

BATTERY METALS INSIGHT

July 2019

Q2 2019: PERSPECTIVES FOR THE COBALT INDUSTRY BEYOND THE RECENT PRICE RETREAT

Quarterly pricing wrap: After slight rebound, cobalt sulfate prices resume downtrend

Cobalt sulfate prices started the second quarter recovering some of the value lost since they went into freefall in mid-2018, but the momentum did not last long and prices were once again under heavy pressure towards the end of the quarter.

The support in early April came mostly from the increase in electrolytic cobalt prices and a slight uptick in Chinese demand. Platts assessments rose to Yuan 52,000/mt DDP China on April 18 from Yuan 45,500/mt on March 28, with CIF North Asia

prices rising to \$8,450/mt from \$8,100/mt over the same period.

At that time some producers claimed they were still making losses, and waiting to see where electrolytic prices would settle to get a clearer picture on the magnitude of those losses. An international producer estimated that producers were still making some profit at levels such as \$8,000/mt CIF and slightly less than Yuan 50,000/mt DDP China “due to the current low raw materials prices,” he said at that time.

However, the rally came to an end shortly by the same time when major cobalt producer Glencore on April 15 announced it had resumed exporting and selling a limited quantity of cobalt from its Kamoto Project in the Democratic Republic of Congo, which was halted since November 2018 due to issues with high uranium content.

Glencore said in its first-quarter earnings report released late April that its cobalt production was up 56% from Q1 2018 to 10,900 mt, including 3,500 mt that were produced but not sold due to high uranium content.

The cobalt sulfate downtrend resumed from mid-April on, with steepest declines starting in mid-May. From the peak in mid-April, Platts’ CIF North Asia assessment lost 11% to \$7,500/mt near the end of June, while the DDP China reference tumbled 25% to Yuan 39,000/mt.

The oversupply and decreasing demand were considered by several market participants as the main reasons driving cobalt sulfates down in the period.

“New energy vehicle producers have tried to install ternary batteries before the end of the transition period [to the new Chinese subsidy policy for electric vehicles, slated to start in June 25] to get subsidies as much as possible, and now it’s just around the corner,” said a consumer source in May.

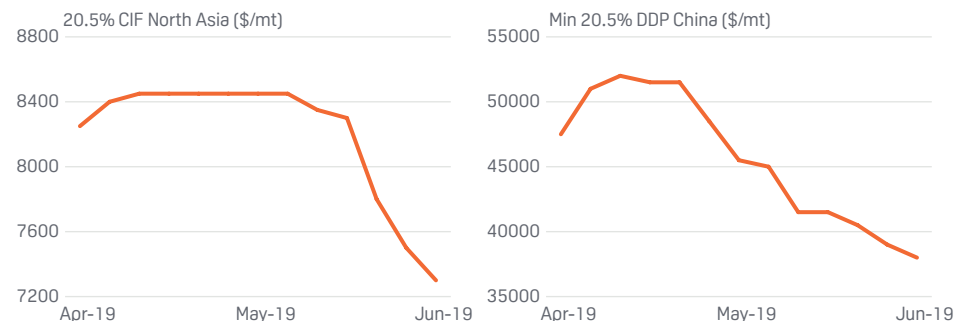
The subsidy for pure battery EVs with driving ranges of 400 km and more has been cut by 50% to Yuan 25,000 per car from the previous Yuan 50,000, according to the Chinese Ministry of Finance.

Although most market participants expect the new subsidy policy since it will force OEMs to accelerate improvements in areas such as the driving range, several sources expected it to harm cobalt sulfate demand in the short term.

A report from Platts Analytics on June 10

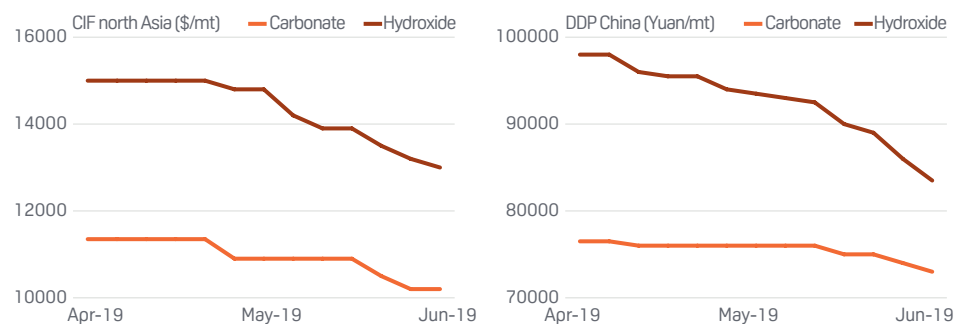
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COBALT SULFATE PRICING



