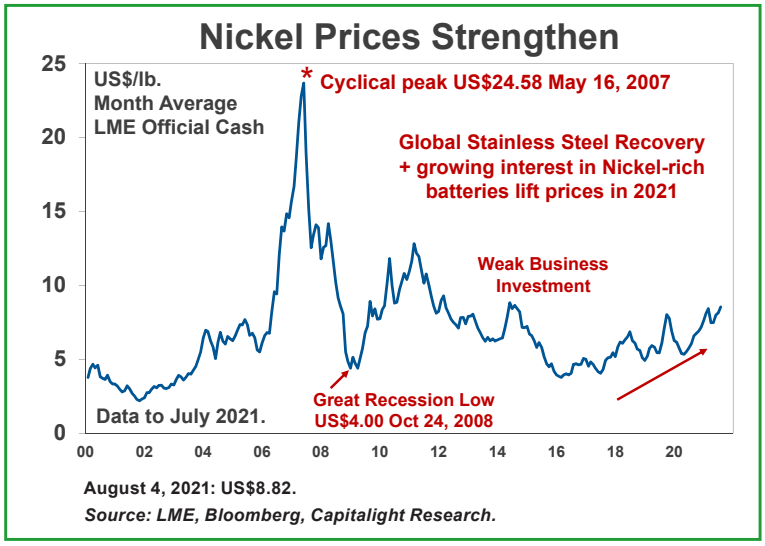
Source: Asian Metals Inc, Bloomberg, Capitalight Research.

- Focus on Nickel - 'Deficit' emerges in 2021.
- EV batteries will dominate nickel's growth story.
- Battery megafactory announcements accelerate in Europe, boosting demand for 'critical minerals'.

Europe Unveils Plan to Achieve Net-Zero Carbon Emissions by 2050

In a major policy move in mid-July, the European Commission laid out a path towards achieving net-zero GHG emissions by 2050 (including a reduction of 55% by 2030 from 1990 levels).

At the heart of the plan is a revamp of the EU's carbon market known as the 'Emissions Trading System', initially set up in 2005. The ETS is a 'cap and trade system', under which large industrial emitters, such as steelmakers and power generators, either buy or receive tradeable emission allowances, with the overall cap declining over time. The Commission proposes extending the scheme to the transport and building industries and phasing out the 'free credits', which many sectors have benefitted from in the past – including airlines operating inside the European Economic Area – by 2036. To prevent 'trade & investment leakages' outside the bloc, carbon taxes would also be applied at the border (initially limited to carbon-intensive products such as steel and cement).



Source: LME, Bloomberg, Capitalight Research.

Brussels wants to include automakers in the 'Emissions Trading Scheme'. The EC would set tougher emissions standards for new passenger vehicles, setting a de facto date to ban the sale of new diesel and gasoline-fuelled cars from 2035. The Commission also aims to promote the development of 'green fuels' including hydrogen for vans & trucks and speed up the rollout of electric vehicle charging points (to be available every 60 kilometres). The EC proposes to increase the target for renewable fuels in the energy mix from 30% to 40% by 2030. Taxes would also be applied on kerosene jet fuel for airlines and marine fuels for shipping.

Many of these initiatives will be hotly contested in the European Parliament – among the 27-member bloc plus Iceland, Liechtenstein and Norway. Outside the EU, it might be argued that the carbon border tax could be protectionist and goes against World Trade Organization agreements, unless all trading partners agree or implement similar taxes. However, the proposals are indicative of the policy environment for industry and 'critical metals' going forward.

Turning to the United States, President Biden's proposed infrastructure investment plan – a 'once-in-a-generation' program to repair and expand key infrastructure – was agreed by a bipartisan group in late July and, despite some challenges, looks likely to be passed by Congress. The deal involves roughly US$550 bn in new federal investment in steel & materials-intensive infrastructure (US$1 trillion including previous commitments). The plan includes US$110 bn for roads, bridges & major projects, US$39 bn to modernize the transit system, US$7.5 bn for EV charging stations, US$5 bn for zero-emission and low-emission school buses, US$17 bn & US$25 bn respectively for port & airport infrastructure and US$73 bn for electric grid modernization.

