

# Critical Metals

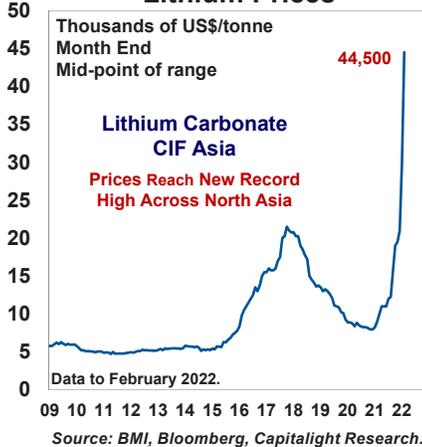
For a Sustainable World 

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## Lithium Prices

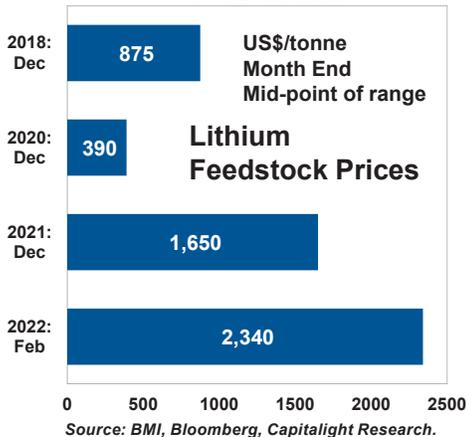


- Commodity prices surge, as Russian invasion of Ukraine triggers sanctions & global supply risks.
- Nickel prices soar near the record level of May 2007 – in one of the most extreme price moves ever seen on the LME.
- Rising defence spending (especially by Germany & Europe) lifts prospects for rare earths.

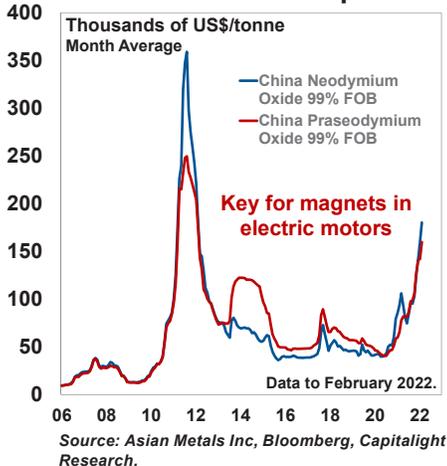
## Geopolitical Risk Premiums Rise in Commodity Prices

The ‘economic bombs’ unleashed on Russia for its February 24th invasion of Ukraine by the United States, Canada, the U.K. and EU – as well as Japan and South Korea – have triggered a broad-based surge in global commodity prices. Russia is normally an important supplier of many ‘critical minerals’ and oil & gas (please see the table on page 2). While actual restrictions on key Russian exports were not initially implemented (fearing the fallout on western economies), unprecedented financial market sanctions on Russian banks – including freezing the overseas assets of the central bank and denying several key Russian banks access to the SWIFT system of international payments – and the widespread condemnation of Russia’s actions in Ukraine are likely to be more effective than many observers had initially expected.

## Spodumene Concentrates 6% FOB Australia



## Rare Earth Prices Outperform



## Russian Supply Risks Lift Nickel Prices



The 'reputational risk' of continuing to operate in Russia has led major companies to suspend operations or exit investments in Russia (including BP, Shell, Exxon, Visa, Mastercard and Apple). The U.K. has blocked access to the London insurance and reinsurance market for Russian aviation and space companies. Though sanctions affecting marine insurance have yet to be announced, six of the world's major containership companies (controlling 62% of world capacity – including MSC, Maersk, CMA CGM, Hapag-Lloyd, ONE and Yang Ming) will no longer call at Russian ports and many

tanker owners are refusing to carry Russian oil – considerably disrupting world trade and commodity supplies. Refined metals are usually shipped in containers or break-bulk vessels.

The financial blockade of Russia's economy has probably already triggered a severe recession in Russia, which will not be easy to hide from the Russian public. J P Morgan expects Russia's GDP to collapse by 35% in the second quarter of 2022 and to contract by 7% in 2022 (Source: Reuters). Russia's growing economic and political isolation is expected to reduce long-run growth to roughly 1% p.a.

