COPPER

What Else?

AUGUST 2023

Independent Capital Group

INTRODUCTION

The objective of this paper is to provide the reader with a thorough understanding of the current dynamics of the copper markets and to outline the direction it is projected to take by the conclusion of this decade.

The copper industry includes copper mines, smelters, refiners, recycling facilities and fabricators of semi-finished products from copper and copper alloys, such as tubes, wire rods and bars. Mining, processing, recycling and the transformation of metal into a multitude of products creates jobs and generates wealth. Nearly one million people work directly for the global copper industry, from mining to fabrication.

Copper has been utilized for over 10'000 years and continues to fulfill a range of society's requirements. As the energy transition gathers momentum, moving toward widespread electrification, copper's role becomes pivotal in ensuring the successful realization of this transition. Copper plays an important role in the modernization of aging power generation and transmission infrastructure, enabling the smooth incorporation of emerging renewable energy sources such as solar photovoltaic, offshore and onshore wind, concentrated solar power, nuclear, and hydropower. The realm of transportation is also embracing rapid electrification, witnessed through the increasing sales of electric vehicles (EVs) across major markets. The next 25 years are projected to experience unparalleled demand growth of copper. Grasping the magnitude of this extraordinary demand is essential for effectively addressing the ensuing challenge. Various reports from international institutions and national governments have sounded alarms over the feasibility of fulfilling the surge in mineral demand spurred by the race toward achieving net-zero emissions.

The U.S. Department of Energy (DoE) has classified copper as a ‚near-critical' material. Recent statements from the USGS suggest that copper supply is worth vigilant monitoring, raising expectations of inclusion in the "critical" category.

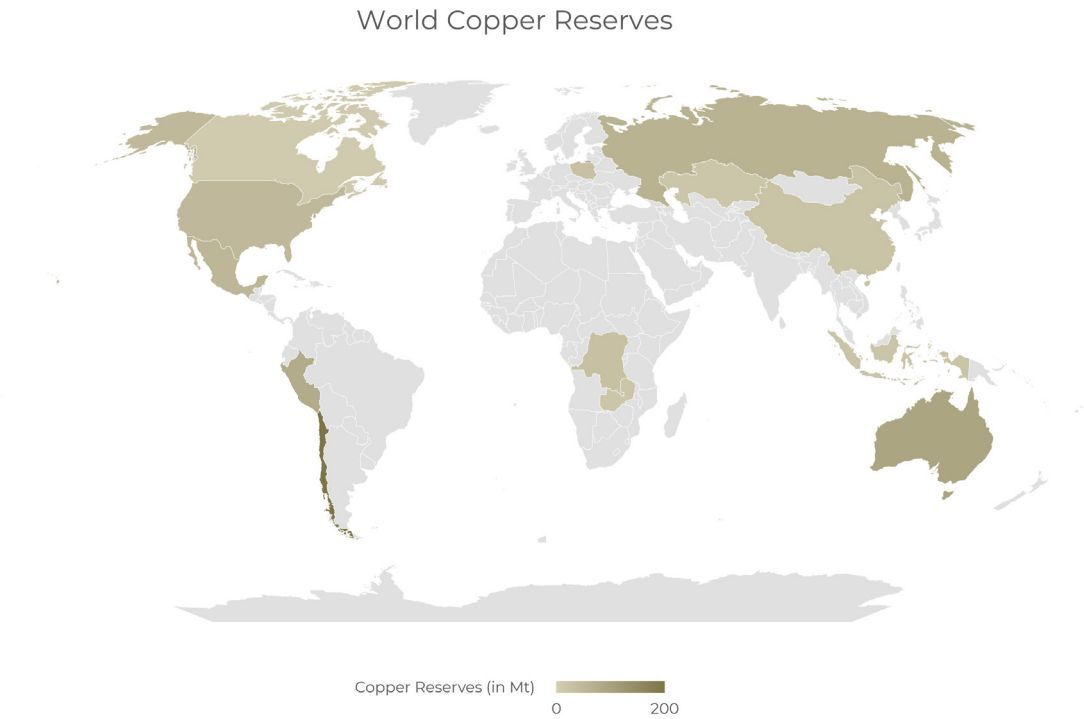
TABLE OF CONTENTS

TABLE OF CONTENTS

COPPER SUPPLY

«THE ESTIMATED RESERVE LIFESPAN RELATIVE TO CURRENT PRODUCTION EXCEEDS FOUR DECADES»

Where are the currently estimated copper resources located?



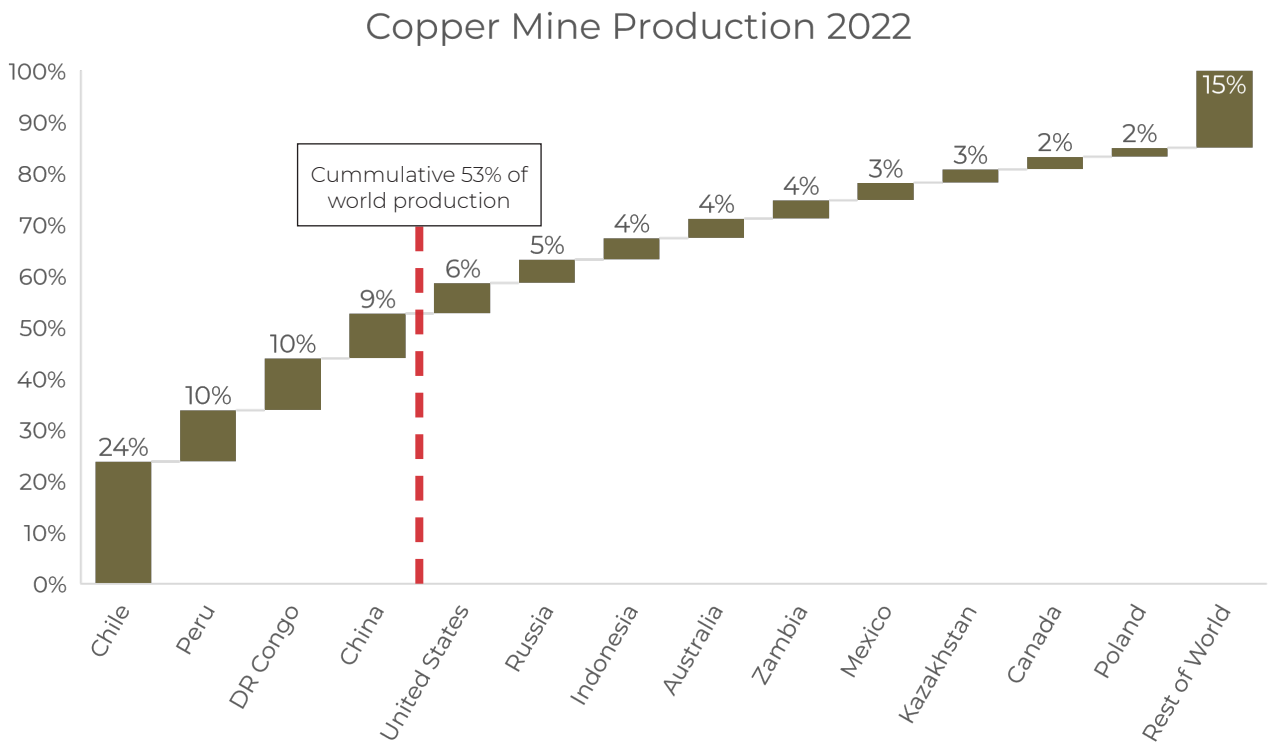
Currently, the cumulative sum of recognized and yet-to-be-unearthed copper resources on a global scale stands at around 5'600 million tons (Mt). Among these resources, 880 Mt are classified as reserves - established deposits deemed economically viable for extraction in today's market. This expansive definition of copper resources encompasses not only these designated reserves, but also supplementary deposits acknowledged to exist, albeit without current economic feasibility for extraction. Moreover, undiscovered deposits allude to potential reserves deduced from geological and scientific comprehension, awaiting further exploration and assessment. The estimated reserve lifespan relative to current production exceeds four decades. The geographical distribution of these reserves is visually depicted in the accompanying map, where regions of deeper shading denote concentrations of higher value (Max. 200 Mt in Chile).

«LATIN AMERICA HELD A SIGNIFICANT SHARE, CONSTITUTING 40% OF THE GLOBAL COPPER MINE PRODUCTION»

How much copper is currently being produced and where?

During 2022, worldwide copper mine production was close to 21 Mt, with Chile and Peru emerging as the biggest contributors. More than 50% of copper mine production is concentrated within just four nations. Latin America held a significant share, constituting 40% of the global copper mine production in the same year. This concentration constitutes a considerable risk factor. Looking at copper refining, a considerable portion of 42% of refining is conducted in China, while an additional 9% is attributed to Chile.

