BBVA Research

Energy and Commodities

Lithium and cobalt

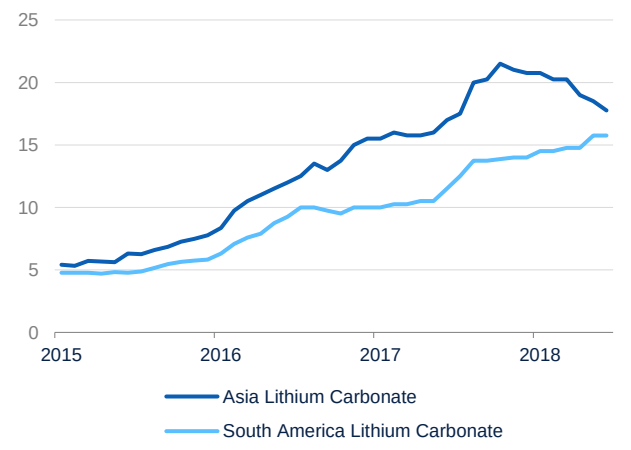
Same purpose, different paths

Adrian Casillas / Marcial Nava

The commodities of a new energy era

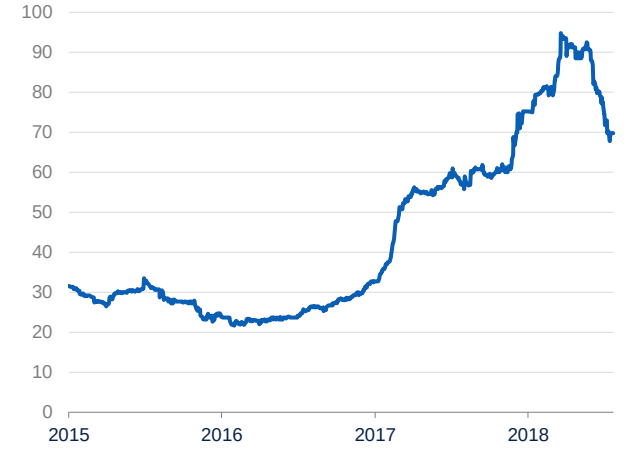
Lithium and cobalt are the latest vogue in commodity markets, as evidenced by the significant growth in their prices since 2016. On the London Metal Exchange (LME), the average spot price of cobalt went from $22,813 per metric ton in 1Q16 to $87,352 in 2Q18, a 282% increase. The weighted average stock price of the largest public cobalt mining companies went up 85% in the same period.[1] Similarly, Asian and South American lithium-carbonate prices went up by 93% and 120%, respectively, and the weighted average stock price of the five largest lithium firms increased by 84%.[2]

Chart 1. Lithium Prices ($'000 per metric ton)



Source: BBVA Research and Bloomberg

Chart 2. LME Cobalt Spot ($'000 per metric ton)



Source: BBVA Research and Bloomberg

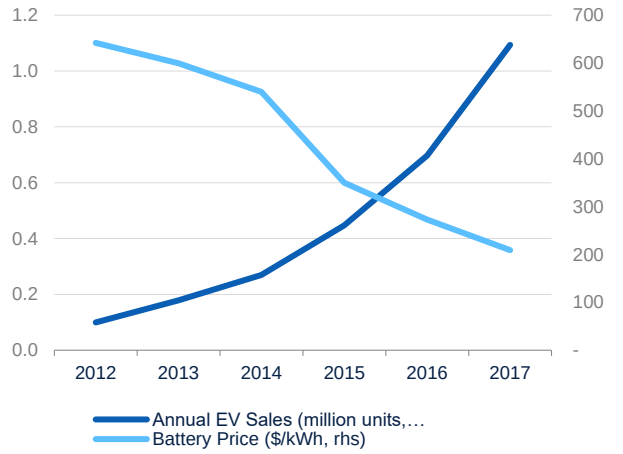
Lithium and cobalt are basic components of the lithium-ion batteries that power cell phones, computers, and electric vehicles (EVs).[3] Although both metals have been in high demand for a while due to their use in consumer electronics, the recent spike in prices is largely the result of positive expectations generated by the rapid growth of electric vehicle sales. The share of demand for lithium used in the production of electric vehicles went from 20% in 2014 to 49% in 2018. According to Bloomberg New Energy Finance (BNEF), this share of demand could reach 90% by 2030. Meanwhile, the share of cobalt used in the manufacturing of electric vehicles went from 1% in 2014 to 8%, and it could reach 49% by 2030.[4]

