Sector Thoughts

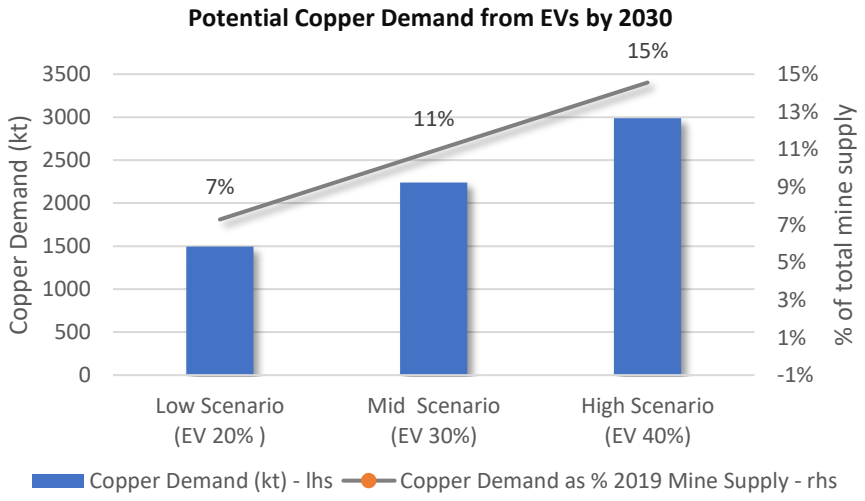
A Primer on Copper

De-carbonisation and the demand for copper

The demand for copper has traditionally been linked to industrialisation and a guage of the econonic health of the global economy. Copper is now central to the global pursuit of de-carbonisation and tackling climate change. We estimate the additional copper demand from EVs and charging infrastructure could be over c.3,000 kts by 2030 which is over 15% of total mine supply

- In 2019 global electric-light-vehicle (EV) sales comprised 2.5% of all light vehicle sales. By 2030 this is expected to increase to between 26% and 40%
- EVs use on average 84kgs of copper per vehicle compared to c.23kgs for an internal combustion engine car. Future EVs are estimated to require increasingly higher amounts of copper, potentially over 160kgs per vehicle
- We estimate the additional copper demand from EVs and charging infrastructure to be in the range of c.1,500 kgs to c.3,000kgs by 2030. This would amount to between 7% and 15% of 2019 global copper supply
- An increase in copper demand of up to 3,000 kgs would be twice that of total annual production of the world's largest copper mine (Escondida) which currently produces c.1,400 kgs per year
- The additional demand from EV charging infrastructure and from the wind and solar energy sectors, the pursuit of global de-carbonisation is set to have a major impact on copper demand
- Given the limited number of copper discoveries in the past ten years and the time it takes to bring discoveries to production, we expect the demand and supply conditions to remain tight for the foreseeable future

Copper Demand and EV sales as a percentage of total vehicle sales



Source: ICSG, SEAL Advisors

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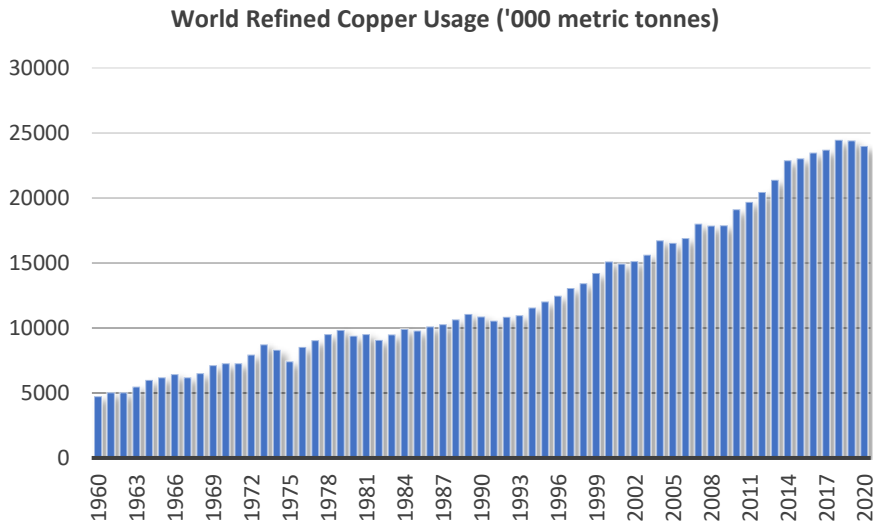
De-carbonisation and the demand for copper

Copper is synonymous with the de-carbonisation agenda

With the highest electrical conductivity rating of all industrial metals, as well as being eminently ductile, copper plays a key role in electrification which in turn is synonymous with technological progress and economic development. Worldwide usage of refined copper has grown at a CAGR of 3.4% since 1900, and at a CAGR of 2.8% since 1960. More recently, China's emergence as a global economic power has significantly augmented copper demand, with China now accounting for c.50% of global copper consumption.

