Nickel: The Critical Metal That Will Drive the Electric Vehicle Revolution

sherritt

Late in 2017, nickel prices started an ascent that was driven by a number of factors, including growing demand from traditional applications and declining stockpiles of available supply. Contributing to rising prices and renewed interest in nickel is the emergence of electric vehicle (EV) batteries as a major source of future demand given announcements from carmakers and governments around the world aimed at reducing carbon emissions.

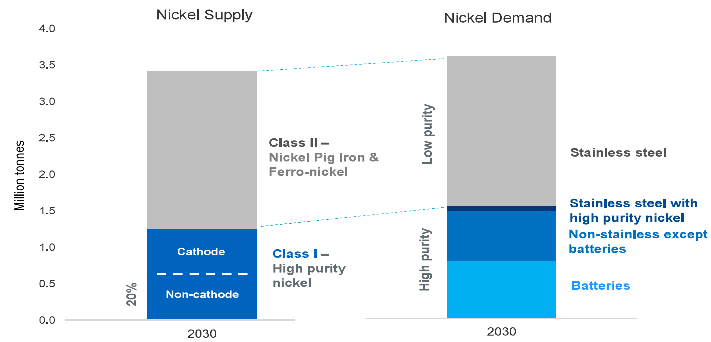
The initial enthusiasm for the EV market may have been overstated and anticipated changes to market fundamentals did not immediately materialize. But starting in the summer of 2020, a number of developments caused many to reassess and increase their demand forecasts for nickel, particularly as EV battery chemistry continues to evolve to take advance of nickel's energy density and storage capacity benefits.

NOT ALL NICKEL IS THE SAME – WHY PURITY MATTERS

Historically, the global nickel market, about 2.3 million tonnes refined annually, is driven by stainless steel production which employs an alloy of nickel, iron and chrome. Stainless steel production remains the primary demand driver for refined nickel and accounts for about 60-70% of the global nickel consumption.

Nickel purity is driven primarily by intended applications. Higher purity nickel is more commonly used in battery technologies, electronics, special alloys and higher grade stainless steel. Nickel with lower purity is primarily earmarked for the production of lower grade stainless steel products.

The International Nickel Study Group (INSG) broadly categorizes nickel into three distinct grades: refined nickel (also known as Class I) which contains >99% purity nickel, charge nickel (also known as Class II) containing <99% purity nickel (examples are ferronickel and nickel pig iron) and chemical which can range in form and purity – examples of which are nickel sulphate (NiSO4) and nickel oxide (NiO).



Source: Wood Mackenzie

Class I nickel

Class I nickel is the highest purity nickel. Sintered nickel briquettes, as produced by Sherritt's refinery in Fort Saskatchewan, Alberta, are well suited for stainless steel, high nickel and other exotic alloys and battery chemical applications. Briquettes are ideal for dissolution applications and foundry applications, due to salient handling characteristics.

Class II nickel

Ferronickel and nickel pig iron (NPI) containing significantly less than 90% Ni (some NPI are as low as 2% Ni), are classified as Class II nickel and represent about 50% of the total nickel supply, which is up from 40% in 2009 based on CRU data. Over the past decade, the ramp up of NPI production to meet the needs of the stainless steel industry has created significant oversupply that had caused a prolonged depression in LME nickel prices as stocks climbed to historically high levels.

The increase in NPI production capacity from virtually zero in 2008 to an installed capacity of over 500,000 tonnes by 2014 (much of which is located in Asia) introduced a market disruption that was not anticipated by the traditional nickel producers. By 2020, NPI accounted for approximately 900,000 tonnes or nearly half of all nickel supply.

The introduction of NPI has had a number of impacts to the nickel market largely as a result of oversupply. The most notable being downward pressure on nickel prices for a prolonged period.

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The effect of low prices and plentiful Class II NPI supply has also forced some high-grade nickel producers to close mines or limit expansion. The substantial and growing supply of NPI feed from Indonesia and the Philippines to smelters in China are combining to produce driving nickel surpluses and a reduced nickel price to a level at which 40% of nickel miners are currently estimated to be losing money on a total cash cost basis.

NICKEL'S INCREASING IMPORTANCE IN EV BATTERY CHEMISTRY

The emerging EV battery market is changing the perception of nickel and the dynamics of the nickel market. Growing market anticipation for the adoption of electric vehicles represents a potential boon for nickel producers.