Source: S&P Global Platts

LITHIUM CARBONATE AND HYDROXIDE PRICING



Source: S&P Global Platts

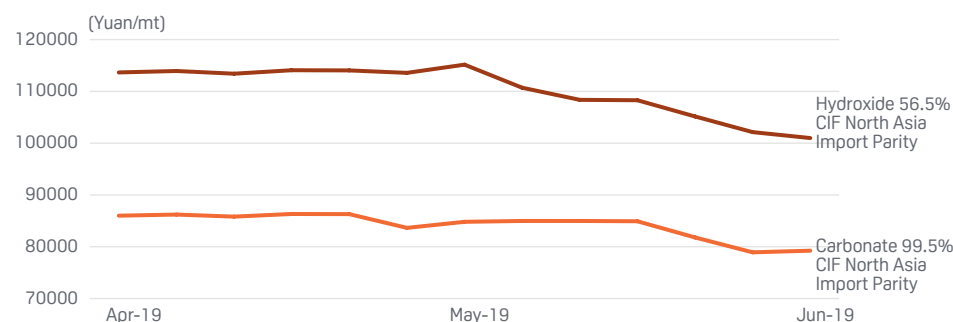
showed that global sales of electric vehicles fell 21% in April from March levels, citing a “stagnant” US PEV (plug-in electric vehicle) market and “Chinese subsidy rollbacks” as the main reasons for the decrease.

“Cobalt sulfate actual trades are sparse, tonnages are few on weak demand,” said a Chinese consumer source who was receiving indicative offers at Yuan 45,000/mt in late May, but heard about deals closed at Yuan 43,000/mt at that time.

According to some market participants, producers were already selling at a loss at that point. This situation led a Chinese producer to reduce production by 2,000 mt/month in order to avoid further losses. There were also rumors that could not be confirmed about other producers following the same path.

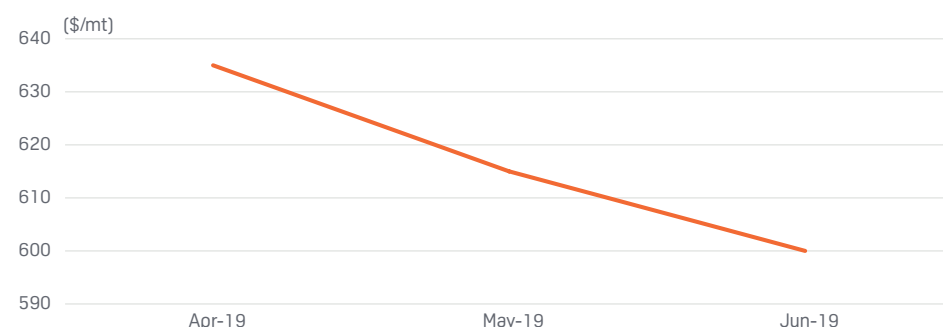
Despite sources’ expectations that the downtrend could take a pause due to the unsustainable correlation between spot prices and the cost of production, prices kept falling over June. Platts’ last weekly assessments from the second quarter were at \$7,300/mt CIF North Asia and Yuan 38,000/mt DDP China, both for 20.5% Cobalt sulfate. It remains unclear where the bottom of the market might be.

LITHIUM CARBONATE AND HYDROXIDE SPREADS



Source: S&P Global Platts

SPODUMENE CONCENTRATE 6% PRICING



Source: S&P Global Platts

EVs will pave the way for cobalt demand; increasing supply is the big challenge

Aiming to increase the driving range of electric vehicles (EVs), most automakers have been adopting batteries featuring nickel-rich cathodes. This has driven a spike in demand for cobalt in recent years since it is essential for nickel-rich cathodes due to its capability of providing higher safety and longevity. However, the high price of cobalt soon triggered a drive to reduce its usage.