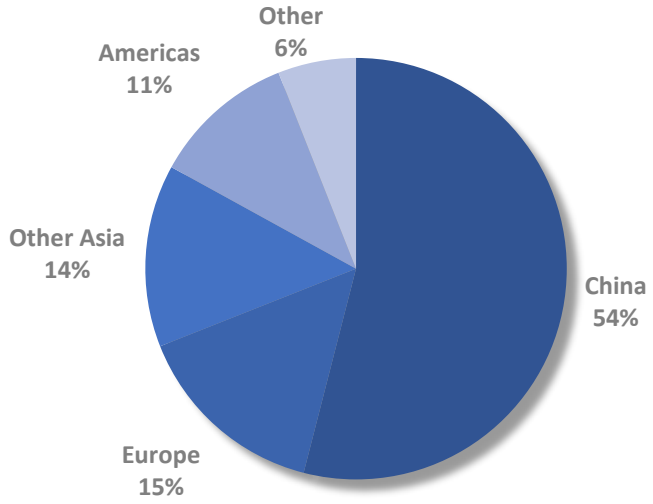
Figure 1: World Refined Copper Usage 1960 to 2020



Source: Statista, IEA

China is the biggest consumer of copper

Figure 2: World Consumption of Refined Copper by Region, 2020



Source: Statista

In addition to its key historic role in industrialisation and economic development, copper has emerged as a crucial metal in the shift towards de-carbonisation. The Paris Agreement (2016) aims to keep a global temperature rise this century to "well below 2 degrees Celsius", and to pursue efforts to limit the temperature

increase even further to 1.5 degrees Celsius. It is estimated that for the core objective of the Paris Agreement to be achieved, a 70% reduction in carbon emissions would be required. Widespread adoption of renewable energy and electrification is crucial to achieving these goals. In order to make this shift from an economy run predominantly on fossil fuels to one run mainly on renewable/low carbon inputs necessarily entails increased usage of copper given the latter's role in electrification. The principle use for copper in this transitioning economy are to be found in electric vehicles (and their associated charging infrastructure), as well as wind and solar energy. In many respects, the 'red metal' is increasingly being viewed as a 'green metal' given its role in move to carbon neutrality.

Electric Vehicles

Electric vehicles expected to make up c30% of total sales by 2030

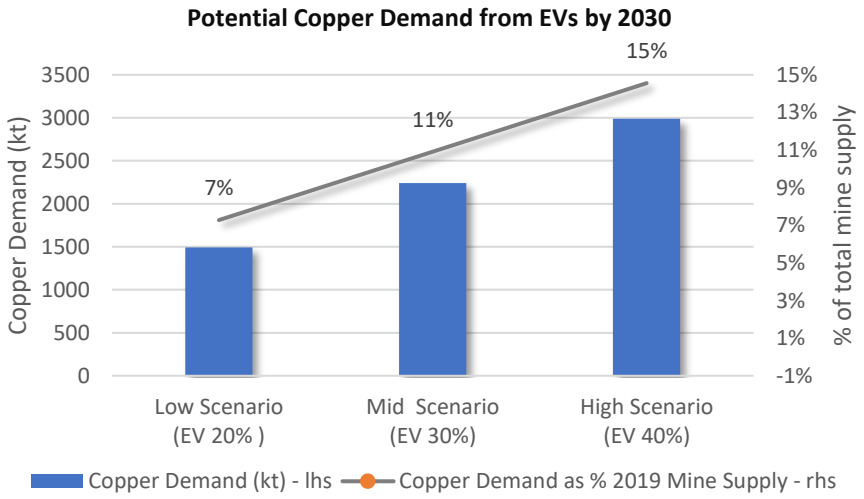
In 2019 global electric-light-vehicle (EV) sales comprised 2.5% of all light vehicle sales. In 2020, the global EV sales share increased to 4%. Few would argue that EV penetration is set to rise significantly over the next decade given environmental concerns, government policy and improving EV charging infrastructure. Currently there is a relatively wide range of forecasts for the predicted penetration rates of EV sales by 2030 ranging from 26% by IHS Markit to over 32% predicted by Deloitte and up to 40% in various industry reports.

