William Blair

EMERGING MARKETS DEBT

Investment Management
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# Rise of Electric Vehicles:
## Impact on Commodities and Emerging Markets

Metals have often been crucial in the advancement of societies and modern living standards. With most metals sourced from emerging market (EM) countries, their impact to these economies is indisputable. In this paper we explain how demand drivers stemming from electric vehicles (EVs) and their infrastructure could impact the utilization of several metals and the countries from which they are sourced.

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# Introduction

According to the International Energy Agency (IEA), transportation emissions account for almost one-fourth of direct $CO_2$ gases released into the atmosphere[1]—and vehicles are responsible for three-fourths of these emissions, thus making them one of the key focus areas of regulatory efforts on climate change.

Governments around the world have set optimistic targets to cut greenhouse gas emissions in an effort to reduce pollution. Tax benefits, grants, and outright bans on internal combustion engine vehicles aim to promote the transition into cleaner transportation. While consumers are being incentivized to switch to less polluting automobile alternatives there is also an undeniable grassroots sentiment by individuals to reduce their environmental impact.

Under its New Energy Vehicle (NEV) 2021-2035 strategy, released in November 2020, China plans to increase penetration of EV sales to 20% of total new vehicles by 2025. In the same month, U.K. Prime Minister Boris Johnson announced a ban on new petrol and diesel cars from 2030 as part of the country's green plan. The European Union (EU) will aim to increase EV stock to 30 million cars on the road by 2030, up from 1.4 million currently, while also effectively banning internal combustion engine auto sales by 2035. And recently, U.S. President Joe Biden set a target that 50% of the vehicles sold in the country should be EVs by 2030.

The push toward EVs and their infrastructure supports the demand for several metals, and we believe a number of metals we call commodities of the future—lithium, nickel, aluminum, and copper—are well positioned to benefit from this demand surge.

Although mining is perceived to have negative environmental consequences, nowadays there are ways to reduce the environmental impact of the extraction of minerals. Companies are striving to improve the sustainability of their operations by switching to renewable energy sources and recycling water.

1 "$CO_2$ Emissions from Fuel Combustion 2020," International Energy Agency (IEA).

# Electric Vehicles

There are several types of EVs. Battery EVs (BEVs) are fully electric with rechargeable batteries and no gasoline engine. Plug-in hybrid EVs (PHEVs) can be recharged by plugging into an external energy source or by their internal engines. Fuel cell EVs (FCEVs) generate power through oxygen and compressed hydrogen. Conventional hybrids (HEVs) combine an internal combustion system and electric propulsion to improve efficiency. Exhibit 1 illustrates.

In 2020 the global EV car stock hit 10 million units, soaring 43% over 2019 numbers.[2] In the EU, 54% of all car registrations were EVs in 2020. While forecasts vary, we believe there is a clear trend in favor of EVs, and we believe EVs should continue to gain market share in the near term.

### Lithium: Elemental for EV Battery Production

The rise of EVs is likely a major reason for the surge in demand for lithium, a key component of lithium-ion batteries. Bloomberg estimates that lithium demand from batteries will increase fivefold from 2021 to 2030.[3] S&P expects lithium demand from all uses to triple by 2025 to almost 1.5 million metric tons.[4]

2 Global EV Outlook 2021, International Energy Agency (IEA).
3 BloombergNEF.
4 "Lithium Supply Is Set to Triple by 2025. Will it be Enough?" S&P Global Platts, October 2019.

