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Critical Raw Materials Bulletin

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Content

Critical Raw Materials

The Coming Green-Energy Inflation[1]

If you think inflation is bad, wait until the rest of the commodity markets really heat up.

On both sides of the Atlantic, leaders promise that more green energy—solar, wind, and electric vehicles—will cure Western overreliance on volatile oil and natural gas and further isolate Russia. But that cure would be far worse than the disease because green energy's staggering use of basic minerals will fuel inflation.

Producing energy from wind and solar machines, and especially from batteries, requires an enormous increase in supplies of copper, nickel, aluminum, graphite, lithium, and other minerals. Each electric vehicle contains about 400 pounds (~181 kg) more aluminum and about 150 pounds (~68 kg) more copper than a conventional car. The same goes for the suite of minerals necessary to build the tens of thousands of wind turbines and millions of solar modules needed for green plans.

Unfortunately, as the International Energy Agency (IEA) and others have pointed out, the supply of critical minerals isn't expanding apace. Not even close. That's an incendiary formula for inflation.

International Monetary Fund economists last year looked at mineral commodity data going back to 1879. They calculated the inflationary impact of trying to meet mineral demands to build enough machinery for a green double-down. Metal prices would reach historical peaks, they wrote, "for an unprecedented, sustained period of roughly a decade." The IMF also pointed out that the "integrated assessment models" for the energy transition "do not include the . . . potential rise in costs."

The raw materials we cannot do without[2]

Critical Raw Materials (CRM) are resources that are crucial to our economy, but the supply of which is anything but secure. These include lithium, which is found in just about all rechargeable batteries, as well as neodymium and dysprosium, used in the permanent magnets for electric motors and wind turbines. The problem with critical materials is not that they are rare, but that they are for the most part produced by only one or a few countries.

The European Union has officially defined 30 different materials as critical in order to draw attention to the problem. But what concrete options do we have to do something about it?

"Actually, there are three ways to limit the risk of shortages," Peter Tom Jones, Director of the KU Leuven Institute for Sustainable Metals and Minerals (SIM) explains. "The first is to find an alternative if that is possible. You can, for example, replace neodymium with copper in order to make a different type of electric motor. But for that, you need so much copper, that this metal would itself soon end up on the list."

"The second way is by recycling, which in this context is referred to as 'urban mining'. The aim is to set up a circular system, so that all the materials that you import remain usable. But the cost of recycled materials is generally higher, so it is difficult for recycling firms to compete with those offering newly mined raw materials. Additionally, there is not yet enough material in the system to cover our future needs. In order to complete the energy transition, for lithium alone, we will need over 40 times more of it in 2040 than we produce now.

"Unfortunately, a third approach will also be necessary: Europe will have to do its own mining. We actually have most critical raw materials here, too, but are not (yet) mining them. By importing them, we are in fact exporting the environmental burden and social exploitation to the rest of the world. We have to take responsibility and extract our own raw materials, in an environmentally and socially responsible manner. But as mining will always have a major impact, at the same time we need to do all we can to collect waste material selectively and to promote recycling."

If we want more renewables, we're going to need a lot more mining first[3]

Low-emission technologies require huge volumes of special minerals. The supply of these is much lower than the probable demand.

The fact is, wind turbines, solar panels, and electric vehicle batteries use certain key minerals in much bigger quantities than the technologies they are meant to replace. A typical onshore wind turbine contains five tons of copper. It also uses large amounts of manganese, chromium, zinc, and rare earths. Solar panels also require a range of minerals. Fossil fuel and nuclear power plants need a lot less of these minerals to generate the same amount of electricity.

An electric vehicle uses more than twice the amount of copper and manganese than a conventional car. Unlike a conventional car, an electric vehicle also needs lithium, nickel, cobalt, neodymium, and graphite.

US President Joe Biden wants to build hundreds of thousands of wind turbines, thousands of square miles of solar panels, and hundreds of millions of electric vehicles to eliminate carbon emissions. That would require an almost unimaginable increase in mining for the requisite minerals.

An analysis out of the United Kingdom indicates the scale of the electric vehicle challenge alone. To replace all of the U.K.'s nearly 32 million cars with electric vehicles would use roughly twice the cobalt, nearly all the neodymium, 75% of the lithium, and 50% of the copper produced in the entire world in 2018. Converting the entire U.S. fleet of 260 million cars would take about eight times more than that.

The World Bank estimates that, over the next 25 years, the world would need to mine the same amount of copper mined over the past 5,000 years, largely because of the push for renewable energy and electric vehicles. The International Energy Agency sees demand in 2040 for lithium soaring 4,200%, graphite 2,500%, nickel 1,900%, and rare earths 700%.

The good news is that we actually have lots of needed minerals sitting in the ground. The bad news is that it takes about 10 years to get a USA federal mining permit approved. In Australia and Canada, countries that also have high regulatory standards, it takes just two to three years. Guess where companies are more likely to invest.

Automakers go back to the future to secure battery metals[4]

Henry Ford was right all along, it turns out. After decades of honing just-in-time global supply networks, car companies are going back to Ford's founding principle of self-sufficiency. Ford's iconic River Rouge complex in Dearborn Michigan made its own iron and steel, supplied by company freighters from its own iron ore and coking coal mines in Michigan and Kentucky. World War One had created material shortages and disrupted logistics. Ford's answer was to take full ownership of the automotive supply chain from mine to product.

