

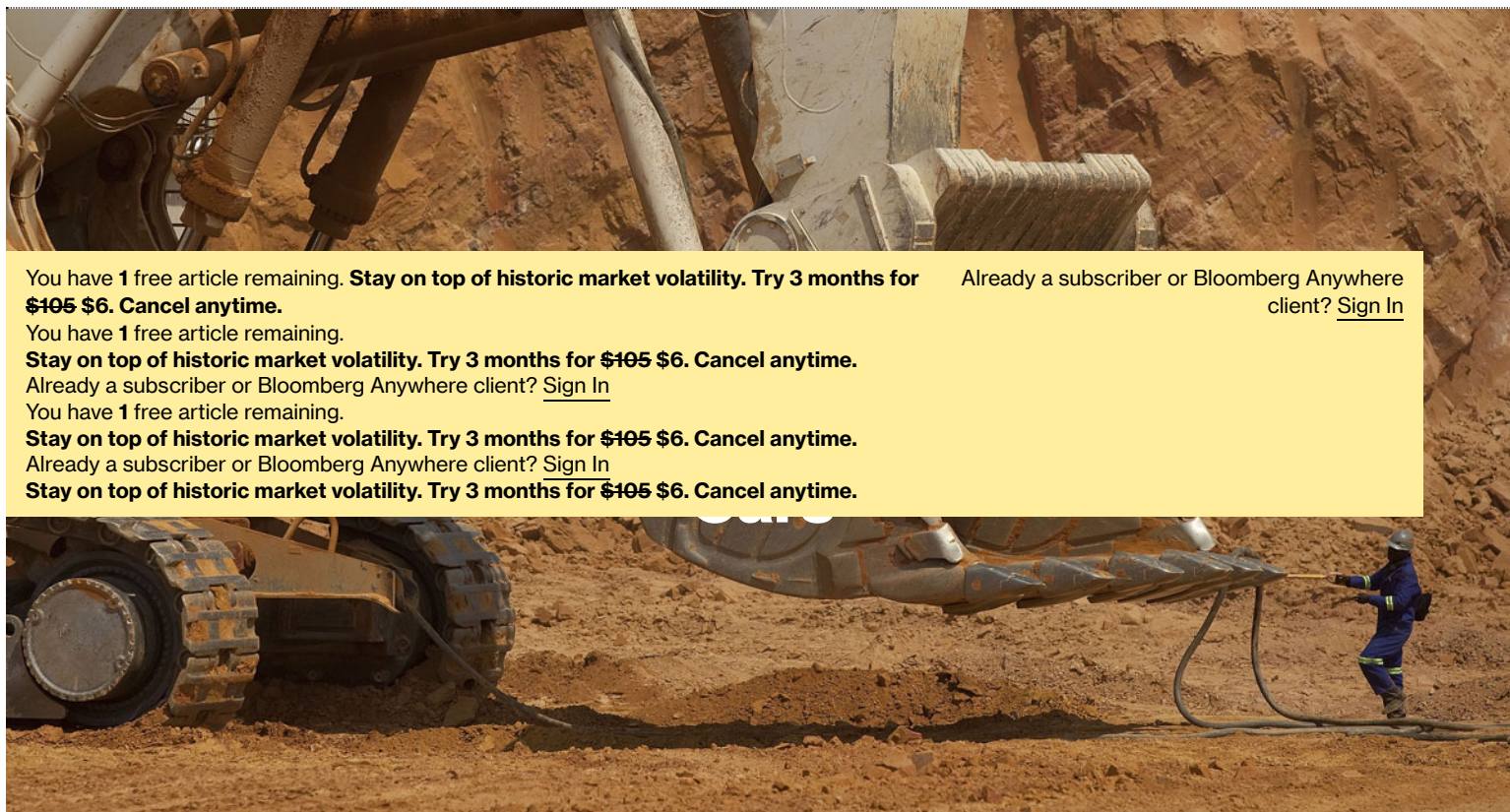
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Giant Terex Corp. mining excavator in Katanaga, D.R.C. Photographer: Simon Dawson/Bloomberg

By Jack Farchy and Hayley Warren

December 2, 2018

Over the past two years, cobalt has emerged as one of the hottest commodities of the electric-vehicle revolution. The silvery-blue metal, an important component in lithium-ion batteries, has more than doubled in price, making carmakers and tech giants fret about securing their future needs.

