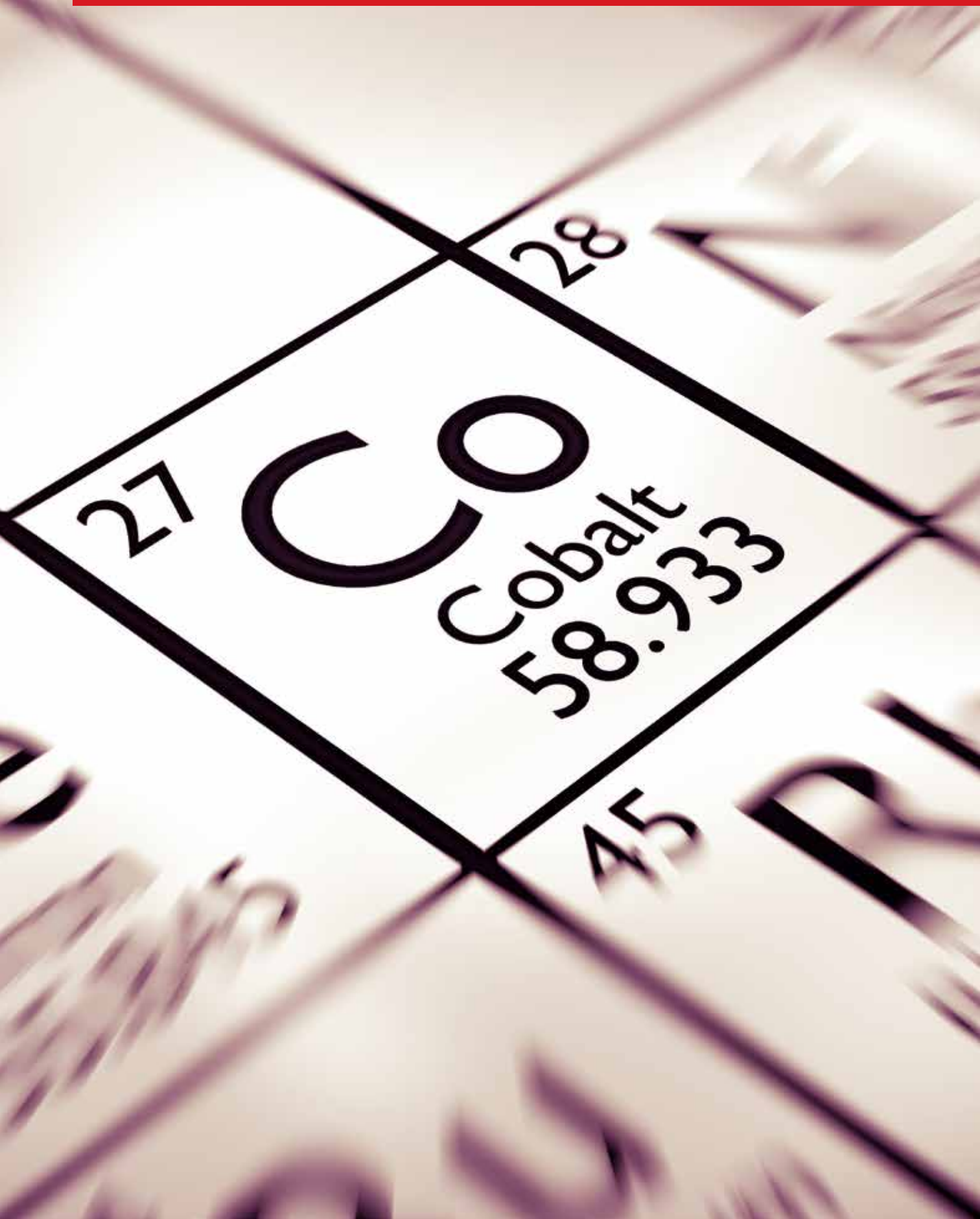
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The New Precious Metals

Demand for materials needed in batteries and energy storage has created a dynamic new market for once-obscure metals. Can supply keep up with demand?

The global shift toward electric vehicles is already under way. In response to ever tougher emissions laws, the big automakers are investing billions of dollars in the next generation of electric cars and the technologies needed to power them. And while these are still early days, the pace of change is accelerating. By 2040, according to the latest estimate from Bloomberg New Energy Finance, more than half of all new vehicles sold will be electric powered.