EXHIBIT 1

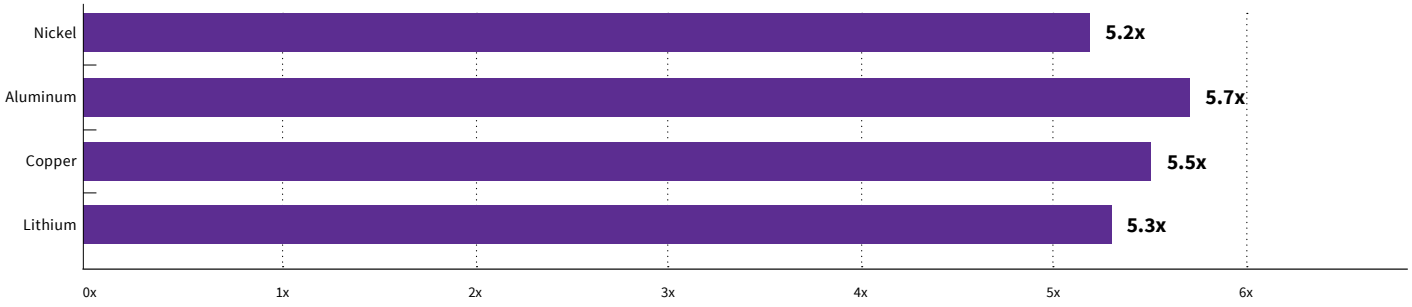
## Types of Electric Vehicles

| | Battery EV (BEV) | Plug-in Hybrid EV (PHEV) | Fuel cell EV (FCEV) | Conventional hybrid (HEV) |
|---|---|---|---|---|
| **Power Source** | Electric Battery | Gasoline/Diesel and Battery (plug in) | Hydrogen | Gasoline/Diesel and Battery (Charged from Engine) |
| **Average Battery-Only Range** | 181 Miles | 26 Miles | 300-Plus Miles | N/A |
| **Estimated Cost of Ownership by 2025** | €33.2K | €34.3K | €44.6K | €33.7K |

Sources: U.S. Department of Energy, Newmotion by the Shell Group, European Consumer Organisation. Cost of ownership is from "Electric Cars: Calculating the Total Cost of Ownership for Consumers" Element Energy, for The European Consumer Organisation, as of April 25, 2021. The cost is an estimation for a medium car bought new in 2025 and includes depreciation, VAT, fuel, electricity, insurance, and maintenance.

EXHIBIT 2

## Expected Increase in Metal Demand from Lithium-ion Batteries, 2021 to 2030




Source: BloombergNEF, as of 2021.

## "As is the case with other metals, EMs play a pivotal supply role in lithium"

**Alexandra Symeonidi, CFA**

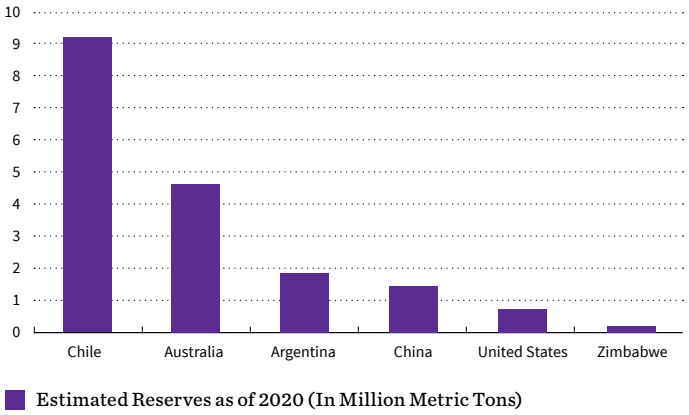
More than 90% of lithium supply is mined as primary product in hard ores. Total global reserves are estimated at 21 million metric tons in 2020, 23.5% higher than they were in 2019 due to continuing exploration of the soft metal. As is the case with other metals, EMs play a pivotal supply role.

Although about 50% of mined lithium currently comes from Australia, most known reserves are in Chile. In fact, more than 40% of world reserves are found in Chile. As the country continues to turn reserves into production, its lithium exports should increase, affecting its trade balances. This is already beginning to occur: Chilean lithium exports were almost four times higher in 2020 than they were a decade ago.[5] Although country resources shown in exhibits 3 and 4 are measured in metric tons of lithium compounds, the countries below report in lithium carbonate equivalent, which is a metal with very high lithium content.