Tesla’s cars, for example, employ cathodes that combine nickel, cobalt and aluminum (known as NCA), which use less cobalt than the first generation of nickel-cobalt-manganese cathodes (NCM 111, meaning that the three elements are present in the same proportion). Several manufacturers have been trying to develop a NCM 811 (using 80% nickel, 10% cobalt and 10% manganese), but the results achieved so far indicate that this is still years away from reaching commercial viability.

TOP 20 PROJECTS: ONLY TWO ARE PRIMARILY COBALT-FOCUSED

Project	Commodity	Current Controlling Company(s)	Production (mt)
Mutanda*	Copper, Cobalt	Glencore Plc	27,300
Tenke Fungurume*	Copper, Cobalt	China Molybdenum Co. Ltd., BHR Newwood Invst Mgmt Ltd., Gécamines SA	18,747
Kamoto*	Copper, Cobalt	Katanga Mining Ltd., Democratic Repub of the Congo	11,112
Etoile*	Copper, Cobalt	Shalina Resources Ltd	7,000 E
Ruashi*	Copper, Cobalt	Jinchuan Grp Intl Rsrc Co. Ltd, Gécamines SA	4,752**
Sudbury Operations	Nickel, Copper, Cobalt, Platinum, Palladium, Rhodium, Gold, Silver	Glencore Plc	4,200
Polar Division	Nickel, Copper, Palladium, Rhodium, Platinum, Cobalt, Gold, Osmium, Iridium, Ruthenium, Silver, Selenium, Tellurium	PJSC MMC Norilsk Nickel	3,520**
Ramu	Nickel, Cobalt, Chromite	Metallurgical Corp. of CN Ltd.	3,275
Moa Bay	Nickel, Cobalt, Iron Ore	Sherritt International Corp., General Nickel Co SA	3,234
Murrin Murrin	Nickel, Cobalt	Glencore Plc	3,200
Taganito	Nickel, Cobalt, Iron Ore	Nickel Asia Corp., Pacific Metals Co., Sojitz Corp.	3,100**
Ambatovy	Nickel, Cobalt, Magnesium	Sumitomo Corp., Korea Resources Corp., Private Interest, Sherritt International Corp., POSCO, STX Corp.	2,852
Goro	Nickel, Cobalt	Vale S.A.	2,104
Boss*	Cobalt, Copper, U3O8	Eurasian Rsrc Grp S.à r.l., Gécamines SA	2,100**
Voisey's Bay	Nickel, Copper, Cobalt	Vale S.A.	1,902
Kola Division	Nickel, Copper, Palladium, Platinum, Gold, Cobalt, Rhodium, Silver, Selenium, Tellurium	PJSC MMC Norilsk Nickel	1,814**

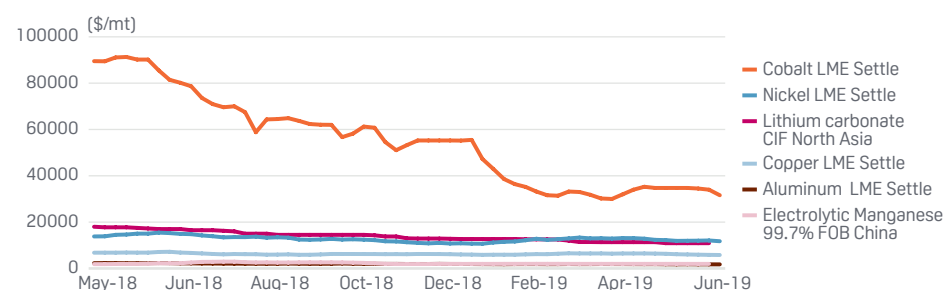
TOP 20 PROJECTS: ONLY TWO ARE PRIMARILY COBALT-FOCUSED (cont.)

Bou-Azzer	Cobalt, Nickel, Copper, Arsenic	Managem S.A.	1,807
Jinchuan	Nickel, Copper, Cobalt, Platinum, Palladium, Gold	Jinchuan Group Co. Ltd.	1,682**
Rio Tuba	Nickel, Cobalt, Iron Ore, Limestone	Nickel Asia Corp., Pacific Metals Co., Sojitz Corp.	1,500**
Terrafame	Nickel, Zinc, Copper, Cobalt, U3O8	Terrafame Oy	1,408**