Nickel is used in a variety of battery applications, notably as the main metal in lithium-ion battery cathodes. High nickel content, is in fact, emerging as the preferred chemistry of lithium-ion batteries.

EV Battery Chemistries

There are essentially five lithium-ion battery chemistries that have been employed to varying degrees in electric vehicle applications. In all cases, lithium is the charge carrier and the anode is typically composed of lithium metal intercalated in graphite. The cathode is the main component that defines the performance characteristics of lithium-ion batteries. The five main cathode chemistries are:

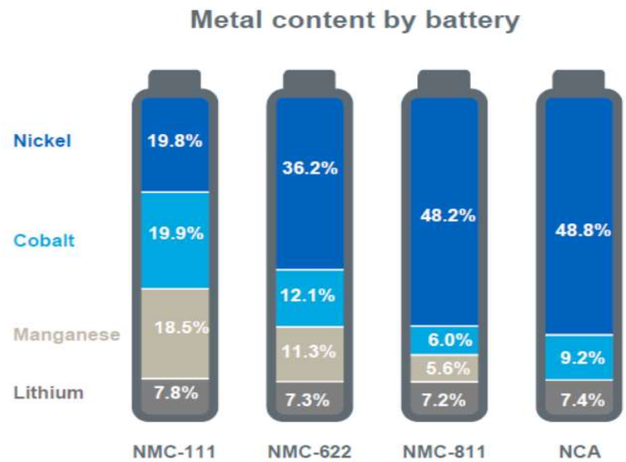
- **NMC – nickel, manganese, cobalt** – Initial NMC compositions contained approximately equal amounts of nickel, cobalt and manganese, commonly designated as NMC 111; however, due to high costs and supply uncertainty for cobalt, NMC battery production is gradually migrating to lower and lower levels of cobalt, NMC 622 and ultimately NMC 811 could become the standard. The NMC 811 formulation is expected to provide an optimal mix of cost, performance, safety and reliability.

- **NCA – nickel, cobalt, aluminum** – has comparable costs, higher energy density and acceptable stability compared to NMC formulations. Interestingly, NCA formulations already have a nickel content above 80% with significantly reduced cobalt content.

- **LFP – lithium iron phosphate** – has a good safety profile and an adequate energy density which make this a good candidate for short range EV applications. For example, Chinese manufacturers adopted this chemistry for bus applications.

- **LCO – lithium, cobalt oxide** – this is the original lithium-ion battery chemistry first introduced by Sony and adopted by the consumer electronics industry. However, the high cobalt content impacts its economic use in EVs.

- **LMO – lithium, manganese oxide** – highly reliable and cost effective, it was used extensively in early EVs (e.g. Nissan Leaf); however, due to its low energy density, it has been surpassed by the NMC, NCA and LFP formulations.



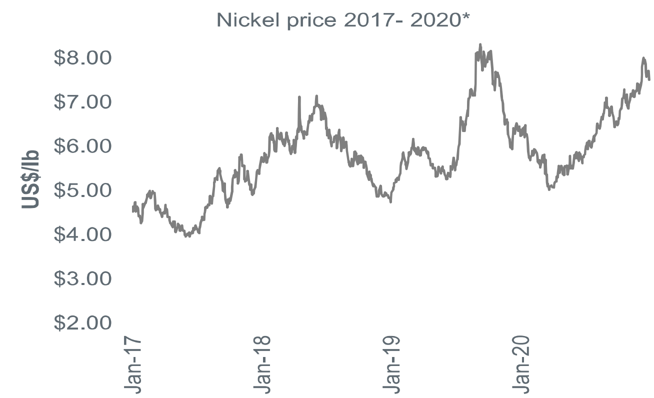
NMC is steadily becoming the dominant cathode chemistry for high performance EV batteries. Although Tesla currently uses NCA in its models, it may deploy NMC or some other chemistry in the future. The NMC 811 formulation is considered promising due to its relatively low cost, competitive energy density, projected stability and the potential to sustain a high charge-discharge cycle count. These factors are expected to translate into affordability, reliability and longer vehicle range. However, the NMC 811 formulation must undergo further refinement to confirm safety, durability and overall performance before it will be widely adopted.