## Commodity Supplies At Risk From Russian Invasion

### Russian Share of Global Production (%)

#### Critical Metals

Nickel 6.50-7.0% (Nornickel)  
 (20% of Class 1 refined nickel)

Cobalt 4%

Palladium 41%\*

Platinum 10%

Aluminium 6% (Rusal)

Copper 3.5%

Titanium (Ukraine & Russia) 15%

#### Energy

Crude Oil 11.4% \*\* (Rosneft, Lukoil, Surgutneftgas)

Natural Gas 17% + (Gazprom)

#### Grains & Fertilizers

Wheat 17%

Wheat (Ukraine & Russia) 29%

Fertilizers 13% (Uralkali, Uralkem, Phosagro, Eurochem)

Potash 20% ++

\*Russia (Nornickel) is the world's largest palladium producer.

\*\*Russia was the world's second-largest exporter of crude oil in December 2021; In the past 5-10 years, Russia ranked in the top three Oil & NGL producers (the others are the United States and Saudi Arabia); in 2021, the USA was by far the world's largest producer with output of 17.76 mb/d (18.7% share) compared with 10.80 mb/d in Russia (11.4% of the total) and 9.09 mb/d in Saudi Arabia; please note that Saudi Arabia and Russia cut oil sales in 2020 to shore up prices and have only gradually been bringing back supplies. Canada was the world's fourth-largest Oil & NGL producer in 2021, with output at 5.48 mb/d (5.8%).

+ Russia supplies 40% of Europe's natural gas.

++ Russia is the world's second-largest source of potash after Canada; Belarus is also a major producer; potash is a low-carbon fertilizer and is in Canada's list of 'critical minerals'. Potash prices have recently skyrocketed.

**Source: Capitalight Research, Reuters, Wood Mackenzie and OPEC.**

## Impact on 'Critical Minerals' from Russian Invasion

Recent developments have lifted the price and demand outlook for 'critical metals' – both in the short and medium term – as follows:

1) A significant 'geopolitical risk premium' has been introduced into key base metal prices for nickel, aluminium and copper. **Nornickel (Norilsk Nickel) is Russia's largest mining company and supplies 20% of the world's Class 1 refined nickel—deliverable on both the LME and SHFE – and suitable for producing both stainless steel and nickel sulphate for EV batteries.**

While we are not aware of any negative impact on Russian production from recent events, LME official cash settlement prices for nickel soared as high as US\$19.50 per pound on March 7 and closed at US\$21.81 for 3-month futures. In early trading on March 8, the 3-month price rose to a record US\$101,365 (US\$45.98 per lb) as a Chinese market participant (Tsingshan Holdings) and others struggled to cover large short positions and escalating margin calls in a tight and illiquid market. Three-month futures

subsequently dropped back to US\$80,000 as of 08:15 GMT, at which point the LME suspended trading. The spike in nickel prices on March 7 and 8 was one of the most extreme moves ever seen on the LME. Paper losses on Tsingshan Holdings' short positions (30,000 tonnes on the LME and 120,000 tonnes in bilateral deals with banks) are in the billions – possibly as high as US\$12 billion using extreme pricing (Source: Bloomberg, BMI). In a very controversial move, the LME cancelled all nickel trades executed on or after 00:00 hours on March 8 in the inter-office market and on LME Select, until further notice. The LME will resume nickel trading on Wednesday March 16, with new daily price limits and position disclosure requirements.

As background, the record 'official cash settlement' price (the price series monitored in this report) was US\$24.58 set on May 16, 2007 at the top of the commodity market super-cycle of 2001-08, just before the 'Great Recession' (caused by difficulties in the U.S. mortgage market). LME nickel prices started 2022 at US\$10.13. Prices have also escalated on the SHFE, which suspended futures trading for one day, following the LME suspension - amid critically low inventories. Please see the nickel price chart on the front cover.

**Germany has been planning to rely on increasing supplies of close-by Finnish & Russian nickel to build out its rapidly growing battery and electric vehicle industry – via the partnership between Nornickel and BASF (Germany's leading chemical company).** BASF intends to make nickel 'precursor cathode active materials' (PCAM) next door to Nornickel's Harjavalta nickel refinery in Finland; the refinery's feedstock comes from Norilsk Nickel's Siberian mines as well as the Talvivaara mine in Finland. The PCAM material will be shipped to Schwarzheide in Germany to be made into 'cathode active materials' (CAM) for nickel-rich EV batteries. Recent developments could complicate these plans.



Source: Pingeat and Shutterstock.com

Nornickel is also the world’s largest palladium supplier (accounting for 41%), represents 10% of world platinum production and is a major copper and cobalt producer – mostly produced in association with nickel. Palladium is used chiefly in catalytic converters to reduce emissions from gasoline-fuelled vehicles.