NICKEL OUTLOOK: Nickel-rich EV Cathode Chemistries Likely to Gain Market Share

LME nickel prices strengthened in July to an average of US$8.54 per pound and are US$8.82 as of August 4, near the previous peak of US$8.93 on February 22 – prior to the Tsingshan announcement that it can and will produce some nickel matte from a nickel pig iron (NPI) facility in Indonesia – aimed at the battery sector. Prices are well above a pandemic low of only US$5.01 on March 23, 2020 and the US$6.31 average of 2019.

The global supply & demand balance for nickel has likely moved from a 'surplus' in 2020 to a small 'deficit' in 2021 and is expected to remain largely balanced in 2022.

This year's swing into 'deficit' reflects a strong recovery in world nickel consumption – up an estimated 16% to 2.77 million tonnes – as well as last year's mine & smelter construction delays due to COVID-19, especially in Indonesia. The strike at Vale Canada in Sudbury (starting on June 1) also lifted U.S. nickel briquette premiums over LME prices to a new record of 34-37 US¢ per pound as of July 27. Vale reached a tentative five-year agreement with USW Local 6500 on August 3rd.

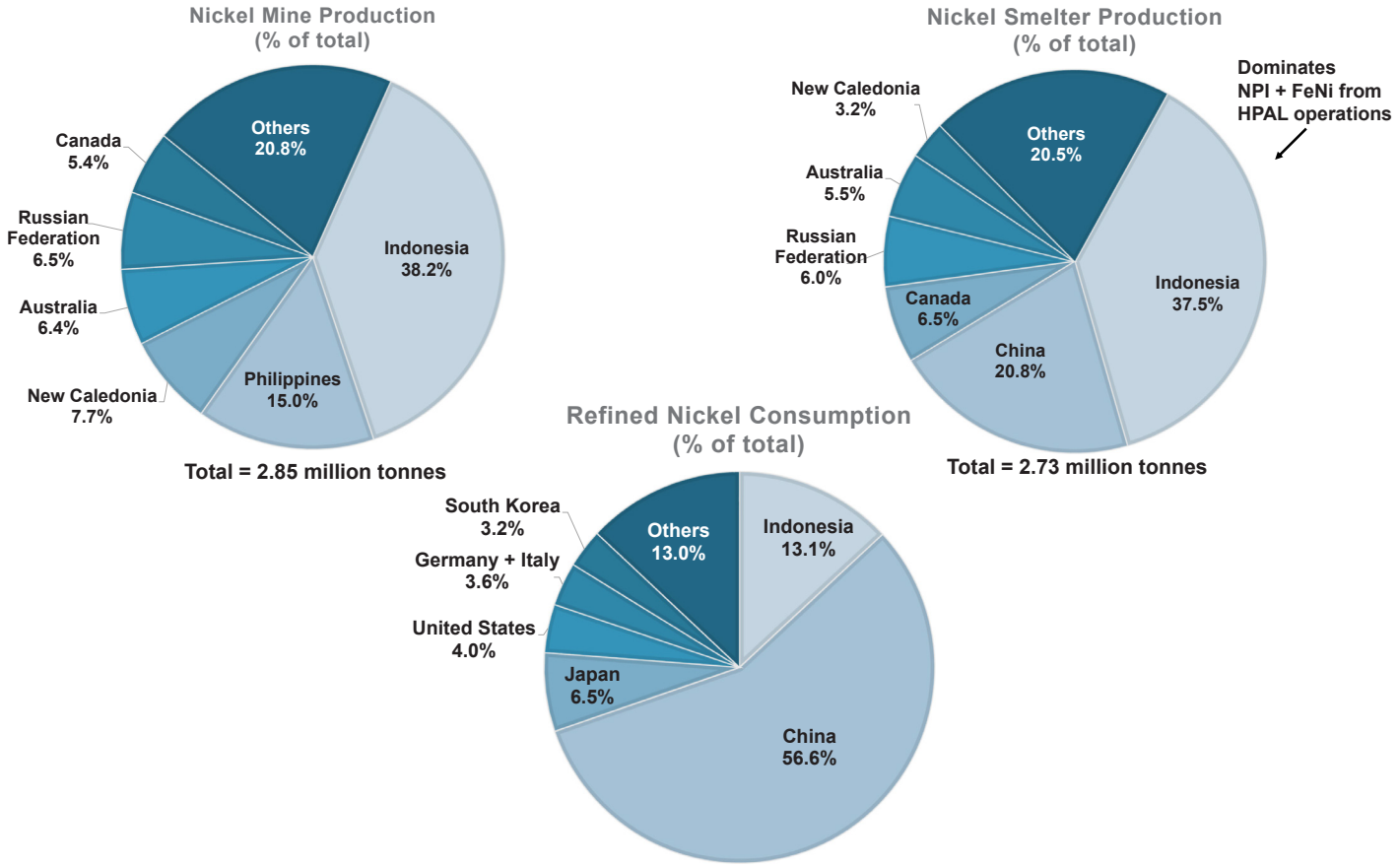
World stainless steel production has recovered markedly in 2021 – up an expected 12.9% for the year as a whole, and another 6% in 2022, after dropping -0.6% in 2020 during the pandemic. The gain not only reflects an overall recovery in global business investment, but also growing capital spending on 'green' infrastructure using nickel-containing stainless steel (e.g. wind turbines and processing plant). Stainless steel output may slow in coming years, after this year's bounce back, but President Biden's bipartisan 'infrastructure program' and the EU 'green deal' will underpin demand.