5 Banco Central de Chile.

EXHIBIT 3

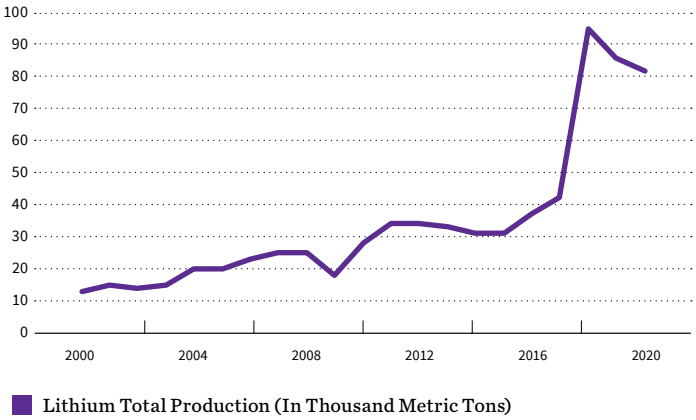
### Chile Dominates in Lithium Reserves




Source: U.S. Geological Survey (USGS), as of 2021.

EXHIBIT 4

### Global Lithium Production Has Spiked Over the Past 3 Years




Source: USGS, as of 2021.

Over the past few years, companies have invested in Chile given the country's vast lithium reserves. In late 2018, China-based Tianqi Lithium, one of the largest hard rock lithium producers in the world, acquired roughly 24% of Sociedad Química y Minera de Chile (SQM).

Moreover, companies in the sector have set aggressive targets to increase production to meet expected demand. Tianqi Lithium, for example, produced more than 70,000 metric tons of lithium carbonate, comprising about 21% of total global supply, in 2020, and its production is expected to grow 70% in 2021. SQM, another significant player in the market, increased lithium production by 43% in 2020 to 64,600 metric tons, comprising about 20% of global supply. Production is expected to increase by another 47% in 2021. SQM expects lithium carbonate demand to grow from 330,000 metric tons in 2020 to 900,000 to 1,000,000 metric tons in 2025.

Lithium-ion battery technologies, such as the EVs themselves, are diverse. Depending on end-use, they are produced with a number of other metals and new technologies keep changing. Lithium, nickel, and cobalt are the most common elements of EV battery production, although they can also include manganese, titanate, and iron. Exhibit 5 illustrates.

### Nickel: High Grade, High Demand

Nickel is also experiencing demand from EV batteries because it helps deliver higher energy density and greater storage capacity. The very common NCA batteries for EVs, for example, are 80% nickel.

Indonesia is the world's largest producer of nickel, comprising up to 30% of global nickel supply in 2020, according to USGS estimates.[6] In January 2020, Indonesia enacted a two-year nickel export ban to help accelerate the construction of new smelters and preserve nickel resources. The decision will allow Indonesia to process nickel domestically and potentially benefit from an upcoming demand surge in the metal.

The second and third largest nickel producers are the Philippines and Russia, with approximately 13% and 11% of total global nickel supply, respectively.

