Critical Metals
For a Sustainable World

Capitalight Research Inc.

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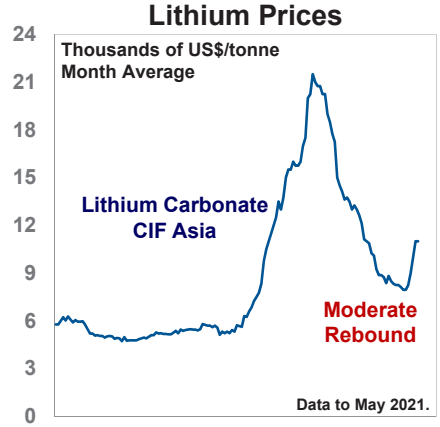
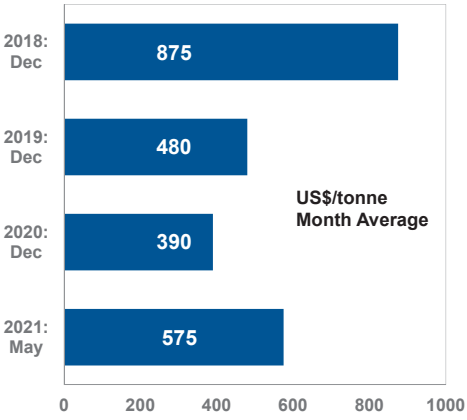
Patricia Mohr
Patricia.mohr@capitalightresearch.com

Lithium Prices



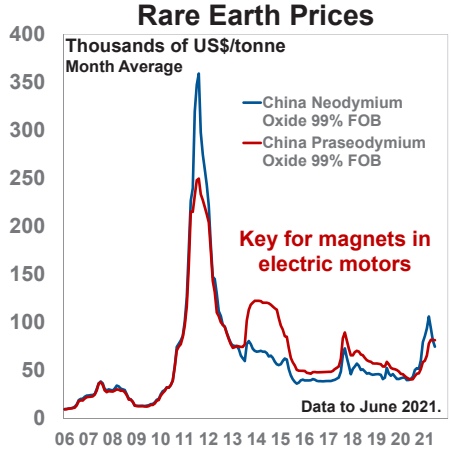
Source: BMI, Bloomberg, Capitalight Research.

Spodumene Concentrates
6% FOB Australia



Source: BMI, Bloomberg, Capitalight Research.

Rare Earth Prices



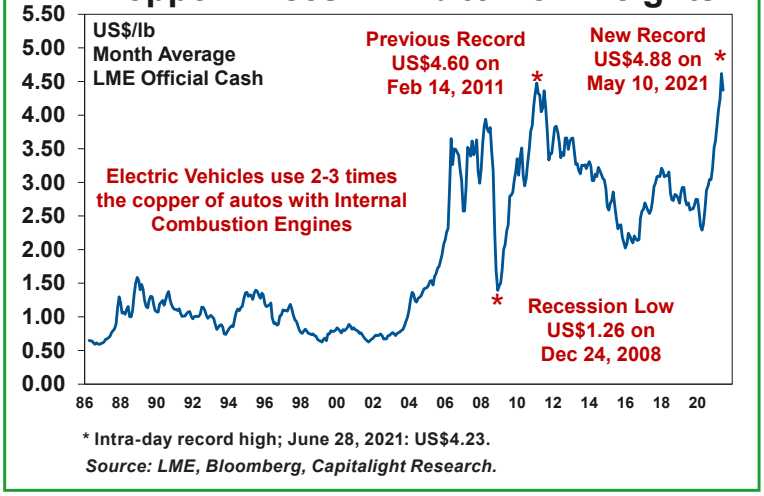
Source: Asian Metals Inc, Bloomberg, Capitalight Research.