Stainless steel still accounts for 72% of overall nickel consumption in 2021. However, the metal's use in nickel-rich cathode chemistries for lithium-ion batteries is growing and will likely dominate the outlook. Nickel demand in battery 'precursor' materials will advance by about 8% in 2021 to 215,000 tonnes – 7.8% of global nickel consumption and another 9% in 2022. Demand has recently been strong in Japan. By 2030, nickel use in batteries could reach 1.3 million tonnes or almost 30% of the nickel market (possibly as high as 1.7 million tonnes). Some observers expect nickel-rich NCM batteries to account for 75% of the cathode market by end decade.

LFP cathodes (lithium iron phosphate) attracted renewed interest in early 2021 – especially in China, which led the global pick-up in EV demand, and where low battery cost is important (to keep vehicle prices below levels qualifying for government subsidies). Going forward, LFP cathodes could also be favoured for use in 'delivery vans' in G20 markets (applications involving short 'city' driving ranges at slower speeds and where low 'cost' is important).

However, for high-performance passenger vehicles, we note an increasing number of auto manufacturers announcing a preference for nickel-rich cathodes in lithium-ion batteries. Renault is backing NCM cathodes for its

Profile of Global Nickel Industry, 2021e



Source: Wood Mackenzie estimates.

proposed megafactory at Duai, France, in partnership with China's Envision AESC (9 GWh of capacity in 2024, potentially ramping up to 24 GWh by 2030). There has also been a shift recently from NCM 523 to 622 and 811 cathode chemistries, using more nickel in their production, as battery makers seek greater energy density. Manufacturers are attempting to reduce the use of cobalt, given its high cost and supply-side risks, though safety considerations will probably limit this development. LME cobalt prices jumped to US$51,556 per tonne in July.

Turning to mine & smelter developments, substantial expansion is expected in Indonesia from 2021-23 and more moderate gains in Australia and New Caledonia. Global mine production could increase by almost 9% p.a. and smelter output by 6.6% p.a. – possibly turning today's supply & demand 'deficit' into a temporary 'surplus' in 2023.