This dynamic results in a significant flow of copper concentrate from Latin America to Asia, and correspondingly, refined copper is transported from China to regions spanning Asia, Europe, and North America.



«THE MAJORITY OF THE LARGEST GLOBAL COPPER MINES POSSESS SUBSTANTIAL LIFESPANS, AVERAGING AROUND 30 YEARS»

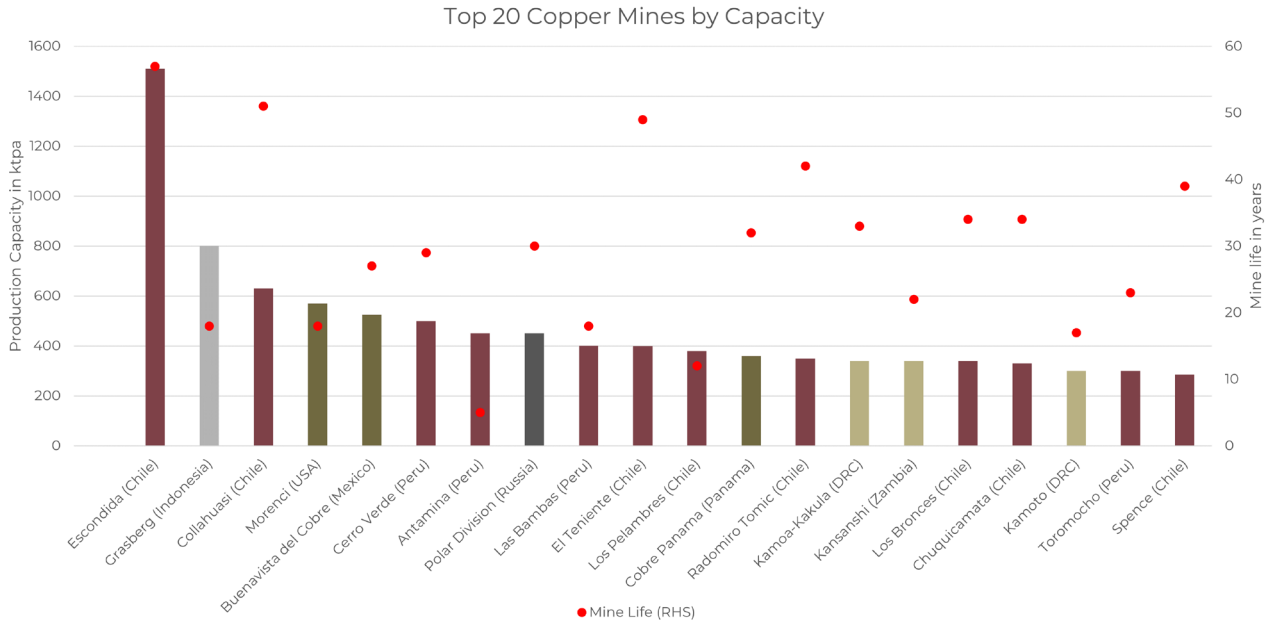
What are the largest copper mines?

Displayed below is a graph illustrating the 20 most prolific copper mines globally, ranked by their production capacity.

The majority of the largest global copper mines possess substantial lifespans, averaging around 30 years, with only a limited number falling below the 15-year threshold.

Escondida, located in Chile, stands out as the world's largest and most significant copper mine since 1990. Nestled in a region renowned for its abundant mineral deposits, this mine is operated by BHP (57.5%). It also has partial ownership by Rio Tinto (30%), JECO (10%), and a Japanese consortium (2.5%). BHP targets an annual average production of 1.2 Mt of copper over the medium term, a 20% increase on Escondida's FY22 production of 1 Mt.

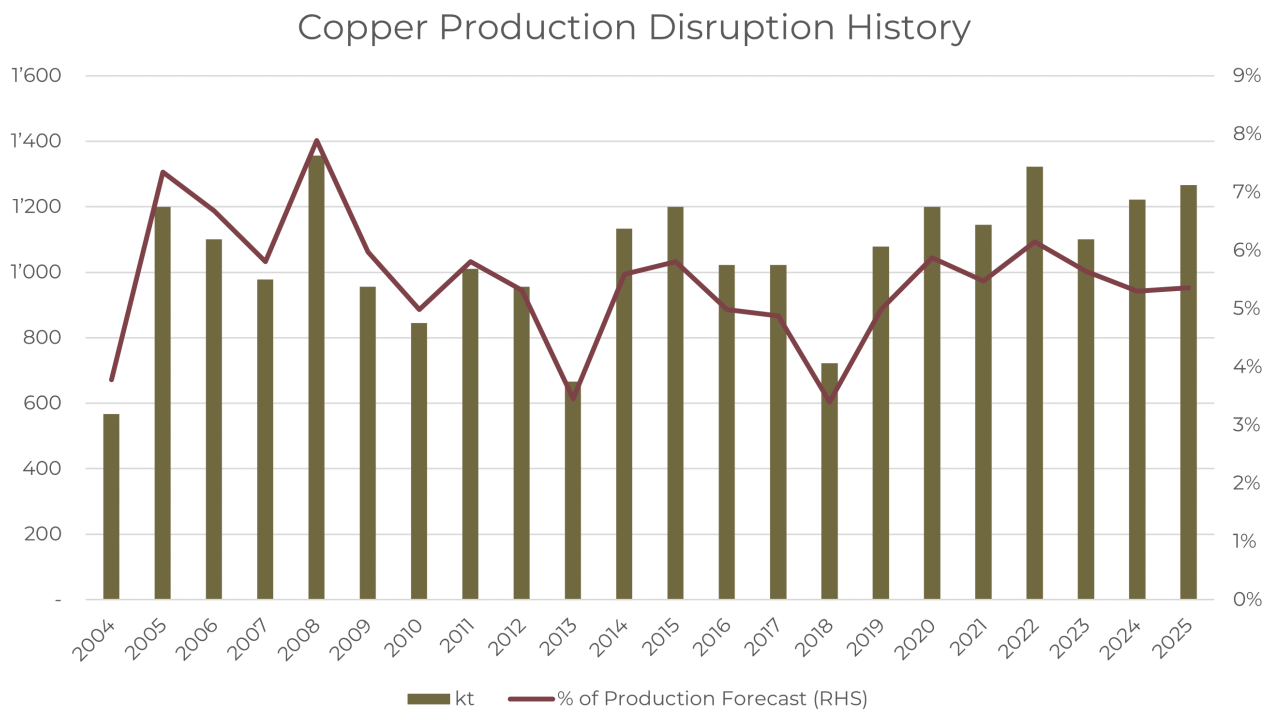
The Grasberg copper mine in Indonesia ranks as the second largest globally. This mine operates as a joint venture, with Freeport-McMoRan holding a 60% stake and Rio Tinto possessing 40%. Freeport owns a 48.76% interest in PT Freeport Indonesia, which operates the mine. In 2022, the mine delivered an output of 754 thousand tons (Kt). Forecasts from Scotiabank indicate that Grasberg is poised to achieve similar results, targeting 752 Kt in 2023 and a slightly elevated 801 Kt in 2024.



«LONG-TERM AVERAGE DISRUPTION RATE OF 5.3%»

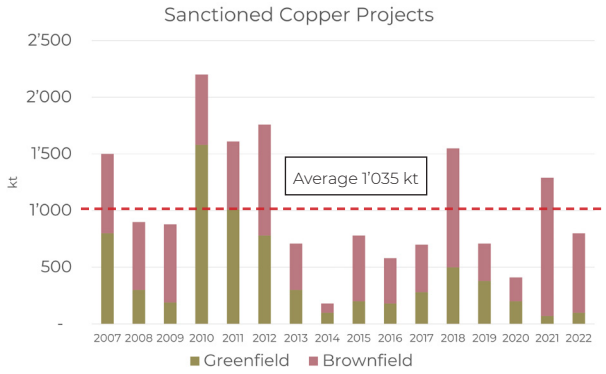
What impact do disruptions have on copper supply?

Factoring in a long-term average disruption rate of 5.3%, a market that is balanced can easily shift into undersupplied. Especially in Latin America, supply risks remain elevated due to social unrest, water scarcity and other factors.



«A MERE THREE ADDITIONAL DISCOVERIES WITHIN THE PAST FIVE YEARS»

How has copper mine growth evolved in recent years?