Innovation and government incentives are behind the increasing sales of electric vehicles. In particular, the price of the battery pack has gone from $800 in 2011 per kWh to about $200 today.[5] Battery prices could reach $100 per kWh sometime in the next decade. This together with cash and other incentives would make EVs a better alternative than combustion engines. BNEF places worldwide annual sales of EVs at 11 million by 2025 and 30 million by 2030. Moreover, EVs could attain 55% market share of all commercial transit by 2040. These figures

1: Glencore, Rangold Resources, Ivanhoe Mines Ltd., China Molybdenum Co. Ltd.
2: Albemarle Corp., Sociedad Química y Minera de Chile SA, FMC Corp., Tianqui Lithium Corp., Jiangxi Ganfeng Lithium Co Ltd.
3: For a detailed explanation on how lithium-ion batteries work see: https://www.energy.gov/eere/articles/how-does-lithium-ion-battery-work
4: Morsy, Salim (2018). "Long-term Electric Vehicle Outlook, 2018." Bloomberg New Energy Finance. May 21.
5: Nikolaos Soulopoulos (2018). "When Will EVs Be Cheaper Than Conventional Vehicles?" Bloomberg New Energy Finance. March 22.

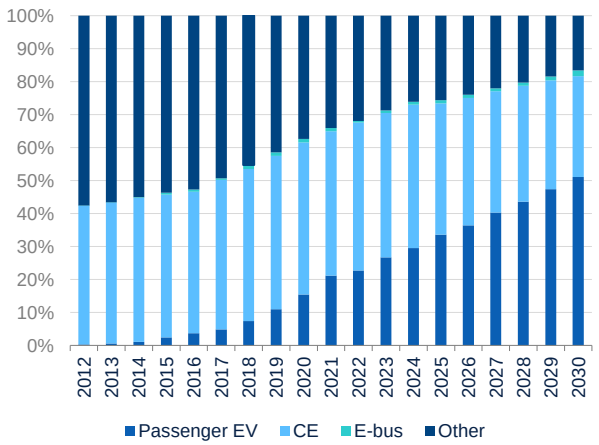
would imply an increase in the annual demand of cobalt from 123,349 metric tons in 2018 to 359,556 by 2030 and in the demand of lithium from 52,894 metric tons in 2018 to 286,072 by 2030.[6]

Chart 3. Global EV sales and lithium-ion battery prices



Source: BBVA Research and Bloomberg New Energy Finance

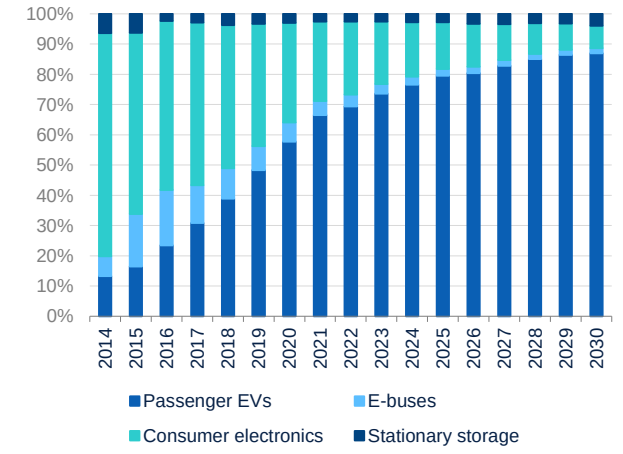
Chart 4. Share of cobalt demand by segment