But for this "electric-mobility revolution" to roll out as planned requires global supply chains to run smoothly—from raw-material inputs to the finished batteries that will power all these electric vehicles. Indeed, any serious and lasting dysfunction along this supply chain would cause enormous economic damage to automakers and could temporarily derail the entire project.

And yet, even at this early stage, potential bottlenecks are emerging. One is the concentration of battery manufacture and recycling in just one country, China. The other is the relative scarcity of the raw materials needed to make power cells. This is compounded by the fact that nearly two-thirds of the world's supply of just one of these essential metals, cobalt, comes out of the Democratic Republic of Congo (DRC).

Cobalt is just one of a new class of precious metals that are coming to the fore: the so-called battery metals that allow us to store "clean" energy and wean ourselves off the internal combustion engine. They are the metals needed for the energy-intensive lithium-ion batteries that power our electronic gadgets and a still-small fleet of electric vehicles.

Demand for the metals used in batteries—such as nickel, manganese, lithium and cobalt—is already growing fast. Gerbrand Ceder, professor of materials science and engineering at the University of California, Berkeley, points out that "more than half of all cobalt now goes into lithium-ion batteries, and that demand will only grow. Portable electronics and laptops set a floor on how much is needed. The switch to electric vehicles comes on top of that."

All the big automakers are scaling up for mass production—VW announced in December measures enabling a €30 billion ($34 billion) investment in electric vehicles over the next five years. A September 2018 report from Woods Mackenzie projects electric vehicles to reach 6% of total sales by 2025, and then rise rapidly.

"While perceived scarcities can trigger price shocks...they also accelerate research into alternatives.

—Gerbrand Ceder, University of California

But to reach those targets automakers need a secure, stable supply of battery metals. In order to have some certainty, they enter into forward supply contracts; but should cobalt or lithium prices

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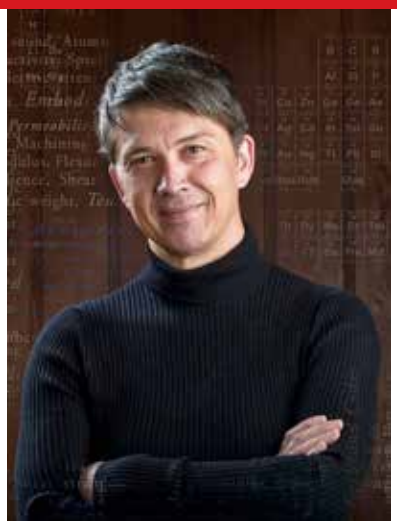
double or more, then their economic models go out the window. Tesla has already faced shareholder criticism on this issue. Smartphone manufacturers would be less affected, as the metals content in their devices is much smaller than that for electric cars.

"Another key demand driver," says Anthony Milewski, chairman and CEO of Cobalt 27, a dedicated investment vehicle for cobalt and nickel, "will be energy storage systems for renewables—from homes to businesses all the way through to megasystems storing energy from solar farms."



Ceder, University of California: Most scarcity is perceived rather than real.

Expanding global demand and inelastic supply means that, for most of the past decade, the international prices of all these metals have been rising fast. Least affected by new-battery demand, at least so far, is manganese. There is abundant supply and it is mainly used by steelmakers, whose appetite sets the price. Yet manganese is also used in animal feed and fertilizers, which are also experiencing rising demand. Lithium has had a good run, with Chinese battery and materials companies making major acquisitions in Chile and elsewhere to gain secure supply.

But rising lithium prices have sparked new mining investments. As Gavin Montgomery, director of battery raw materials at the Edinburgh-based global energy and metals research and consultancy group Wood Mackenzie, notes, "There's now a lot of new mine supply coming out of Australia on top of traditional brine operations in South America." Brine operations extract lithium using seawater or other salted water (from lakes or geothermal wells), but is vulnerable to weather. Prices fell back in 2018.

Montgomery, Wood Mackenzie: Cobalt is still a relatively small market so these new projects coming through means there's no shortage of supply.

Most nickel goes into making stainless steel, but its increasing use in car batteries will further boost demand. Ceder calculates that "should lithium-ion battery production rise over the next six years to 500 gigawatt hours a year, that alone will require around a quarter of total nickel output."

But of all the battery metals, cobalt—which provides stability and durability—has been the star performer. Over the two years up to 2018 the spot price of this bluish-grey metal quadrupled to peak at $95,000 per tonne on the back of rising demand from automakers and inelasticity of supply.