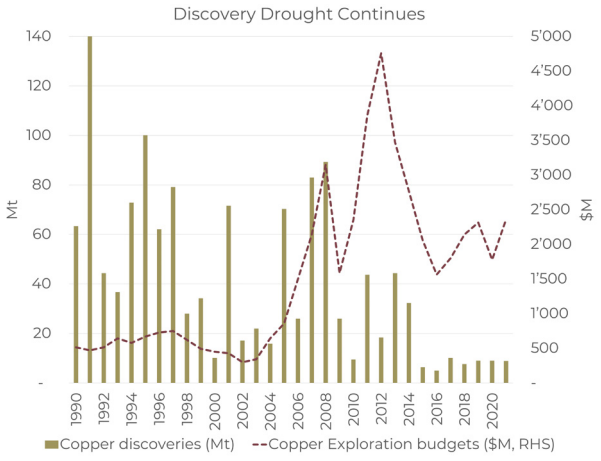


Looking back 15 years, it's evident that exploration endeavors have experienced a downturn since 2010. Delving deeper into previously sanctioned copper projects, a clear pattern emerges where mining companies favor brownfield expansions over greenfield projects, as depicted in the graph above.

The difference between greenfield and brownfield projects lies in their starting points: greenfield projects launch on land without pre-existing infrastructure,while brownfield projects take root on sites already equipped with some level of pre-existing infrastructure or past development.

Despite a noticeable uptick in the collective copper discoveries spanning from 1990 to 2010, the downward trajectory observed in the speed and magnitude of significant findings over the past decade continues. Almost all novel copper resources stems from pre-existing and well-established discoveries originating in the 1990s. This research has unveiled a mere three additional discoveries within the past five years, contributing a modest 5.6 Mt of reserves to the total.

This outcome directly results from companies allocating a larger portion of their exploration budgets to existing operational mines - a tendency that has persisted over the course of the last decade. Significant copper findings are not only becoming more rare but also increasingly located at greater depths.



«ANALYSTS PREDICT NOTEWORTHY SUPPLY INCREMENTS IN 2023, SUCCEEDED BY A NOTICEABLE DECELRATION»

Are there any major projects set to enter the market soon?

Upon evaluating projects poised to hit the market, analysts predict noteworthy supply increments in 2023, succeeded by a noticeable deceleration until the years 2027 and 2028.

Experts emphasize that most supply expansions in 2027 and 2028 hinge on projects that are still pending approval. This raises concerns about potential delays in project initiation and subsequent supply enhancements postponed until after 2030. This situation occurs because projects are complex in nature and the amplified focus on ESG considerations.

Notably, statistics underscore that approximately half of the projects encountered delays averaging around three years when compared to data from 2018.

Future supply is often categorized into distinct project stages. How these projects are calibrated for risk and integrated into the fundamental production can significantly shape the ultimate projection for future supply.

The first of the two tables on the next page show projects in various stages such as commissioning, construction, or already in the process of ramping up production. All projects highlighted in the second table are currently in either the feasibility or final investment decision (FID) phase. This implies the potential for these projects to initiate production within a span of 2 to 7 years. This forecast aligns with the provided timescale and is accompanied by a typical risk factor of around 70%.

A considerable 30% of the upcoming supply in the next five years is attributed to three mines.

Projects highlighted in deeper shades of red are located in South America, those in lighter red correspond to African locations, while projects in darker green signify the Middle/North Americas and the lighter ones are located in Asia. Grey is indicative of locations beyond these specified regions.

Comissioning/Construction/Pre-Construction/Ramp-Up

Project	Country	Company	Stage	Production (kt p.a.)
Quellaveco	Peru	Anglo American	Construction Started	300'000
Kamoa-Kakula	Democratic Republic of Congo	Ivanhoe Mines	Operating	284'000
Qulong	China	Zijin Mining Group	Operating	160'000
Udokan	Russia	Metalloinvest	Construction Started	135'000
Mina Justa	Peru	Minsur	Commissioning	92'000
Timok	Serbia	Zijin Mining Group	Operating	91'000
Tominskoye	Russia	Russian Copper	Preproduction	81'000
Khoemacau	Botswana	Cupric Canyon Capital	Operating	62'596
Gunnison	United States	Excelsior Mining	Operating	56'700
Xietongmen	China	Jinchuan Group	Construction Started	50'000
Pumpi	Democratic Republic of Congo	Wanboa Mining	Operating	45'000
Pumpkin Hollow	United States	Nevada Copper	Operating	40'000
Florence	United States	Taseko Mines	Limited Production	38'555
Pilares	Mexico	Southern Copper	Construction Started	35'000
Musonoi	Democratic Republic of Congo	Jinchuan Group	Construction Started	34'500
Dar Alou	Iran	National Iranian Copper	Construction Started	32'500
Aljustrel	Portugal	I'M SGPS	Operating	32'000
Tshukudu/Motheo	Botswana	Sandfire Resources	Construction Started	30'000
Kambove	Democratic Republic of Congo	China Nonferrous	Construction Started	28'000
Pedra Branca	Brazil	OZ Minerals	Commissioning	24'000

Feasibility/Final Investment Decision (FID)

Project	Country	Company	Stage	Production (kt p.a.)
Michiquillay	Peru	Souther Copper	Feasibility	225'000
El Arco	Mexico	Souther Copper	Feasibility Complete	190'000
Los Chancas	Peru	Souther Copper	Feasibility	150'000
Josemaria	Argentina	Josemaria Resources	Feasibility Complete	131'000
Tia Maria	Peru	Souther Copper	Construction Planned	120'000
Resolution	United States	Rio Tinto	Preproduction	120'000
Zafranal	Peru	Teck Resources	Feasibility Complete	75'000
Upper Kobuk	United States	Trilogy Metals	Feasibility Complete	70'300
Costa Fuego	Chile	Hot Chili	Comissioning	66'000
Santo Domingo	Chile	Capstone Mining	Construction Planned	63'500
Alemao	Brazil	Vale	Prefeasibility	60'000
Eva	Australia	Copper Mountain	Construction Planned	45'000
Magistral	Peru	Nexa Resources	Feasibility Started	40'500
Tizert	Morocco	Managem	Feasibility Started	40'000
El Pilar	Mexico	Souther Copper	Construction Planned	35'000
Kambove	Democartic Republic of Congo	China Nonferrous	Construction Started	28'000
NorthMet	United States	PolyMet Mining	Construction Planned	24'853
Black Butte	United States	Sandfire Resources	Feasibility Complete	23'000
Buenavista	Mexico	Souther Copper	Preproduction	20'000
Victoria	Canada	KGHM International	Construction Planned	18'000

«CHILE AND PERU STAND AS PIVOTAL SOURCES FOR THE PRESENT AND FUTURE COPPER SUPPLY»

In addition, it is crucial to underscore that approximately half of the supplementary supply is projected to originate from projects positioned in non-traditional or comparatively more challenging jurisdictions, such as the Democratic Republic of Congo (DRC), Papua New Guinea (PNG), Botswana, and other similar locations.

Chile and Peru stand as pivotal sources of the present and future copper supply. Scotiabank's projections indicate that Chile's production is set to peak in 2025 at 6.1 Mt, while Peru's peak is anticipated to occur in the same year at 2.8 Mt. Subsequently, production from these regions is predicted to decline due to diminishing grades and orebody depletions. Despite the envisioned emergence of several new mines, production is foreseen to decrease by 11% and 13% respectively from their peak levels by 2030.

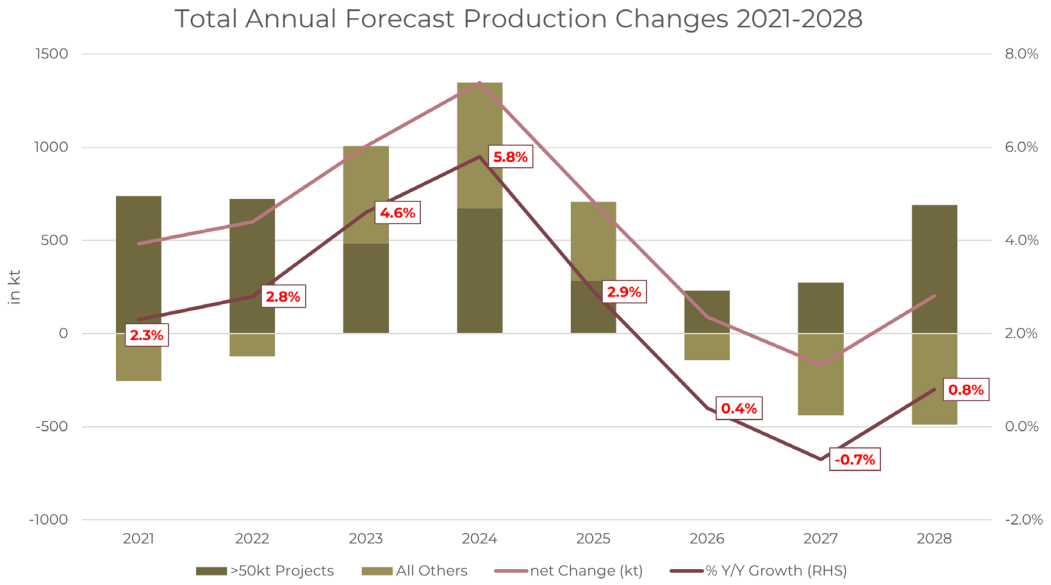
Notably, the Chilean state-owned copper mining company, Codelco, finds itself in the challenging position of requiring an investment of $35bn over the medium term solely to sustain the existing output levels of 1.7 million tons per anum (Mtpa).