The following projects appear to be in the cards, though there is considerable uncertainty over volumes and timing: Tsingshan Holding Group plans to significantly expand its output in Indonesia (Nickel Pig Iron for stainless steel & matte for the battery segment, with the proportion of each dependent upon relative profit margins); PT Smelter Nikel Indonesia – an HPAL plant, whose construction has been completed; Lygend Mining – an HPAL smelter in Indonesia – which started shipping Mixed Hydroxide Precipitate (MHP) to China in June and the restart of the Goro HPAL plant in New Caledonia, producing MHP, by Prony Resources.

Environmental Issues May Eventually Slow Indonesian Production

In our view, the outlook for supply in the second half of the decade is more uncertain than the outlook for demand. Tsingshan's announcement on March 3 – indicating that it can economically convert NPI (normally used in stainless steel) from laterite ore in Indonesia to nickel matte for eventual use in battery precursor materials – initially pressured nickel prices, after a run-up earlier in the year. Tsingshan will provide 60,000 tonnes of matte to Huayou Cobalt and 40,000 tonnes to CNGR in China for battery use from its Morowali plant in Sulawesi (likely later this year) – raising the possibility of further conversion at other NPI facilities in Indonesia.

However, nickel prices began to firm up again in May and June and bounced back over pre-announcement levels in late July. While Tsingshan plans to install 2 GW of solar & wind power – and eventually hydro power from Borneo – to cut carbon emissions at its Morowali site, this may prove to be challenging due to biodiversity issues and difficult terrain.

Many observers have probably concluded that expanded nickel matte production in Indonesia will be confined mostly to China's supply chain, given the higher overall CO_2 emissions from processing laterite ores compared with sulphides (7 times more) and Indonesia's current reliance on coal-based power. In G7 markets, automakers and their battery suppliers are likely to be sensitive to GHG emissions and other environmental issues.

More recently, Indonesia's Energy and Mineral Resource Ministry has signalled a desire to restrict further building of NPI or FeNi capacity – after unprecedented expansion – in favour of higher value-added products – for example, stainless steel or nickel sulphate (normally attracting a premium over LME or SHFE prices). This policy change is intended to maximize the value of remaining nickel reserves in Indonesia and garner higher government royalties. However, stainless steel export expansion into western markets may prove difficult – the European Commission imposed high anti-dumping duties on two Indonesian producers on

May 27, 2021 (19.9% & 20.2%). Indonesia has also announced that it will prohibit the further use of coal-based power.

On a more positive note for Indonesia, Hyundai and LG (the world's second-biggest battery maker) have recently announced they will build a US$1.1 bn electric vehicle battery plant in Indonesia's West Java province, taking advantage of the country's nickel supply and potentially huge consumer market. The plant is expected to start in 2024 with a capacity of 10 GWh. Another megafactory is planned for Bekasi.

TESLA Moves To Secure 'Sustainable' Nickel Supplies

Tesla is mitigating supply-side risks by securing a long-term contract for nickel with BHP Billiton from its Nickel West operations in Australia. This contract follows a deal with the Prony Resources consortium, which acquired Vale's Goro operation in March 2021. Goro will produce MHP from the HPAL process and will utilise 'dry stack tailings', after a conversion. Tesla is also believed to have secured a third source of supply from a major producer.

Also of note, Western Australia is preparing to move beyond lithium and nickel mining into chemical processing to serve the growing world battery market. A nickel sulphate plant (BHP Billiton) and two lithium hydroxide plants (involving Tianqi Lithium and Albemarle) are scheduled to start later this year. Western Australia has further ambitions to integrate forward into precursor chemicals (Source: Reuters).

