

Mining for Metals in the EV Value Chain

Analysis of Supply and Demand

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International commitments to achieving net-zero emissions targets by 2050 are further pushing the electric vehicle (EV) market into the spotlight; and, the supply of commodities remains crucial to the EV industry, and its growth.

EV batteries, particularly the new generation of lithium ion (Li-ion) batteries, require a variety of rare metals, many of which are new to the automotive industry. Consequently, if EV sales targets (and emissions targets) are to be met, there must be significant and immediate expansion of these commodities' markets. Moreover, the EV industry must compete with other industries for the same commodities, if it is to secure supply; consequently, analyses of reserves and production must be conducted with an eye for current and future competition.

This report provides a synopsis of the essential metals and commodities required for EV batteries. For clients of the firm, we make available our full report on all key EV battery metals.

LITHIUM

The average Li-ion battery pack in an EV contains 8-10kg of lithium; therefore, due to huge growth within the EV market, lithium has become one of the world's most in-demand commodities.

However, lithium reserves are limited, which will be a long-term concern for the EV industry, particularly because almost all the latest electronics also require it, thereby creating intense supply competition. Within the next decade, supply will become seriously limited, and prices will rise. Whilst battery technologies will move away from lithium, in the short-to-medium term it will remain a critical component, since lithium's storage capacity is unmatched.

NICKEL

The cathodes in the new generation of Li-ion batteries contain at least 60% nickel, and some contain even more – 90% in LG Chem's cathodes, used by Tesla. As one of the most critical materials in the EV sector, demand is predicted to increase tenfold, from 36,000 tonnes in 2018 to 350,000 in 2025. Nickel supply has been increasing worldwide, and is expected to reach 3,242 tonnes by the end of 2022.

Despite a price increase between 2020 and 2022, due to the Russian invasion of Ukraine and COVID-19, nickel prices are expected to fall after 2022, and stabilise at around \$15,000/tonne, primarily because production can easily keep pace with demand.

COBALT

Cobalt is essential for Li-ion batteries, and demand is increasing dramatically, due to the expanding EV industry. In 2021, the EV industry became the leading consumer of cobalt, totalling 34% of global demand. This expansion is set to continue, as cobalt demand is driven by governmental legislation towards EVs. Prices rose dramatically in 2021, due to supply issues caused by COVID-19, and were kept high by stockpiling, but prices dropped in August 2022, as these issues were resolved.

The Democratic Republic of the Congo (DRC) holds over 50% of global cobalt reserves, and is the world's largest producer, at 120,000 tonnes in 2021; however, there are significant ESG concerns surrounding the DRC's mining practices, primarily, child labour, and poor mining practices and human rights abuses. In addition, around 80% of cobalt mines in the DRC are owned or financed by Chinese investors. These concerns are causing EV manufacturers to turn to other countries, such as Australia and Indonesia. Indonesia is expected to experience the largest increase in refined cobalt production, potentially reaching around 1/4 of global supply. Conversely in key EV adoption markets such as Europe, cobalt production remains limited. Where reserves do exist, extraction and refinement projects in these regions could be excellent investment opportunities.

MANGANESE

Manganese makes up around 33% of NMC (nickel manganese cobalt) cathode materials. However, supply is sufficient and stable, so prices will remain stable in the coming years. Due to South Africa holding the vast majority of the world's reserves, we expect the country to dominate the market for the foreseeable future, despite some small competition from China and Gabon. If Ukraine is able to utilise its significant reserves, then it could dramatically increase its percentage of world supply; however, this is uncertain.

COPPER

The quality of its energy transmission and storage capacity make copper ideal for use in EV motors, batteries, and inverters, as well as in wiring and charging stations. The copper content of hybrid EVs is more than double that of a conventional ICE car, and a fully electric vehicle contains two and a half times more. As such, huge growth in the EV market will drive up demand and, due to the slow increase in supply, we expect copper prices to rise.

In 2021, China consumed 52% of global refined copper, but it is also the world's largest producer at around 42% of the global supply. Chinese copper consumption will lead the market, as will its production of refined copper, which we can expect to see used domestically and exported on the international market.

GRAPHITE

Graphite helps to store the energy inside a charged battery and it has no known substitutes; therefore, it will remain fundamental to the EV industry and, as demand for batteries and battery storage rises, so will demand for graphite.

Furthermore, China will continue to dominate the market. Despite calls in the US and Europe to reduce dependency upon Chinese graphite, and potential small upticks in production in other markets, such as Turkey, this will be insufficient to challenge China. Indeed, even though graphite mining outside of China may increase, China's dominance in graphite processing will remain unchallenged – it produces/refines 100% of the graphite used for Li-ion batteries.