*Projects located in the Dem. Republic of Congo. ** Estimate

Source: S&P Global Market Intelligence

COBALT IS THE MOST EXPENSIVE METAL USED IN BATTERIES



Source: S&P Global Platts

DEMAND SIDE: THE VIEW FROM PLATTS ANALYTICS

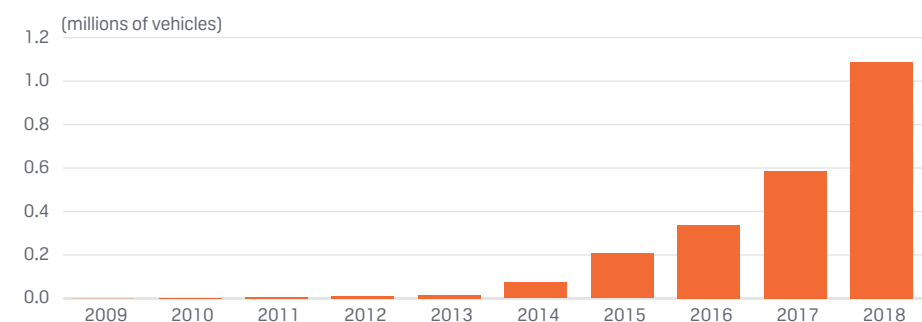
China will continue to drive cobalt demand through EVs

Despite dropping last year for the first time since 1992, the Chinese passenger car market remains the largest in the world by sales, having surpassed the US back in 2009. According to the China Passenger Car Association, passenger vehicle sales in mainland China dropped by 5.8% in 2018 to 22.35 million. However, S&P Global Platts Analytics anticipates growth in China's auto market will continue in the long-term, to the point where by 2040 22% of vehicle miles driven (VMT) in the world will be driven in China, up from just 15% today.

As a result, future demand for materials and energy in the transportation sector is,

to an increasing degree, in the hands of the Chinese consumer. And China's auto market is increasingly dominated by new energy vehicles – that is, vehicles completely or mainly driven by new energy sources, including plug-in hybrid electric vehicles (PHEVs, extended-range electric vehicles included), battery electric vehicles (BEVs), and fuel cell vehicles (FCVs). The first graphic shows the strong growth in the Chinese NEV market, with 2018 sales approaching 4% of the total light duty auto market. Platts Analytics anticipates NEV sales to continue to grow, breaching 15% market share by 2025.

CHINESE LIGHT DUTY NEW ENERGY VEHICLE SALES



Source: S&P Global Platts Analytics

Given the current limitations of the lithium-iron phosphate (LFP) and the lithium-manganese oxide (LMO) cathodes regarding energy density, which determines the driving range of an EV, most industry participants still expect NCM and NCA cathodes to featured in the biggest portion of the EV li-ion batteries that will be manufactured in the coming years.

This means that the demand for cobalt will keep on rising, but despite the current oversupply increasing the supply at the same pace won't be an easy task in the medium term, when EVs get more traction worldwide: cobalt is mainly produced as a byproduct of nickel and copper, and despite its relatively high price when compared to other minerals, it rarely justifies building a cobalt-sole project due to the huge cost of production.

China has prioritized NEV adoption for economic, security, and environmental reasons. Road transportation accounts for the bulk of China's oil demand, while the country imported nearly 70% of its oil requirements in 2018. A transition away from fossil fuel-powered road transportation would reduce dependence on international oil suppliers and cut emissions of pollutants that choke Chinese cities. Furthermore, China sees electrification of transport as an opportunity to gain global dominance in NEV manufacturing, part of a shift to an innovation-driven economy. China's NEV strategy relies on both supply-side regulation (the NEV mandate) and demand-side incentives (consumer purchase subsidies and tax breaks).

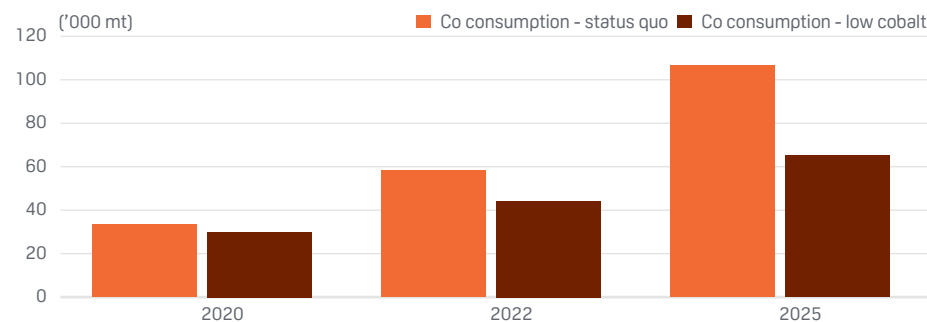
Notwithstanding these policy priorities, China's central government has moved to roll back both national and local purchase subsidies. As outlined in Platts Analytics' Q1 Electric Vehicle Sales and Policy Scorecard, March 2019 saw a reduction in national NEV purchase subsidies of around 60% with provincial and local subsidies being eliminated in late June. This move is intended to drive consolidation and innovation in a sector that has come to rely heavily on government