Our overall comment – over the medium-term, the ability of nickel producers to attract 'offtake agreements' and 'funding' will depend more than in the past on meeting 'sustainable' development principles, high ESG rankings and most importantly – on minimizing life-cycle CO_2 emissions from mining through final processing. In addition, miners may wish to increase profit margins and the saleability of their material through new processing technology (especially if they develop their own technology to meet the high-specification and unique requirements of users). We note the attempt to eliminate 'intermediate steps' in the current supply chain.

Canada's Nickel Industry is Well Positioned

The Canadian mining industry is well positioned to benefit from rising nickel demand in the coming decade, with low prospective CO_2 emissions. Four projects are being advanced – Dumont Nickel in Quebec, the Crawford Nickel Sulphide Project in Timmins, Ontario (Canada Nickel), Turnagain Nickel in B.C. (Giga Metals) and Decar Nickel District in B.C. (FPX Nickel), among others.

These developments offer an opportunity to develop 'industry clusters' in Canada, with mine supplies integrated into battery chemicals & cell manufacture – especially in Quebec, the 'Ring of Fire' in Ontario and Northern British Columbia. Low-cost hydro-electricity will provide a significant competitive advantage for Quebec and British Columbia.

A large deep-sea nodule project in the Pacific Ocean (between Hawaii and Mexico) – the Nori Clarion-Clipperton polymetallic project (The Metals Company) is also well placed for development. The nodules contain high to medium-grades of nickel, copper and manganese as well as some cobalt. Harvesting will involve little disturbance of the ocean floor, will take place in an area with little plant or animal life and – unlike some land operations – does not involve deforestation. Life-cycle CO_2 emissions are estimated to be 70-80% lower than land mining & processing.

Price Sensitivities Around the Base Case:

High Case: LME nickel prices and premiums & payables for intermediate products – such as 'nickel sulphate' and 'Mixed Hydroxide Precipitate' for the battery sector – have been higher than generally expected in 2021. Demand in both the stainless steel and battery segments has been strong in the face of major supply disruptions, which could continue.

Nickel Price Outlook - Annual Averages

pre-pandemic 2018	2019	2020	2021F	2022F
5.95	6.31	6.25	8.52	8.88

Recent disruptions have included: the absence of Russian nickel in the U.S. spot market for much of this year, possibly linked to flooding at two Nornickel mines in the Norilsk Division in late February; buying ahead of the imposition of a substantial Russian 'export tax' on nickel as of August 2021 (a 15% base rate plus another levy of US$2,321 per tonne – also applied to copper, aluminium, steel & ferroalloys, with the additional levy specific to each commodity, lasting through December); the Russian export tax could be replaced by another measure in 2022; a recent earthquake off Sulawesi, though production appears to have been unaffected; and further operating delays due to COVID-19. Disruptions could delay the start-up or expansion of smelters in Indonesia, despite substantial plans. LME inventories dropped by 7% in July and are almost non-existent on the SHFE.

Low Case: Mine & smelter expansion in Indonesia could proceed more rapidly than assumed in the Base Case in late 2021 and 2022. Commodity prices could also be damped in 2022 by a Fed decision to begin 'tapering' current quantitative easing earlier than expected. The first increase in the Federal funds rate could actually occur in 2022:H2 instead of 2023:H2.

Nickel Quarterly Averages

		Actual						Forecast					
		20-1	20-2	20-3	20-4	21-1	21-2	21-3	21-4	22-1	22-2	22-3	22-4
		5.77	5.53	6.46	7.23	7.99	7.87						
Sensitivities	High							9.37	10.25	10.25	10.50	9.70	8.95
	Base							8.95	9.25	9.25	9.50	8.75	8.00
	Low							8.51	8.25	8.25	8.50	7.75	7.00
Probability	High							20	20	21	21	23	23
	Base							60	60	58	58	55	55
	Low							20	20	21	21	22	22
Probability-Weighted Forecast								8.95	9.25	9.25	9.50	8.75	8.00

LME official cash settlement, US$/lb., quarterly averages.