- **Copper prices will remain on a higher plane.**
- **Nickel strengthens for high performance EVs.**
- **Global battery plant expansion continues apace.**

Decarbonization Moves to Centre Stage in the Global Economy

'Critical metal' prices – led by copper and Rare Earth Elements – rallied substantially in the early months of 2021 and are likely to be in tight supply medium term. Copper prices will remain on a higher plane than in the 2012-2020 period. This reflects an 'explosion' in 'net-zero carbon emission commitments' by national governments and corporate entities since the Fall of 2020 – to mitigate climate change, stepped-up demand for the metals needed to achieve a gradual transition away from higher to lower-carbon fuel sources & electricity supplies (wind & solar) and general under-investment in new mine capacity in the past decade. Massive government monetary & fiscal stimulus to bolster national economies coming out of the pandemic – especially in the United States and the EU – and an emphasis on the 'metal-intensive

Copper Prices Climb to New Heights



* Intra-day record high; June 28, 2021: US$4.23.

Source: LME, Bloomberg, Capitalight Research.

infrastructure' needed to achieve climate-change reduction targets have added to demand.

As an example, President Biden has called for 100% carbon-free electricity in the United States by 2035 and a doubling of U.S. offshore wind capacity to 30 GW by 2030 (requiring 2,000 turbines). The 'European Green Deal' was officially endorsed by the European Parliament in late June 2021.

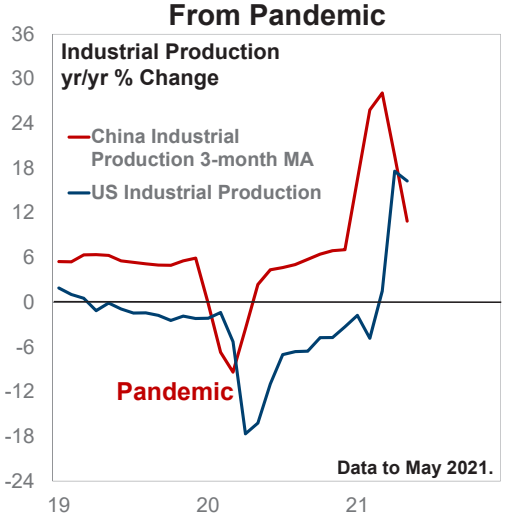
According to the International Energy Agency, 44 countries (including Canada & the United States) and the European Union (another 27 nations) have committed to achieving 'net-zero emissions' – most by 2050, though some earlier and China later by 2060 (as of April 23, 2021, noted in the IEA's report 'Net Zero by 2050, A Road Map for the Global Energy Sector', May 2021). China's announcement was quickly followed by Japan and South Korea (for 2050). These countries account for 70% of global GDP.

As of February 2021, around 110 companies (including Canada's largest mining company – Teck Resources – and two of its largest oil producers–Canadian Natural Resources and Cenovus Energy) have also announced 'net-zero emission' targets. More recently, Canada's five largest oil sands producers have unveiled the 'Oil Sands Pathway to Net-Zero' initiative – to be achieved by 2050 partly through stepped-up Carbon Capture Utilization & Storage (via a CO_2 trunk line & new sequestration hub near Cold Lake), new solvent-based technology replacing natural gas to lift bitumen, development of a hydrogen fuel industry (accompanied by CCUS) for heavy-haul trucks & freight and small modular nuclear reactors (SMRs).

While GHG emissions can be reduced in the coming decade with technology under development today, it should be acknowledged that 'net-zero emission' targets are largely aspirational. The technology does not exist currently to even approach 'net-zero targets' (particularly without CCUS or Direct Air Capture with CO_2 sequestration in the oil & gas industry). In coming decades, massive investment in new technology and product development will be required through engineering, advanced processing and materials science (chemistry and physics).

Not surprisingly, China's new 14th five-year plan – unveiled in March 2021 – continues to place priority on maintaining GDP growth in a "reasonable range" (unlike past five-year plans no specific average annual target is set; growth will be robust this year at 8.4%). China will likely be slower to cut GHG emissions than G7 countries, with CO_2 emissions not peaking until around 2030, and coal-based power remaining important. While the five-year plan will reduce China's energy intensity per unit of GDP by 13.5% by 2025 and CO_2 emissions intensity by 18%, no absolute carbon emission reductions were set. Nevertheless, China has led the global development of electric vehicles and views the

Global Economy Rebounds From Pandemic



Source: National Bureau of Statistics China, US. Federal Reserve Bank of St. Louis.

development of 'green industries' as an important part of its 'Made in China' industrial strategy.

Global decarbonization efforts could well become more ambitious in the lead-up to COP26 – the 26th annual 'Conference of the Parties to the UN Framework Convention on Climate Change' – to be held in Glasgow on November 1-12, 2021.