Auto companies are facing up the same problems today, compounded by the need to go electric, which means creating totally new metallic supply chains. While Ford worried about iron ore and rubber, his successors are battling supply crunches and soaring prices in key battery inputs such as lithium, nickel and cobalt.

"Henry Ford ... was right," according to the current incumbent CEO of Ford Motors, Jim Farley. "The most important thing is we vertically integrate." The company intends to take control of its supply chains "all the way back to the mines."

Metals accounted for 40% of battery costs in 2015, a ratio that has risen to 80% this year, according to consultancy Benchmark Minerals. The common theme is of supply failing to react fast enough to a step-change in demand as EV sales accelerate and the world builds ever more gigafactories to supply the necessary batteries.

> *"Even in the most optimistic scenarios where every single raw material project in the pipeline comes on stream and existing operations expand aggressively, there will not be enough raw material for the battery supply chain as we go into 2030.*
>
> *Benchmark Minerals*

The industry's current semiconductor problems "are a small appetizer to what we are about to feel on battery cells over the next two decades," RJ Scaringe, CEO of EV start-up Rivian Automotive, told the Wall Street Journal.

The biggest headwind to more lithium and nickel supply is capital. New mines cost a lot of money and come with an extended development time of several years. Automakers can deploy a lot of capital. They have already done so at the battery manufacturing stage of the supply chain. Extending that vertical integration into the mines that produce the enabling metals is now becoming a matter of urgency.

Carmakers will "need to become miners"[5]

Benchmark Mineral Intelligence's inaugural Battery Megafactories Europe 2022 event in Berlin concluded with a stark warning to automakers. Among the key takeaways from the event, is the huge raw material gap that has opened up amid the furious battery factory buildout taking place globally:

- Even in the most optimistic scenarios where every single raw material project in the pipeline comes on stream and existing operations expand aggressively, there will not be enough raw material for the battery supply chain as we go into 2030;
- Lack of supply is not due to any geological constraints, but a simple lack of capital investment to build the mines of tomorrow;
- Benchmark forecasts that lithium chemical supply will be in a deficit of over 300,000 tonnes by 2030, with nickel sulphate supply set to fall short of demand by nearly 400,000 tonnes,

cobalt by over 75,000 tonnes and flake graphite by nearly 2 million tonnes by the end of the decade;

- Both lithium and cobalt face medium-term challenges to meeting automotive consumer ambitions; raw material constraints will prevent battery production topping the 1 TWh threshold until 2025.

Benchmark founder Simon Moores stressed that automakers will "need to become miners" and only bringing downstream capacity to market will not be sufficient to feed the booming EV battery supply chain.

Is the Ocean Floor the Answer to Forecast Battery Metals Shortages?[6]

With concerns that several metals critical to the world's electric vehicle (EV) future are becoming harder and more expensive to find, there is a growing push to mine the world's ocean beds and their vast areas of polymetallic nodules.

The nodules have been evaluated to contain four essential battery metals – cobalt, nickel, copper, and manganese – and it has been estimated that there are enough battery metal resources contained on the world's ocean floors to fuel hundreds of millions of EVs.

While the potential to mine these vast resources of polymetallic nodules has been on the agenda for decades, technical and environmental roadblocks have so far halted their commercial development. While some critics suggest the difficulties of large-scale mining of polymetallic nodules may be too technically challenging, proponents have pointed out that the petroleum industry has been operating in some of the world's most treacherous ocean environments for many decades. They have also highlighted that subsea polymetallic nodule mining sites benefit significantly from a lack of overburden, a major cost for onshore miners.

Metals for Clean Energy -Pathways to solving Europe's raw materials challenge[7]

Eurometaux, Europe's metals association's recent study evaluates how Europe can fulfill its goal of "achieving resource security" and "reducing strategic dependencies" for its energy transition metals, through a demand, supply, and sustainability assessment of the Green Deal and its resource needs.

It concludes that Europe has a window of opportunity to lay the foundation for a higher level of strategic autonomy and sustainability for its strategic metals through optimised recycling, domestic value chain investment, and more active global sourcing. But firm action is needed soon to avoid bottlenecks for several materials that risk being in global short supply at the end of this decade.

Europe will require significant new supplies of nickel, lithium, and cobalt for its domestic battery cathode manufacturing plans. Of these metals, Europe only has a significant existing market for nickel, which is mainly used in stainless steel.

By 2050, batteries will be Europe's major use for lithium, nickel, and cobalt under all the study's scenarios, with new demand reaching up to 3500% of Europe's lithium consumption today, 350% of cobalt, and 110% of nickel.

It is noted that uncertain technology developments after 2030 will likely impact these long-term projections, and so regular attention will be required to the battery market.

Deutsche Bank in their report "Commodities security in a volatile world", analyze the dependencies and risks within the German commodity supply chains and makes recommendations for a new commodity strategy.

