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9 **Cobalt Supply in a Tight Corner as EV Market Expands**

\$57,000

The price per metric ton of cobalt last traded on the London Metal Exchange

156,000 metric tons

Cobalt demand from lithium-ion batteries in 2030, forecast by BNEF

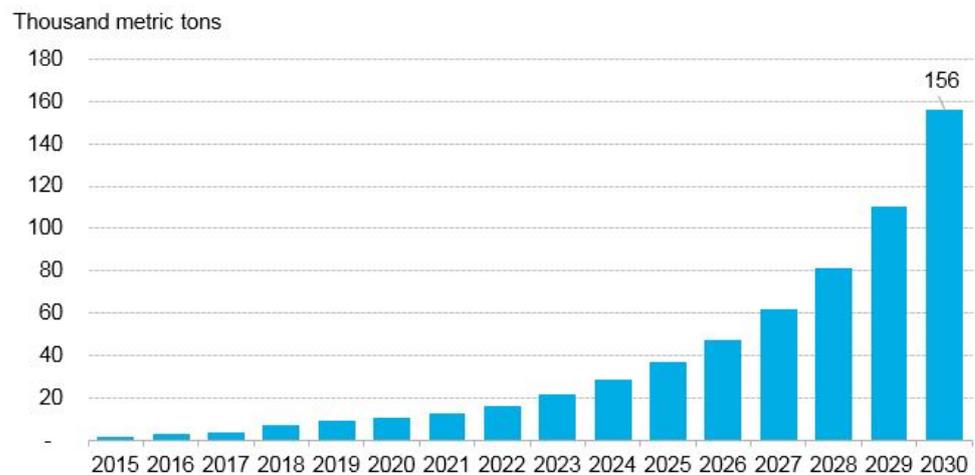
4,500 metric tons

Projected cobalt supply deficit in 2021, forecast by Benchmark Mineral Intelligence

The growth of the electric vehicle industry is propelling cobalt demand to new heights – beyond what the current supply chain may be able to meet. Large mines coming online in the Democratic Republic of the Congo (DRC) should satisfy demand in the short term, but beyond 2020 the adequacy of supply looks less certain due to a forecast demand ramp-up from electric vehicles. Some market research firms see a cobalt supply shortage of around 5,000 metric tons by 2020-21.

- Cobalt is added to most lithium-ion batteries to act as a stabilizer for the chemical structure – it improves energy density and battery lifetime. These batteries power a growing number of electronic devices, from smartphones and stationary storage systems to electric vehicles.
- Cobalt prices have doubled in the last year, and buyers are looking for new sources of supply, to meet rising demand and as an alternative to deposits in the DRC. Mining companies in Canada, Australia and the U.S. are starting to appear.
- The strength of cobalt demand will largely depend on how quickly electric vehicles are adopted and the proportion of cobalt used within cathode chemistries. Battery makers are already moving toward chemistries that require less cobalt.
- This note examines the pressures building in the cobalt market. It does not offer investment advice. Readers would have to come to their own view on whether current prices for the metal accurately discount the outlook for cobalt demand and supply.

Figure 1: Cobalt demand from lithium-ion batteries to hit 156,000 metric tons in 2030