COPPER PRICES CONSOLIDATE IN JULY

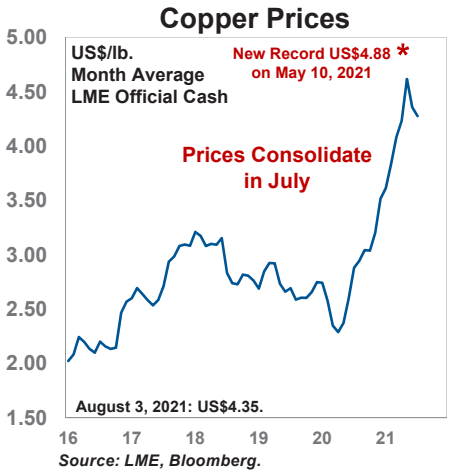
Turning to copper, LME official cash settlement prices edged down seasonally in July to US$4.28 per pound from US$4.36 in June. Prices eased on concern that outbreaks of the COVID-19 Delta variant – particularly in Asia – might slow the global economic recovery. However, copper rebounded to US$4.42 at month end – ahead of a potential strike at Escondida in Chile (the world's biggest copper mine).

Copper prices remain lucrative, with C1 cash costs for a sample of six senior Canadian & international producers averaging a mere US$1.33 in 2021:Q2. Prices had surged to a new intra-day record high of US$4.88 on May 10 – up from a pandemic low of US$2.09 in April 2020 – on sentiment for a 'green recovery' and the emergence of a significant global 'deficit' in 2021.

Copper prices are expected to average US$4.20 for 2021 as a whole – assuming US$4.35 in 2021:Q4, and may ease slightly to US$3.96 in 2022, as a wave of new mine supply gradually comes on stream. Prices averaged considerably lower at US$2.72 in 2019 and US$2.80 in 2020. This forecast is unchanged from that shown in the last 'Critical Metals' report.

Key developments over the past month include:

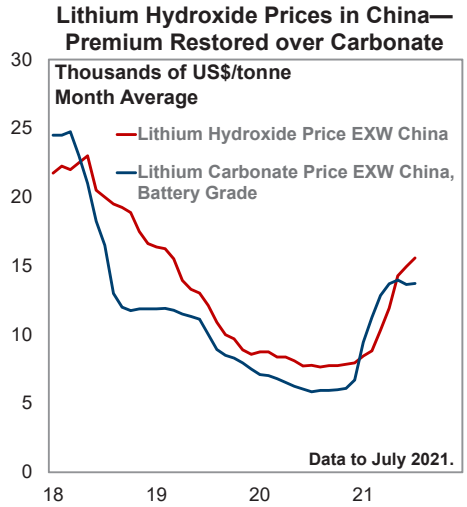
- The Kamoa-Kakula greenfield project in the Democratic Republic of Congo is ramping up, with exports of concentrates and blister copper (from the Lualaba Copper Smelter) getting underway.
- China's 'National Food and Strategic Reserves Administration' conducted its second auction of copper cathodes (30kt) on July 29, after selling 20kt to domestic fabricators at slight discounts on July 5-6. Strategic reserve sales are intended to cool commodity prices, after rising inflation threatened to hurt China's manufacturers earlier this year. As with the first batch, the impact on LME copper prices was not noticeable, though 'sentiment' has been damped.
- In Peru, an opposition-led alliance will control Peru's Congress, in a setback for newly-elected President Pedro Castillo, who aims to reform the country's constitution and hike mining taxes. In Chile, recent primaries – ahead of Chile's first-round Presidential election next November 21 – have resulted in a well-known right-wing candidate and a moderate left-wing candidate – moving the political landscape towards centre and helping to soothe the country's financial markets. Chile and Peru are the world's largest and second-largest copper mining countries.



Source: LME, Bloomberg.