The conclusion of the report suggests; The relevant players in the German economy need to define which raw and refined materials will be required to ensure long-term economic growth as well as a successful transformation. Following this analysis:

- A strategic approach to inner-European sourcing and mining should be set out. This requires a thorough analysis of natural resources on the European continent and corresponding studies regarding the environmental impact and economic feasibility of potential exploitation.

- Germany and other EU members should secure commodity partnerships with countries in South America and Africa as well as with Australia to diversify the supplier basis for raw and refined materials. In that context, bilateral or multilateral government agreements could pave the way for private sector initiatives. The private partnerships could either be set up via traditional long-term supply agreements or by creating a stronger link between the partners through e.g., direct (equity) investments.

- Recycling capacities should be built up in Germany and elsewhere in the European Union. The same applies to further research and development efforts needed to advance the substitution of critical raw materials.

Australian universities get $173m in funding[8]

Australia's Curtin University is set to receive a share of more than A$242 million ($173m) in federal government funding to lead the

development of the Resources Technology and Critical Minerals Trailblazer hub.

The facility is being built together with the University of Queensland, James Cook University, and 33 company partners across Australia involved in value chains requiring lithium, nickel, cobalt, vanadium and hydrogen resources. The goal is to turn research outputs into breakthrough services, products and businesses.

Canada to invest C$2 billion on mineral strategy for EV battery supply chain[9]

Canada's federal budget will include an investment of at least C$2 billion ($1.6 billion) for a strategy to accelerate the production and processing of critical minerals needed for the electric vehicle (EV) battery supply chain, two senior government sources said.

Prime Minister Justin Trudeau's government, will make the investment to ramp up the extraction of processing of critical minerals including nickel, lithium, cobalt and magnesium, said the sources.

"There are some particular projects that we are looking at and working on at the present time," Natural Resources Minister Jonathan Wilkinson said to Reuters. All the potential projects, "whether they're extraction or processing, need to be accelerated significantly, and that's what the critical mineral strategy will be about," he added.

Lithium

Musk urges entrepreneurs to enter lithium space[10]

Right now, the mining and refining of lithium appear to be the key limiting factor to "accelerating the advent of a sustainable energy future," Musk told analysts.

There isn't a shortage of lithium ore, Musk pointed out — lithium itself is a common element, but it needs to go through "a whole series of refinement steps" that requires a lot of industrial equipment before it can be used in a battery cell. He encouraged entrepreneurs to enter the lithium space,

> *Do you like minting money? Well, the lithium business is for you.*
>
> *Elon Musk*

Lithium prices remain high because EV demand has continued to grow and supply hasn't been able to keep up, Morten Lund, partner with Stoel Rives, said. However, he views this as a temporary issue, somewhat comparable to the silicon shortages that the solar industry experienced in the past.

"It was just a matter of suddenly, solar became very attractive and there weren't enough silicone facilities. So we built some more and three years later, silicone prices plummeted," he said.

'Mr. Lithium' Warns There's Not Enough Battery Metal to Go Around[11]

Batteries, and more precisely battery metals, are poised to replace chips as the new bottleneck for the auto industry. While there's been a lot of attention on nickel, especially after Russia's invasion of Ukraine, another key metal — lithium — is a source of concern for manufacturers dealing with all manner of supply chain challenges.

One person who's been warning of a lithium shortage for a while is Joe Lowry, known in mining circles as "Mr. Lithium" has been in the business for decades.

He said; "In the next two years, even though there will be significant growth in supply, it will be less than demand, so the gap will just continue to grow. I believe there will be a day in the future when lithium is in oversupply, but it won't be in this decade.

You can build a battery factory in two years, but it takes up to a decade to bring on a lithium project. It's not a commodity; it's a specialty chemical. The auto industry is just finally figuring that out. Lithium qualification for an auto company can take over a year.

The additional production this year will be less than 150,000 tons. So then, it's who gets the material? Whose EV models don't get made? In a 2050 scenario, there's time for everything to happen that needs to happen. But in 2030, it just isn't going to happen. Just look at the mess we're in from a lithium supply standpoint with less than 10% EV penetration."

Electric vehicle targets 'impossible' without changes to lithium pipeline[12]

Battery manufacturers are confronting a severe lithium shortage, highlighting the need to challenge China's dominance of raw material supply chains, an Australian lithium producer has warned.

Stuart Crow, chair of Lake Resources, said western companies and governments had failed to build adequate supply chains for lithium, making the sudden boom in electric vehicle manufacturing unsustainable.

"Right now China owns basically 70-80 per cent of the entire supply chain for electric vehicles and lithium-ion batteries, and therefore energy storage," Crow said. "The west has been remarkably slow to adopt a strategy to try and assist and secure a supply chain."

"The forecasts for the [lithium] deficit this year vary from 50,000 tonnes per annum out to 400,000 tonnes, on a market that looks potentially to produce 450,000 tonnes a year," he said. "Anecdotally, we're hearing stories of two very large battery makers in the market trying to source 150,000 tonnes [each] of lithium hydroxide this year. And with 450,000 tonnes of supply, it's not going to happen."

Daniel Morgan, a mining analyst at investment bank Barrenjoey, said it was "impossible for the [EV production] targets being made by either carmakers or governments to be met". He added: "There's a great love of throwing out lofty targets, but where the rubber hits the road it's not going to happen."