Source: Bloomberg New Energy Finance

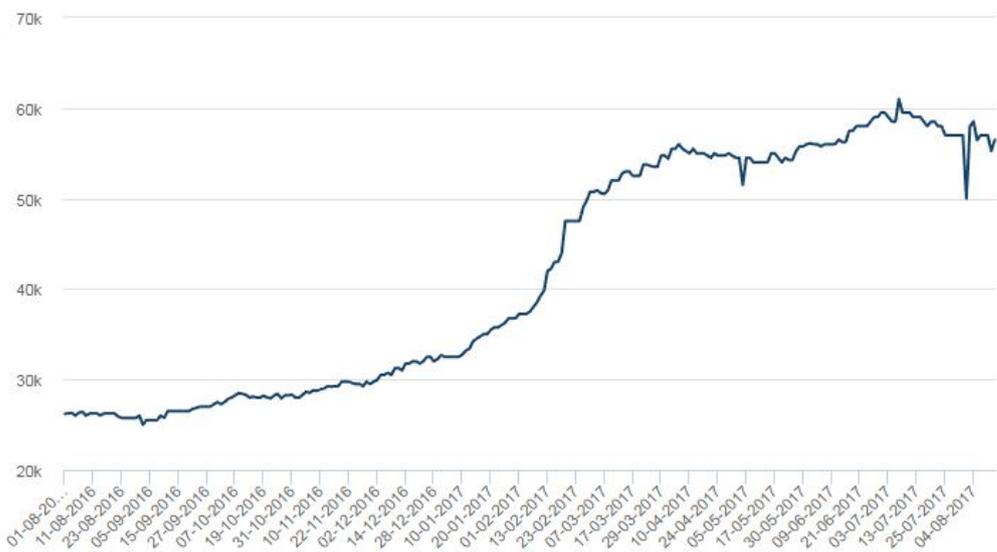
Bryony Collins

The cobalt market

The DRC copper belt is rich in deposits of a lustrous, silvery-blue metal used in everything from jet turbines to paints, but it is demand from the fast-growing electric vehicle industry that could potentially upset the balance in cobalt mining. Faced with supply chain risk in the politically-unstable DRC, and stockpiling of the metal by investors and the Chinese state, cobalt supply is likely to become tighter as electric vehicle demand picks up.

Cobalt prices have increased by more than 100% in the last year and were trading at \$57,000 per metric ton on the London Metal Exchange in mid-August, the metal's highest this decade. Elevated prices create an opportunity for a raft of smaller mining companies and producers to enter the fray. Companies that are stockpiling the metal, such as **Cobalt 27 Capital**, and big producers like **Glencore** stand to benefit. Larger buyers may have an advantage in securing supply over smaller competitors.

Figure 2: Cobalt prices more than double in the last year on London Metal Exchange



Source: London Metal Exchange

Price in \$ per metric ton of cobalt metal with a minimum of 99.3% purity.

Wider adoption of electric vehicles could trigger significant deficits in the cobalt supply chain, according to Benchmark Mineral Intelligence (BMI), a raw materials analysis and price forecast company. The re-opening of Glencore's Katanga mine in 2018 and launch of Eurasian Resources' RTR mine in 2019, both in the DRC, will add much needed supply to the market in the near term, but beyond 2020 there is a risk that a larger cobalt supply shortage will occur due to the greater uptake of electric vehicles, forecasts Caspar Rawles, cobalt analyst at BMI. Electric vehicles will become price-competitive with gasoline models on an unsubsidized basis beginning in 2025, and that will drive many more EV sales, forecasts BNEF.

Consumer demand for smartphones had already raised interest in cobalt, a metal that traditionally has been unglamorous, mined as a by-product of copper and nickel. The expected, far-reaching roll-out of electric vehicles will add far larger calls on cobalt supply. Just 5 to 10 grams of cobalt is

used in a smartphone, compared to 15 kilograms in a Tesla Model X, according to investment group CLSA.

Cobalt is a critical component in most lithium-ion batteries because it “acts as a binder for the lithium ions and allows ions to move from the cathode to anode during discharge. The total amount used is relatively small but integral to the batteries’ stability and performance,” said BMI managing director, Simon Moores. This increased demand for the chemicals used in batteries will take cobalt from a niche specialty chemical to a position as a major commodity of the future, according to BMI.

Production of refined cobalt reached 93,000 metric tons worldwide in 2016, but by 2030 cobalt demand from lithium-ion batteries alone will exceed 156,000 metric tons, forecasts Bloomberg New Energy Finance in the *Long-Term Electric Vehicle Outlook 2017*. This reinforces Rawles’ view that “at current levels, production growth won’t be able to keep the pace with the growth in demand [for cobalt].” He forecasts a deficit of 4,500 metric tons in 2021 and potentially a more significant shortage in the years after that. Analysts at Macquarie Research go one step further -- forecasting a higher deficit of as much as 5,340 metric tons in 2020, according to Reuters. There are limited new supply projects coming online, and refined output in key supply countries such as Australia, Russia and Zambia is down on previous years’ levels.

Electric cars drive up demand

Demand from the electric vehicle supply chain is a key reason for the cobalt metal market shifting from oversupply to near-deficit in a little over a year, from the end of 2015 to mid-2016.

Manufacturers of cells for lithium-ion batteries, such as **BYD** and **LG Chem**, require increasing amounts of cobalt in order to power electric vehicles and stationary energy storage units made by the likes of **Tesla**, **Daimler** and **Nissan**.

There will be more than 100 million electric cars globally by 2030, which will require 1,300GWh of lithium-ion battery capacity to power them, according to BNEF forecasts. This will require a lot of cobalt – 156,000 metric tons in 2030 alone – which will far surpass demand from other consumer electronics, such as smartphones, BNEF says.