The focus on the metal has turned a spotlight on the obscure supply chain that takes cobalt produced in mines in the Democratic Republic of Congo, Canada or Morocco, and ultimately delivers cobalt-containing batteries to companies from Samsung Electronics Co. to Volkswagen AG. That supply chain is dominated by Chinese companies.

Many of the leading companies that mine cobalt, such as Glencore Plc and Vale SA, are well known. So too, at the other end of the spectrum, are the tech companies and carmakers that buy batteries.

In between them sit companies that refine cobalt ore to make chemicals like cobalt sulphate; companies that combine these chemicals with other metals like nickel and manganese to make the cathode element of a lithium-ion battery; and companies that assemble the cathodes with the other components to make battery cells, and ultimately batteries.



Copper and cobalt mine operated by Katanga Mining Ltd. Photographer: Simon Dawson/Bloomberg

While there's little cobalt mining in China itself (1 percent of the world's total output in 2017), Chinese companies have snapped up cobalt mines abroad in recent years, particularly in the Democratic Republic of Congo, the largest source of the metal.

### **Cobalt Origins**

More than two-thirds of cobalt mined in 2017 came from the Congo



Sources: Darton Commodities Ltd.

One key concern for cobalt buyers is that more than half of the world's supply of the metal originates from a country where there has never been a peaceful transition of power. Reports of child labor at some small-scale mines in Congo has prompted some end users to trace the supply chain for the cobalt in the batteries they buy.

Eight of the 14 largest cobalt miners in Congo are now Chinese-owned, accounting for almost half of the country's output.