support. By generating greater domestic competition, China hopes to make its NEV industry more competitive on the global stage. Additionally, it relieves the fiscal burden of subsidizing a rapidly increasing number of purchases. In light of government's announcements, Platts Analytics anticipate that the move to roll back subsidies will continue until by the end of 2020 the national purchase subsidy is fully eliminated.

China introduced the NEV mandate to help support the NEV industry through the difficult transition of reducing national demand-side subsidies. The NEV mandate requires that a given percentage of each manufacturer's auto sales be covered by NEV credits, which are awarded for the sale of plug-in electric or hydrogen fuel cell vehicles. Manufacturers can maximize the credits they are awarded by selling NEVs with higher performance standards, including longer zero-emission range, higher energy density batteries, and more energy efficient drive trains. NEV credits are required for 10% and 12% of light duty auto sales in 2019 and 2020 respectively.

In order to do so, manufacturers are adopting innovative battery chemistries that give greater energy density while reducing cost and weight. Increasingly, this involves the cobalt content being lowered and replaced with nickel. In the past, Chinese EV manufacturers largely used cobalt-free lithium iron phosphate (LFP) chemistries. However, the focus on extending vehicle range saw them adopt the NMC chemistry

GLOBAL COBALT DEMAND FROM PASSENGER LIGHT-DUTY VEHICLES



Source: S&P Global Platts Analytics

**S&P Global
Platts**

GO DEEPER

Platts Analytics Scenario Planning service provides in-depth and comprehensive coverage of Alternative Transportation developments. Coverage includes the **EV Essentials monthly** publication, which tracks historical progression of EV sales growth and other key metrics, the quarterly **Electric Vehicle Sales and Policy Scorecard** assessing the potential impact of major policy initiatives and investments on EV adoption momentum at the national and company level and the **Platts Analytics Long Term EV Outlook**.

Reach out to scenarioanalytics@spglobal.com to get access to the reports, and further analysis.

that relies on nickel, manganese and cobalt. The majority of new Chinese PEVs now use the NMC 523 (e.g. BYD, BAIC, Geely) or NMC 622 (e.g. Great Wall) chemistries. CATL, one of the largest Chinese battery manufacturers, is testing this year the NMC 811 with 80 % nickel,

10 % manganese, 10% cobalt, reducing even further the battery's cobalt content. However, even if technology changes are reducing the cobalt content of each battery, the rapid EV uptake will still lead to a large growth of cobalt demand (see chart).

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SUPPLY SIDE: THE VIEW FROM S&P GLOBAL MARKET INTELLIGENCE

Cobalt production set to keep rising despite oversupply and DRC instability

The rapid drop in cobalt prices in 2018 and 2019 and regulatory turmoil in the Democratic Republic of Congo, the leading global producer, will not halt significant increases in cobalt supply as projects are committed for the long term.

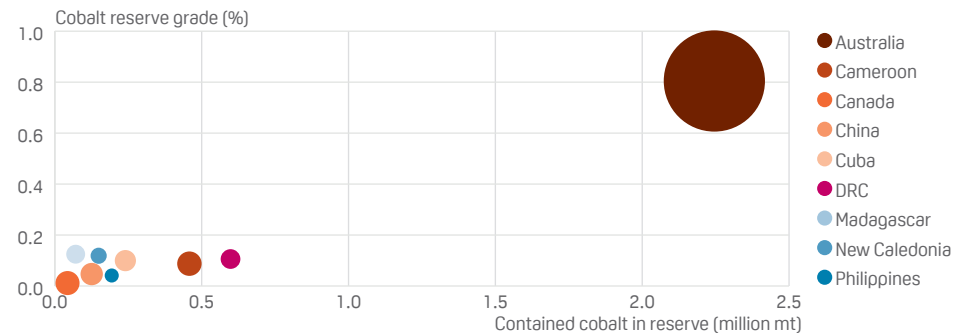
The cobalt market was shaken in 2018 by significant price fluctuations and changes to royalty rates and mining regulations in the Democratic Republic of the Congo, which produces almost 70% of the global cobalt supply. Despite these headwinds, mined cobalt supply increased by 20% year over year to almost 139,000 mt in 2018, according to S&P Global Market Intelligence.