6 USGS, 2021.

EXHIBIT 5

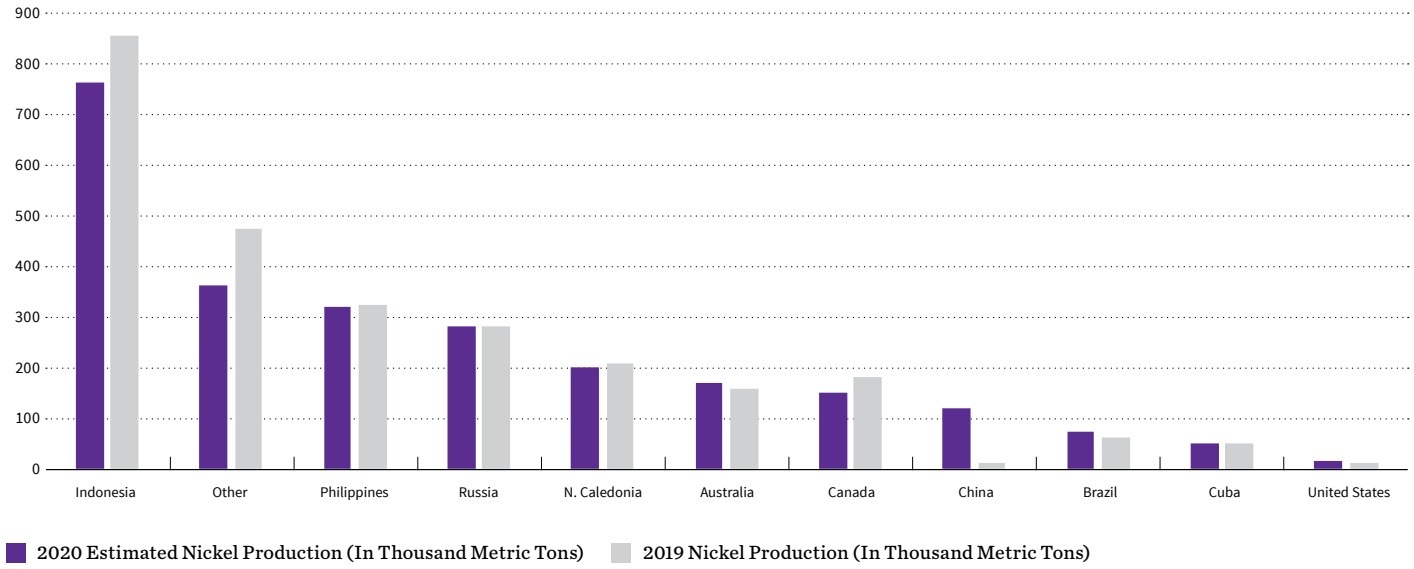
## Lithium-ion Battery Technology Uses and Advantages

| | Lithium, Cobalt, Oxide (LCO) | Lithium, Nickel, Cobalt, Aluminum, Oxide (NCA) | Lithium, Nickel, Manganese, Cobalt, Oxide (NMC) | Lithium, Manganese, Oxide (LMO) | Lithium, Titanate, Oxide (LTO) | Lithium, Iron, Phosphate (LFP) |
|---|---|---|---|---|---|---|
| **Uses** | Portable Electronics | EVs, Electronic Devices | Most Common Among EVs | Medical Applications, Electric Bikes | EV Production, Energy Storage | EVs, Electric Motorcycles |
| **Main Advantage** | Smaller Volume | Higher Capacity | Lower Cost | Safer | Fast Charge | Long Lifecycle |

Source: William Blair, as of June 2021.

EXHIBIT 6

## Indonesia Accounts for 30% of Total Nickel Production




Source: USGS, as of 2021.

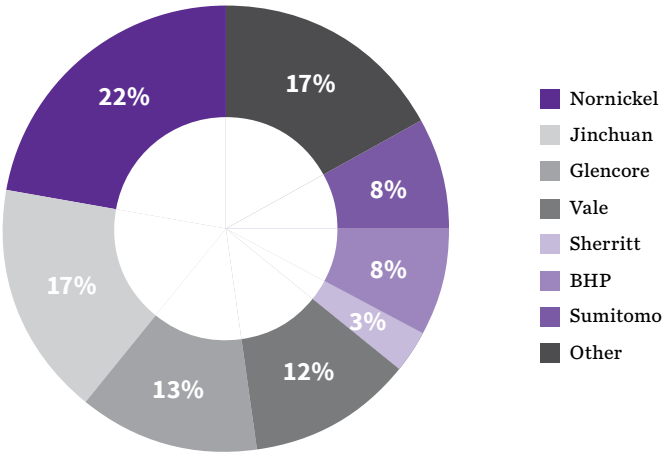
As with all metals, nickel quality (grade) varies. In the construction of EV batteries only high-grade nickel is used. But the high-grade nickel market is very concentrated. As shown in exhibit 7, seven companies accounted for 83% of total supply in 2020.[7] The largest high-grade nickel supplier in the world is Russia's Norilsk Nickel, which had a 22% market share in 2020, followed by the Chinese Jinchuan Group, with 17% market share in the same year. Brazil's Vale accounted for 12% of total market share in 2020.