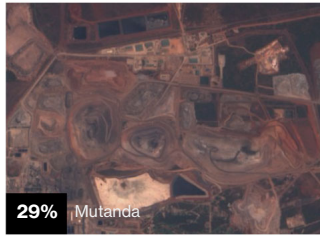
### Mining Stronghold

Share of 2017 output in Democratic Republic of Congo

■ Chinese-owned

2km

2mi



29% Mutanda

**Mutanda Mining**  
Glencore, Switzerland



21% Tenke Fungurume

**Tenke Fungurume**  
CMOC, China



9% Tilwezembe

**Other D.R.C.**  
including artisanal mining



8% Luiswishi

**Congo Dongfang Mining**  
Zhejiang Huayou Cobalt, China



6% Ruashi

**Ruashi Mining**  
Jinchuan Group, China



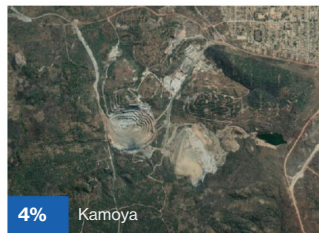
5% Etoile

**Etoile/Usoke**  
Shalina Resources/Chemaf, U.A.E.



4% Mukondo

**Boss Mining**  
ERG, Luxembourg



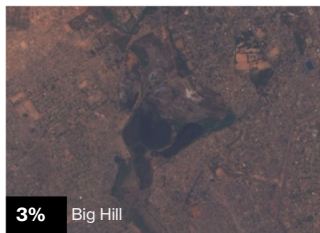
4% Kamoya

**Kamoya**  
Wanbao Mining Ltd. (Comika), China



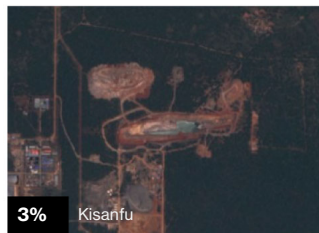
4% Diverse

**Metal Mines**  
Nanjing Hanrui Cobalt, China



3% Big Hill

**Big Hill**  
GTL, Belgium/D.R.C.



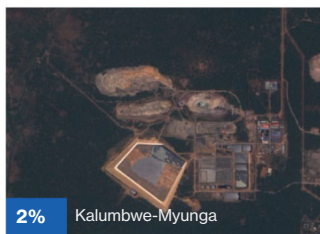
3% Kisanfu

**Somika**  
Somika SPRL, D.R.C.



3% Diverse

**MJM**  
Jiana Energy, China



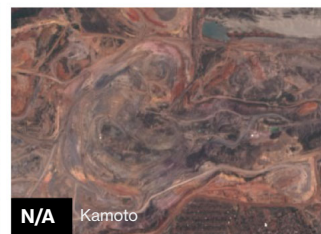
2% Kalumbwe-Myunga

**MKM**  
CREC, China



1% DIMA

**Sicomines**  
CREC, China



N/A Kamoto

**Glencore**  
Katanga Mining/KCC, Switzerland

Katanga Mining Ltd. production was suspended in 2015, and restarted in 2018.  
Sources: Darton Commodities, EO Browser/Sinergise Ltd., USGS Mineral Resources

After the cobalt has been mined, it is sold-sometimes via traders-to refiners. They produce cobalt metal and powder, which are mostly used to make superalloys used in jet engines, or chemicals like cobalt sulphate, which are used to make batteries.



Photographer: Jasper Juinen/Bloomberg

China is even more dominant in the production of cobalt chemicals needed to make batteries than Congo is in cobalt mining. According to data from Darton Commodities Ltd., China accounts for more than 80 percent of the production of cobalt chemicals.

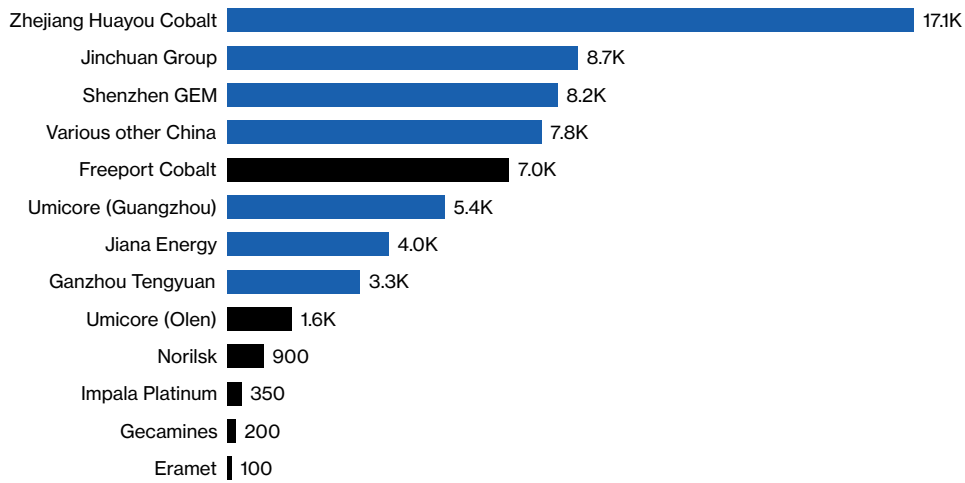
“China controls a massive proportion of the world’s cobalt sulphate,” says George Heppel, an analyst at consultancy CRU Group in London. “Aside from one chemical refinery in Finland, they control pretty much the entire world’s cobalt chemical refining capacity.”

### Chemical Strength

Cobalt refined in 2017, in metric tons

■ China-based company

Chemical	Powder	Metal
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Chemical refers to refined cobalt excluding metals and coarse powders.  
Source: Darton Commodities Ltd.

In the next stage of processing, the cobalt chemicals are put together with other metals, such as manganese or aluminum, to make cathodes—the positively charged part of a battery.




Photographer: Jasper Juinen/Bloomberg

There's a wide range of different chemical makeups of lithium-ion batteries. Not all of them use cobalt, but many of the most popular do. Following the surge in cobalt prices, most

batterymakers are researching ways to reduce the proportion of cobalt in their batteries.

Currently in the ascendancy in the electric-vehicle industry are nickel–manganese–cobalt oxide (NMC) batteries, used in most electric cars, and 57 percent of the production capacity for this type of cathode is in China. Tesla Inc., however, uses nickel–cobalt–aluminium oxide (NCA) batteries, which have a lower proportion of cobalt. Cathodes of this type are largely made in Japan. The consumer electronics industry largely uses lithium–cobalt–oxide (LCO) batteries, which contain the highest proportion of cobalt.