Top bid for lithium up 140%[13]

Pilbara Minerals Ltd.'s auction of spodumene concentrate — a partly-processed form of lithium — attracted a top bid of $5,650 a ton on Wednesday for a cargo of 5,000 tons(concentrate grade of 5.5% Li2O). That compares with $2,350 at the previous sale in late October on the Australian miner's Battery Metal Exchange.

The jump in the auction bid is roughly in line with the increase in lithium carbonate — a chemical used in battery production — in China. It started rising in the middle of last year as the global recovery from the pandemic coincided with a surge in EV demand.

The rally has lost momentum in recent weeks — prices are currently at 467,500 yuan ($71,182) a ton, according to Asian Metal Inc. — as the worsening virus outbreaks upended supply chains and clouded the consumption outlook. The auction result suggests Chinese lithium compound prices are unlikely to drop below 400,000 yuan a ton, Daiwa Capital Markets' analysts Dennis Ip and Leo Ho said in a note.

Does Tesla really need to start mining and refining lithium?[14]

> *The price of lithium has gone to insane levels! Tesla might actually have to get into the mining & refining directly at scale unless costs improve*
>
> *Elon Musk*

At the start of April 2022, Elon Musk, once again hit the headlines with his comments regarding lithium. This time it was in response to data that showed there had been a 1,654% rise in the lithium price in the last ten years.

Lithium mineralization occurs in a number of forms: brines; clays; and pegmatites, are the three most common deposit types and there are at least 130 deposits being mined, developed or explored at present. So Elon is right, in part - there is a lot of lithium out there, but many of these deposits will never be developed and mined for a whole raft of reasons including, environmental sensitivities, political issues, project economics, processing issues, other technical constraints, the availability of funding, and so on.

The rapid rise in lithium prices over the past ten years and its perceived positive supply-demand fundamentals has resulted in a boom in listed lithium explorers, developers and miners, but as we saw between 2018 and 2020, "too many cooks can spoil the broth".

Between 2018 and 2020, the price of lithium carbonate fell from circa US$21,000 per tonne in January 2018 to just c. US$8,000 per tonne by the end of 2020 with refiners receiving more raw material than they needed, leaving many miners with product they couldn't sell, causing several producers to go bust, development projects to stall and explorers to move on to projects in other commodities.

Tesla has a lot of capital and a lot of clever people, while it may not have the knowledge base for mining yet, it has already started by hiring its first geologist and there can be no doubt that a company like Tesla could attract the best and brightest but building a mine or a refinery is a high-risk business

Lithium mining: How new production technologies could fuel the global EV revolution[15]

Despite expectations that lithium demand will rise from approximately 500,000 metric tons of lithium carbonate equivalent (LCE) in 2021 to some three million to four million metric tons in 2030, McKinsey believes that the lithium industry will be able to provide enough product to supply the burgeoning lithium-ion battery industry. Alongside increasing the conventional lithium supply, which is expected to expand by over 300 percent between 2021 and 2030, direct lithium extraction (DLE) and direct lithium to product (DLP) can be the driving forces behind the industry's ability to respond more swiftly to soaring demand.

Although DLE and DLP technologies are still in their infancy and subject to volatility given the industry's "hockey stick" demand growth and lead times, they offer the significant promise of increasing supply, reducing the industry's environmental, social, and governance (ESG) foot-print, and lowering costs, with already-announced capacity contributing to around 10 percent of the 2030 lithium supply, as well as to other less advanced projects in the pipeline.

Over the next decade, McKinsey forecasts continued growth of Li-ion batteries at an annual compound rate of approximately 30 percent. By 2030, EVs, along with energy-storage systems, e-bikes,

electrification of tools, and other battery-intensive applications, could account for 4,000 to 4,500 gigawatt-hours of Li-ion demand.

Demand for Electric Vehicles Will Keep Lithium Prices High[16]

The EV market accounts for almost 80% of lithium-ion battery demand, according to a report from Jiayue Zheng, a consultant at Wood Mackenzie. The lithium-ion battery market encountered shortages last year because of "thriving" EV market demand and rising raw-material prices, she says, and Wood Mackenzie believes that battery supply won't meet demand until 2023.

Keith Phillips, CEO of Piedmont Lithium, meanwhile, expects OEMs and battery companies to experience dramatic shortfalls in the lithium they'll need to make batteries because it takes more than 10 years to bring a natural-resource project from "idea to production," and most lithium project developers slowed down during the 2018 to 2020 bear market.

Australia, the world's largest lithium producer, forecasts a tight lithium supply-and-demand market in 2023. In a quarterly report issued in December, it said world demand is estimated to rise to 724,000 metric tons of lithium carbonate equivalent by 2023, from 486,000 metric tons in 2021, as "global EV uptake rises," driven by government measures, lower vehicle prices, and increasing vehicle model choices. The report also sees world lithium production at 821,000 metric tons in 2023, up from 485,000 metric tons in 2021.

"I could not be more bullish" on the outlook for lithium, says Piedmont Lithium's Phillips. "We expect [EV] demand to grow dramatically," given that these cars are smoother, quieter and faster, and far less expensive to fuel and maintain, he says. "As EV demand grows, lithium demand will grow, and we expect shortages for the next 10 [to] 15 years, at least."