"Cobalt is a mainly a byproduct of copper or nickel production," Ceder points out. "There are very few pure cobalt mines, and as a byproduct it occurs in such low concentrations that it's impractical to increase output of nickel—which is mainly used in making stainless steel—just to get more cobalt."

Continuing worries about security of supply also fed into the price spike. A major concern is that more than 60% of the world's supply comes out of just one country, the Democratic Republic of the Congo, where December's disputed presidential election is unlikely to improve on a dismal record of instability, armed conflict and endemic corruption. Looking forward, Montgomery believes that "political instability in the DRC could pose huge risks to supply."

But over the past decade, global mining giants like Glencore and China Molybdenum have poured billions of dollars into Congolese mines; and these are now producing more cobalt. Glencore has brought its giant Katanga mine back on stream with a capacity of some 30,000 tonnes per annum (33,000 US tons), according to the company, while in January the originally Kazakh-based Eurasian Resources Group (ERG) started its Metalkol cobalt and copper reprocessing plant in the DRC with capacity for a further 24,000 tonnes.

"As cobalt is still a relatively small market with just over 100,000 tonnes of annual demand, these new projects coming through means there's no shortage of supply," says Montgomery. At the same time, Chinese refiners and battery-makers have been destocking and pulling out of forward contracts. The result is that over the past six months, cobalt's price has more than halved to $32,000 per tonne.

Milewski believes the real cause of the recent glut is "not big mine openings, which were built into models, but the tremendous amount of artisanal cobalt being produced in the Congo." This informal mining sector in the DRC is large, difficult to track, prone to mining accidents and often uses child labor. But while its cut-price cobalt may have depressed spot prices, Milewski says that "the impact of this is short term and doesn't change the long-term fundamentals."

Montgomery comments on the exuberant run-up of prices through mid-2018: "People thought the electric-vehicle revolution was here already, while in reality they still represent only a

NEW WEALTH OUT OF AFRICA

Technology is raising old metals to new highs. Africa has them all.

For centuries, gold and diamonds were focal points in the global contest for dominance in Africa. Now, electric vehicles have made cobalt and lithium, essential for batteries, into prized commodities as well.

Cobalt has been used for years in aircraft turbine engines; drying agents for paints, dyes and pigments; magnetic recording media and steel-belted radial tires. It is also a key component of batteries, which are soaring in importance with the emergence of electric vehicles.

The Democratic Republic of the Congo (DRC) alone produces nearly two-thirds of the world's cobalt and has massive untapped reserves of lithium. This makes the DRC Africa's principal link in the supply chain for the electric-vehicle industry. It is not alone. Morocco, Madagascar, Botswana, South Africa, Zambia and Zimbabwe also produce cobalt—albeit in vastly smaller quantities.

But African nations also have meaningful resources of other metals rendered newly valuable by new applications. Zimbabwe is among the top producers of lithium, and Mali has identified untapped reserves. Other battery materials, such as graphite—used in high-temperature lubricants and friction materials as well as batteries—are also found in Africa. Madagascar and Mozambique are among the world's top 10 producers.

"Africa is critical to the short- to medium-term growth of the electric-vehicle industry," says David Merriman, manager of battery and electric vehicles materials at research and consulting firm Roskill. With the electric-vehicle market projected to be worth $567 billion by 2025, Africa has the potential to benefit immensely.

Yet so far, Africa is a minefield that has not much benefited the African people. Minerals are the second-largest export category after hydrocarbons, comprising about 10% of total exports. But in most countries, the sector has been on a deceleration. In South Africa, minerals' contribution to GDP nosedived from 21% in 1970 to 7% now. In West Africa as a whole, the sector's contribution has sunk to less than 1%, from an average of 5% over the same period. Yet the African Development Bank estimates that mineral resources, if well exploited, have the potential to contribute over $30 billion annually in government revenues over the next 20 years.

A June 2018 report by McKinsey & Company reckons that with no major expansion of mining capacity expected outside Africa, the world will continue depending on the DRC for cobalt, which could increase its share of the global supply to 75%.

Current political realities make that a problem for the industry, however. "The geopolitical environment is crucial to the supply chain," Merriman comments. The presidential election in the DRC in late December—initially the focus of widespread hopes that Africa's resource-rich giant would finally enjoy its transition to democracy—was repeatedly postponed and widely declared a farce by outside observers.

"Political instability in the DRC could pose huge risks to supply," says Gavin Montgomery, director of battery raw materials at energy and metals research and consultancy group Wood Mackenzie.