### Positive Charge

Battery cathode capacity, in tons 

■ Fully commissioned ■ Commissioned by end 2021



Source: Bloomberg NEF

Finally, the cathodes are brought together with the other components of a battery to make battery cells and then whole batteries in so-called “megafactories.”



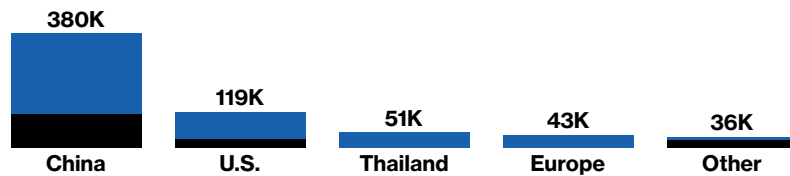
LG Chem battery packs at Korea's Hyundai plant. Photographer: SeongJoon Cho/Bloomberg

After Tesla pioneered the concept of a gigafactory in Nevada, there are now dozens of similar plants springing up across China. Chinese companies, like Contemporary Amperex Technology Co., are rapidly expanding. “We are going to increasingly see a lot of battery manufacturing migrating to China because the materials involved in manufacturing it are so readily available,” says Heppel.

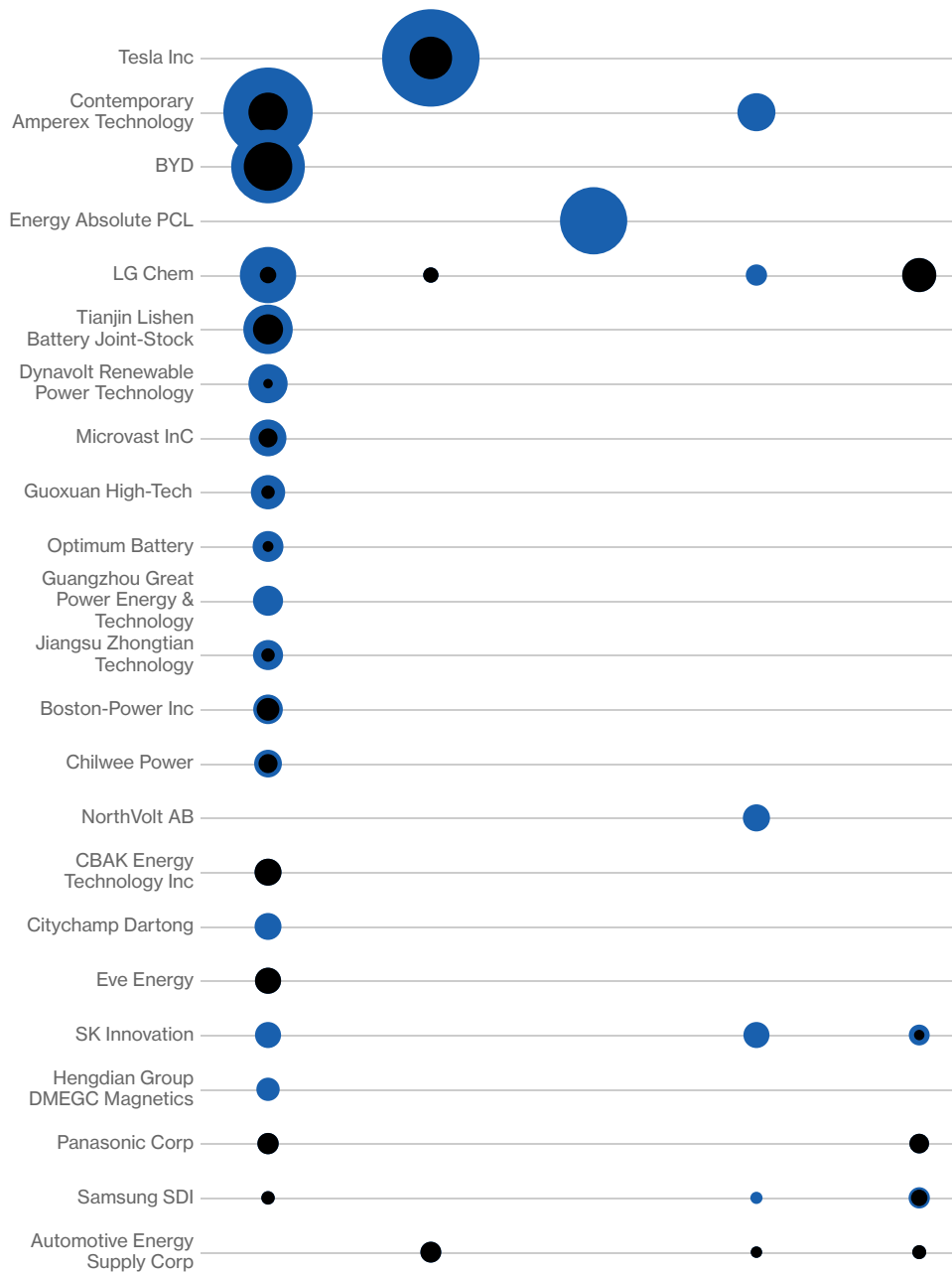
### Power Hungry

Battery plant capacity, in megawatt hours ↴

■ Fully commissioned ■ Commissioned by end 2021







Only manufacturers with combined capacity exceeding 5,000MWh are broken out  