What are 'Critical Minerals'?

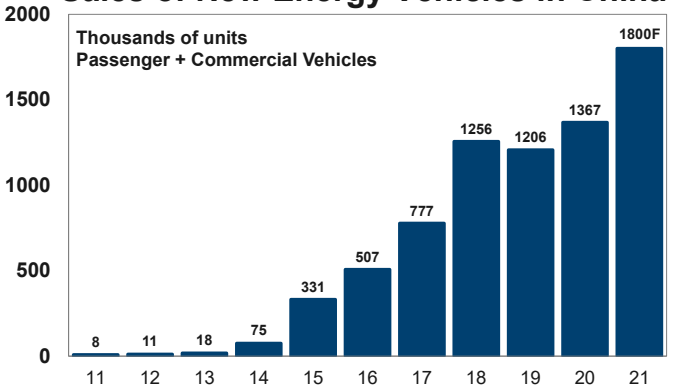
This report will comment on the outlook for key 'critical minerals' needed for the transition to a lower-carbon and more digitalized economy – copper, nickel (used in the cathode chemistries of lithium-ion batteries to achieve a greater electric vehicle driving range), lithium and 3 of the 17 rare earth elements – neodymium, praseodymium & dysprosium – used in the permanent magnets driving electric vehicle motors as well as wind turbine generators.

Canada and the United States finalized a Joint Action Plan for collaborating on 'Critical Minerals' on January 9, 2020 – to secure the supply chains for the 'critical minerals' needed for rapidly developing communication, aerospace, defence and clean technology industries as well as national security. Canada has recently unveiled a list of 31 'critical minerals' and the United States 35, set out by Executive Order of President Trump in May 2018, underpinned by the Biden Administration. While copper is not on the U.S. list, due to a large domestic copper-mining industry, we have designated it as 'critical', given its enormous importance to electrification and e-mobility.

U.S. State Department concern over the 'security of supply' of rare earth elements (REEs) likely goes back to the 2010-11 reduction in REE export quotas by China and China's withdrawal of REE exports to Japan during a dispute,

China announced a new NEV development strategy for 2021-2035 on November 2, 2020. NEV sales are targeted to account for 20% of total vehicle sales (passenger & commercial) by 2025 – up from 5% in 2020. For passenger vehicles alone (cars & SUVs), the NEV market share should climb from only 2% in 2016 and 6.2% in 2020 to 20% by 2025. Implies copper use in passenger vehicles will increase from 100 kt in 2020 to 520 kt in 2025.

Sales of New Energy Vehicles in China



NEVs: Battery electric vehicles, Plug-in Hybrid vehicles and Hydrogen-powered vehicles.
Source: China Association of Automobile Manufacturers (CAAM).

China is the world's largest auto market, accounting for 29% of global sales pre-pandemic (United States 23%). In 2020, China's passenger vehicle sales dropped by -6.5%, though overall vehicle sales – totalling 25.2 million units – only fell by -2% , given a 20% increase in commercial vehicle sales (heavy trucks, buses …). Overall NEV sales climbed by 10.9% to 1.367 million units. Sales surged in the opening months of 2021 (NEVs +224% YTD), but will slow seasonally over the summer.

After a plunge in sales in early 2020 – caused by the scheduled expiry of NEV purchase subsidies by December 2020 as well as the pandemic – China extended its EV purchase subsidies by a further two years through 2022. However, subsidies will be reduced by 20% in 2021 and 30% in 2022. China is moving towards more market-determined sales, though 'green quotas' will still guide NEV adoption.

triggering an enormous price spike (please see the chart on page 1 showing neodymium and praseodymium oxide prices). China dominates the world's supply of mined REEs (over 50 %) and accounts for over 80% of REE separation & processing.

China's emphasis on developing its 'processing' industry has allowed the country to dominate the global REE supply chain. According to the U.S. Department of Energy, the United States currently imports 80% of its processed rare earths directly from China; part of the remainder is also sourced indirectly from China through other countries. (The degree of import dependency – as well as potential for supply-chain disruption – defines criticality.)