LONG-TERM NICKEL OUTLOOK IS STRONG

The nickel market has seen significant volatility over the past couple of years. Total inventories held at the LME and Shanghai warehouses have seen significant fluctuations since the beginning of 2017 (470,000 tonnes) reducing to 90,000 tonnes in late 2019 as companies appeared to be stockpiling nickel for the expected EV battery demand. Restocking of nickel inventories and oversupply largely driven by the market impacts of COVID-19 in 2020 have returned inventory levels to what appears to be a near-term levels of approximately 250,000 to 300,000 tonnes.

Current inventory levels are impacted, in part by the COVID-19 pandemic, which has caused a slowing of demand in the traditional markets (stainless steel) and a delay in the expansion of the EV markets as countries deal with the pandemic. The long-term market fundamentals continue to point to supply deficits as countries continue to implement their EV strategies which are a significant component of their climate change strategies.

Prices, too, have been volatile. While not always following the supply-demand relationship and inventory fluctuations, prices have trended upwards since the beginning of 2017 – an increase of about 60% to the end of 2020.



*Source CIQ

Ethical and responsible supply

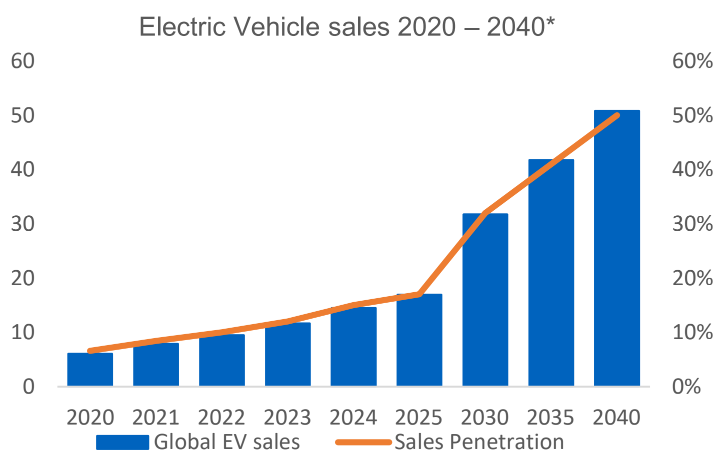
The aspiration for EV producers to source materials responsibly has provided additional motivation for shifting battery chemistries from cobalt to lower priced nickel. Cobalt production is prone to supply shortages, severe price fluctuations and a dependence upon one major geographical supplier.

While many suppliers produce cobalt ethically and responsibly, including Sherritt, the industry is actively pursuing reforms where concerns exist. The Democratic Republic of the Congo, for example, which provides approximately 60% of the world's cobalt, has a cobalt mining history fraught with ethical uncertainty, including the use of child labour and the funneling of proceeds to criminal organizations.

EV Battery Market

The projected rapid growth in light electric vehicle adoption will be a benefit to Class I nickel producers. While it is expected that OEM manufacturers will implement a number of cathode chemistries, depending on the intended application of the vehicle, NMC formulations will have an important role in the mix.

The increased nickel and reduced cobalt compositions will offer significant benefits in terms of cost and energy density over current NMC formulations. A projected EV production of 15 million units in 2025 will add between 300 000 and 900 000 tonnes per year of incremental nickel demand, which represents an increase of between 10 and 40% in refined nickel demand. This increase could position EV demand for nickel alongside that for stainless steels in terms of absolute consumption. The large range in projected demand is due to uncertain information regarding the choice of lithium-ion battery chemistries (NMC or NCA) and the specific formulation of the cathodes; for example, the amount of nickel can vary from approximately 30% to in excess of 80%.



*Source Bernstien, March 2020

The growth in EV production is being driven by several powerful factors: government regulatory policies, geopolitical concerns over supply security and consumer pull. Governments around the world are creating policies meant to foster innovation and help lower costs for the transition to electric vehicles.

At the same time, governments are providing incentives for manufacturers and consumers in the form of tax credits and consumer subsidies, amongst other initiatives. Countries that have imposed some form of deadline for the transition or adoption of electric vehicles include China, India, France, Germany, the UK, Norway and the Netherlands. This represents what could be considered the "leading edge" of the transition to light-vehicle electrification.