**2) Escalating oil prices – at a high of US\$123.70 per barrel for WTI and US\$127.98 for Brent (closing prices on March 8) – will likely spur consumer interest in shifting to electric vehicles, despite rising battery costs.** Gasoline prices across the United States climbed to a new record of US\$4.17 per gallon on March 8 (AAA) – the highest since the US\$4.11 on July 2008.

Russia is among the top three oil & NGL producers in the world (the second-largest in 2021) – accounting for 11.4% of global production. Total Russian exports of crude oil & condensates as well as refined products totalled roughly 7.8-7.9 mb/d in December 2021, of which crude oil & condensates alone were about 5 mb/d (source IEA).

While western governments were initially reluctant to sanction Russian oil & product exports, to prevent negative fallout on consumers and their economies, Canada and



subsequently the United States, have now banned the import of Russian oil and refined products. The U.K. also announced on March 8 that it will phase out the import of Russian oil & products by the end of 2022, allowing time for consumers and industrial users to adjust. In our view, these bans will be semi-permanent and not reversed easily.

The U.S. imported a surprisingly large 672,000 b/d of crude & refined products from Russia in 2021 (8% of total imports, EIA data), of which 30% or 199,000 b/d was crude, while 475,000 b/d was refined products (mostly unfinished products such as naphtha, some types of fuel oil and feedstock for heavy oil refineries). Russian crude imports touched a record high in 2021 due to the halt in Mars grade crude production on the Gulf Coast, as hurricanes damaged the LOOP system in Louisiana. Imports of Russian crude have eased back this year.

Canada’s Suncor Energy says that Western Canada can replace one-third to half of the sanctioned Russian oil in the U.S. market. Interestingly, Canada is the world’s fourth-largest oil & NGL producer with output of 5.48 mb/d (please see the table on page 2).

The U.K. ban will have only a small impact on the physical markets for oil & products, though an important psychological one. Russia supplies a third of U.K. road diesel imports. On March 1, Russian ships were banned from U.K. ports.

Prior to the Russian invasion, the oil supply & demand balance was tightening, with world oil & liquids consumption at a seasonally strong 99.8 mb/d in 2021:Q4 (close to pre-pandemic levels) and supply from OPEC & non-OPEC countries lower at only 92.642 mb/d. OECD commercial inventories were falling and below the five-year average (for both crude and refined products) – a widely followed indicator of market tightness.

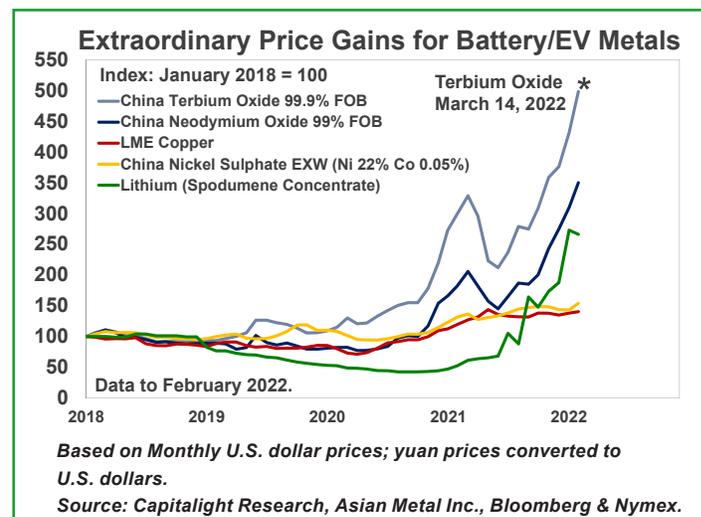
After cutting its output an enormous 9.7 mb/d in May & June 2020 – to shore up prices during the

'Great Lockdown' – OPEC+ has been normalizing its output gradually and continued with this policy at its last meeting on March 2, 2022; (output is scheduled to increase another 0.4 mb/d in April, with cutbacks completely phased out by September). Global oil consumption rose by a robust 6.5% in 2021.

The actual disruption of Russian exports has been significant, even without a complete embargo. Should prices skyrocket in coming weeks and the OPEC-10 be persuaded to ramp up output more quickly, four members – Saudi Arabia (2 mb/d), the UAE (0.4 mb/d), Kuwait (0.2 mb/d) and Iraq (0.4 mb/d) – have spare capacity of 3 mb/d which could be quickly brought on stream to cover the shortfall – though only part of it. While WTI oil prices slipped to US\$95 the morning of March 15 – on concern that COVID lockdowns in China could slow China's economy, oil prices are likely to remain high for some time.