Stepped-up demand for 'critical minerals' offers an opportunity to rejuvenate and grow the Canadian mining & processing industry. We note the increased opportunities opening up for Canadian junior and senior mining companies in 'industrial' metals as well as the recent commercialization of new Canadian 'names' in technology, materials science and battery recycling – of interest to investors (including ESG-focused investors).

More recently, the International Energy Agency has noted the potential for short supplies of 'critical minerals' and has called on countries to stockpile battery materials. Given this year's surge, automotive manufacturers are beginning to fear rising raw material prices. Tesla is concerned over tight supplies of nickel and cobalt.

Copper Prices Climb To A Higher Plane

LME cash copper prices surged to a new record of US$4.88 per pound on May 10, 2021 (intra-day) – surpassing the previous record of US$4.60 on February 14, 2011 and a pandemic low of only US$2.09 in April 2020. Despite a global demand drop of about -0.7% in 2020, China's rapid economic recovery from its February 2020 lockdown, tight scrap supplies and strategic stockpiling by the state reserve bureau triggered record Chinese cathode imports. China's refined copper consumption actually rose by over 4.7% last year – up from only 1.8% in 2019, when the U.S.-China trade war and slower industrial activity limited growth (data source Wood Mackenzie). China accounted for more than 53% of world demand last year, given its enormous manufacturing base; the United States a mere 7.5%. Investment fund sentiment for a 'green' recovery – with increasing net long positions by managed money on the LME & COMEX – also lifted copper prices from mid-June 2020.

Prices have since pulled back to the US$4.50 mark in the first half of June 2021, mostly due to calls by Beijing to limit speculative buying to reign in rising raw material prices (China's Producer Price Index surged by 9% yr/yr in May — the largest increase since September 2008). Under pressure from government, 15 Chinese smelters have agreed to cut copper concentrate purchases by 8.8% in 2021 and rely more on domestic scrap & blister (the equivalent of 300,000 t of contained copper, though it remains to be seen if this occurs).

Copper prices dropped further to a still lucrative US$4.31 on June 16, following the announcement by China's National Food & Strategic Reserves Administration that it will conduct sales of refined copper as well as aluminium and zinc in batches to dampen prices (the first sale since 2005 will occur on July 5-6 at a modest 20,000 t). Estimated state copper reserves are about 1 million tonnes.

'Risk-off sentiment' – following the June 15-16, 2021 Federal Open Market Committee meeting – pressured prices further to US$4.18 on June 18. Economic projections indicated

a slight pick-up in expectations for inflation (particularly in 2021) and the possible need to raise the target Fed funds rate to 60 basis points by year-end 2023 from 10 basis points previously. Negative financial market reaction to prospects for Fed 'tapering' of quantitative easing (currently involving the purchase of US$120 bn per month of Treasury securities & mortgage-backed bonds) has been seen before in 2012-14.

Turning to fundamentals, the supply & demand balance for refined copper (cathodes) will likely turn from a moderate 'surplus' in 2020 to a significant 'deficit' in 2021 (almost 250,000 t). Global refined consumption at 24.1 mt (+2.6%) will be well ahead of production this year. Demand outside of China is picking up, with a gradual end to the 'Great Lockdown' of 2020. The IMF forecasts robust global GDP growth of 6% in 2021 and 4.4% in 2022, after a drop of -3.3% last year. 'Green initiatives' such as funding for EV charging infrastructure – included in President Biden's bipartisan infrastructure plan – will add to rebounding demand, with the positive impact just getting underway.

Price Sensitivities around the Base Case:
High Case: A combination of higher-than-expected demand in China and 'supply-side risks' – linked to Covid-19, technical challenges with underground block caving or labour disruptions & blockades – could lead to higher copper prices than forecast in the Base Case.

Copper Price Outlook - Annual Averages

pre-pandemic				
2018	2019	2020	2021F	2022F
2.96	2.72	2.80	4.20	3.96

Recent political developments in Chile and Peru – the world's number 1 and 2 largest copper mining countries – also point to higher mining taxes ahead – to finance stepped-up government spending on health & education and address issues of inequality. New mine investment could be significantly cut in the second half of the decade, though projects currently under development will go ahead (Quebrada Blanca has a 15-year tax agreement in place). Chile is in the process of drafting a new constitution, following civil unrest in 2019 and will hold a Presidential election in November 2021; a left-leaning candidate is leading. The Lower House approved a proposal to substantially lift mining royalties on May 6, 2021 (linked to copper prices) – likely to be moderated by Chile's Senate.