The significance of EVs for copper demand is that a (battery electric) EV uses on average 84kgs of copper per vehicle. This compares to c.23kgs for an internal combustion engine (ICE) car. Hence, an increasing EV sales penetration rate will result in significant incremental demand for copper.

84kgs of copper in an EV

To give an idea of the impact of EV sales could have on global copper demand, Figure 15 shows three potential scenarios based on the penetration rate of EVs of total vehicle sales by 2030. The range is 20% EV in the low scenario up to 40% EV of total global passenger car sales for the high scenario.

Figure 3: Copper Demand and EV sales as a percentage of total vehicle sales



Source: ICSG, SEAL Advisors

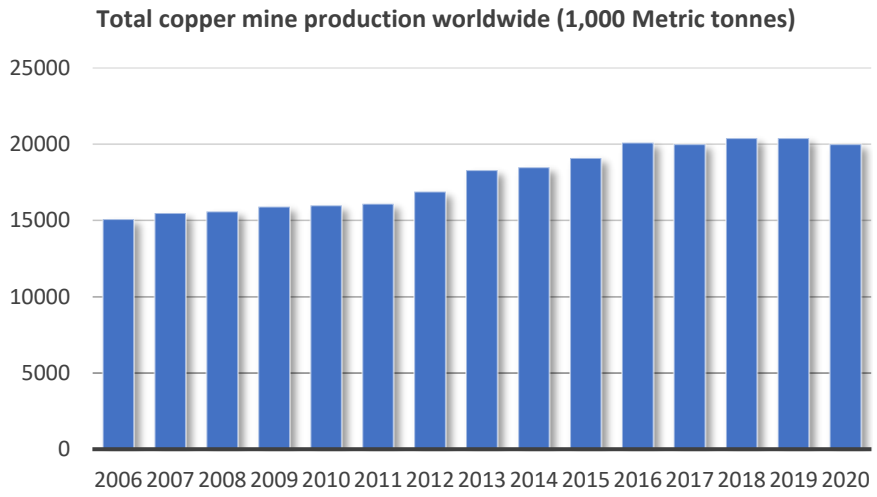
Implied copper demand from EVs to be significant

From our scenario analysis, we estimate that the implied EV-related copper demand could range from 7% of global mining supply in the low scenario to 15% in the high scenario. While this is based on 2019 copper supply, Figure 16 shows that for the last five years total copper production has been static. It is also worth

noting that average copper usage per EV is likely to rise as battery technology develops. Some mining industry commentators speculate that future EVs will require c163kgs[i] of copper per vehicle compared to at c.84kgs today.

Copper production has been stable in recent years

Figure 4: Total world copper mine production since 2006



Source: Statista

EV charging infrastructure requires significant amounts of copper

We also need to take the impact of the necessary charging infrastructure to support the increasing proportion of EVs in the global car stock. A fast charger typically requires 8kgs of copper, whereas a normal charger uses around 0.7kgs of copper. On this basis, EV charging infrastructure might require an additional c.390 kts of copper or even higher as the proportion of fast charges increases.

While EVs are likely to be the most significant single source of additional copper-related demand in terms of green technologies, wind and solar energy combined are likely to exceed that of EVs[ii]. This is due to a combination of a continued rapid roll-out of wind and solar power along with the fact that renewables are some 12x more copper intensive than traditional energy systems. It is estimated that wind turbines require between 2.5 tonnes and 6.4 tonnes of copper per MW for the generator, cabling and transformers. Photovoltaic systems used in solar power generation use c.5.5 tonnes of copper per MW. Glencore estimates that generation and grid infrastructure might account for c.500 kts of copper in 2030.

EVs and related infrastructure could account for 15% of copper supply

By summing the above and taking the mid case for EVs, then we can see that incremental 2030E copper demand directly related to decarbonization might total some 3,100 kts, representing just over 15% of current global mine supply.