As per Wood Mackenzie, there are presently 63 proposed copper projects (32 greenfield and 31 brownfield) in the pipeline for development in Chile and Peru throughout this decade.

Collectively, these projects could yield a combined production capacity of 6 Mt by 2030. However, analysts estimate that a substantial new capital investment of $100bn would be necessary to realize these projects.

«THIS SITUATION MAKES ANALYSTS WORRIED ABOUT WHETHER THE MARKET CAN HANDLE EVEN SMALL SUPPLY SHORTAGES»

Given the variety of projects, how is overall supply growth expected to develop?



The expansion in mined supply is predicted to remain moderate until the year 2028.

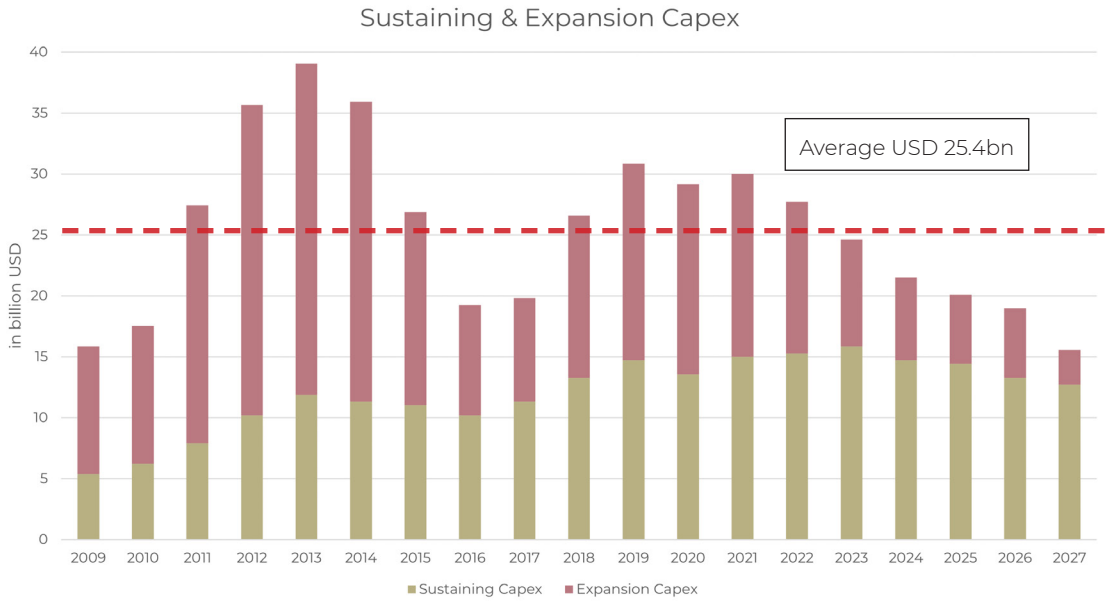
Analysts are still awaiting the approval and full development of a new large-scale greenfield copper project since the pandemic.

Thecurrentyearandthesubsequenttwo are anticipated to witness noteworthy growth in primary mine supply. However, beyond this time frame (despite the assumption of progress in several ongoing projects), the growth trajectory appears to be restrained.

This situation makes analysts worried about whether the market can handle even small supply shortages without causing prices to go up.

«THE SURPLUS CASH FLOW IS PREDOMINANTLY ALLOCATED TOWARDS DEBT REDUCTION AND ENHANCING SHAREHOLDER RETURNS»

What about company investments?



Within the mining industry, capital expenditure (Capex) remains stagnant and insufficient to address persistent supply deficits.

While the yearly average planned sustaining capital of $14.8 billion per annum (bnpa) for the period spanning 2021 to 2026 exhibits a 33% increase from the $11.1bnpa recorded in the 2010 to 2020 period, the average yearly planned growth capital investment of $9bnpa in the 2021 to 2026 period marks a 47% decline compared to the $16.9bnpa incurred from 2010 to 2020. Consequently, growth capex stands notably lower than the levels observed in the preceding decade.

Furthermore, mining companies find themselves subject to substantial pressure from shareholders, urging them to maintain growth discipline despite the more favorable commodity price outlook.

The surplus cash flow is predominantly allocated towards debt reduction and enhancing shareholder returns. Additionally, the prevalent escalation in policy ambiguity, political risk, and mounting environmental requisites are converging to create a complex environment for producers.

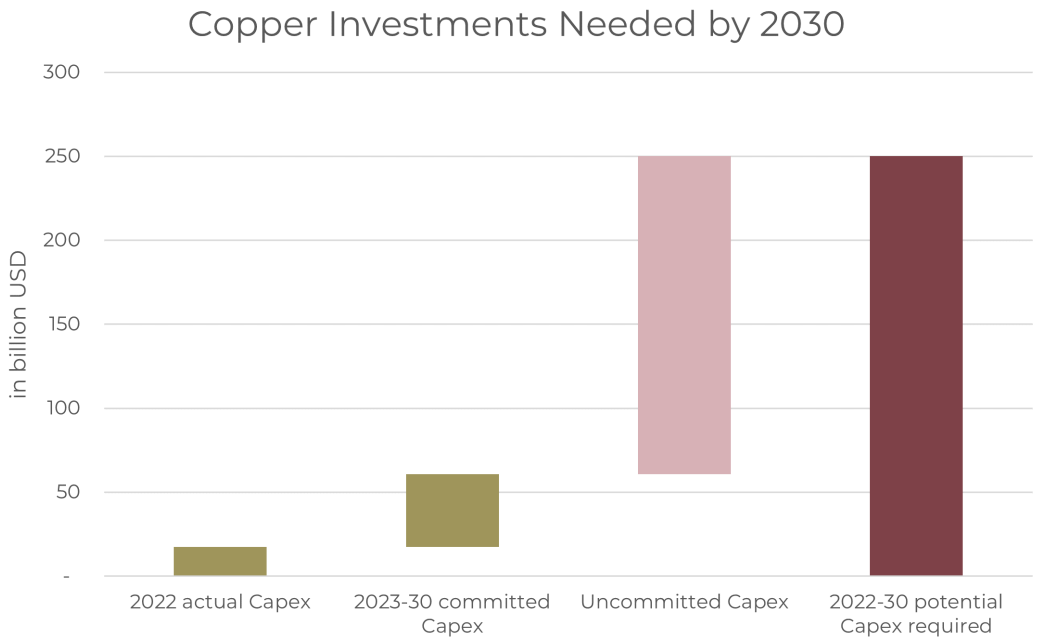
«PROJECTIONS SUGGEST A NEED FOR APPROXIMATELY USD 250 BILLION IN INVESTMENTS BY 2030»

According to BHP, the shift towards a decarbonized world highlights the need for mining, thereby creating a considerable demand for supplementary investments.

In the context of copper, BHP's projections suggest a need for approximately $250bn in investments by 2030. This estimation aligns with the requirement for expanding mine capacity by up to 10 Mtpa in response to depletion and diminishing grades. Among this $250bn, only a minor fraction has already been earmarked by various companies, leaving the predominant share as uncommitted capital expenditure.

In alignment with the insights from the Energy Transition Council (ETC), the realm of copper mining demands an accumulated investment ranging between $270bn and $420bn, while refining necessitates an allocation within the bracket of $325bn to $500bn, spanning the period from 2022 to 2050 to ensure adequate supply.

Most of this investment is urgently required within the next decade to facilitate the substantial scale-up mandated by various demand scenarios.



«PRESENT AVERAGE INCENTIVE PRICE STANDS AT $9'000/T»

Where is the current incentive price for new projects?

When considering incentivizing prices, the present average stands at $9,000/t. However, to counterbalance the projected deficit by the conclusion of this decade and stimulate the emergence of an additional 8 Mt of supply, the marginal incentive price is approximated to be around $13,000/t, as indicated by Goldman Sachs.

Considering the prevailing spot pricing, nearly half of the projects face challenges in achieving economic viability.

The average capital intensity for novel copper projects has surged to an estimated $22'400/t of annual copper equivalent (CuEq) production, considering an average production size of approximately 100'000 tons per anum (tpa) and an average capex of $2.2bn. This marks a 25% increase compared to the figures from 2018, according to Wood Mackenzie.