Companies have long recognized the potential demand surge for nickel due to EVs and related infrastructure and are committed to increasing supply to the market. Norilsk Nickel, for example, has a strategic ambition to increase nickel production up to 17% from 2020 to 2030. Vale, meanwhile, plans to boost nickel production 20% from current production levels by 2025.

7 Nornickel annual report, December 2020.

EXHIBIT 7

## High-Grade Nickel Production Is Concentrated




Source: Nornickel annual report, as of December 2020.

### Solving the Weight Problem: Aluminum

While battery technology certainly differentiates EVs from conventional vehicles, it also makes vehicles heavier. Replacing steel parts is one way to reduce vehicle weight and improve energy efficiency. Aluminum, a lightweight but strong and malleable metal, is a good substitute for certain steel components and can help reduce the vehicle's overall weight.

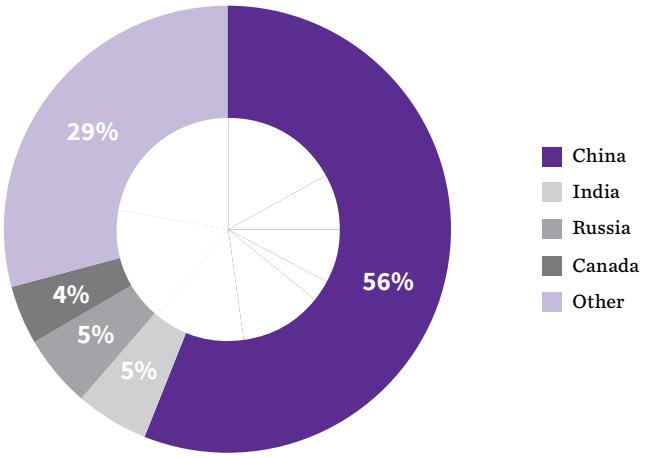
Although aluminum is more expensive than steel per metric ton, EV automakers have been increasingly using the metal, particularly for battery, motor housings, and body structural components, as they transition to multi-metal vehicles. Mexico is the fifth largest producer of auto parts in the world, primarily serving the all-important U.S. auto market. We believe its auto components industry is well poised to benefit from the rise in lightweight auto parts.

China dominates both the supply and demand of aluminum. In 2020, China produced about 37 million metric tons, according to USGS estimates, which is about half of the total global aluminum supply. China has also increased its share of global aluminum production capacity from 11% in 2000 to almost 60% currently. This increase has at times created oversupply and depressed prices. However, Chinese consumption has also grown due to urbanization, economic growth, investments in infrastructure and real estate, and, most recently, the focus on EVs.

The largest aluminum producers in the world are based in China. Aluminum Corporation of China Limited (Chalco) and Hongqiao Group are the largest producers of primary aluminum globally. Chalco is 32% owned by Aluminum Corporation of China, which is a state-owned and strategic company for China. Russia's United Company Rusal is the third largest primary aluminum producer globally, accounting for 6% of global production in 2020. It believes aluminum is the way to more sustainable industries and sees demand spiking in the coming years.

EXHIBIT 8

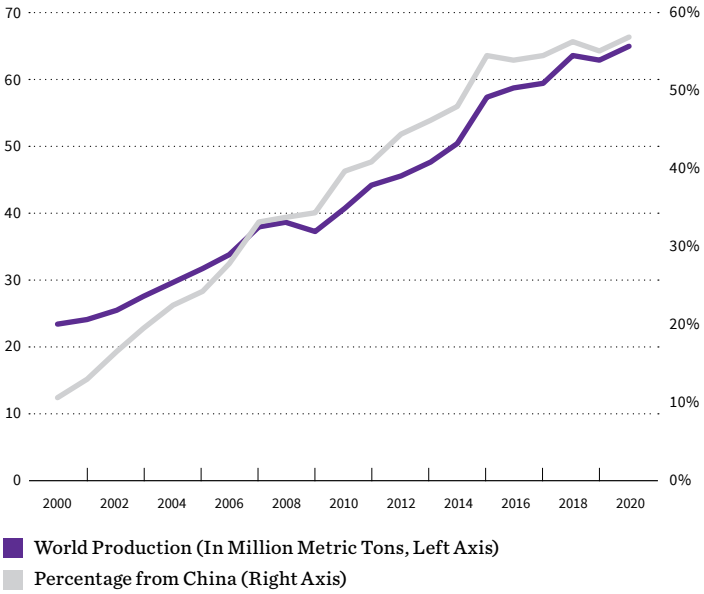
China Accounts for More Than Half of the World's Aluminum Capacity