Source: BBVA Research and Bloomberg New Energy Finance

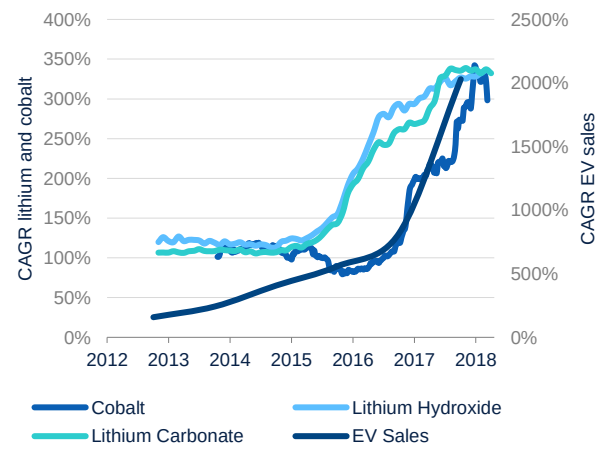
In anticipation of what appears to be an irreversible trend, virtually every automaker has plans to release EV models in the proceeding years. Automakers and their suppliers will benefit from countries and cities pledging to ban gasoline and diesel vehicles as well as from the development of public charging infrastructure. Of all countries, China has the most aggressive strategy for EV expansion. This includes incentives to both supply (quotas, credits, etc.) and demand (subsidies, licenses, etc.). China already has the largest fleet of electric vehicles in the world, and sales are expected to reach 5 million units by the middle of next decade, around 35% of global sales.

Chart 5. Share of lithium demand by segment



Source: BBVA Research and Bloomberg New Energy Finance

Chart 6. CAGR of EV sales and EV related commodities



CAGR = compounded annual growth rate.
Source: BBVA Research and Bloomberg New Energy Finance

6: *Ibid.*

As the market for electric vehicles grows, automakers and battery manufacturers have built supply chains around lithium and cobalt. However, the rapid increase in the prices of these commodities has raised concerns about auto and battery manufacturers' ability to secure a stable sourcing. In the following paragraphs we describe how, despite being abundant, the future of these raw materials differs significantly.

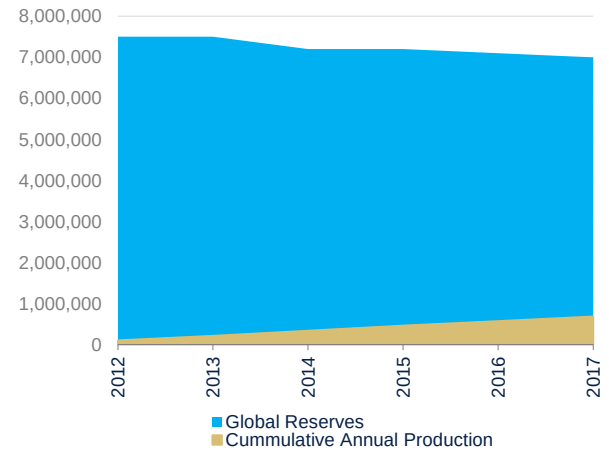
Can stable supply be assured?

Cobalt

Cobalt resources are plentiful. They are estimated at about 145 million metric tons including terrestrial and maritime deposits. Reserves –or the stock of economically extractable material- are estimated at 7.1 million metric tons[7] after a series of discoveries made in the 2000s. Global production reached 110,000 metric tons in 2017. **Despite the expected upward trend in electric vehicles, a shortage of cobalt caused by depletion seems unlikely.** However, supply can still be disrupted by factors associated with its high degree of concentration in one country, the Democratic Republic of Congo (DRC), from which nearly 60% of all cobalt used in refinement originates.