India, for example, has pledged to have electric vehicles comprise 40% of all vehicles on its roads by 2032. The most populous countries, China and India, see electric vehicles as a way to reduce pollution and air-borne particulate matter within their cities, thus leading to a healthier environment. China, in particular, is focused on leading the transition to electrified vehicles. China intends to put a cap on carbon emissions across multiple industries, implement stricter emission control requirements on automobiles and ultimately end the sale of gasoline- and diesel-powered cars.

> ***"nickel producers will struggle to increase the supply of Class I material that is suitable for battery applications"***

Many industry observers see this as the tipping point in EV evolution, as China is now the world's largest car market, having overtaken the United States in 2006. The automotive industry has gradually embraced the call, especially since the 2015 "Dieselgate" scandal, and is developing electric vehicles with longer battery life and increased driving range, while also helping to build the infrastructure for long-distance transport.

In the near future, it is anticipated that nickel producers will struggle to increase the supply of Class I material that is suitable for battery applications. At the outset, current producers will have to increase capacity, which will require an expansion of existing resources; many of which are facing declining grades. Further out, new investment will be necessary, which will require favorable economics. It will be very difficult for the traditional nickel industry to meet increased future demand unless the incentive price of nickel increases dramatically relative to the last decade.

The industry is faced with limited options to expand capacity. These options include the following:

- Exploitation of lower quality laterite ores that have lower nickel grades along with significant amounts of other metal contaminants that make processing more complex and more expensive. At present, high pressure acid leaching (HPAL) is the process of choice for the extraction of nickel from low grade limonitic laterite ores. In its present state of development, HPAL technology may not be able to economically process lower quality ores.

- Exploitation of additional sulphide ore bodies. It is estimated that about 40% of current nickel reserves are sulphides. However, many commercially viable ore bodies have already been depleted and those that remain are complex.

An alternative option is to implement a disruptive extraction and refining technology that is amenable to the production of nickel sulphate from complex, low nickel grade laterite ores. Currently, there is a race between traditional nickel producers and the Chinese nickel industry to introduce technology that will reduce the incentive cost of nickel sulphate.

The recent announcement to produce high-purity nickel from matte, a low-purity intermediary nickel produced from laterites is a case in point. While the process is not innovative, its wide spread use has limited due to additional refinement cost considerations and the high carbon emissions the smelting process produces.

IMPLICATIONS FOR INDUSTRY PLAYERS

The key determinants for the future of nickel miners and refiners will be the extent of electric vehicle adoption, the choice of battery technology and the ability of miners to provide supply in an ethical and sustainable manner. Electric vehicle adoption will depend on government policies and incentive targets, future battery costs, charging infrastructure, consumer references and the will of leading automotive manufacturers to invest in the value chain.

Nickel miners face a significant capital outlay should they invest in Class I nickel production with marginal economics based on today's prices. Currently, nickel sulphate demands a premium of about 15% over the Class I nickel price on the London Metal Exchange. However, much of this premium is absorbed into the increased cost of producing nickel sulphate.

Nickel sulphate is primarily produced from the dissolution of briquettes and powders. Of the approximately one million tonnes of refined Class I nickel that is produced annually, only 350,000 tonnes is in the form of briquettes, powder and what is considered chemical grade nickel.

All of Sherritt's nickel and cobalt production is in the form of briquettes and powder, representing approximately 35,000 tonnes of nickel on a 100% basis. Sherritt pioneered the production of briquettes and all current nickel and cobalt briquette production around the world is based on Sherritt's technology. Sherritt is a world leader in this field and continues to develop improved products and processes which can meet current and future needs of our customers.

Battery manufacturers and OEMs will need to work together to develop a sustainable supply of Class I nickel if they are to protect themselves from price fluctuations and material shortages; this ought to lead to greater investment in Class I nickel.

ABOUT SHERRITT

Sherritt is a world leader in the mining and refining of nickel and cobalt from lateritic ores with projects and operations in Canada and Cuba. The Corporation is the largest independent energy producer in Cuba with power operations across the island. Sherritt licenses its proprietary technologies and provides metallurgical services to mining and refining operations worldwide. The Corporation's common shares are listed on the Toronto Stock Exchange under the symbol "S".

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