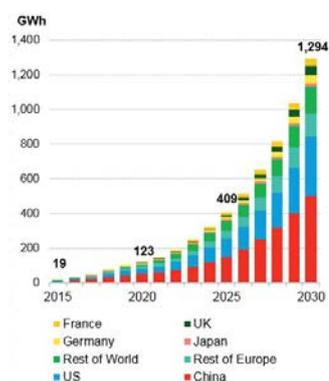
On the back of forecasts such as BNEF’s, and general industry sentiment about growth prospects for electric vehicles, investors, hedge funds and natural resource companies are looking to secure their own slice of the cobalt pie – either in physical form or as royalty streams from new mines.

Cobalt 27 has purchased 2,158 tons of physical cobalt and is holding it in warehouses in Europe and the U.S., in addition to royalties on cobalt exploration projects. The Chinese Reserve Bureau accumulated 5,000 tons of cobalt between late 2015 and mid-2016 after China identified it as a critical raw material, according to a report by Darton Commodities, published in February 2017. Hedge funds are also getting in on the action. **Pala Investments** and **Shanghai Chaos Investment** stockpiled the equivalent of 17% of 2016 global cobalt production, according to the BNEF insight note, *Metals Demand from Batteries* ([web | terminal](#)).

“Between now and 2021 any surplus production will be snapped up and/or stockpiled by consumers and producers,” said BMI’s Rawles. However, beyond 2021 he anticipates that demand will outpace the growth in supply and that a “significant deficit” could occur. This contrasts with the BNEF viewpoint that supply shortages are more likely in the short term before new mines are located and developed. See the previously-mentioned [insight note](#) for more.

Speculation about rising cobalt demand has been fueling a cycle of bullish sentiment, with prices going up and people expecting them to continue to rise, in turn driving further purchases.

Figure 3: Global lithium-ion battery demand to hit 1,300GWh by 2030



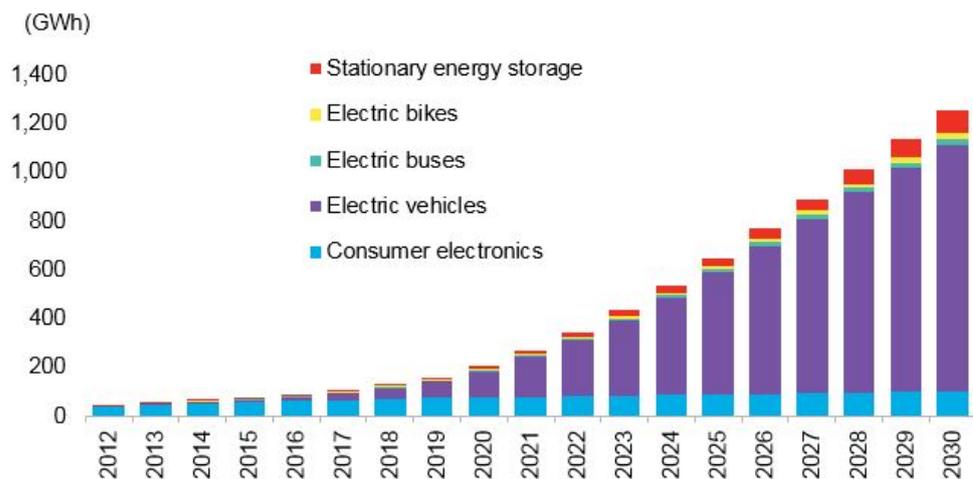
Source: Bloomberg New Energy Finance

Stockpiling the metal and refusing to sell also exacerbates the tight supply situation. "The majority of stockholders are believed to be pursuing a long-term strategy with no intention of liquidating positions in the near future," wrote Darton Commodities in its report.

In China, the price of cobalt sulfate exceeded 100,000 Chinese yuan (\$15,000) per metric ton in March 2017, before falling back down to around 80,000 Chinese yuan per metric ton in early July, according to data from BMI. Cobalt sulfate is a compound of the metal used to produce batteries, and so is the most useful to track, said Rawles.

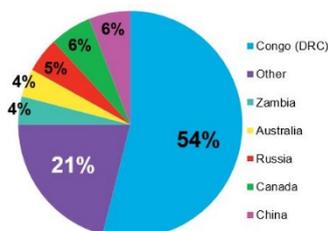
Any increase in cobalt costs is likely to have only a limited impact on overall battery prices, and ultimately the price of electric vehicles. Were cobalt prices to increase four-fold, this would lead to just a 13% increase in the cost of a lithium nickel manganese cobalt battery, according to BNEF. The cobalt within a Tesla Model X accounts for a mere 0.8% of the selling price, and 1.8% of the selling price of a Chevrolet Bolt, according to CLSA.