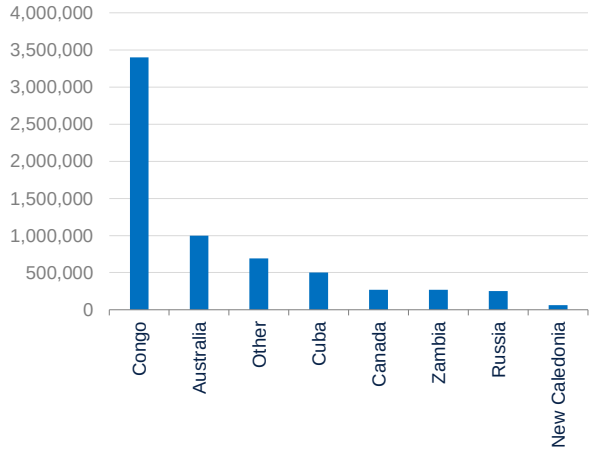
The DRC is notorious for its political instability and for being in constant dispute over the ownership of its mineral riches. Thus, any sort of conflict around major mines could affect the market. Another red flag comes from the fact that nearly 20% of the cobalt exported from the DRC is extracted by hand, often involving child labor.[8] This creates ethical and reputational problems for buyers which include some of the biggest names in high-tech. Companies such as Tesla and Panasonic have responded by adopting due diligence practices that take human rights into consideration. However, political instability and human right abuses have ultimately forced automakers and battery manufacturers to begin looking for permanent solutions like reducing or eliminating the use of cobalt. Tesla, for example, has managed to lower the amount of cobalt per car from 11 kg in the Model S to 4.5 kg in the most recent Model 3.[9] At the firm level, production is slightly better distributed as the three largest producers –Glencore (UK), Gecamines (DRC) and China Molybdenum- account for roughly 38% of global output. Around 90% of cobalt is extracted as a byproduct of copper and nickel mining, which makes it very vulnerable to the dynamics of these commodities. Yet, DRC copper mines, from which its cobalt is extracted, make up a very small percentage of worldwide copper production.

Chart 7. Cobalt production and reserves (metric tons)



Source: USGS 2012-2018 Cobalt Report

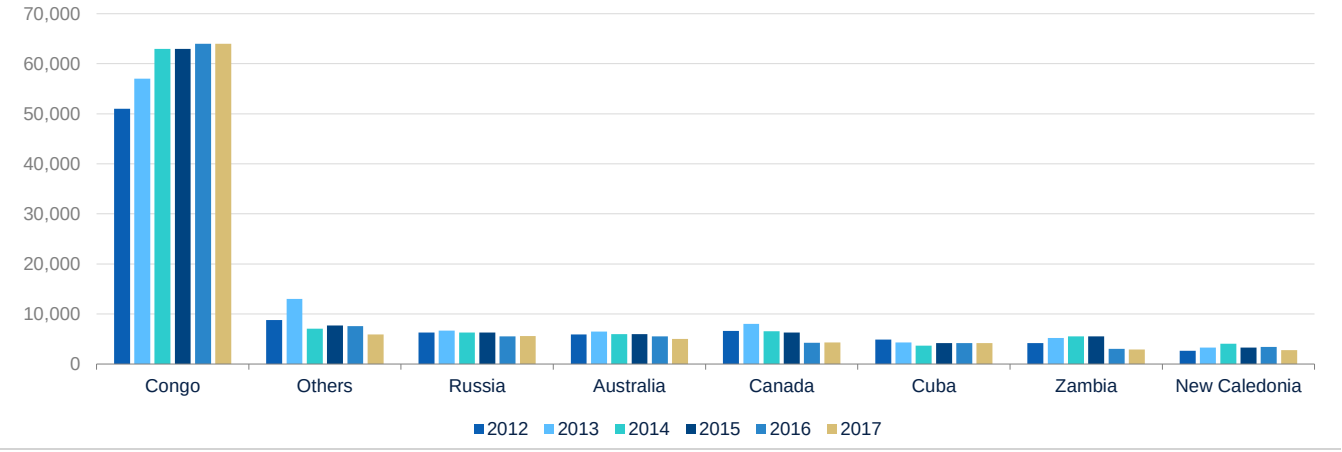
Chart 8. Cobalt reserves by country (metric tons)



Source: BBVA Research and USGS 2018 Cobalt Report

7: U.S. Geologic Survey, Mineral Commodity Summaries, January 2018, https://minerals.usgs.gov/minerals/pubs/commodity/cobalt/
8: Amnesty International (2017), "Time to Recharge. Corporate Action and Inaction to Tackle Abuses in the Cobalt Supply Chain." https://www.amnesty.org/download/Documents/AFR6273952017ENGLISH.PDF
9: Alvarez, Simon (2018). "Tesla is leading electric car batteries away from cobalt mining industry." TESLARATI. May 7. https://www.teslarati.com/tesla-battery-tech-cobalt-mining-industry/