Nationalization of lithium in Mexico becomes official[17]

The nationalization of lithium has been made official following the publication of the new Mining Law in the Official Gazette, making it clear that the mineral belongs entirely to Mexico.

The presidential decree, endorsed by the two chambers of Congress, declares lithium to be of public utility, for which no concessions, contracts, or licenses will be granted to private or foreign companies.

Consequently, as of this Thursday the government can make effective the announcement made yesterday by President Andres Manuel Lopez Obrador to review all authorized contracts for lithium. The president explained that this examination will be due to events such as the agreement between a British company and a foreign transnational that was sold a lithium concession contract in Sonora by the former.

The president replied to criticisms of the nationalization that said that Mexico lacks the technology to develop the lithium industry by saying that one thing has nothing to do with the other because if the country does not have the capability now, it can develop it or even acquire it, but the important thing is that lithium is in Mexican hands.

Graphite

'An orphaned commodity': Graphite overlooked in race for EV minerals[18]

Global supplies of the electric battery raw material "Graphite" could see demand increase up to five-fold by 2050 amid an accelerating switch from petrol to electric vehicles and years of underinvestment in the industry.

Despite graphite making up more of the mass of electric vehicle (EV) batteries than any other mineral, analysts and producers say graphite hasn't captured investor attention like the booming lithium market where prices jumped nearly 500 percent last year. The challenges that have held up companies seeking to develop new graphite mines have included longer project lead times than lithium, lengthy processes where companies adjust the product to suit battery makers, and opaque pricing structures in the China-dominated supply chain.

Credit Suisse research analyst Phineas Glover forecasts a supply crunch as EV production ramps up, forcing a supply deficit of 32 per cent by 2025 and demand to grow five-fold by 2050.

Morgans analyst Max Vickerson said graphite was a "developing story" that markets remained cautious about after investors were disappointed when shares in some companies fell between 2016 and 2020. "There were people who got burnt last time around," Vickerson said.

Graphite is the next big trouble in EV battery supply chain[19]

Graphite is expected to become the next major bottleneck in the production of battery packs for electric vehicles (EVs), as experts in the field fear that the supply of the raw material will be short of demand in the next couple of years. The situation is expected to worsen as the demand still has room to spike higher, and some industry players are already experiencing tightness.

Currently, the problem doesn't lie in the scarcity of the material itself, but rather in a.) the projected astronomical demand rise and b.) the limited locations of the available resource.

Starting with the former, the market demand for EVs has reached approximately 11,000,000 cars for 2022, each of which needs, on average, 75 kg of natural graphite. The production currently stands at 785,000 tonnes, so in 2022, we already have 40,000 tonnes of graphite deficit.

China produces about 80% of this and could potentially ramp up this production to 915,000 tonnes by 2025, but this won't be enough to cover the demand, which in the meantime, is only going to grow

US battery directive advances graphite projects[20]

Tight graphite supply out of China and rising output costs globally are accelerating the push towards establishing domestic production in the US.

Prices for raw materials used in lithium-ion batteries, including graphite, have jumped in recent months. The Argus assessed range for 94pc grade graphite flake has gained 60pc in the past year on a fob China basis, driving up prices in Europe and the US. Strong demand has coincided with the lingering impact of power supply disruptions in China and rising energy costs globally that have constrained output.

US president Joe Biden issued a directive on 31 March to use the Defense Production Act to secure US battery supply chains for EVs and renewable energy storage.

The directive is also providing impetus to projects in the US to build graphite-processing facilities, including Australia-based Syrah Resources Vidalia facility in the US, US-based Westwater, which is constructing the first phase of its Kellyton natural graphite processing plant; US-based Graphite One, which has partnered with Chinese anode producer Sunrise (Guizhou) New Energy Material for its proposed US graphite material plant; and Hong Kong-based Graphex, which plans to establish a US CSG facility via a joint venture with Emerald Energy Solutions

Tight supply of anode materials attracts strategic investment from power battery producers[21]

Since the beginning of this year, in order to reduce the cost and ensure supply, battery companies such as EVE Battery, CATL, BYD, and SVOLT have strengthened the control of the anode material link through strategic shareholding.

Driven by the rapid growth of market demand in the downstream battery industry, as well as the upward price of graphitization and needle coke markets, lithium-ion battery anode materials have a phased misalignment between supply and demand.

On April 24, Yunnan Zhongke Xingcheng Graphite Co., Ltd. Introduced EVE Battery as a new shareholder, and its registered capital increased from 600 million yuan to 1 billion yuan, an increase of about 66.67%. On April 19, Shanshan Co., Ltd. (600884.SH) announced that Ningbo Shanshan New Energy Technology Development Co., Ltd., a wholly-owned subsidiary, signed a strategic investment agreement with four strategic investors, Ningbo Meishan Bonded Port Area Wending Investment, BYD, CATL., and CNCP Kunlun Capital. On April 8, Dow Technology (300409.SZ) announced that it intends to introduce strategic shareholders such as BYD. On February 19, the board of directors of Zhongke Electric (300035.SZ) deliberated and passed the "Proposal on the Capital Increase and Share Expansion of Subsidiary Gui'an New District Zhongke Xingcheng Graphite Co., Ltd. and Cooperation with CATL". On January 11, Hebei Kuntian New Energy Technology Co., Ltd. added a new shareholder, SVOLT with a shareholding ratio of 1.8%.