Source: USGS, as of 2021. Shows 2020 estimated aluminum capacity, in thousand metric tons.

EXHIBIT 9

China Increased Aluminum Production From 11% in 2010 to 57% in 2020s




Source: USGS, as of 2020.

# EV Infrastructure

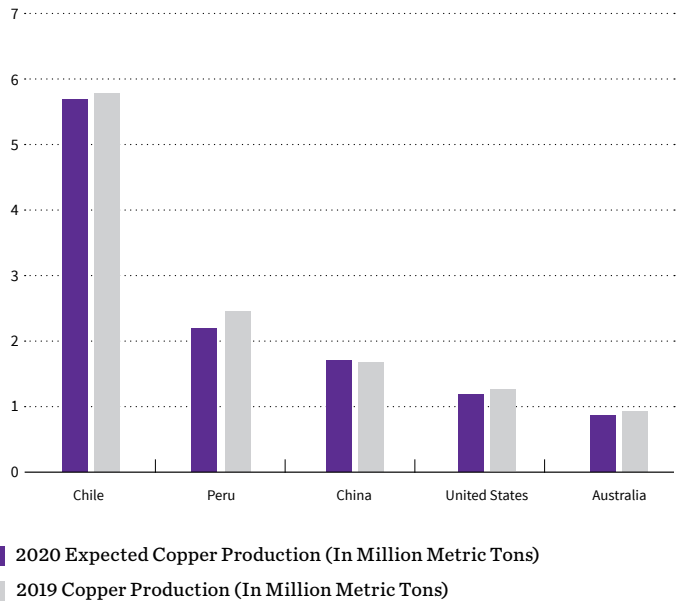
Regardless of the type of EV or its components, all EVs need charging stations, and the growth of EVs on the roads requires proportionate growth in charging stations worldwide.

The lack of charging stations is cited to be the first barrier for EV adoption in company fleets by members of EV100, an initiative that brings together companies committed to switching their fleets to EVs and installing charging infrastructure for employees and customers by 2030.

Unlike internal combustion vehicles that can only be fueled at gasoline stations, EV owners have several options for charging: at home, at work, or at public stations. Public charging stations are particularly important in the EV rollout as they provide autonomy and flexibility to EV drivers. In 2020, public charging stations grew 46% year-over-year to 1.3 million units, of which 30% were fast chargers.[8]

EXHIBIT 10

## Chile and Peru Dominate Global Copper Mining




Source: USGS, as of 2021.

China is home to the largest network of charging stations worldwide. In 2020, about 800,000 out of the total 1.3 million public charging stations, or 62%, were in China.[9] And China has been building public charging stations at a very fast pace, with Chinese public charging stations growing 55% year-over-year in 2020.

We believe charging station investments are set to grow around the world. For example, the EU targets 1 million charging stations by 2025 as part of its European Green Deal Investment Plan, a significant increase from the roughly 290,000 public charging stations in the EU currently (just 13% of which are fast charge). The target might sound optimistic, but industry experts, such as the European Automobile Manufacturers' Association (ACEA), are pushing for 1 million charging points by 2024 and 3 million by 2029.

The United Kingdom's Committee on Climate Change suggests 1,170 charge points will be required per 100 kilometers of road by 2030, but in 2019 there were just 570 charge points per 100 kilometers of road. The government's 10-year green plan includes an investment of £1.3 billion for charging stations to address this future need.

Meanwhile, the U.S. administration is planning to build 500,000 charging stations in the next few years. That's up significantly from the 100,000 public charging stations that existed in the United States in 2020, of which just 17% were fast charge.