SILICON

In the future, silicon could be a viable replacement for graphite EV battery anodes because it can absorb ten times more energy. This would dramatically increase the EVs' range; consequently, demand for silicon is expected to increase steadily.

Nevertheless, silicon supply is ample since silica (from which silicon is extracted) is a common compound. Investment into companies conducting R&D into silicon usage in batteries could be highly profitable because efficiency, storage capacity, and range are critical issues facing the viability of EVs.

PHOSPHATE

Lithium-iron-phosphate (LFP) batteries are not new and are characterized by low energy density, but their low cost has made them popular in some markets. However, phosphate's use in the EV industry is predicted to rise, because of developments in LFP battery technologies which will dramatically improve the performance of these much cheaper batteries.

Consequently, LFP batteries, and so phosphate, will play a larger role at the cheaper end of the EV market, particularly in smaller cars, where range is less important. Short-term, China will continue to dominate the phosphate market but if Morocco can utilise its deposits, this could change in the medium term.

RARE EARTH METALS

Rare earth metals are primarily used in EVs for increasing the power of the EV motor, thereby giving it a longer range. Sufficient range is essential to EVs' success, particularly if they are to replace ICE vehicles, such as lorries, used in long-haul transportation.

The rare earth market is currently dominated by China – it controls 90% of world neodymium supply – and this will continue, despite discomfort from the West. However, new players such as Australia, USA, and Angola are trying to increase their market share, and manufacturers like Tesla and BMW are developing EV motors which do not require rare earths. These new ventures could be profitable investments, due to western countries' desire to reduce Chinese dependence, and the EV market's huge expansion.

We believe that rare earth metals will remain crucial to EVs, because of the efficiency of these batteries and the sheer quantities in which EVs must be produced in order to meet net-zero targets. As such, the price of these metals should rise, along with demand.

GLOBAL EV SUPPLY CHAIN

Commodities are, necessarily, the foundation of the EV supply chain. Price, production, and reserves of key components will shape the future EV market. Therefore, countries which control essential commodities, control global EV production. The EU has led the charge in facilitating the rise of EVs, through legislative decisions (e.g., banning new ICE vehicle sales by 2035) and in 2016, the USA announced steps to promote EV usage through collaborative programmes between private and public sectors. China however remains a leader in the EV market.

China's strategy is to dominate the EV supply chain, from mining of raw materials to the manufacture of components. It invests in other countries' commodities reserves, then sends raw materials back to China for processing, before handing processed materials to Chinese companies and factories, for EV production. This almost fully closed supply chain cements China at the centre of the EV market, and we expect this to continue. China's early emphasis on controlling the EV supply chain (particularly in critical commodities), gave it a head start, thereby facilitating continuing market dominance.

It might be argued that exported Chinese EVs will only populate the lower end of the market; however, due to China's dominance of essential commodities and battery component production, we expect to see Chinese technologies, if not their EVs, being utilised on the global market.

MINING REGULATORY FRAMEWORK

The EV and mining industries are linked. Therefore, if key commodities markets are underregulated, so is the EV supply chain. If EVs are to be the sustainable and ethical alternative to ICE vehicles, then the commodities supply chain also needs to demonstrate these qualities.

The exploitation of countries with essential commodities should be a critical concern, as demand for these materials rises. China currently dominates the raw materials market – e.g., it owns or finances 80% of Congolese cobalt mines and controls 90% of neodymium production – and it has long history of poor mining practices. If the ESG aspects of mining practices do not improve, the EV industry risks being little more ethical or sustainable than the fossil fuel industry. Due to there being few binding international mining regulations, the onus is on the mining companies themselves, and their downstream purchasers, to regulate the industry and choose more ethical and sustainable practices.

FOR FURTHER INFORMATION

This paper is the executive summary from a full report which provides insights for investors who seek to understand the opportunities and risks of investing into the mining of critical battery materials for electric vehicles. The full report's research has been complemented through the Firm's existing work in advising major corporations, banks and institutional investors on M&A and financing opportunities in the mining and EV sectors globally. The full report explores in technical detail all aspects of mining for the EV battery value chain, including the scientific and technological innovations, the commercial opportunities and risks and regulatory incentives. The paper covers all key regions globally.

Stirling Infrastructure advises both companies and stakeholders in the mining and EV value chains on debt and equity capital raising and the sale and acquisition of companies and technologies within associated sectors. The firm also provides management consulting services in relation to making strategic investments into mining, battery manufacturing, software development and EV infrastructure.

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