Chart 9. Global production of cobalt (metric tons)



Source: BBVA Research and USGS 2012-2018 Cobalt Report

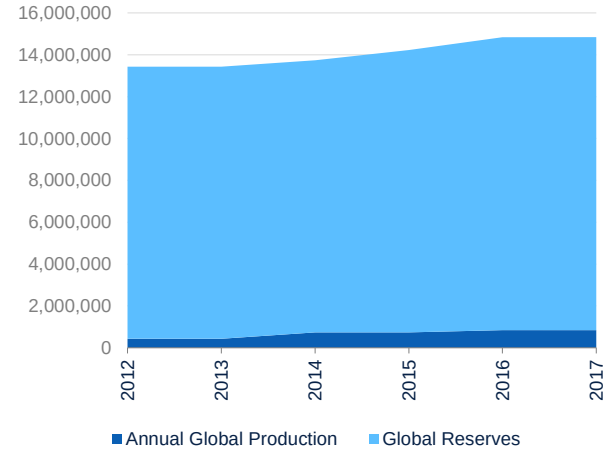
Lithium

The risk of running out of lithium is also very low. Identified global lithium resources are in the order of 53 million metric tons. Worldwide reserves are estimated at 16 million metric tons, with 96% of them located in four countries: Argentina, Australia, Chile, and China. In 2017, global production was estimated at 43,000 metric tons; from which, 89% came just from Argentina, Australia and Chile.[10] At the firm level, the market is controlled by four companies: Tianqi (China), SQM (Chile), Albemarle (USA) and FMC (USA).

Despite its abundance, higher prices were primarily the result of rigidities in the value chain. After being extracted from brines or hard rock formations, most of the raw material is turned into lithium carbonate or lithium hydroxide. The former has the most applications (ceramics, glasses, pharmaceutical, etc.), but the latter is preferred by manufacturers of EVs. Lithium hydroxide is necessary for some types of advanced cathodes, such as nickel-cobalt-aluminum oxide (NCA) and nickel-manganese-cobalt oxide (NMC). Lithium from brines in South America can be turned into lithium carbonate at a relatively low cost but converting it to lithium hydroxide is expensive and requires additional investments. As expectations for electric vehicles surged, the supply of lithium hydroxide tightened, leading to higher prices. The process for obtaining lithium hydroxide from hard rock deposits –mainly located in China and Australia- is less expensive, yet investments have just started to flow. Incoming projects are expected to increase production capacity by almost 70%.[11] Lithium hydroxide is likely to surpass lithium carbonate in terms of demand growth.

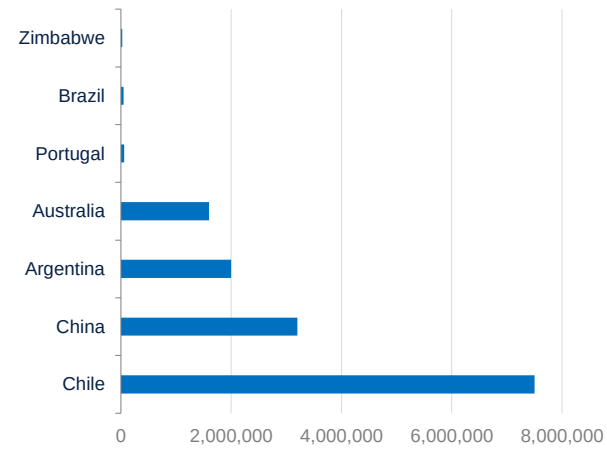
10: Source: U.S. Geologic Survey, *Mineral Commodity Summaries*, January 2018, https://minerals.usgs.gov/minerals/pubs/commodity/lithium/
11: Azevedo, M., Campagnol, N., *et. al.* (2018), "Lithium and cobalt-a tale of two commodities." McKinsey & Company, June. https://www.mckinsey.com/industries/metals-and-mining/our-insights/lithium-and-cobalt-a-tale-of-two-commodities