3) Natural gas prices have also surged internationally since the invasion – with the Netherlands TTF one-month forward price at 212 euros per MWh on March 7 – up from only 16.3 euros a year earlier. Russia supplied 45% of European gas imports in 2021 (50% of German imports). Misguided energy policy in Germany, where low CO<sub>2</sub>-emitting nuclear power plants are being closed down, has contributed to rising dependence on Russian gas supplies.

Recognizing the need for energy security, the EU has now announced a plan – REPower EU – to reduce its purchase of Russian gas by two-thirds by year end. **The plan focuses on accelerating the rollout of renewable energy projects – wind and solar – requiring the use of REEs, copper and aluminium;** speeding up the permitting processes for building renewables and making required improvements in grid infrastructure. While the EU will also promote development of 'green hydrogen' (water-electrolysis), we do not believe that the technology is economic – further R&D and technical progress are required. (In contrast,



Alberta's proposed new 'blue hydrogen' industry will be based on domestic, low-cost natural gas supplies, with CO<sub>2</sub> emissions abated through large-scale underground 'carbon capture & storage' facilities.)

4) **Over the medium term, stepped-up defence spending in Europe and other western countries will spur both demand and prices for rare earths (especially terbium and neodymium).** In an historic policy shift on February 27, Germany's Chancellor signalled that Germany would invest more than 2% of GDP on defence – up from an estimated 1.53% (US\$65 bn) in 2021, after years of resisting pleas from NATO allies, and set up a Euro 100-billion (US\$112 bn) fund to re-equip its military.

Many NATO countries are not currently meeting the 2% of GDP spending guideline reaffirmed at a NATO summit in 2014 (at the time of Russia's annexation of Crimea). Of the 30 NATO members, only ten met the threshold in 2021 (Greece, the United States at about 3.52%, Croatia, the United Kingdom, Estonia, Latvia, Poland, Lithuania, Romania and France – listed in order of spending as a % of GDP). Meeting the 2% target in other countries would increase annual defence spending by roughly US\$80 bn. In addition, we note that previously neutral countries – such as Finland and Sweden – are warming to the idea of NATO membership.

## Québec's Clean Energy Advantage Lures Cathode Materials Plants

In a major positive development for Québec and Canada, General Motors Co. and its joint-venture partner POSCO Chemical announced on March 7 that they intend to build a new plant in Bécancour, Québec to produce 'cathode active material' or CAM for batteries – part of the North American supply chain for GM's new Ultium batteries for electric vehicles such as the Chevrolet Silverado EV and the Cadillac LYRIQ crossover. The chemistry for GM's Ultima battery is nickel-rich NCMA (nickel, cobalt, manganese, aluminium) and is designed to minimize the use of high-cost cobalt. The cost of the plant is estimated at C\$500 million.

BASF will also construct a battery materials facility in Bécancour to produce and recycle 'cathode active materials' (CAM) by 2025 – up to 100,000 tonnes of cathode material. The plant will supply the EV market in Canada, the United States and Mexico (USMCA free trade partners). Cathodes represent about 40% of the value of a battery.

It appears that Bécancour – on the south side of the St. Lawrence River opposite Trois-Rivières – will become a hub for producing materials used in EV-battery cathodes. Québec's very low cost

and low carbon-emitting hydro power appears to have been key in attracting these investments. Québec's electricity grid has a current carbon intensity of less than 27 grams of CO<sub>2</sub> equivalent per kilowatt-hour compared with roughly 445 grams for Germany, where BASF is also building a cathode plant (as outlined previously). The carbon intensity of power in South Korea is about 500 grams CO<sub>2</sub> per kWh, in Japan 600 grams and in Indonesia 625 grams (Source: ElectricityMap as of March 12, 2022, 8:00 am). Québec is the world's fourth-largest producer of hydro-electricity and 'renewable energy' accounts for 99% of its grid power, important in lowering the carbon intensity of cathode and anode materials for EVs.

Canada's ample endowment of 'critical minerals' – nickel, aluminium, cobalt & graphite – and a geopolitically stable environment were probably also important in attracting these investments. Federal & Québec government investment support was probably also key, though details have not been disclosed.

On the mining side, Vale is reportedly looking at Québec for a 'nickel sulphate' plant and Nouveau Monde is building a battery-grade graphite purification plant for the anode supply chain.

In Ontario, Glencore, Electra Battery Materials Corp. and Talon Metals have formed a consortium with the Ontario government to investigate the possibility of building a 'nickel sulphate plant' and a battery 'precursor cathode active materials' plant beside Electra's cobalt refinery and recycling facility. Electra's battery-grade 'cobalt sulphate' refinery is set to be commissioned in December; the company was previously called First Cobalt.