 Source: Bloomberg NEF

“There’s not going to be enough cobalt for everyone to avoid China,” says Heppel. “No matter how clever people try to be, there’s always going to be more readily available materials in China, which gives them a significant advantage.”

*Correction: A previous version mislabelled the joint venture countries for the Big Hill mine.*

Editor: Dylan Griffiths  
 Photo Editor: Gina Turner

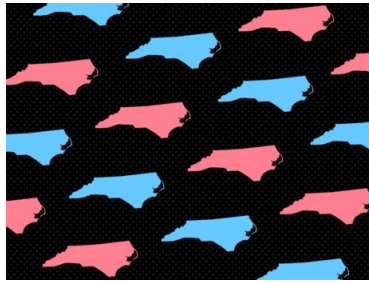


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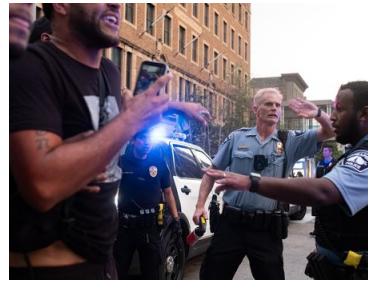
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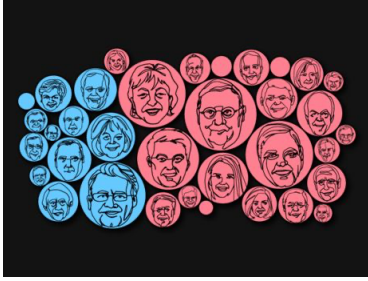
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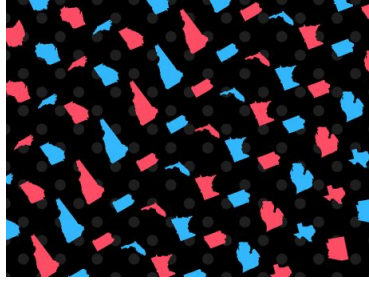
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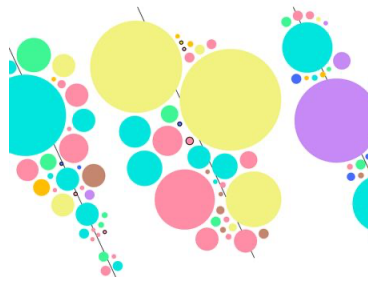
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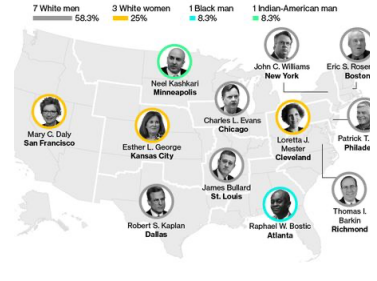
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