Historically, the DRC is no stranger to supply disruptions. Most component manufacturers now operate on a just-in-time basis, leaving little stockpiled material to absorb shocks, but without exposing themselves to certain types of loss. "Few consumers are willing to sign longer term agreements with suppliers in areas considered geopolitically unstable," Merriman says. Foreign investors are also looking warily at ownership disputes, the role of artisanal mining, child labor and changes in mining laws—both actual and potential. A new mining code enacted last year increased royalties and added a 50% windfall profits tax when commodity prices rise 25% above levels in a project's feasibility study, among other changes.

Of greater concern, particularly for western manufacturers, is China's deep presence in African mining. Beijing is a major source of direct investment in both operations and infrastructure. And as major buyers of precious metals, Chinese companies are important offtake partners: They secure deals with other Chinese companies to buy the minerals yielded if an exploration pans out. Securing the market in advance makes it possible to raise funds for development. China is also, according to the US Geological Survey, "the world's leading producer of refined cobalt and a leading supplier of cobalt imports to the US." —*John Njiraini*

Milewski, Cobalt 27: Energy storage systems for renewables will drive demand.

small percentage of car sales."

He sees more than adequate supply to the middle of the next decade. But from then on, with electric-vehicle sales picking up sharply, he calculates that "meeting growing demand for cobalt will require new production equivalent to another ERG project coming on stream every year."

How is that demand is going to be met? "Further supplies could come from upgrading methods, to extract more cobalt from the ore or from mine tailings," observes Ceder. Also, most automakers would like to be less reliant on Congolese supply, and there are new cobalt mining projects in Idaho and Ontario—although with annual output of around 1,000 tonnes these are relatively insignificant. Montgomery suggests that Indonesia, where several new nickel-cobalt projects are going ahead, could be "a sizeable alternative source for battery metals."

More recycling of metals from damaged or discarded batteries could help fill the gap. According to recycling expert Hans Eric Melin, founder and director of the London-based Circular Energy Storage consultancy, around 14,000 tonnes of cobalt is already recycled each year and volumes will only grow. A potential bottleneck could arise—especially in an era of trade wars—because while "there are some recycling companies like Umicore in Europe, around two-thirds of all battery recycling goes on in China, with South Korea accounting for most of the rest." That is because these are the main centers of new-battery manufacture, and companies use recycling to feed their production.

Melin notes that "as a battery will stay in a vehicle for maybe 10 years, the global impacts of recycling will not be felt until later on." Ceder agrees that "it will be at least 10 years before recycling makes a dent." And while Montgomery acknowledges that "recycling will have an impact," he says it will be "limited in terms of overall metal demand."

With the so-called cobalt cliff looming, the response of big automakers has been to look into ways of reducing the cobalt content in their batteries. Most aim to move from today's 20% cobalt content to nearer 10% by using 8-1-1 (8 parts nickel, 1 part cobalt and 1 part manganese) chemistries. Higher cobalt prices have certainly acted as a strong incentive to "engineer it out" as far as is possible. However, since spot prices have dropped, Montgomery says that "cobalt thrifting has become less urgent," noting that "two Korean companies planning to introduce 8-1-1 batteries have held back."

And there are other pitfalls. Ceder points out that "while 8-1-1 cells work very well, a higher nickel content makes them less stable and raises safety concerns for automakers who wouldn't welcome the negative impacts for their brand of a battery fire or accident. Cobalt enhances the battery's stability, and that's needed especially for plug-in hybrids whose batteries need to handle fiercer charging and discharging cycles."

Looking forward, he sees automakers adopting two strategies to reduce cobalt content. One is to stick with nickel-manganese-cobalt batteries but to "engineer out" the amount of cobalt needed, as with Tesla's focus on very small cell technologies. The other is to develop a new class of cathode materials that doesn't need any cobalt at all. One such model is based solely on manganese. But as Ceder warns, "These are only at the R&D stage, and historically it's taken a long time to move from there to commercial production. You can't suddenly switch to a new technology."

Cobalt ore.

So there is no quick fix. As more electric vehicles hit the road, demand for battery metals is expected to soar. Cobalt's recent rollercoaster ride doesn't rule out its price trebling again within the next five years.

Yet Ceder remains skeptical. "Most scarcity is perceived rather than real," he says, recalling the scare over China's near monopoly of "rare earths" a decade back. "And while perceived scarcities can still trigger price shocks that are extremely harmful, they also help accelerate research into alternatives." ■