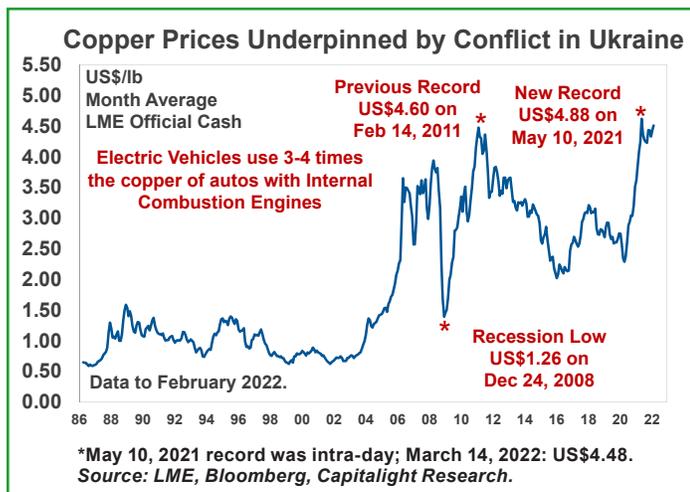
## Copper Prices Climb Near-Record High

In contrast to nickel's wild ride, trading in LME copper has been relatively sedate. The LME 'official cash settlement' price for copper rose as

### Supply Chain for Lithium-Ion Batteries

1. Raw Materials
2. Refined and Precursor Materials
3. Components and Active Materials
4. Cell Production
5. Module Production
6. Battery Pack Assembly
7. Integration in the Vehicle (OEM Assembly)
8. Battery Recycling

**Source: Propulsion Québec, Cluster for Electric and Smart Transportation.**



high as US\$4.87 per pound on March 7 (close to the previous intra-day record of US\$4.88 on May 10, 2021), before edging back to US\$4.48 on March 14 – still quite a lucrative level. Traders are concerned over regional shutdowns in China to contain COVID. Prices averaged US\$4.43 in January and US\$4.51 in February.

There has been a massive re-pricing in global commodity markets. Due to the complications of trading with Russia, traders have been assuming that significant Russian supplies have been pulled out of the market, with or without actual sanctions. Russia normally accounts for a fairly modest 3.5% of global copper production.

Copper inventories on the SHFE have edged up for five consecutive weeks (except the last one), as high cathode prices have made it difficult for traders to sell in China; traders have been exporting material overseas. Nevertheless, 'visible exchange stocks' on the LME, COMEX, SHFE and in bonded warehouses in Shanghai remain low at only 8.7 days' consumption.

The net result, we have moderately increased the copper price forecast to US\$4.45 for 2022 and US\$4.25 for 2023, up from US\$4.23 in 2021. Please see Table 2 at the end of the report.

### **Nickel Prices**

LME 'official cash settlement' prices started 2022 at US\$10.13 per pound in January and

US\$10.97 in February. LME prices soared as high as US\$19.50 on March 7, before trading was suspended from March 8-15.

Our comment: many analysts have recently expected the supply & demand balance for nickel to shift from 'deficit' in 2021 to a 'surplus' in 2022 (though NOT two major investment banks in New York or several major nickel traders), as new Indonesian supply comes on stream. Tsingshan Holdings likely also expected the market to move into 'surplus', given its plans to substantially increase Indonesian production, encouraging the company to sell 'short'. However, we note that the global supply and demand balance for nickel is probably still in 'deficit' in early 2022.

Two developments might ramp up Indonesian nickel supplies quickly this year, alleviating tight supplies of the kind of nickel necessary for EV battery production in China (provided they ramp up on time). Firstly, the Huaye project in Morowali (in which Tsingshan Holdings has a stake) – will produce as much as 52,000 tonnes of nickel in MHP (mixed hydroxide precipitate); the first 5,000 tonne shipment was bound for Ningbo (Shanghai) in February (BMI data); and secondly, shipments of nickel 'matte' rather than nickel pig iron at Tsingshan's Morowali plant (as much as 100,000 tonnes, with 60,000 tonnes shipped to Huayou Cobalt and 40,000 tonnes to cathode maker CNGR Advanced Material in China). Other producers also plan to start producing 'matte' in Indonesia and nickel pig iron output will be ramped up in 2022 for the stainless steel industry.

Please note that nickel 'matte' (with a nickel content of 70-75%), MHP and nickel pig iron are not deliverable grades on the LME or SHFE. The LME requires nickel that is 99.8% purity and in the form of cathodes, pellets, briquettes and rounds. It is possible that nickel 'matte' could be swapped for 'refined nickel metal' to cover the short position that has brought trading to a halt on the LME.