Table 1: Estimated additional copper demand from EV (and related) by 2030

Source	Cu Demand (kts)
Electric Vehicles (mid scenario)	2,241
Charging Infrastructure (EV)	390
Generation & Grid infrastructure	500
Total additional copper demand	**3,131**
Percentage of mine supply (2019)	**15.3%**

Source: ICSG, EV industry forecasts, Glencore, SEAL Advisors

If copper usage per EV were to increase to the levels some industry forecasters are estimating, then the demand of c.3,131 kts above would increase by c.2000 kts for a total additional Cu demand of c.5,100 kts, or c.25% of current worldwide mine supply.

Copper production is forecast to increase

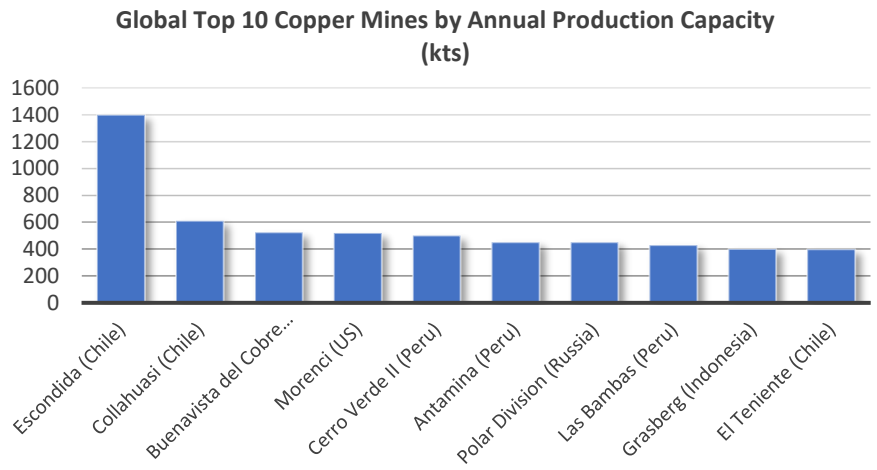
The question then becomes, can mine supply expand to meet the additional c.3000-5000kts of additional annual copper demand from 2030E? We have already shown (Figure 16) that global copper mine production has been relatively flat at around 20.5 million tonnes for the past five years. Going forward the International Wrought Copper Council (IWCC) is forecasting this to start rising again and expect production to be around 20.9 million in 2021 and the ICSG is forecasting world copper mine production to increase by 3.7% to around 23.3 million tonnes in 2020. Looking over the longer term, Fitch Solutions' most recent long-run forecast indicates that mine production will grow at an average of 3.7% for next 10 years to reach 29.4 million tonnes by 2030.

While top-down long-run forecasts indicate that copper mine production will experience steady growth for the next 10 years it is nonetheless worth putting in perspective additional demand relating to EV and green energy sectors relates to production at the individual mine level.

Increase copper demand equivalent to 2 to 3.5x the largest mine

Figure 17 shows the top 10 copper mines by current annual production capacity. The largest producing mine being Escondida in Chile. An increase in annual copper demand of 3,000 to 5,000 kts would be equivalent to 2 to 3.5 Escondidas. Moreover, given that a greenfield copper mine can take more than 15 years to bring from discovery to production, if the discovery hasn't already been made, it is unlikely that it will be producing by 2030. According to S & P Global Market Intelligence, a total of 224 major copper deposits were discovered between 1990-2019, but only 16 of these were found in the last 10 years and only one since 2015. A major contributing factor to this notable lack of success is the collapse in mining industry capex allocated to grassroots copper exploration; at 36% in 2019, this is near the low of 32% in 2009.

Figure 5: Ranking of global top 10 copper mines by annual production



Source: Bloomberg Intelligence, ICSG, 'The World Copper Factbook 2020'

Even though the majority of the major discoveries made since 1990 are not yet in production which could support increased supply, what is clear is the demand

and supply dynamics of the copper market are such that conditions are likely to be tight.

Long-term outlook remains positive

Despite forecast growth of 3.7% per year which could see annual production increase from c.20 million to c.30 million tonnes this is more than likely to be consumed by the general increase in infrastructure projects and the incremental demand expected as a result of decarbonization initiatives.

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NOTES

[i] Noted mining entrepreneur Robert Friedland is quoted as saying that he estimates the future copper requirement per EV at 359 pounds = c.163 kgs

[ii] Fitch estimates that renewables will account for c.62% of annual 'green copper' demand between 2020-2030 – cited on Mining.com, June 2021