Future supply of mined cobalt is expected to increase at 12% [an average of 12% a year, or 12% over the whole period?] from 2019 to 2023, driven mostly by growth in the DRC. There will be continuous year-over-year increases, except in 2022 when growth will stall due to a one-year drop in production from Glencore's Kamoto mine despite continued growth elsewhere.

Kamoto restarted production of cobalt in 2018 though export of cobalt hydroxide from the operation has been curtailed due to uranium contamination. Uranium content is a known issue in Kamoto ore. Previous supply of cobalt metal, however, was not affected as the uranium was removed during processing. Uranium was also expected to be removed during the production of cobalt hydroxide, but contamination persisted, rendering the product unsuitable for export. A temporary solution has allowed uranium removal from 1,200 mt of cobalt in hydroxide per month. Our estimates for Kamoto account for cobalt contained in produced hydroxide, though some of this material may not have been exported to the market in 2018. Once the permanent solution of an ion-exchange plant is operational, cobalt exports will not be constrained [it's being installed in 2022 presumably?].

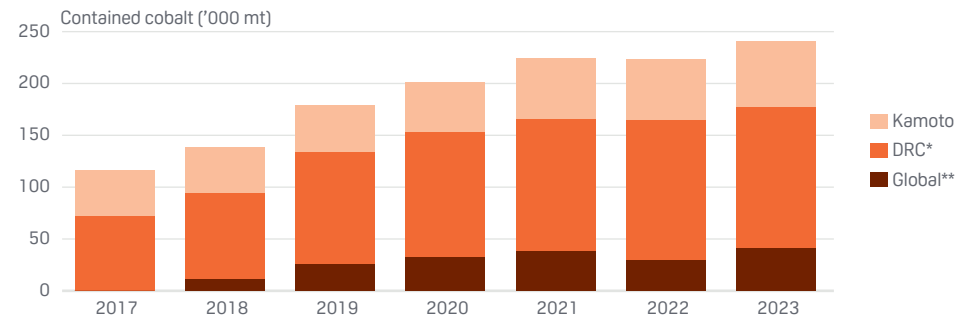
We expect Kamoto's output of cobalt to rise during 2019 to planned levels of around 26,000 mt, which will make it the world's largest producer. Exports will continue at a reduced rate before increasing toward the end of 2019 with the introduction of

DRC HOSTS HIGHEST COBALT RESERVES, GRADES AND PRODUCTION GLOBALLY



Data as of June 11, 2019. Countries with >100,000 tonnes contained cobalt in reserves. Bubble size by 2018 estimated production. Cameroon contains 177,000 mt of cobalt at a grade of 0.26%, however no cobalt production. Morocco reserve grade is the highest globally. However, there are less than 20,000 mt in reserves. DRC = Democratic Republic of the Congo
Source: S&P Global Market Intelligence

GLOBAL MINED COBALT SUPPLY FORECAST



Data as of June 11, 2019. DRC = Democratic Republic of the Congo. *Exclude Kamoto. **Exclude DRC and Kamoto.
Source: S&P Global Market Intelligence

the ion-exchange plant. Much of 2019's production is expected to be exported in 2020, notwithstanding DRC Ministry of Mines objections to the construction of the plant.

The only major producer in the DRC to see a reduction in cobalt output was Eurasian Resources Group, or ERG, at its Boss mine. Supply from the operation was already in decline when the company decided to place the operation on care and maintenance in February 2019. A feasibility study, incorporating sulfide resources and additional capacity to retreat historic tailings deposits similar to the company's Metalkol RTR operation in DRC is underway for ongoing operations. Metalkol RTR is due to start commercial cobalt and copper production in 2019, and on reaching capacity will quadruple ERG's cobalt output.