Low Case: Commodity prices could be pressured again 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.

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
		2.56	2.42	2.96	3.25	3.85	4.41e						
Sensitivities	**High**							4.30	4.55	4.20	4.30	4.00	4.05
	Base							**4.20**	**4.35**	**4.00**	**4.10**	**3.85**	**3.90**
	Low							4.10	4.10	3.80	3.90	3.70	3.75
Probability	**High**							0.15	0.15	0.20	0.20	0.20	0.20
	Base							0.70	0.70	0.60	0.60	0.60	0.60
	Low							0.15	0.15	0.20	0.20	0.20	0.20
Probability-Weighted Forecast								**4.20**	**4.35**	**4.00**	**4.10**	**3.85**	**3.90**

Prices: US$/lb., quarterly averages.

These developments will more than offset a likely slowdown in new cathode demand in China in 2021. The recent build-up in cathode inventories in bonded warehouses in Shanghai, government sales of cathode stocks and a greater reliance on domestic scrap supplies by smelters may limit the gain to 0.5%. Semi-fabricators are also reporting that some infrastructure projects are being delayed due to recently high copper prices, but not in the supply chain for electric vehicles.

World demand growth for copper will accelerate further by 3.8% in 2022 to about 25 mt. However, an edging up in new mine supply in 2021:H2 (with the gradual ramp-up of Kamoa-Kakula in the DR Congo, Mina Justa in Peru and Timok in Serbia) and more substantial new mine development in 2022 (+1.2 mt) and another +1.1 mt to 23.4 mt in 2023 – under development for some time – will probably ease market conditions for a time. New projects such as Quebrada Blanca Phase 2, Quellaveco and Pilares and expansion at Cobre Panama, Grasberg, Spence and Aktogay are included in these estimates. The net result, prices are expected to average US$4.20 in 2021, moderating to a still lucrative US$3.96 in 2022.

Despite prospects for near-term easing in 2022-23, it is important to note that the current mine expansion wave will peak in 2024 and a large projected gap in required mine supply will open up in the second half of the decade. Trend copper prices must remain well above long-term 'incentive levels' to justify new mine development (around US$3.50). Copper demand from renewable power projects, energy storage and electric vehicles could double by 2025 to 8.5 mt. **Unlike recent years, prices will be driven less by short-term macro-economic developments in China and more by rising demand linked to global decarbonization.**

Nickel – New EV Battery Chemistries Point To Stronger Demand Ahead

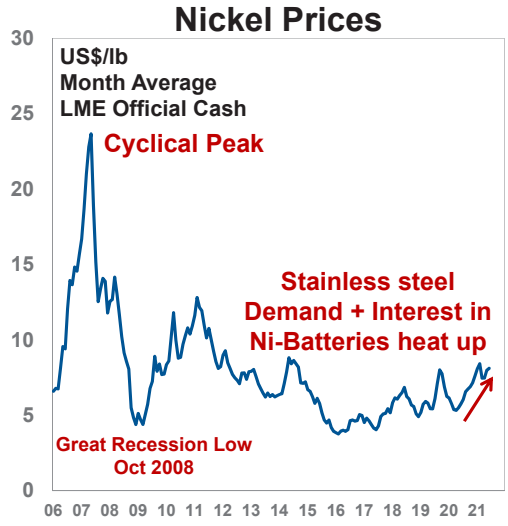
LME nickel prices have also rallied this year to a high of US$8.93 per pound (US$19,689 per tonne) on February 22 – from a pandemic-low of US$5.01 on March 23, 2020 and an average of US$6.31 in 2019. A strong recovery in global stainless steel production – up 26% yr/yr in 2021:Q1 and a further robust gain in Q2 – and growing interest in nickel-rich batteries have lifted nickel consumption. Stainless steel still dominates first-use nickel demand, accounting for about 73% of overall nickel consumption last year – in a 2.4 million tonne market – with nickel used in batteries a much smaller 8% and high alloy steel 3%. However, battery demand for nickel will probably outpace stainless steel through 2030; there has been a shift recently from NCM 523 and 622 to 811 cathode chemistries in lithium-ion batteries (NCM 811: 8 parts nickel, 1 part cobalt, 1 part manganese) – chemistries reportedly favoured by BMW, Volkswagen and GM. Some cobalt is being replaced by nickel.