Natural flake graphite market still affected by supply chain issues[22]

The natural flake graphite market continued to face availability issues because of uncertainties created by factors such as China's anti-pollution efforts, Covid-19 outbreaks and global logistics disruptions.

Tightening availability and uncertain output expectations, as well as delayed shipments, meant that flake graphite prices rose on both a fob China and a cif Europe basis to more-than-three-year highs during the winter season of 2021-22.

Fastmarkets' price assessment for graphite flake 94% C, -100 mesh, fob China, has increased by 38.33% since last November to $830 per tonne on Thursday, March 24, the highest in the three-and-a-half years since Fastmarkets began to assess it.

In principle, the traditional winter stoppages in China might not cause supply concerns, given that downstream buyers would restock before the seasonal halt and suppliers sell their inventory during the winter season

But limitations on power supplies and environmental checks during the second half of last year led to dwindling inventory and less buying appetite among downstream buyers, especially in the refractories sector, according to a second source. Meanwhile, the widening use of flake fines in anode material over the past two years has sparked increasing concerns about a supply shortage.

Fastmarkets' price assessment for graphite spherical 99.95% C, 15 microns, fob China, was $3,500-3,800 on March 24, up by 26.47% from last November.

Concern about limited availability of material has had its own effect on demand, with consumers seeking to secure material, according

to sources. "Supply-side issues have caused a ripple effect outside of China, with people scrambling to fill their supply pipelines," another source said. Meanwhile, while the international markets gradually recover from the effects of Covid-19, demand for flake graphite was also increasing, another source said, especially in the new energy sector.

Rare Earths

Rare Earth Magnet Market Outlook to 2035 Report[23]

Adamas Intelligence announced the publication of 'Rare Earth Magnet Market Outlook to 2035' report.

Among the findings of our analysis:

- Market for Magnet Rare Earth Oxides to Increase Three-Fold by 2035 from the US $15.1 billion this year to the US $46.2 billion by 2035

- Constrained by an expected under-supply of neodymium, praseodymium, dysprosium and terbium oxide from 2022 onward, global shortages of NdFeB alloys and powders will amount to 66,000 tonnes annually by 2030 and 206,000 tonnes annually by 2035 – nearly one-third of the total market.

- Constrained by a lack of new primary and secondary supply sources coming to market from 2022 onward, coupled with the inability of existing producers to steadily increase output at the rate of demand growth, it is forecasted that global shortages of neodymium, praseodymium and didymium oxide (or oxide equivalents) will collectively rise to 21,000 tonnes annually by 2030 and 68,000 tonnes by 2035 – an amount roughly equal to China's total production last year.

Rare Earth Magnet Supply Chain Summarized in 5 Simple Steps[24]

With all the news surrounding rare earth elements (REE), it can be quite easy to get lost in conversations about the supply chain. The following key steps of the mine-to-magnet supply chain will guide you through any conversation.

- Step #1: Mining (Ore); This process involves mining large amounts of ore that contain a mixture of rare earth minerals, such as bastnaesite, monazite, and xenotime.

- Step #2: Extraction (Mineral Concentrates); It is necessary to extract a concentrated mixture of rare earth elements. This is done using a multi-stage process of leaching and precipitation to harvest the REE's.

- Step #3: Separation (Oxides); This step involves taking the mixed REE concentrates and separating them out into individual rare earth oxides through heated chemical known as calcination.

- Step #4: Processing (Metal); Next, the oxides are processed into rare earth metals.

- Step #5: Magnet production (Magnets); This process requires

    - 1) melting alloys using a combination of materials including rare earth metals,
    - 2) milling, pressing and sintering to produce rare earth magnets with the desired properties,
    - 3) machining the magnets into final part geometries, and
    - 4) magnetizing finished magnets.

First of a kind European rare earth deal[25]

German auto parts supplier Schaeffler has signed a raw materials deal to ensure the supply of rare earth magnets from Europe for its burgeoning electric vehicle (EV) motor business, an executive told Reuters. It is the first reported agreement by a European auto sector supplier or automaker to source rare earths within the region.

Schaeffler has agreed a five-year deal with Norway's REEtec to supply rare earth oxides from 2024, said Andreas Schick, Chief Operating Officer of Schaeffler. "We are transforming into an e-motor supplier and are ramping up significantly," he said in an interview. "Therefore on the rare earth side we need competent partners, not only going through the standard supply chain through China, we need a local supply chain for Europe."

Australia's first integrated rare earths refinery[26]

Perth-based company Iluka Resources is set to build Australia's first integrated rare earths refinery at Eneabba, Western Australia, following a final investment decision.

The $1.2 billion project will produce high-value separated rare earth oxides (neodymium, dysprosium, praseodymium and terbium), critical to a range of technologies including electrical vehicles, clean energy generation, advanced electronics, and medical and defence applications.

The refinery will have a production capacity of 17,500 tonnes per annum of rare earth oxides and has been designed specifically with the capability to process feedstocks sourced from both Iluka and a range of potential third parties. Construction is expected to commence later this year, with first production earmarked for 2025.