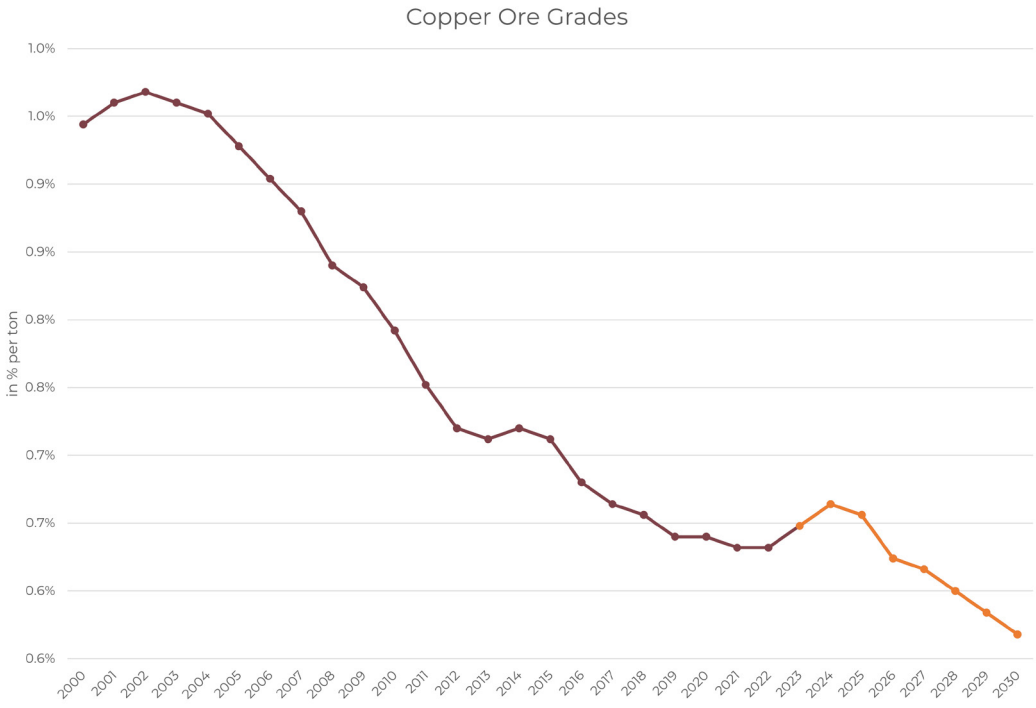
At this heightened capital intensity level and with an average tax rate of 40%, analysis suggests that a project would necessitate an unexpectedly high average incentive copper price of over $9,000/t to attain a standard minimum after-tax internal rate of return (IRR) of 15% — representing a 30% increase compared to the numbers from 2018.

The likelihood of a heightened taxation framework for the mining sector in Latin America is an inevitable outcome, prompted by the election victories of leftist candidates in both Chile and Peru during 2021, alongside the mounting public pressure for enhanced social initiatives in these nations.

«OVER THE LAST DECADE, ORE GRADES HAVE DEMONSTRATED A CONSISTENT DOWNWARD TREND»

Are there additional factors driving the high incentive price?

Another potential explanation can be attributed to the decline in ore grades. Over the last decade, ore grades have demonstrated a consistent downward trend, primarily due to the depletion of easily accessible high-grade reserves. In the case of Chile, the world's leading copper producer, the extracted ore grades have decreased from around 1% in 2000 to 0.7% in 2019. This phenomenon poses heightened challenges and increased costs when it comes to bolstering or sustaining production for established mines. This issue is made worse by the fact that as ore grades decrease, more water and energy are needed for extraction, which clashes with stricter environmental rules. As ore grades diminish in conventional locations, resulting in lower profitability and returns for mining companies, and amid escalating fiscal uncertainties, mining operations are progressively gravitating towards regions such as the DRC, PNG, Botswana, Panama, Zambia, and Mongolia. These places have untapped high-quality resources that could potentially help solve the challenge posed by declining ore grades.



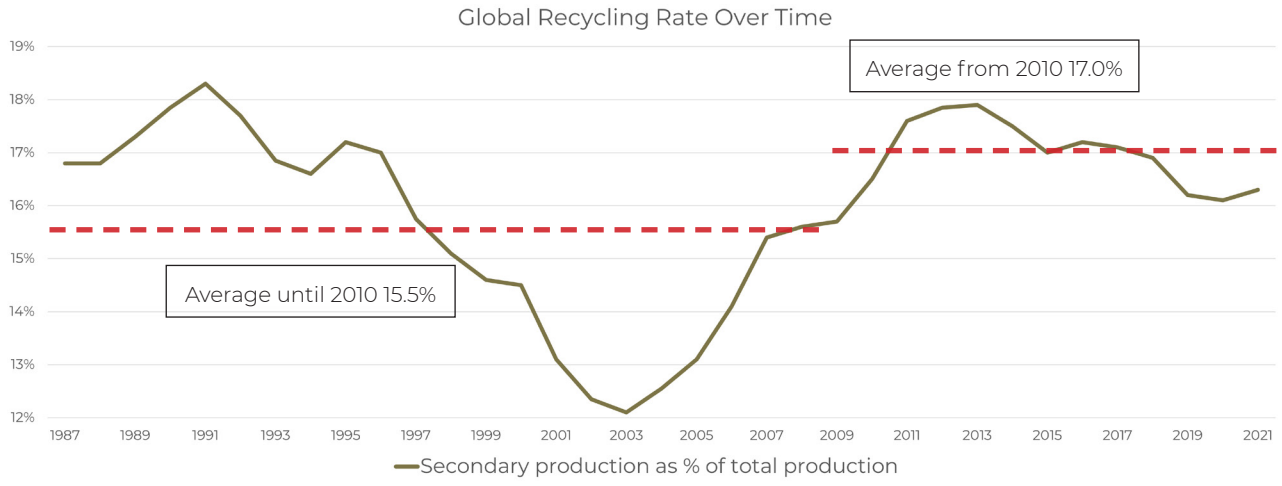
«THE AVAILABILITY OF SCRAP SUPPLY IS PROFOUNDLY INFLUENCED BY THE PREVAILING COPPER PRICE»

Could recycling be a possible gap filler?

Copper can be recycled from various sources, for example old electrical wires, cables, and industrial waste, collectively referred to as „scrap" or „secondary" copper. This recyclable material has historically contributed an average of 18.7% to consumption over a span of 25 years. Notably, its peak reached 25% in 2012, amounting to 4.9 Mt, coinciding with a period of elevated copper prices.

In recent times, recycling rates have largely maintained historical stability and have even shown an increase between 2010 and the present. While recycling copper presents advantages for the environment and the economy, multiple challenges and considerations can hinder its extent. The availability of scrap supply is profoundly influenced by the prevailing copper price. Further constraints include the intricate nature of recycling processes, contributions from small-scale sources, absence of compelling incentives, regulatory barriers, and economic deliberations, as recycling could potentially demand more energy and resources compared to producing fresh copper. Factors like collection, transportation, and processing costs play a role in this equation. Consequently, these factors collectively contribute to why recycling rates are not higher.

Despite these challenges, projections from MineSpans indicate a rise in the end-of-life recycling input rate to a range of 20-23% within the upcoming 3 decades.



COPPER DEMAND

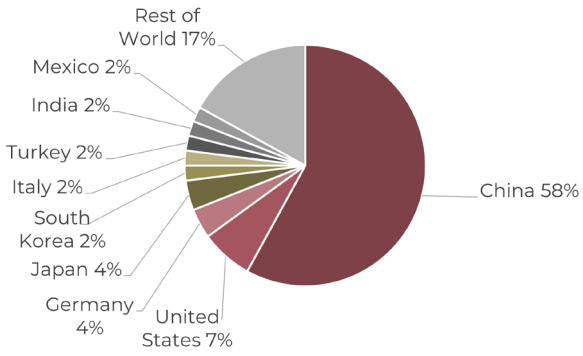
«COPPER IS AN ESSENTIAL MATERIAL IN A WIDE VARIETY OF APPLICATIONS NECESSARY FOR QUALITY OF LIFE AND SUSTAINABLE ECONOMIC GROWTH»

Globally, where is copper primarily consumed?

China accounts for approximately 60% of worldwide refined copper consumption, while the second largest consumer, the United States, comes in at around 7%.

Growth in copper demand differs greatly across regions. For the past 25 years, growth can be mainly attributed to the Asian market, where demand has expanded eight-fold over the past four decades, largely driven by industrial expansion in China.

Refined Copper Consumption

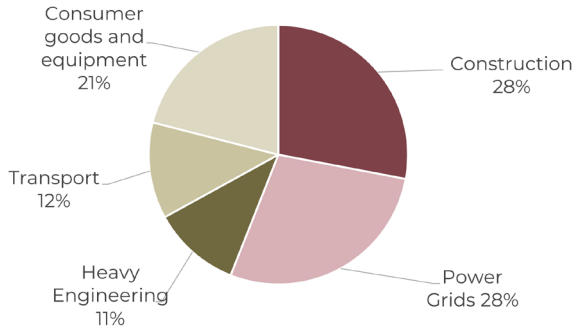


Copper has unique physical and chemical properties including thermal conductivity, ductility, ability to resist corrosion and machinability and castability - these high-performance properties make copper an essential material in a wide variety of applications necessary for quality of life and sustainable economic growth. Nearly 75% of the refined copper produced worldwide serves the purpose of fabricating electrical conductors, encompassing a range of cables and wires.