Figure 4: Electric vehicles will boost lithium-ion demand growth nine fold over 2015-30, forecasts CLSA



Source: CLSA

Figure 5: Congo dominated world cobalt supply in 2016



Source: USGS

The unstable DRC

The Democratic Republic of the Congo produced as much as 54% of cobalt globally in 2016, with no other country coming close, according to the U.S. Geological survey. This reliance on one politically-unstable country to provide the majority of cobalt poses a problem. In the near term, there is a risk that President Joseph Kabila refuses to step down and that the general election agreed for 2017 fails to materialize. That could incite violent protests from the opposition and have a knock-on effect on cobalt mining, and exports.

Added to this instability is the controversial issue of artisanal mining in the DRC. This came to global attention in 2016 when a report by Amnesty International shed light on the hazardous working conditions and use of child labor by some traditional hand mining entities. The report made allegations against some of the world's largest technology firms for sourcing cobalt from artisanal mining further down their supply chains, and called for the DRC government to regulate unauthorized mining areas.

Apple stopped buying cobalt from artisanal mining sites in the DRC in March 2017, and the Responsible Cobalt Initiative has been launched, requiring companies to ensure that the cobalt they buy is sourced responsibly. Members include **Sony**, **HP** and **Samsung**.

The total volume of cobalt extracted through artisanal practices dropped by around 35% in 2016, to around 8,500 tons, largely in response to these human rights concerns, but also due to depletion of some of the easily-accessible high-grade ore deposits, according to Darton Commodities.

This reduction in artisanal mining, which accounted for one fifth of all DRC cobalt exports in 2015, could reduce overall cobalt supply globally and also be a factor in upending the supply-demand balance.

China changes its chemistry

Another important reason for the boom in cobalt demand is that leading cell and cathode manufacturers in China now favor a battery chemistry with a higher proportion of cobalt than they previously used. Around three quarters of new passenger electric vehicles sold in China in 1Q 2017 used a lithium nickel cobalt manganese (NMC) chemistry, as opposed to the lithium ferrous phosphate (LFP) chemistry that dominated its manufacturing business last year, according to a CLSA report. The preference for NMC batteries is a result of automakers seeking higher energy density in order to be eligible for subsidy support from the government. The latter has, in turn, tightened the rules on access to that support.

To serve China's fast-growing production of electric vehicles, its top 30 cell manufacturers for lithium-ion batteries expect to ramp up their production capacity to as much as 204GWh in the next 3 to 5 years, according to CLSA. This production increase, coupled with the switch to NMC, will mean that China's battery making industry will put increasing strain on the delicate demand-supply balance for cobalt.

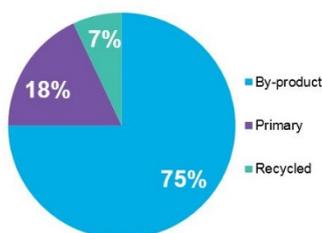
Just a by-product

Cobalt supply is also vulnerable to the fact that the vast majority of it is produced as a by-product of nickel and copper mining, with only 18% sourced from primary cobalt mines. It is therefore adversely affected by the fact that many nickel and copper mines are reducing their output in a bid to boost prices. Up to a quarter of global nickel production capacity needs to be closed for prices to rise, according to Norilsk Nickel, the world's largest nickel producer, in a [Financial Times article](#). This opens up an opportunity for companies wanting to enter the business of pure-play cobalt mining.

The market is expanding – there were 46 active mining projects for cobalt in May 2017, up from just 10 the previous year, according to Dorfner Anzaplan, a mining services company. Companies active in the market so far include **First Cobalt** and **Belvedere Resources** in Canada, and **Panoramic Resources** and **Tiger Resources** in Australia. However, the majority of these companies are at the exploration stage and are years away from production.

Pure-play cobalt companies like these are catering to investor demand for direct access to cobalt supply. Investors may not want to take increased exposure to other commodities by buying equity in large natural resource companies such as **Glencore** or **Freeport** (both of which derive less than 10% of overall earnings from the metal). Up until now, there have been very few ways to invest directly in cobalt, but several new companies are trying to change that.

Figure 6: Cobalt mined mainly as a by-product



Source: Benchmark Mineral Intelligence

Nevertheless, companies in the DRC will likely control much of the market for the foreseeable future. Large copper and cobalt projects in the African nation will be needed “if there is any hope of keeping [cobalt] supply in line with demand”, said Rawles.

Control by big producers

In the world of cobalt supply, it pays to know the top dogs. Production of both refined cobalt products and the metal itself is dominated by Glencore and Chinese companies including **Jinchuan Group** and **Zhejiang Huayou Cobalt**, with others like Finland’s **Freeport Cobalt** and **Umicore** also holding a decent stake. The fact that just a handful of sources dominate the supply chain means that they largely control the flow of cobalt, the price they sell it for and ultimately who they sell it to.