Chart 10. Lithium production and reserves (metric tons)



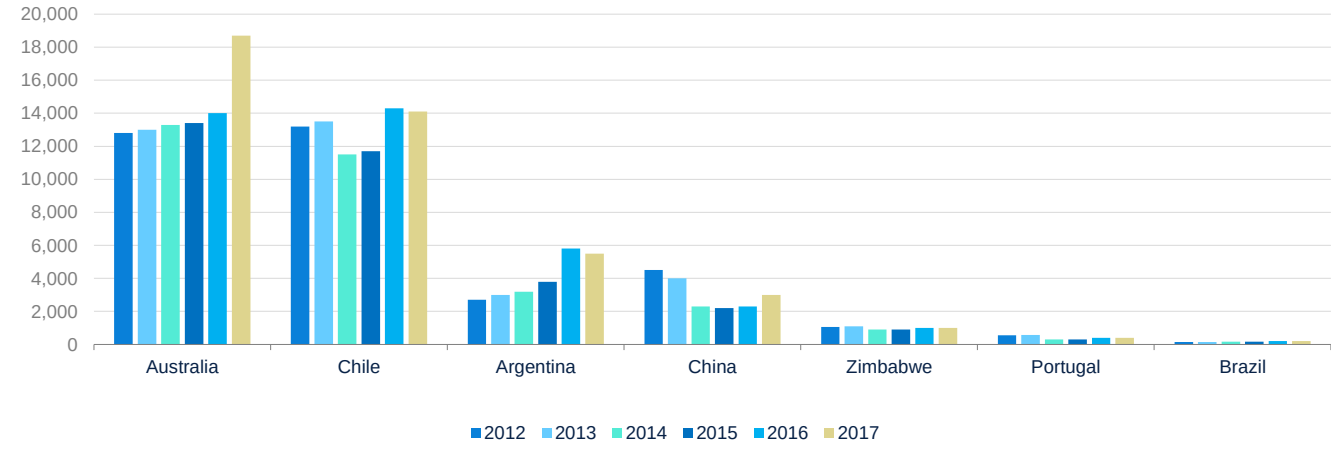
Source: BBVA Research and USGS 2012-2018 Lithium Report

Chart 11. Lithium reserves by country (metric tons)



Source: BBVA Research and USGS 2018 Lithium Report

Chart 12. Global production of lithium (metric tons)



Source: BBVA Research and USGS 2012-2018 Lithium Report

Opportunities in the value chain

As long as lithium-ion batteries remain the most preferred alternative for energy storage, lithium and cobalt are likely to become as important for automakers as steel and aluminum are today. The expansion of electric vehicles will trigger substantial investments across all stages of the lithium and cobalt value chain including extraction, transportation, refining, and recycling. Going forward, several mining companies –including multinational firms as well as a new set of relatively small players- will actively look to fund new ventures. As of October 2017, there were 42 lithium projects and 36 cobalt projects in progress.[12] Opportunities for the banking industry could be as plentiful as lithium and cobalt reserves. And in the case of lithium, some of the countries with the biggest potential for mining -Argentina, Spain, Portugal, U.S., Peru and Mexico- are all part of the BBVA footprint.

12: Frith, James (2018), "Lithium-Ion Battery Materials: Supply and Demand." Bloomberg New Energy Finance, October 9.

In addition to mining, freight transportation and infrastructure will be needed to move lithium and cobalt from production centers in South America, Australia and Sub-Saharan Africa to chemical and manufacturing facilities in China, Europe and the U.S. As it stands, investors from South Korea, Japan, and China have already begun to invest in South America in order to support their lithium mining operations. The majority of their investments have gone to Chile and Argentina; though, we are seeing and should continue to see investments in Bolivia and Peru. This is comparable to the large investments in Sub-Saharan African resources made by Chinese investors beginning in the 2010s. It has been estimated that nearly $3bn of investments would be needed to increase lithium production in South America and Australia.[13] As the number of electric vehicles on the road increases, sizable amounts of raw materials, including lithium and cobalt, can be salvaged from defunct units. A new recycling industry –which is virtually non-existent for lithium- will emerge. Recycling may provide 50% of cobalt supply and 30% of lithium supply by 2030. [14]