LITHIUM: Limited Spot Market Availability Lifts Prices

Lithium carbonate prices rose in most international markets in July, with prices in Europe and North America climbing towards the higher levels in China (please see BMI assessed prices on page 10). Contract prices with price breaks were revised up, with market participants noting exceptionally tight spot market availability for lithium hydroxide and spodumene feedstock in Australia.



Source: BMI, Capitalight Research.

Lithium Hydroxide EXW China – used in nickel-rich cathodes – is currently priced at about US$15,575 per tonne – well above carbonate at US$13,725 EXW China. The traditional relationship – with hydroxide prices normally above carbonate – was reversed at the beginning of the year, given carbonate's relatively rapid demand recovery in China linked to strong demand for LFP cathodes. However, hydroxide prices moved above carbonate again in May alongside rapidly growing demand for nickel-rich cathodes in both China and international markets. Battery makers are shifting from lower-to-higher nickel content in NCM cathodes; NCM 622 and 811 cathodes are estimated to account for 41% of this market in 2021 compared with 21.9% last year.

Spodumene concentrate prices FOB Australia (6% Li2O) surged in July to an average of US$925 per tonne – surpassing the previous peak back in June 2018. Prices had fallen as low as US$375 during the pandemic last Fall – probably no higher than average mine cash costs. The latest price assessment includes an exceptionally high auction bid of US$1,250 for a 10,000 dmt cargo of spodumene from Pilbara's Pilgangoora Operation for August. Excluding this transaction, average quotes were in a US$600-750 range.

In a major development for the industry, the LME began trading a 'lithium hydroxide futures contract' on July 19 – to be settled using Fastmarkets MB's price assessment for Lithium Hydroxide Monohydrate (Min 56.5% LiOH2O Battery grade, spot prices, CIF China, Japan and Korea in US$ per kilogram). The new LME contract will enable hedging price and counterparty risks, but is not a way of 'discovering cash prices' for lithium – unlike the 'official cash settlement prices' for LME-traded copper and nickel used in this report. Unlike refined metals, chemical compounds cannot be stored in a warehouse for long, making it difficult to have a physically settled contract. The CME Group also introduced a lithium hydroxide futures contract in May.

Megafactory investment in Europe will be extraordinary, with the number of planned facilities now rising to 27 through 2030. Renault, French battery development company Verkor, automaker Stellantis (working with SVOLT) and German automaker Mercedes Benz are all planning substantial cell capacity in Europe.

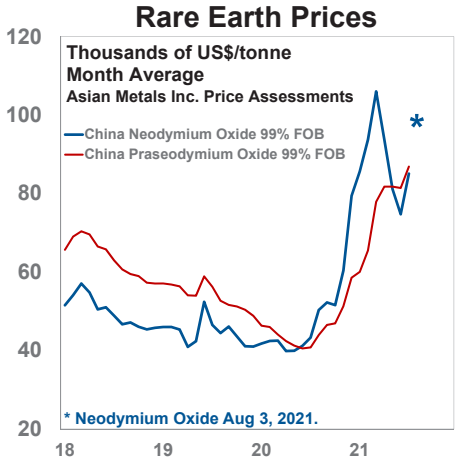
Nissan and Envision AESC have also announced their intention to build a 25 GWh NCM megafactory in the United Kingdom (9 GWh by 2025) – the second megafactory for Sunderland.

RARE EARTH ELEMENTS

The price of 'Neodymium Oxide 99% FOB' in China – a key light rare earth element used in magnets for EV motors and generators in wind turbines – rebounded to US$86,086 per tonne in July and strengthened further to US$96,750 as of August 3 (based upon Asian Metal Inc. price assessments). Prices had eased back in May and June, after inventory replenishment earlier in the year. Praseodymium Oxide and Dysprosium Oxide (a heavy rare earth) also bounced back in July and early August (see chart on page 9).