**Rising Defence Spending Will Lift Rare Earth Demand Medium Term**

Rare earth element prices continued to advance in February. China neodymium oxide (a key light REE used in permanent magnets for EVs and generators for wind turbines) rose to US\$190,000 per tonne on February 21 and remained at this level through March 7, before edging down to US\$182,500 on March 11 (still up 70% yr/yr). Similarly, China terbium oxide (an important and ‘rare’ heavy REE) climbed to US\$2,370 per kilogram on February 23 and stayed there until March 10, before edging down to US\$2,325 (up 52.2% yr/yr) on March 11. Prices for these REEs have returned to the high levels of 2012, just after the spike of 2010-11 caused by China’s ban on REE exports to Japan.

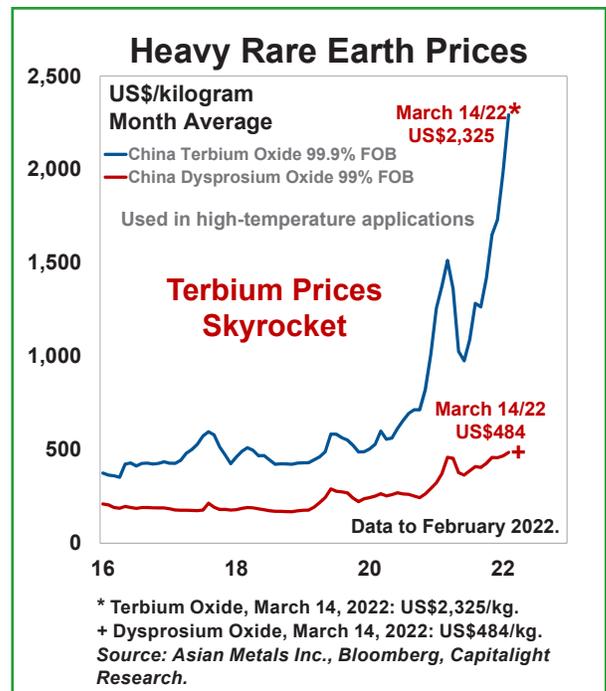
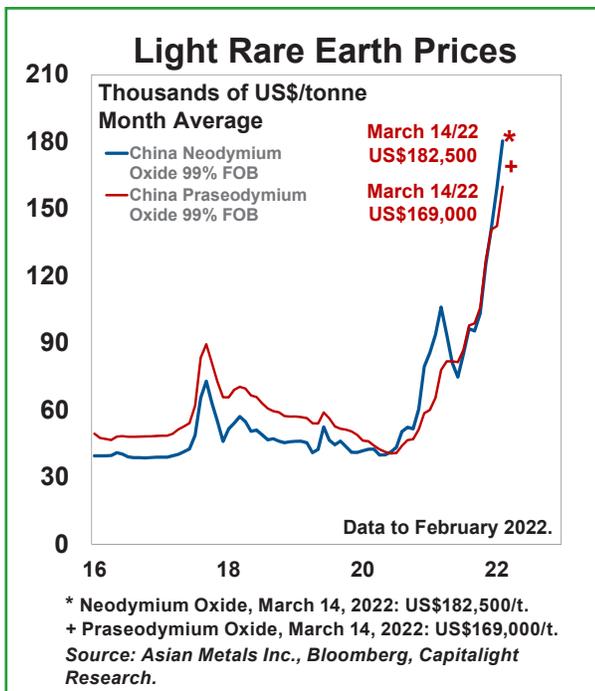
Measured against pre-pandemic levels in January 2018, prices for both China terbium oxide and China neodymium oxide have outperformed WTI oil, even with the recent surge in oil prices. Terbium oxide remains the strongest of the ‘critical metals’ covered in this report (excluding the spike in nickel prices to US\$45.98 per pound on March 8 – a transaction cancelled by the LME).

Heavy rare earths are in short supply in China as well as globally. Mine capability for heavy rare earths has been falling in China – a key reason for the recent consolidation of REE producers in the southern part of China. China also relies for about half of its heavy rare earths on imports from Myanmar, where political instability has raised uncertainty over supplies. The number of heavy REE projects outside of China is quite limited. Aclara Resources' project in Chile is one of the few.

Prospects for stepped-up defence spending by NATO countries and others will boost demand for neodymium (used in missile guidance systems), praseodymium (for aircraft engines and satellite components) and heavy REEs terbium and yttrium (for the advanced targeting systems of jet fighters).