Sectors that prominently consume copper are construction, electrical and electronic equipment manufacturing, the power industry, transportation, mechanical engineering, and the production of assorted equipment and consumer goods.

Copper is recognized as a key material for creating an energy efficient, reliable, and safe power supply to communities around the world.

Copper Demand by Sector



«AS A RESULT OF THE ENERGY TRANSITION, POPULATION GROWTH AND ECONOMIC DEVELOPMENT, THE ANNUAL REFINED COPPER DEMAND IS EXPECTED TO DOUBLE BY 2050»

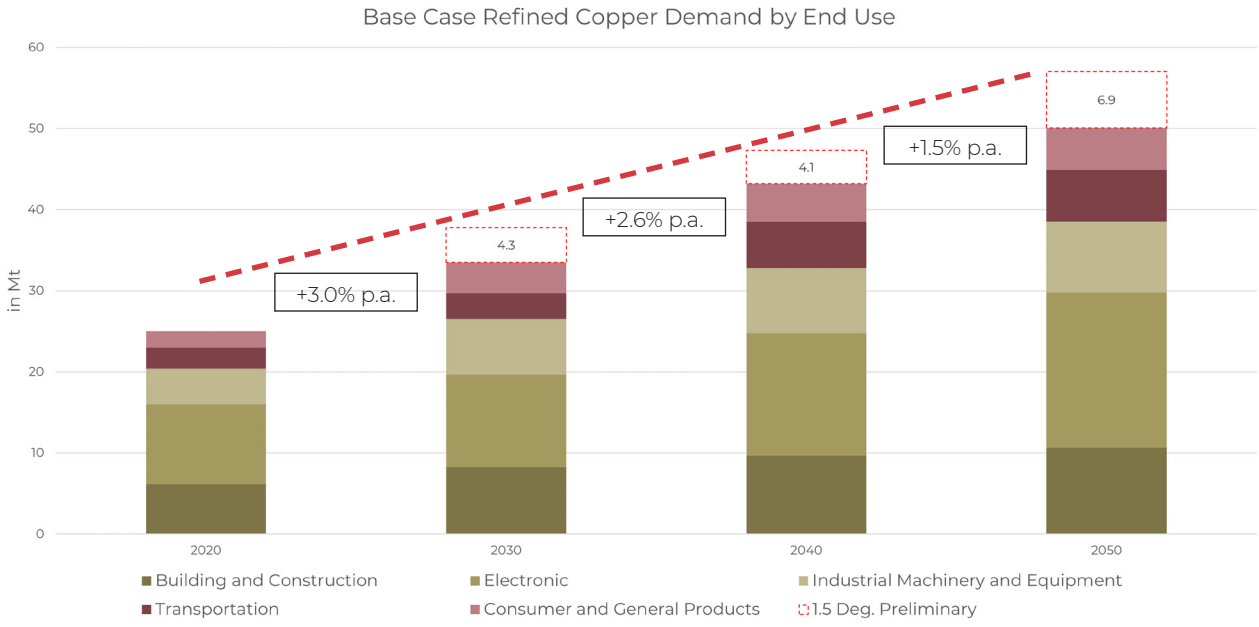
What are the main drivers behind copper consumption?

Global annual refined copper usage has been consistently rising from 0.5 Mt in 1900 to about 2 Mt after World War II to 25 Mt in 2020. This corresponds to a compounded annual growth rate of 3.4% over this 120-year period.

This increase is due in part to the growth in global population as well as growth in copper usage per capita. In 1950, the average annual refined copper usage per capita was 1.15 kg. By 2020, this number was closer to 3.25 kg.

As a result of the energy transition, population growth and economic development, the annual refined copper demand is expected to double to 50 Mt by 2050 compared to 2020 according to the International Copper Association and a widely cited report by S&P.

According to the projections provided by the Energy Transition Council (ETC) in the graph shown below, achieving the objective of restricting global warming to 1.5 degrees Celsius above pre-industrial levels would result in additional refined copper demand. Specifically, the estimates indicate that by 2030, around 4.3 Mt of additional refined copper would be required. In 2040, this demand is projected to be approximately 4.1 Mt, and by 2050, it is expected to reach 6.9 Mt.

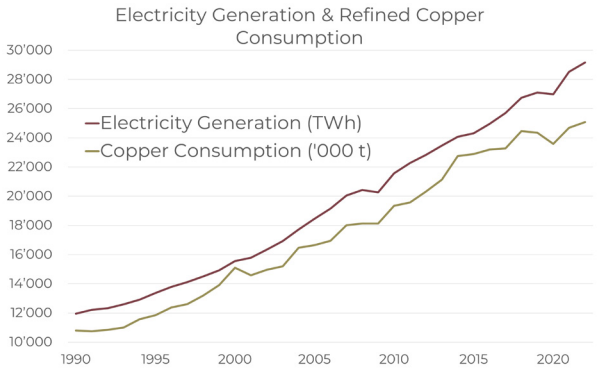


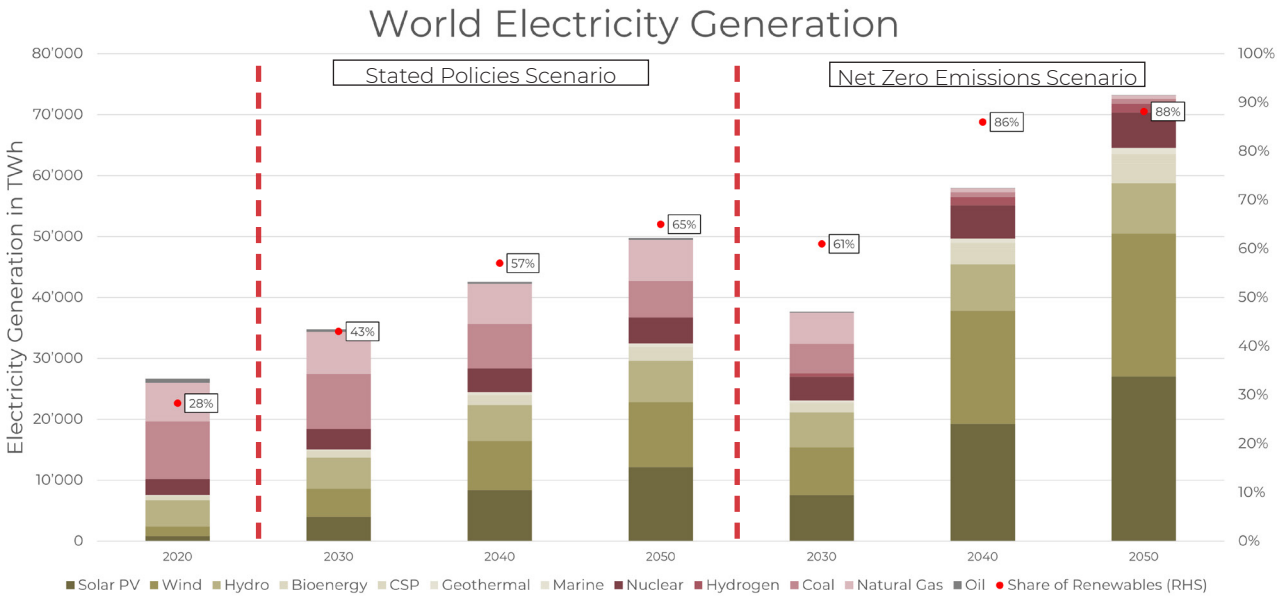
«THE CORRELATION BETWEEN COPPER CONSUMPTION AND ELECTRICITY GENERATION IS EVIDENT AND COMPELLING»

How does copper consumption relate to electricity generation?

As previously noted, an important demand driver is the electrification of the world. What is widely expected and obvious, is that we will have a dramatic increase in global electricity use, rising from 27,000 terawatt-hours (TWh) in 2020 to a range of 50,000 to 73,000 TWh by 2050, according to the IEA's chosen scenario. Supply and demand estimates for copper can vary widely based on sources and scenarios. However, it's undeniable that a modern world will require increased electricity, regardless of its source.

The correlation between copper consumption and electricity generation is evident and compelling. Copper's exceptional electrical conductivity is at the heart of this connection, as it plays an essential role in powering our contemporary society. As electricity demand rises and energy systemsimproveefficiency,thedemand for copper in electrical infrastructure and equipment will remain substantial.





«RIPPLE EFFECTS INTO NON-GREEN CHANNELS MEANS THE 2020S ARE EXPECTED TO BE THE STRONGEST PHASE OF VOLUME GROWTH IN GLOBAL COPPER DEMAND IN HISTORY»

What about the so called "green demand"?