Lithium-ion battery manufacturers and cobalt alloy producers globally will heavily rely on the DRC for cobalt supply. While providing a source of cobalt that is not affected by the social and political risks endemic to the DRC, cobalt production elsewhere is not sufficient to meet current or future demand. Deposits in the DRC remain the highest grade by a wide margin and account for 50% of global reserves.

The extent of the DRC's cobalt endowment goes some way to explain the absence of a significant change in the local mining industry's outlook in response to the significant increase in royalties and the removal of 10-year protections from fiscal changes for existing operators. Even with significant regulatory and operational risks,

the DRC is the most prospective region for current and future cobalt supply. There are, however, some negative outcomes: Glencore is reducing output from Mutanda, specifically citing increased costs in the DRC, while reviewing the economics of the sulfide resource.

International miners operating in the DRC still have the option to pursue legal remedies against the DRC government, but supply commitments ensure that it is very

difficult for these companies to simply take their investments elsewhere.

Cobalt output is set to increase significantly in the coming years. Cobalt prices during 2018 decreased significantly from a peak of \$94,800/mt in April to \$55,000/mt at year-end and dropped further to \$30,000/mt in 2019. Current prices represent a 68% drop from the 2018 peak and are back to levels last seen in 2016 despite a large proportion of output

from Kamoto not being sold and exported. Oversupply from primary cobalt production as well as increased output from the Chinese chemical industry are the main causes of the fall in price. In the long term cobalt demand is widely expected to increase, eventually outpacing mined cobalt supply. But in the next four to five years, with cobalt supply increasing significantly and the export of Kamoto's stockpiled cobalt hydroxide, cobalt prices are likely to stay subdued.

Cobalt industry adopts new technologies to combat unethical production

A group of companies involved across the cobalt supply-chain have joined up to create the Responsible Sourcing Blockchain Network, which uses technology provided by IBM to tackle the most controversial aspect of the market: the existence of unethical production, especially at some smaller, "artisanal" mining operations in the Democratic Republic of Congo.

Volkswagen, Ford, LG Chem, Huayou Cobalt and RCS (a tech company focused on blockchain and traceability) are inputting data into a shared network in order to help verify that the cobalt they are using was responsibly sourced.

"Each participant has the visibility as shared by upstream players," says Sai Yadati, Blockchain Partner at IBM and the Program Manager for the Responsible Sourcing effort. "We identify different 'personas' [the agents operating in each stage of the cobalt supply chain], capture what is necessary and apply the process guidelines" in order to make sure the cobalt was sourced in accordance with existing regulations.

The companies actively input information about what was previously sourced and verified in a separate block within the blockchain through an application created specifically for the project.

Yadati believes that in the near future "even the final consumers of goods [made of cobalt] will demand this information," which increases the interest for responsible sourcing beyond its ethical nature to financial motivations. "For example, Ford and Volkswagen -- even though they are competitors, they work together" to track the information because this is beneficial for both.

IBM plans to expand the usage of the technology in the future for other minerals, including "lithium, nickel and iron ore" and not only the Democratic Republic of Congo but other regions too, Yamati said.

Eurasian Resources Group (ERG), which operates a cobalt project in the DRC, also employed IBM's blockchain tool earlier this year to trace its own production. However, the company is not part of the Responsible Sourcing Blockchain Network so far.

"Using blockchain will allow to track origin of cobalt across the supply chain, including once it's been to smelter and blended, and reduce costs through efficient information sharing, tracking and transparency according to the highest standards," stated ERG.

In addition to this adoption of blockchain technology, the Cobalt Institute earlier

this year launched the Cobalt Industry Responsible Assessment Framework (CIRAF).

The CIRAF is described by the Cobalt Institute as a "reporting framework and managing tool" for companies to demonstrate good practices across four risk categories: environment; occupational health and safety; human rights; and community.

"Within these groupings, a complete spectrum of responsible production and sourcing issues is covered, ensuring the industry has the operational guidance and a management framework in place to establish itself as one of the most progressive and responsible natural resource industries in the sector," stated the Cobalt Institute, which crafted the CIRAF following OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

"All metals and resources should be responsibly sourced, what you have there [in the DRC] is artisanal mining, which is illegal," the Cobalt Institute's president David Weight told Platts. "It's also subsistence activity, so it's necessary to embrace these people, otherwise they won't have nothing," he added, stressing that "they need to be helped, not demonized."