**Lithium Remains in a Supply Squeeze**

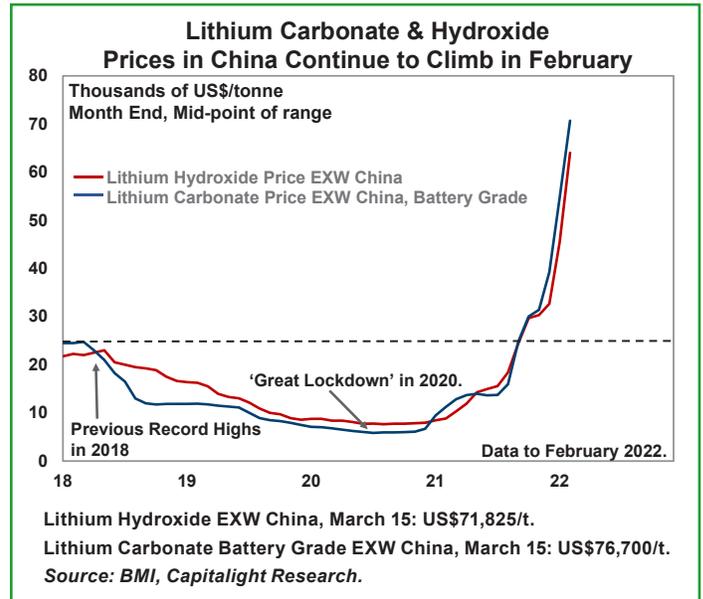
Lithium prices also remain exceptionally strong, unrelated to the Russian invasion. Prices for lithium carbonate (battery grade) advanced further in the second half of February to US\$70,675 per tonne – up an extraordinary 528.2% yr/yr. China lithium hydroxide EXW rose even more in the second half of the



month as buyers turned to hydroxide to make carbonate (an unusual development); prices rose to US\$64,000 – narrowing the gap with carbonate to US\$6,675 (BMI price assessments). Chinese buyers bid up prices for the small amount of spot market tonnage that was available, lifting prices on the high side of price ranges. Prices continued to rise through mid-March. Please see the chart opposite for further details.

Lithium carbonate CIF Asia prices reached a new record high of US\$44,500 in February. Buyers in Japan and South Korea were forced to compete directly with Chinese buyers for the limited amount of spot supplies available.

While demand remained firm for Australia’s spodumene feedstock (6% LiO<sub>2</sub>), the average of high and low prices edged down to US\$2,340 per tonne in February from US\$2,400 a month earlier. Some offtake deals settled at lower final prices, while the volume of higher-priced spot supplies was limited by a lack of availability and shipment delays out of Australia. When the shipping backlog is alleviated, spodumene prices should move up in line with the higher chemical prices to which many spodumene contracts are tied.



In a major supply development, Australia’s Liontown Resources signed a binding term sheet to supply spodumene concentrate to Tesla from the Kathleen Valley mine in Western Australia, subject to the project reaching commercial production by 2025. The term of the agreement is five years, with production at 100,000 dmt for the first year and 150,000 dmt in subsequent years. Nameplate capacity is substantial at 511,000 tpa, ramping up to 685,000 tpa after 6 years of production. Liontown has a similar agreement with LG Energy Solutions.