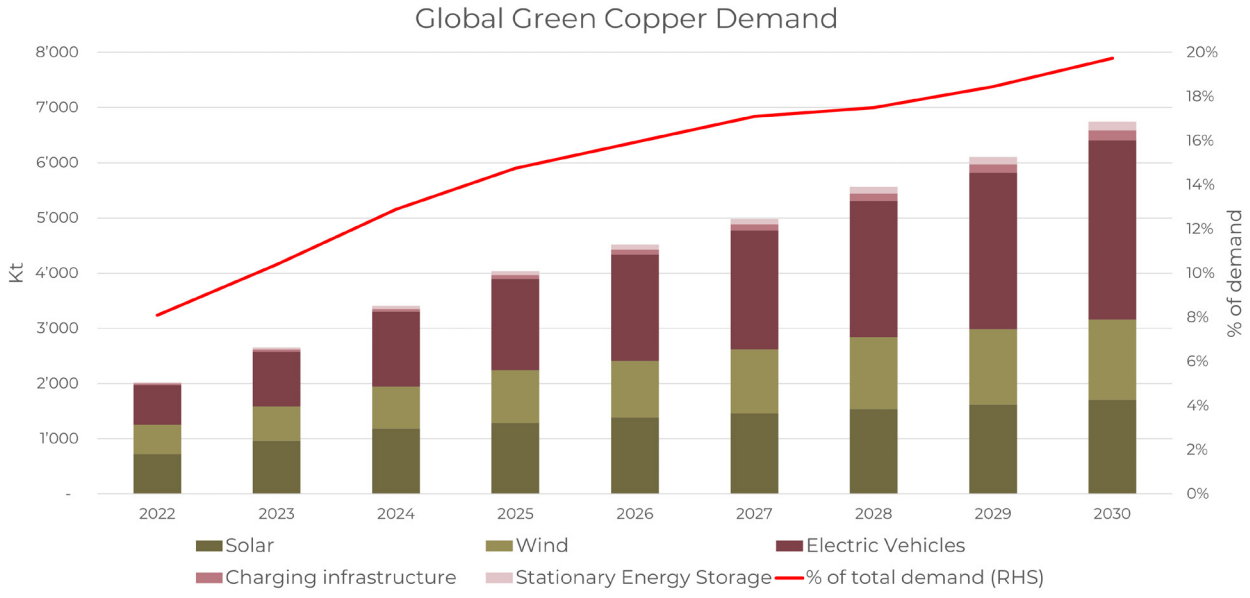
Examining the demand for copper stemming from renewable technologies, often referred to as „green demand," reveals a surge in the percentage of overall copper demand projected for the upcoming years.

The major contributors to green demand escalation, as depicted in the accompanying graph, will be solar energy, wind power, and electric vehicles. Notably, China is anticipated to account for approximately 50% of this heightened demand.

Chinese consumption expectations anticipate positive multi-year growth in grid investment and transport, largely offseting the negative growth in the construction, appliance, and machinery segments. Green demand will have an increasing tightening effect throughout the decade, yet as of today it accounts for 8% of global consumption. This leaves copper demand exposed to cyclical sector headwinds.

The green demand will rapidly increase to account for around 20% of global consumption, matching and then quickly surpassing the incremental demand China generated during the 2000s.

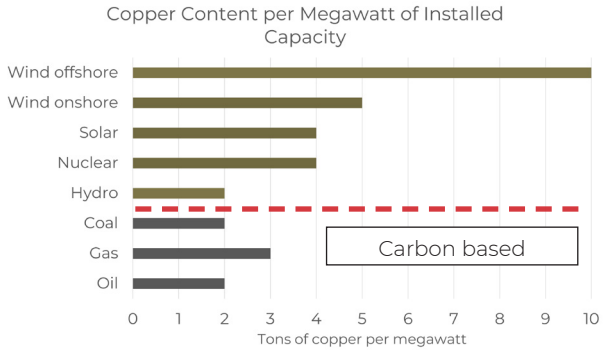
Ripple effects into non-green channels mean the 2020s are expected to be the strongest phase of volume growth in global copper demand in history.



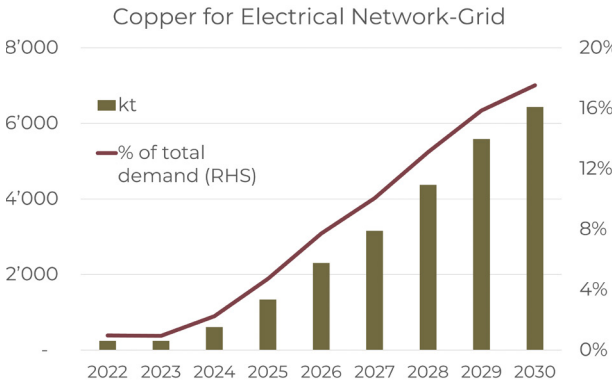
«THE POWER GENERATION SYSTEMS OF THE FUTURE, NOTABLY WIND AND SOLAR, NEED ABOUT 2 TO 5 TIMES MORE COPPER PER MEGAWATT THAN TRADITIONAL CARBON ENERGY GENERATION»

What is copper's role in renewable technologies?

In renewable power generation, copper is present in the electrical conductors of wind generators, photovoltaic (PV) modules, transformers, inverters, cables, and connectors. As these technologies are often weather dependent, variable output of solar and wind power creates the need to install three times more megawatts (MW) for the same amount of energy produced. The power generation systems of the future, notably wind and solar, needabout 2 to 5 times more copper per MW of installed capacity than traditional carbon energy generation.



What is often underestimated is the demand for electrical network-grid. Grids are complex interconnected systems designed to generate, transmit, and distribute electricity from power sources to consumers. They are crucial for supplying electricity to homes, businesses, and various other entities within a geographic area. The grid's architecture and technologies have evolved to accommodate the integration of renewable energy sources, enhance efficiency, and adapt to changing energy demands and technologies and is due for upgrades.



Jefferies' analysts anticipate a significant increase in the demand for copper originating from electrical grids in the years ahead. A 1,100 MVA high-power transformer typically needs 60 tons of copper, a 400 kVA distribution transformer typically contains 480 kg of copper. Analysts expect a major expansion of electricity grids from 75 million km of transmission and distribution to 200 million km by 2050.

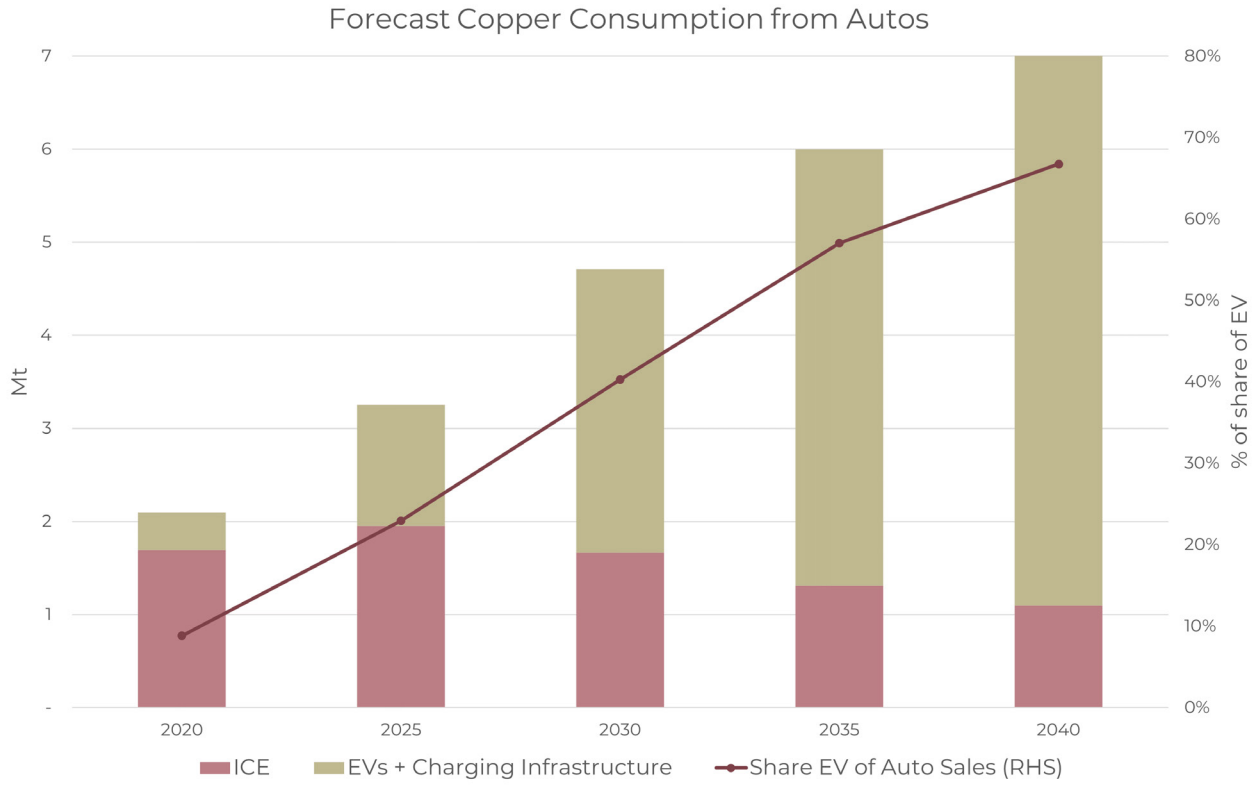
The variability of renewable energy sources also requires large amounts of electrical storage capacity to balance the grid. Lithium batteries usually contain about 0.5 kg of copper per kWh.