### Copper: EV Infrastructure Gives Doctor Copper a Facelift

Copper is sometimes viewed as being so critical to the world that it can be referred to as Doctor Copper because its ability to predict economic turning points suggests it has a Ph.D. in economics.

Copper is likely to benefit from EV infrastructure investments due to its heavy use in vehicles and charging stations. It has excellent electrical conductivity and is durable, allowing it to endure extreme temperatures. These properties make copper ideal for wiring and other electrical applications.

8 BloombergNEF.
9 Global EV Outlook 2021, International Energy Agency (IEA).

In addition, an EV contains three to five times more copper than a conventional one. The International Copper Association (ICA)[10] predicts that more than 250,000 metric tons of copper per year will be consumed as a result of the higher stock of EVs in 2030, from about 80,000 metric tons currently.

The world's largest copper producing country is Chile, with about 29% of global copper mine supply. Peru and China are the second and third largest producers of mined copper, accounting for 11% and 9% of global supply, respectively. On the consumption side, China is also the largest consumer of copper, accounting for almost 60% of global demand as of March 2021.[11]

Although China is a diverse economy exporting a variety of goods, Peru and Chile's exports are more concentrated. Copper exports constituted 56% of the total value of Chilean exports[12] from January to May in 2021 and 32% of Peruvian exports[13] from January to April 2021, highlighting how important copper is to these countries.

### Copper Mines: Mostly Located in EMs

As a top holder of the world's reserves, Chile is home to a number of copper producers as well as the world's largest mine, La Escondida, which alone accounts for about 5% of world production. The largest global producer is Corporacion Nacional del Cobre, Chile's national copper mining company, with 1.6 million metric tons in 2020, approximately 8% of global production. At a smaller scale, Antofagasta, which recently had its debut issuance in the EM corporate universe, is producing an equivalent of 4% of global supply.

Southern Copper Corporation is the world's fifth largest copper producer, with operations in Peru and Mexico. In 2020 the company produced about 1 million metric tons of copper, which is about 5% of global supply.

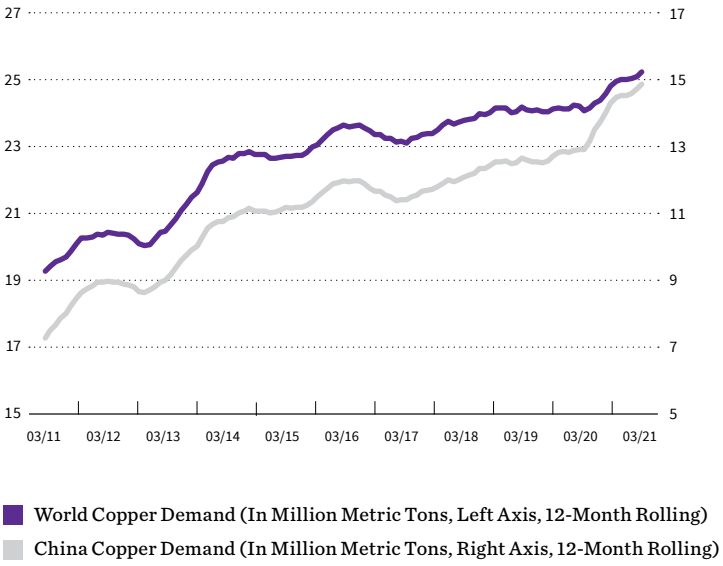
> "An EV contains three to five times more copper than a conventional one."
>
> **Luis Olguin, CFA**

First Quantum Minerals (FQM), which is a copper miner operating primarily in Zambia and Panama, produced an equivalent of 4% of global supply last year. The company increased its copper output by 40% as the Cobre Panama mine has recently fully ramped up. Cobre Panama is one of the largest copper mines in the world, and FQM is one of the few companies in the industry to bring such large projects online recently.

**10** "EV motors boost copper demand", International Copper Association, March 2020.
**11** Bloomberg data.
**12** Banco Central de Chile.
**13** Banco Central De Reserva Del Perú.