Rare Earths Crucial to Advancement of Green Economy, Defense Systems Contributed Opinion[27]

With geopolitical tensions rising, the US recently banned defense contractors from purchasing REE metals from China and will consequently attempt to revive its domestic rare earths industry. However, the US has just one rare earth mine and no processing technology, which highlights the need for a new wave of investment, writes McAlinden Research Partners (MRP).

MRP has recently highlighted the importance of semiconductors amid the ongoing shortage and a permanent shift in behavior due to a global digital transformation. As that transformation accelerates, the role of rare earths will also rise. MRP highlighted the growing demand for battery metals due to the rising number of electric vehicles hitting the road. Demand for rare earths is also expected to increase due to those lofty EV goals currently set by the Biden administration.

These minerals are also imperative in the production of many defense applications. In the industry, two rare earth metals, neodymium and samarium, are used to create magnets that are resilient to high temperatures which is important for mission-critical electronic and defense applications. Other rare earths are used to manufacture fighter jets and soldier semiconductors, a sector that Army Technology notes is projected to be valued at $17.5 billion by 2030.

Rare earths remain a critical group of minerals for the global defense industry, renewable energy development and the rapidly accelerating digitization of the modern economy. The US is at risk of falling behind in the race to secure rare earth supplies if it does not soon boost domestic mining and processing of these metals and shift away from the overwhelming reliance on China.

Manganese

Manganese Could Be the Secret Behind Truly Mass-Market EVs[28]

Tesla and Volkswagen are among the automakers who see manganese as the latest, alluringly plentiful metal that may make both batteries and EVs affordable enough for mainstream buyers.

As a cathode material, manganese is abundant, safe, and stable. But it has never approached the energy density or life cycle of nickel-rich batteries.

General Motors and LG Energy Solutions' pouch-style Ultium cells use a nickel-cobalt manganese aluminum chemistry that reduces cobalt content by more than 70 percent.

High-manganese batteries being eyeballed by Musk and VW would also use less nickel, and zero cobalt. They appear affordable: According to analysts at Roskill cited, a lithium nickel manganese oxide chemistry could reduce cathode costs by 47 percent per kilowatt-hour relative to nickel-rich designs. That has VW mulling manganese as a potential fit for mainstream models, with LFP for bottom-rung vehicles or markets, and bespoke high-performance packs for the likes of Porsche, Audi, Bentley, or Lamborghini.

> *"We need tens, maybe hundreds of millions of tons, ultimately. So the materials used to produce these batteries need to be common materials, or you can't scale.*
>
> *I think there's an interesting potential for manganese.*
>
> *Elon Musk*

Boron

Boron Steel[29]

More steel means more protection. But the conundrum for Ford's engineers was, how do we give you extra protection without adding extra weight that could cost you fuel savings? They looked to the aerospace industry for the answer and found it in boron steel.

Boron Steel is ultra-high-strength steel that Ford uses, along with low-alloy and dual-phase steels, to help protect you while still passing on fuel savings.

Because it can be melded into thinner components than normal steel, it's lighter while still remaining super strong and stiff. It is four times stronger than normal high-strength steel.

Their high yield and tensile strengths allow forming complex shapes that can be wielded in key areas, such as pillars and bumpers.

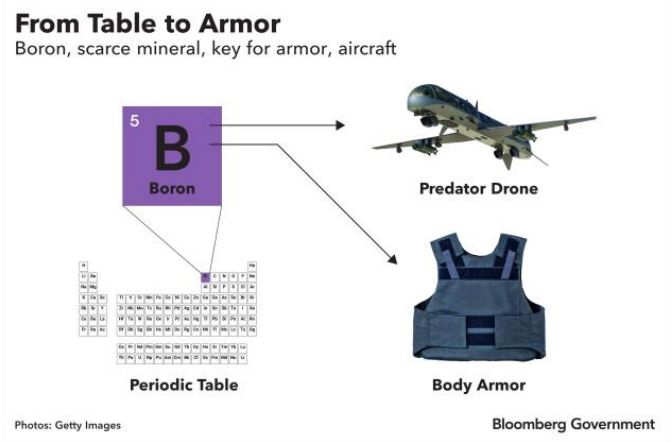
Boron steel is used in the door intrusion beams of all Ford vehicles to help protect passengers in the event of a side-impact, as well as other key areas on specific models, depending on their size and usage.

Boron steel is used in widely diverse ways, from enamels and golf clubs, to pyrotechnics and nuclear reactors.

Boron Mine Casts Bet on Critical Mineral Label[30]

Boron is in U.S. soldiers' body armor, the Predator drone, satellites, permanent magnets, and military helicopters. No electrical vehicle works without it. It's very light, second only to diamonds in hardness, heat-resistant, corrosion-resistant and anti-microbial.

Yet boron has yet to crack the list of "critical minerals" designated by the U.S. Geological Survey, even as increasingly shaky geopolitics threaten global supplies of rare earths and minerals.



"Boron is where lithium was probably 10 years ago, " said Henri Tausch, CEO of 5E Advanced Materials Inc., which owns the mine known as Fort Cady. "Ten years ago, no one heard about lithium, no one talked about lithium, and no one was really aware that it could be a big problem."