Table 1

### Critical Metals - Price Trends

	2018	2019	2020	2021				2022		Latest
	Annual	Annual	Annual	Q1	Q2	Q3	Q4	January	February	March 14
<b>Copper</b>										
LME Copper Official Cash Settlement <sup>1</sup> (US\$/lb)	2.96	2.72	2.80	3.85	4.40	4.25	4.40	4.43	4.51	4.48
<b>Nickel</b>										
LME Nickel Official Cash Settlement <sup>2</sup> (US\$/lb)	5.95	6.31	6.25	7.99	7.87	8.68	8.99	10.13	10.97	(Suspended Trading)
SHFE Nickel, Generic First Contract <sup>2</sup> (CNY/tonne)	102,916	110,746	109,054	131,120	128,570	143,708	147,198	163,176	176,134	207,930
China Nickel Sulphate EXW > 22% Ni, 0.05% Co <sup>2</sup> (CNY/tonne)	28,411	30,487	29,874	35,766	35,714	39,276	39,720	38,513	41,313	42,750
<b>Lithium</b>										
Lithium Carbonate, CIF Asia ≥ 99.2% Li <sub>2</sub> CO <sub>3</sub> <sup>3</sup> (US\$/tonne)	17,063	11,675	8,421	9,083	11,000	13,333	19,833	30,000	44,500	44,500 (Data to Feb 28)
Lithium Carbonate, CIF North America ≥ 99.0% Li <sub>2</sub> CO <sub>3</sub> <sup>3</sup> (US\$/tonne)	14,833	11,215	7,746	8,083	9,750	12,375	17,000	30,000	40,000	40,000 (to Feb 28)
Lithium Hydroxide, FOB North America ≥ 55.0% LiOH <sup>3</sup> (US\$/tonne)	16,771	13,521	10,629	10,458	11,750	14,333	19,333	29,500	38,875	38,875 (to Feb 28)
Spodumene Concentrate, FOB Australia 6% Li <sub>2</sub> O, Lithium Feedstock <sup>3</sup> (US\$/tonne)	886	595	406	472	579	1,048	1,492	2,400	2,340	2,340 (to Feb 28)
<b>Rare Earth Elements</b>										
China Neodymium Oxide 99%, FOB <sup>4</sup> (US\$/tonne)	49,918	44,655	48,757	95,147	83,222	92,267	123,356	159,658	180,363	182,500
China Neodymium Metal 99% FOB <sup>4</sup> (US\$/kilogram)	64	57	62	116	102	115	153	195	219	224
China Praseodymium Oxide 99%, FOB <sup>4</sup> (US\$/tonne)	63,627	54,024	45,725	67,818	81,665	94,484	124,540	142,316	159,875	169,000
China Praseodymium Metal 99% FOB <sup>4</sup> (US\$/kilogram)	114	103	91	96	104	110	139	162	180	193
China Dysprosium Oxide 99%, FOB <sup>4</sup> (US\$/kilogram)	177	234	259	384	398	400	447	466	485	484
China Dysprosium Metal 99% FOB <sup>4</sup> (US\$/kilogram)	262	307	341	497	516	516	554	576	592	589
China Terbium Oxide 99.9% FOB <sup>4</sup> (US\$/kilogram)	455	503	664	1,382	1,121	1,213	1,600	1,986	2,293	2,325
China Terbium Metal 99% FOB <sup>4</sup> (US\$/kilogram)	604	655	849	1753	1,430	1,534	2,038	2,517	2,876	2,920

Sources:

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

Table 2

### Copper Price Outlook - Annual Averages

pre-pandemic		2020	2021A	2022F	2023F	...	Long Term (2025+)
2018	2019						
	2.96	2.72	2.80	4.23	4.45	4.25	5.00+

### Copper Quarterly Averages

Actual													
20-1	20-2	20-3	20-4	21-1	21-2	21-3	21-4	22-1	22-2	22-3	22-4	23-1	23-2
2.56	2.42	2.96	3.25	3.85	4.40	4.25	4.40						

Sensitivities	High							4.85	4.90	4.80	4.65	4.65	4.65
	Base							4.56	4.57	4.40	4.25	4.20	4.25
	Low							4.30	4.30	4.00	3.85	3.85	3.85
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

<b>Probability-Weighted Forecast</b>								<b>4.56</b>	<b>4.58</b>	<b>4.40</b>	<b>4.25</b>	<b>4.21</b>	<b>4.25</b>
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Source: LME official cash settlement, US\$/lb., quarterly averages.

### Nickel Price Outlook - Annual Averages

pre-pandemic		2020	2021A	2022F	2023F	
2018	2019					
	5.95	6.31	6.25	8.38	13.70	9.50

### Nickel Quarterly Averages

Actual													
20-1	20-2	20-3	20-4	21-1	21-2	21-3	21-4	22-1	22-2	22-3	22-4	23-1	23-2
5.77	5.53	6.46	7.23	7.99	7.87	8.68	8.99						

Sensitivities	High							13.60	21.00	17.00	15.00	12.00	11.50
	Base							12.32	16.50	14.00	12.00	10.00	9.50
	Low							11.04	12.00	11.00	9.00	8.00	7.50
Probability	High							0.20	0.20	0.20	0.20	0.20	0.20
	Base							0.60	0.60	0.60	0.60	0.60	0.60
	Low							0.20	0.20	0.20	0.20	0.20	0.20

<b>Probability-Weighted Forecast</b>								<b>12.32</b>	<b>16.50</b>	<b>14.00</b>	<b>12.00</b>	<b>10.00</b>	<b>9.50</b>
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Source: LME official cash settlement, US\$/lb., quarterly averages.

Note: The LME nickel price forecast is revised up significantly due to the logistical challenges facing Russian supplies and the recent short-covering 'squeeze' on the LME. Nickel prices are intrinsically volatile. The outlook over the balance of 2022 will depend upon the length of the conflict in Ukraine, the performance of the world economy (affecting stainless steel and EV demand) and the timing & extent of new supply from Indonesia. The price forecast is subject to adjustment when LME trading and 'Official' price reporting resumes.

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