EXHIBIT 11

## China Now Accounts for 57% of Global Copper Demand




Source: Bloomberg, as of June 2021.

# ESG Considerations: The Canary in the Metal Mine

Developed markets and EMs alike are joining the UN's "Race to Zero," committing to achieving net-zero carbon emissions by 2050 at the latest. Governments around the world are mapping out sizable investment plans earmarked for transition to more sustainable economies. For example, the European Green Deal Investment Plan, set forth by the EU, stated it will mobilize at least €1 trillion in sustainable investments over the next decade.

As industrialized economies look to transition to a sustainable future, they will need to make investments in infrastructure, which, apart from government commitments, will need resources and materials. In this regard, mining or recycling and reusing metals is necessary.

From an environmental, social, and governance (ESG) perspective, mining for metals can be a controversial topic requiring in-depth exploration.

On one hand, mining can have adverse environmental consequences; it often requires large surface areas, potentially damaging biodiversity, and processing can cause high emissions as well as water and soil pollution. On the social side, employee safety and working conditions have been an increasingly important topic for mining companies to address.

However, mining can have positive externalities as well. In many EM countries mining is a source of employment, providing higher income to communities, thereby contributing to higher standard of living. Mining also attracts foreign direct investments (FDI). Both those externalities contribute to higher social standards.

Like many industries, the mining industry is evolving. The European Copper Institute found that the copper industry reduced $CO_2$ emissions by 60% from 1990 to 2020 by investing in efficiency and reducing energy consumption. But the green initiatives have just started: nowadays, mining of "green" metals (which are metals produced with renewable energy sources and sustainable practices) is a new way to address emissions in the sector.

Low-carbon aluminum is one example of a green metal. Produced using mostly renewable energy sources such as hydropower, it typically emits about four metric tons of $CO_2$ equivalent per metric ton of aluminum produced. This is roughly three times below the industry's global average emission rate of 11 metric tons of $CO_2$ equivalent per metric ton of aluminum produced. Recently, a different labelling[14] but also trading[15] of the metal has been discussed, highlighting the focus on sustainable mining.

Companies have also been introducing low-carbon nickel, which will emit less than four metric tons of $CO_2$ equivalent per metric ton of nickel equivalent produced. This is a substantial reduction from the global industry average of 29 metric tons of $CO_2$ equivalent per metric ton of nickel equivalent produced.

So, while mining can have a sizable environmental footprint, metals extracted by mining companies are crucial to transition to cleaner economies and address climate change. The overall cost or benefit of mining to economies and societies will depend on how companies, investors, and consumers adjust and contribute to the world transition to a sustainable future.

**14** "Green aluminum needs common standard, labeling plan: Carbon Trust, Reuters, June 2020.
**15** "London Metal Exchange plans 'low-carbon' aluminium trading", Financial Times, June 2020.

# Conclusion

In conclusion, the push toward EVs and their infrastructure supports the demand for several metals, and we believe the "commodities of the future" are well positioned to benefit from this demand surge. And because all those metals are primarily produced in EM countries, EMs have a pivotal role to play in the transition to green transportation, in our view.

> "While mining for these metals is perceived to have negative environmental consequences, companies are aiming to improve the sustainability of their operations."

**Alexandra Symeonidi, CFA**

Specifically, lithium is a key component of the lithium-ion batteries used in EVs, and Chile owns the world's largest lithium reserves. The NCA batteries commonly used in EVs are 80% nickel, which is mostly produced in Indonesia, the Philippines and Russia. Aluminum, meanwhile, can replace some steel components in EVs, offsetting increased weight from the aforementioned battery technologies, and China is supplying more than half of the world's aluminum needs. Lastly, copper could also benefit from EV infrastructure investments due to its heavy use in vehicles and charging stations, and Chile and Peru have been global leaders in copper production for many years.

While mining for these metals is perceived to have negative environmental consequences, companies are aiming to improve the sustainability of their operations in part by switching to renewable energy sources and recycling water.

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