Sales of New Energy Vehicles (NEVs) in China reached a new record high of 256,000 vehicles in June (+139.3% y/y), according to the China Association of Automobile Manufacturers. Sales totalled 1.206 million in the first half of 2021 and will climb to 2.4 million for the year as a whole – higher than the 1.8 million previously forecast by CAAM. The most popular passenger vehicles were Wuling Hong Guang MINI EV, followed by Tesla's Model 3 and Model Y (manufactured in China).

Cheetah Resources (100% owned by Vital Metals of Australia ASX:VML) continues to advance the Nechalacho rare earth mine in the Northwest Territories (bastnaesite mineral). Rare earth concentrates, produced via sensor-based sorting, will be barged to Hay River before freeze up this year, and transported by truck and rail to the company's new processing facility in Saskatoon, currently under construction. A 'mixed rare earth carbonate' – containing neodymium, praseodymium and other REEs – will be produced via a hydrometallurgical process. Cheetah has arranged an offtake agreement with REEtec of Norway, to separate the material into individual, high-purity rare earths for onward sale into the supply chain.



Source: Bloomberg.

As contract miners for Cheetah Resources, the Yellowknives Dene First Nation are among the first Indigenous groups in Canada to extract minerals from their traditional lands.

(It was previously reported incorrectly that the Nechalacho concentrates would be processed initially at the Saskatchewan Research Council's planned processing facility in Saskatoon.)

Critical Metals - Price Trends

	2018 Annual	2019 Annual	2020 Annual	2020 Q4	2021 Q1	2021 Q2	Latest August 3
Copper							
LME Copper Official Cash Settlement[1] (US$/lb)	2.96	2.72	2.80	3.25	3.85	4.40	4.35
Nickel							
LME Nickel Official Cash Settlement[2] (US$/lb)	5.95	6.31	6.25	7.23	7.99	7.87	8.77
SHFE Nickel, Generic First Contract[2] (CNY/tonne)	102,916	110,746	109,054	120,402	131,120	128,570	144,260
China Nickel Sulphate EXW > 22% Ni, 0.05% Co[2] (CNY/tonne)	28,411	30,487	29,874	30,338	35,766	35,714	39,250
Lithium							
Lithium Carbonate, CIF Asia ≥ 99.2% Li_2CO_3[3] (US$/tonne)	17,063	11,675	8,421	8,008	9,083	11,000	12,000 *July 2021*
Lithium Carbonate, CIF North America ≥ 99.0% Li_2CO_3[3] (US$/tonne)	14,833	11,215	7,746	7,183	8,083	9,750	10,875 *July 2021*
Lithium Hydroxide, FOB North America ≥ 55.0% LiOH[3] (US$/tonne)	16,771	13,521	10,629	10,183	10,458	11,750	13,250 *July 2021*
Spodumene Concentrate, FOB Australia 6% Li_2O, Lithium Feedstock[3] (US$/tonne)	886	595	406	382	472	579	925 *July 2021*
Rare Earth Elements							
China Neodymium Oxide 99%, FOB[4] (US$/tonne)	49,918	44,655	48,757	63,810	95,147	83,222	96,750
China Neodymium Metal 99% FOB[4] (US$/kilogram)	64	57	62	80	116	102	121
China Praseodymium Oxide 99%, FOB[4] (US$/tonne)	63,627	54,024	45,725	52,274	67,818	81,665	96,200
China Praseodymium Metal 99% FOB[4] (US$/kilogram)	114	103	91	92	96	104	112
China Dysprosium Oxide 99%, FOB[4] (US$/kilogram)	177	234	259	266	384	398	419
China Dysprosium Metal 99% FOB[4] (US$/kilogram)	262	307	341	348	497	516	545

Sources:
1) LME, Bloomberg. 2) LME, SHFE, Asian Metal Inc., Bloomberg. 3) BMI, Bloomberg. 4) Asian Metal Inc., Bloomberg.

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