M&A activity could develop as automakers and battery manufacturers try to vertically integrate upstream material sourcing in order to minimize supply risks. Recently, a series of Japanese automakers partnered to secure a stable supply of cobalt.[15] This group will try to secure their supply by signing long-term contract with cobalt miners or even investing in the production of cobalt with government support. Battery manufacturers and automakers could also vertically integrate recycling as an alternative to large-scale mining operations once the industry is mature enough to support it. Big mining conglomerates may seek to acquire more lithium or cobalt assets in the following years.

As the markets for lithium and cobalt grow in complexity, a market for financial derivatives will develop. This will bring opportunities for investors who are not active participants in the industry but would like to share in some of the benefits. So far, no major exchange offers futures contracts or swaps on lithium, nor is it traded in any major exchange. Exposure to lithium can only be accessed through equity from the largest producers or through the Global X Lithium ETF. On the other hand, the London Metal Exchange has announced plans to begin trading cash-settled cobalt futures in January of 2019. A sound derivatives market would allow participants to create trading strategies which rely on the complex relationship between the prices of both commodities.

Long-term considerations

Innovation could significantly alter the prospects for lithium and cobalt in the long-run

The increase in prices of raw materials has incentivized innovation around the lithium-ion battery. Different chemistries have been developed in an attempt to keep production costs under control and improve quality. Because the share of lithium tends to be constant across chemistries, most of these innovations have been geared towards lowering the amount of cobalt in the cathode by using other metals. In this context, the next generation of lithium nickel-manganese-cobalt (NMC) and lithium-nickel-cobalt-aluminum (NCA) are expected to dominate cathode chemistries across EV segments.[16] Both NMC and NCA have significantly less content of cobalt than their predecessor lithium-cobalt-oxide (LCO). However, it is not clear if these new chemistries will reduce the total demand of cobalt. In fact, total demand could still grow as EV sales increase.

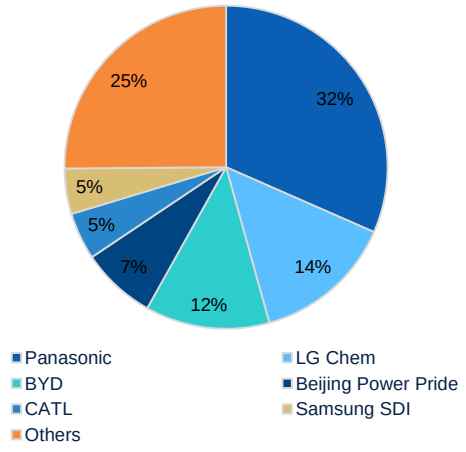
The quest for higher energy density, minimum charging times, and longer life cycles has incentivized the development of new battery chemistries that could potentially reduce the demand for both lithium and cobalt. The list is long and includes: hydrogen fuel cells, redox flow batteries, graphene supercapacitors, aluminum-graphite batteries, thin-film batteries, silicon-dominant anode materials, solid-state batteries, etc. Some innovations go beyond the battery; for example, cars may be able to charge electricity directly from sunlight, or roads could be powered instead of cars. Some of these inventions could displace lithium-ion batteries entirely. However, many of them still face technical and economic hurdles that will take several years or even decades to overcome.

13: Sanderson, Henry (2017). “Electric car demand sparks lithium supply fears” Financial Times. June 8.
14: Morsy, Salim (2018). *Op. cit*.
15: Obayashi, Yuka (2018), “Japan takes steps to ensure stable cobalt supply for automakers.” Reuters. July 24. https://www.reuters.com/article/us-japan-metals-cobalt/japan-takes-steps-to-ensure-stable-cobalt-supply-for-automakers-idUSKBN1KE1ZF
16: Morsy, Salim (2018). *Op. cit.*

Therefore, we can reasonably expect the future of the battery industry to be dominated by multiple technologies rather than just lithium-ion. But one might also consider that a single technology could eventually prevail (e.g. gasoline vs. diesel).