The U.S. accounts for about 20% of boron production, second to Turkey, which mines 60% of the mineral. Even so, the need for boron to be processed in China into boron carbide materials has prompted the Pentagon to recommend that the defense industrial base establish a second U.S. source of boron carbide in addition to Rio Tinto Group, which also mines in California. China is the source of 80% of boron composite materials for military purposes.

The U.S. Defense Logistics Agency (DLA) lists boron as a strategic material because it is used as a component of composite materials (boron fibers) in advanced aerospace structures and as an industrial catalyst to make things like polymers. It also plays a major role in electroplating nickel, lead, and tin; in inner plates of ballistic vests; and for tank armor (carbon boride) and permanent neodymium (NdFeB) magnets, according to DLA.

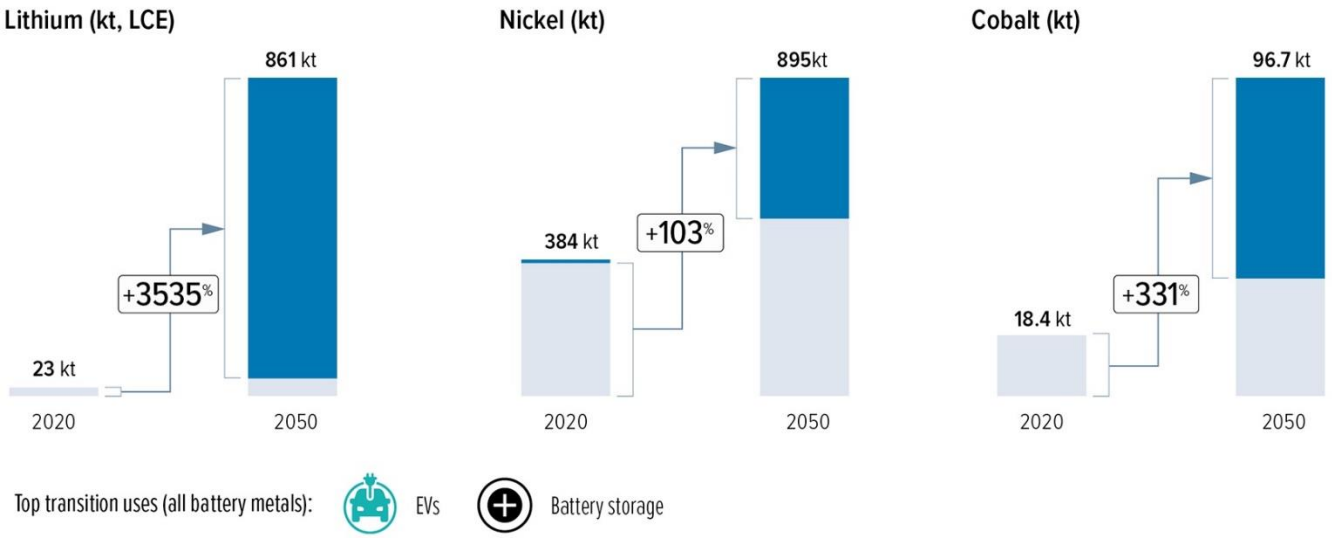
Platinum

Platinum in Batteries[31]

Automotive use of platinum is well established; platinum-based autocatalysts have been the single largest segment of platinum demand for decades. Platinum is also at the forefront of proton exchange membrane (PEM) technology used in hydrogen fuel cell electric vehicles (FCEVs), a market that is poised to grow significantly as automakers look to transition to production of zero-emissions vehicles, initially in the heavy-duty sector.

Next generation Lithium-air and lithium-sulphur battery technologies offer the potential for energy densities three to ten times higher than the lithiumion batteries currently in use, but electrochemical limitations have prevented their widespread use. However, current research and development into lithium-air and lithium-sulphur chemistry using platinum and its sister PGM palladium in cuttingedge lithium-ion batteries looks poised to address those limitations and unlock a step-change in battery performance, including improvements in 'cyclability' and 'discharge capacity'.

2050 Europe's Battery Raw Material Demand



Credit: https://www.eurometaux.eu/media/jmxf2qm0/metals-for-clean-energy.pdf

By 2050, batteries will be Europe's major use for lithium, nickel, and cobalt under all the study's scenarios, with new demand reaching up to 3500% of Europe's lithium consumption today, 350% of cobalt, and 110% of nickel.

Chart of the Month

Top risks for the mining industry

2022	Rank	2021
↑ Environmental risks, including new regulations	01	Commodity price risk
↓ Commodity price risk	02	Global pandemic
↑ Community relations and social license to operate	03	Economic downturn/uncertainty
↑ Political instability/nationalization	04	Community relations and social license to operate
↑ Global trade conflict	05	Environmental risks, including new regulations
↑ Ability to access and replace reserves	06	Permitting risk
↓ Permitting risk	07	Political instability
↑ Supply chain risks	08	Access to capital, including liquidity
NEW Talent crisis	09	Ability to access and replace reserves

Source: KPMG "Global Mining Outlook 2022" https://home.kpmg/xx/en/home/insights/2022/04/global-mining-outlook-2022.html

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