As supply of cobalt becomes tighter, there will be winners and losers in who secures enough of the material to meet their demand, said James Frith, energy storage analyst at BNEF. Automakers are likely to be willing to pay more than paint makers in the quest to secure cobalt, he added.

Glencore could have a big impact on the cobalt supply-demand balance near-term with its move to re-launch its Katanga mine in 2018. This has a potential capacity of 30,000 tons and would double its total cobalt production capacity. However, there is no guarantee that all this supply would reach the market, as the Swiss miner may restrict output and it will take time for the mine to reach its full production output. BMI anticipates that 15-20,000 metric tons per annum will be released onto the market in its first phase.

It is unlikely that Glencore would flood the market, causing a price slide. “Producers are aware as prices increase, cell manufacturers and [car makers] will push more towards the development of higher-nickel, lower-cobalt cathode technology in a move to keep cells costs low,” said Rawles. This would negatively impact producers in reducing demand, so they will be looking to retain a certain balance in the market to ensure it doesn’t get too out of hand, he said.

China is now the leading country controlling cobalt supply after **China Molybdenum Company** paid \$2.65 billion for **Freeport-McMoRan**’s stake in the Tenke Fungurume mine in the DRC. Freeport sold its stake in order to reduce debt, the company told BNEF. The purchase adds 20,000 tons of potential new capacity to China Moly’s supply, so that it now controls up to 15% of global production, and also strengthens China’s position in being able to supply the rapid development of its new electric vehicle industry.

Meanwhile, Finland-based **Freeport Cobalt** has a controlling stake in each part of the cobalt supply chain, from mine-to-market. The company owns the world’s largest cobalt refinery, located in Finland, and has a long-term supply agreement with Tenke Fungurume Mining, which produced 11.4% of global cobalt supply in 2016. In this way it cements its hold in the market and can protect itself from any unexpected price spikes.

Fear over security of supply is driving some manufacturers to integrate vertically their supply chains and to sign longer-term supply deals than before. For example, Glencore signed a 4-year agreement to supply up to 20,000 tons of cobalt to Chinese battery maker **Contemporary Amperex Technology (CATL)**, with **Volkswagen** agreeing to buy the batteries from CATL, according to [Reuters](#). At the time the contract was signed last October, cobalt metal prices were around \$28,500 a ton on the LME, but they have since doubled to \$57,000 per ton – showing the savings that might be made by securing contracts early. Likewise, China Molybdenum has signed

Figure 8: Glencore’s Katanga mine in the DRC



Source: Bloomberg / Simon Dawson

Glencore’s open pit Katanga copper-cobalt mine in the DRC, photographed in 2012 before production was temporarily halted.

a strategic agreement with Ningbo Shanshan to give the battery maker priority over buying cobalt from the Tenke Fungurume copper-cobalt mine if it is expanded.

The handful of companies dominating the cobalt supply chain therefore have a strong hand to play in controlling how much material floods the market, and the resultant price. And their decisions will also impact new companies exploring for cobalt in Canada, Australia and the U.S.

Further out

Long-term, it is likely that the proportion of cobalt within lithium-ion batteries will change or possibly even be replaced by another material. Already, the most advanced battery cathodes require less cobalt, according to BNEF and CLSA. "Over the next 10 years we believe the lithium and cobalt content within batteries is likely to fall 10-20% as battery designs become more efficient," said Tribeca's Cleary. However, he still expects aggregate demand for cobalt to rise more than threefold, due to the number of electric vehicles forecast to come to market, and that ultimately this will lead to a challenging supply situation.

CLSA agrees that cobalt demand growth from batteries will multiply three times from now until 2025, and that the market for battery recycling is likely to expand as a result. By 2025, it forecasts almost a quarter of overall cobalt demand will be met by battery recycling. China will continue to lead the recycling space, due to its lack of domestic cobalt reserves. Companies like **GEM Co.** are already active in the collection and recycling of cobalt and nickel.

The potential popularity of electric buses is another unknown. An electric bus battery pack has an energy capacity of about 660kWh versus the 40-60kWh output of electric cars, so if the former escalates in popularity it would have a significant impact on cobalt demand, writes Julia Attwood, emerging technologies analyst at BNEF.

Read more about the potential impact on commodities markets due to the production of lithium-ion batteries in Attwood's research note ([web | terminal](#)). And keep up-to-date with what BNEF has to say on the topic [here](#).

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