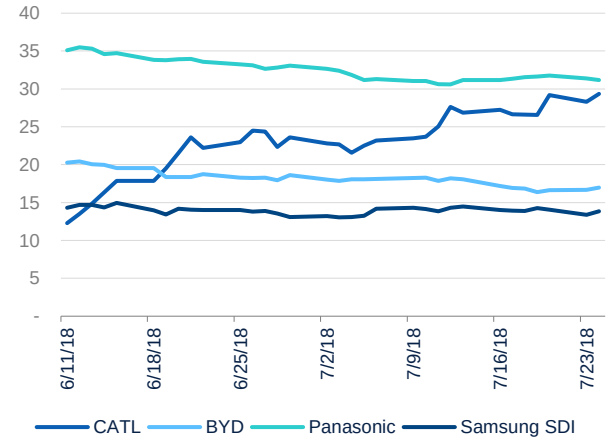
Another important consideration for the future of lithium and cobalt is the rapid ascent of China as the top manufacturer of batteries and electric vehicles. This was possible due to the size of the country's domestic market, technological expertise, government incentives to local industries, and access to raw materials.[17] This has both pros and cons for lithium and cobalt markets. Take cobalt as an example. Although the DRC accounts for roughly 60% of the world's production, Chinese companies are responsible for producing 80% of cobalt containing chemicals used by automakers and battery manufacturers. The monopoly of cobalt refinement benefits China's domestic industries and gives it significant bargaining power over foreign buyers. This power can also be used to prevent prices from collapsing as most of the supply of graded cobalt is controlled by a single player. Consequently, the future of cobalt will be closely linked to developments in China, at least until other countries begin challenging the country's relative position.

Chart 13. 2017 EV battery market share



Source: BBVA Research and Bloomberg

Chart 14. EV battery manufacturers market cap



Source: BBVA Research and Bloomberg

China will also play a critical role in the future of lithium markets. The country's demand for lithium will grow further as battery production expands. Recently, Chinese battery manufacturer Contemporary Amperex Technology Ltd. (CATL) was able to raise nearly $1bn in the market for expansion projects after a successful IPO that lifted the company's market cap to $12.3bn. CATL has already surpassed Panasonic Corp. as the world's largest supplier of batteries for EVs. As a result, China could be supplying two thirds of the world's EV batteries over the next decade. The remaining third would be split among multiple countries, most notably the United States, Japan and South Korea. China already leads the segment of less-advanced battery chemistries, but a change in government subsidies towards better quality has incentivized a move towards lithium-iron-phosphate to nickel-manganese-cobalt cathodes, which are more compatible with the best EVs in the market. Quality has improved, and CATL now has plans to build its first production plant in Germany. It also has contracts with BMW, Honda, Nissan, Toyota and Volkswagen. China's development of state of the art technologies continues, and it is expected to accelerate as R&D efforts increase.

17: Hsiao, I-Chun (2017), "Will China's EV battery makers rule the global market?" Bloomberg New Energy Finance. January 20.

Conclusion

A growing market for electric vehicles has improved prospects for lithium and cobalt. Going forward, different scenarios could unfold. In the short-run, the supply of these metals will continue to catch-up with increasing demand from automakers and battery manufacturers. This means that prices could remain high until incoming investments boost production capacity and the market reaches a new equilibrium with potentially lower and more stable prices. Although there is virtually no risk of depletion for both metals, shortages can occur if miners fail to adjust to higher demand or if unexpected geopolitical events unfold (particularly in the case of cobalt and the DRC). On the downside, investments that result in overcapacity could lead to significantly lower prices. However, the oligopolistic nature of both markets could prevent prices from falling precipitously. Although both metals have relatively good prospects in the EV industry, cobalt is more prone to fall into disuse given its exposure to political instability and human right violations. The main downside risk for both metals comes from innovations that result in a shift to alternative power sources. Although this is a very likely scenario, it may take several years to materialize due to technological and cost constraints. But until this happens, lithium and cobalt will be critical raw materials for energy storage and will offer multiple opportunities for investors.

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