After the early-year surge, prices retreated in March to US$7.47, when Tsingshan – the world's biggest stainless steel producer and a major nickel producer in Indonesia – announced that it had succeeded in making nickel matte from NPI (nickel pig iron). The matte would then be refined and made into nickel sulphate for batteries – potentially alleviating tight supply conditions. Tsingshan and its partners plan to start producing nickel matte for battery use later in 2021 at the Morowali Industrial Park in Sulawesi.

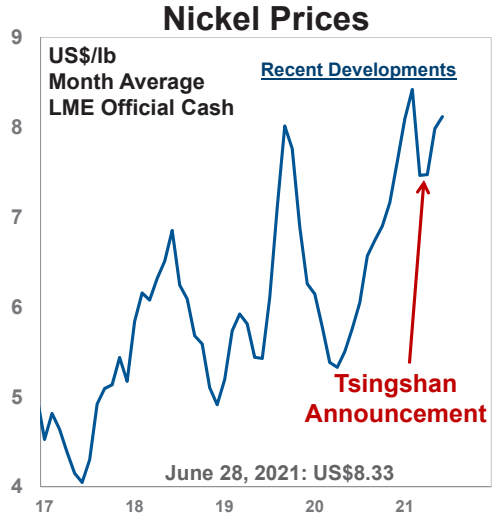
Nickel has subsequently recovered and stands at US$8.33 in late June. Unlike copper, China's government has no plans to sell refined nickel to dampen prices.

The Tsingshan announcement has set off a debate in the nickel industry. To what extent will the conversion of NPI plants in Indonesia

(processing laterite ores) feed the growing battery demand for nickel and restrain the price outlook for LME nickel (refined No. 1 grade)? What will be the impact on Canada's nickel sulphide projects (smelted & refined into LME deliverable nickel)? The answer – the conversion of NPI plants in Indonesia will likely increase the availability of nickel products for the battery sector in coming years – in fact it may be required. However, its use will mostly be confined to China's supply chain. Auto manufacturers in other markets may be reluctant to use this product due to its significantly higher life-cycle CO_2 emissions (currently about 7 times more) than the nickel made from sulphide ores. NPI from laterite ores requires more electricity in its processing and Indonesian power is mostly coal-fired. Tsingshan intends to develop renewable power (solar & wind) – and eventually hydro from Borneo – for the Morowali site, but environmental challenges lie ahead. (In our view, this debate is not about the relative demand for Class 1 versus Class 2 nickel, but rather about comparative CO_2 emissions.)



Source: LME, Bloomberg, Capitalight Research.



Source: LME, Bloomberg, Capitalight Research.

Lithium – Megafactory Expansion Continues in U.S., Europe & China

Lithium carbonate and spodumene concentrate prices have also recovered in the first half of 2021, after a substantial inventory correction from 2018-20. China led the price recovery in late 2020, as manufacturers across the supply chain reacted positively to the extension of China's EV purchase subsidies for another two years (subsidies had previously been scheduled to expire in late 2020 – riling China's auto industry), Chinese consumers recovered from the pandemic and industry moved to replenish inventories.

Global EV sales have increased by an estimated 125% in the first four months of 2021 – spurred in part by large EV purchase subsidies in Germany, France and Italy – as part of COVID-19 relief packages. Global electric vehicle sales (passenger cars & light duty vehicles) totalled just over 3 million units in 2020. While lithium prices have started to edge down seasonally in late June, with the normal increase in domestic supply from China's Qinghai brine operations – prices should strengthen again in the Fall.

In the meantime, world battery plant expansion continues apace. Given plans by OEM auto manufacturers to greatly expand their electric fleet offerings, global battery plant capacity is projected to climb from 755.2 GWh

in 2020 to 2,633.9 GWh in 2025 to 3,791.9 GWh by 2030 – driving demand for lithium and other critical minerals. While China will continue to dominate (currently accounting for 75.2% of cell capacity), European plans are accelerating and starting to advance in the United States (please see insert below). The latest news – Volvo Car Group and Northvolt (a Swedish battery maker) have announced a 50/50 joint venture to build a megafactory in Europe (with up to 50 GWh of capacity, starting in 2026).

U.S. Megafactories – Battery Cell Manufacture

Hub 1 : Tesla West

- *Tesla pilot Fremont, California*
- *Tesla Gigafactory 1 , Sparks Nevada*
- *Tesla Gigafactory 5, Austin Texas*
  Start-up expected in 2022

Hub 2 : New Detroit

- *LG Chem Michigan (2021)*
- *LG Chem/GM Lordstown,Ohio*
  Expected start-up in 2023

Hub 3 : EV South

- *AESE Tennessee*
  Expected start-up 2023
- *SK Innovation US (2021)*
- *SK Innovation US 2*
  Expected start-up in 2023

Others

- *iM3 (2021)*
- *Farasis – location TBC*

Source: BMI, June 2021.

Rare Earth Elements – Critical For EVs and Renewable Power

Prices for Light Rare Earth Elements – neodymium & praseodymium – more than doubled this spring from April 2020 pandemic lows ; dysprosium (a heavy REE) also doubled, but from a low in November 2019 during the U.S.-China trade war. Inventory replenishment as well as prospects for strong international EV sales, renewable energy projects and electronics (e.g. smart phones) lifted prices, though some easing has occurred in May and June.

Efforts are underway in Canada and the United States to address the issue of limited North American processing capacity for REEs and risks in the supply chain. The Saskatchewan Research Council is building Canada's first rare earth processing facility in Saskatoon to concentrate REE ores into mixed REE carbonate and then into individual pure-grade REEs. Northern Saskatchewan has significant potential REE resources for development, as do the Northwest Territories, Ontario and Quebec.

In the United States, the Defense Department has recently awarded funding (under DPA Title III technology investment agreements) for several projects including 1) the separation of rare earth elements at the Mountain Pass mine in California (instead of sending the mixed rare earth concentrate to Asia - likely China - for further processing), and 2) the development of a light REE separation facility by Lynas Rare Earth Ltd. (an Australian company) at Hondo, Texas – expected to be co-located with a proposed heavy REE facility. Other developments are currently underway, involving Canadian and U.S. companies.

A more in-depth review of the nickel market outlook, as well as Lithium and REEs, is planned for coming editions of this report.

Critical Metals - Price Trends

	2018 Annual	2019 Annual	2020 Annual	2020 Q4	2021 Q1	2021 Q2e	Latest June 28
Nickel							
LME Nickel Official Cash Settlement[1] (US$/lb)	5.95	6.31	6.25	7.23	7.99	7.86	8.33
SHFE Nickel, Generic First Contract[1] (CNY/tonne)	102,916	110,746	109,054	120,402	131,120	128,440	137,750
China Nickel Sulphate EXW > 22% Ni, 0.05% Co[1] (CNY/tonne)	28,411	30,487	29,874	30,338	35,766	35,691	36,750
Lithium							
Lithium Carbonate, CIF Asia ≥ 99.2% Li_2CO_3[2] (US$/tonne)	17,063	11,675	8,421	8,008	9,083	11,000	11,000 *May 2021*
Lithium Carbonate, CIF North America ≥ 99.0% Li_2CO_3[2] (US$/tonne)	14,833	11,215	7,746	7,183	8,083	9,500	9,500 *May 2021*
Lithium Hydroxide, FOB North America ≥ 55.0% LiOH[2] (US$/tonne)	16,771	13,521	10,629	10,183	10,458	11,500	11,500 *May 2021*
Spodumene Concentrate, FOB Australia 6% Li_2O, Lithium Feedstock[2] (US$/tonne)	886	595	406	382	472	569	575 *May 2021*
Rare Earth Elements							
China Neodymium Oxide 99%, FOB[3] (US$/tonne)	49,918	44,655	48,757	63,810	95,147	83,222	73,750
China Praseodymium Oxide 99%, FOB[3] (US$/tonne)	63,627	54,024	45,725	52,274	67,818	81,669	81,300
China Dysprosium Oxide 99%, FOB[3] (US$/kilogram)	177	234	259	266	384	398	353

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

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