«ELECTRIC VEHICLES REQUIRE 2-3 TIMES MORE COPPER THAN INTERNAL COMBUSTION ENGINE CARS»

More visible demand from the decarbonization efforts might be the transition from internal combustion engine cars (ICE) to EVs. An EV uses 62.5 to 75 kg of copper, compared to 25 to 30 kg of copper for an ICE. In short, EVs require 2-3 times more copper than an ICE.

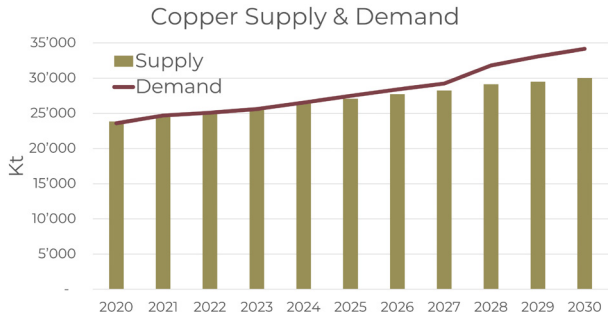
According to analysts, the share of EV's relative to global fleet of light-duty vehicles set to grow from 9% in 2020 to over 40% by 2030. Demand from the auto segment represented ~9% of global copper consumption in 2020. According to Wood Mackenzie, the growing adoption of EVs is anticipated to represent an incremental 1.3 Mt of annual copper demand by 2025 and close to 3.0 Mt of annual demand by 2030, respectively. This would increase the total copper consumed in autos along with the related charging infrastructure, to 3.3 Mtpa by 2025 and to 4.7 Mtpa by 2030, respectively.

EVs in the chart beneath includes all types of EVs, namely battery electric vehicles, plug-in hybrid electric vehicles, and hybrid electric vehicles.



«SIGNIFICANT DEFICITS IN COPPER MARKETS BY THE END OF THIS DECADE»

Combining supply and demand - why are analysts concerned?

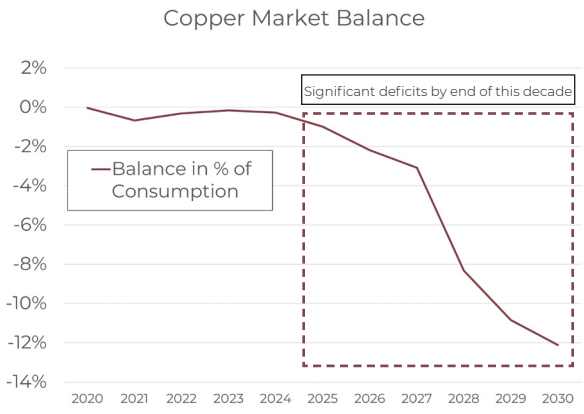


While the present condition of the copper market is rather balanced, the future trajectory remains subject to diverse forecasts from different analysts. The prevailing consensus among these projections points towards a considerable deficit emerging by the conclusion of the decade. This pronounced shortage in the medium term is primarily rooted in the absence of supply expansion.

Considering distinct scenarios of demand growth, the only circumstance that would lead to a minor deficit by 2030 is the expectation of no global growth during that timeframe. Conversely, all other projected scenarios distinctly portray a substantial shortfall in the market.

Nevertheless, the flip side of the coin presents a scenario where advancements in technological performance and diminishing materials intensity could potentially curtail the need for materials, although this necessitates a greater emphasis on innovation and policy intervention. Despite the absence of a copper reserve shortage, the critical question pertains to the feasibility of their timely development and production, with economic viability being a chief concern for companies. The extended timeframe required for new copper mining projects, averaging around 17 years in lead time, diminishes the industry's capacity to promptly address supply shortages. This is why prominent copper producers generally seek higher average prices before committing to substantial mine development expenditures.

The determined push towards carbon neutrality will undoubtedly push copper consumption higher. However, this goal will likely clash with a copper market struggling to keep up with rigid supply constraints.



COPPER PRICE & INVENTORIES

«LOOKING AT THE INFLATION ADJUSTED PRICE, THE COPPER PRICE TODAY IS CLOSE TO ITS AVERAGE SINCE 1959»

Where is the copper price today in a historical context?

A look at a longer-term chart implies that we have a relatively high copper price today. However, comparing historical nominal prices to inflation-adjusted prices allows for a better understanding of how the value of copper has changed over time.

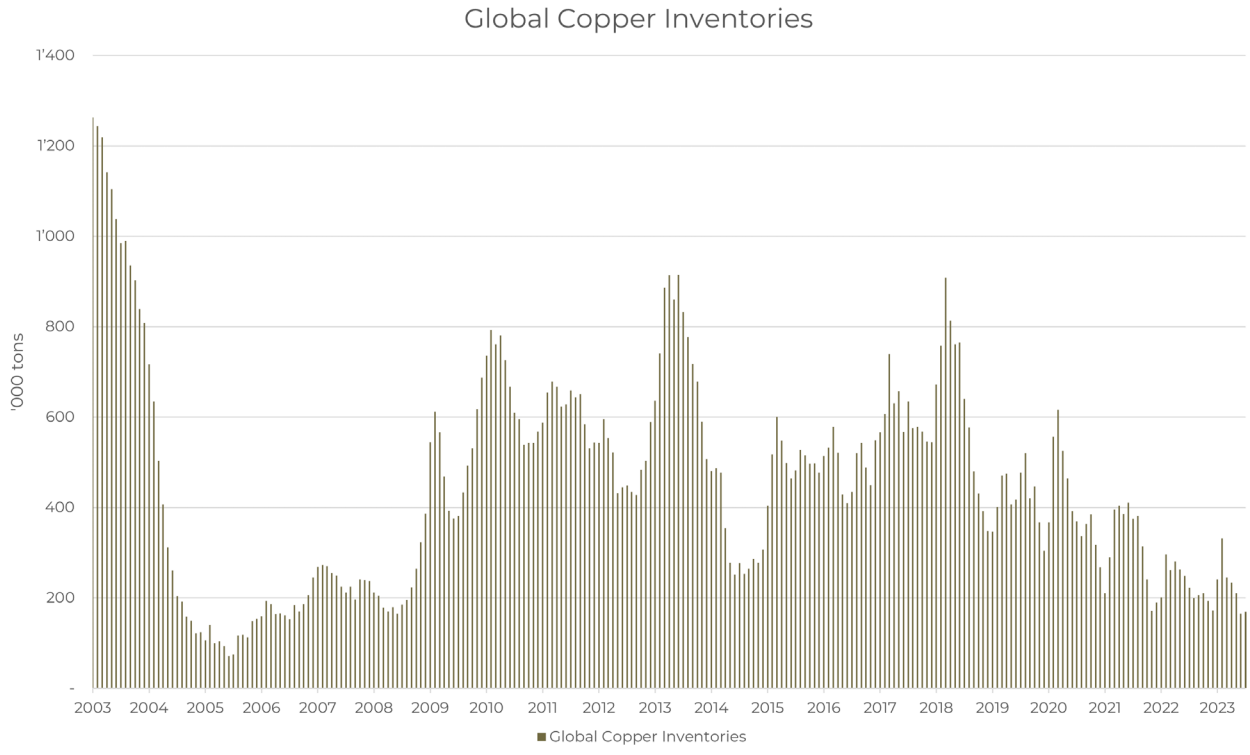
Observing the period from the early 1960s to the 1980s, it becomes evident that inflation-adjusted copper prices exhibited significant elevation. Given the high inflation rates seen in recent times, copper prices would be expected to follow suit. Looking at the inflation adjusted price, the copper price today is close to its historical average.

«GLOBAL COPPER STOCKS CURRENTLY SIT AT AROUND 3 DAYS OF CONSUMPTION, NEARLY AN ALL-TIME LOW»

What happened to copper inventories?

Combined copper stocks registered with the LME, its U.S. counterpart the CME and the Shanghai Futures Exchange (ShFE) totalled 170 Kt at the end of July 2023. This implies that global stocks currently sit at around 3 days of consumption, nearly an all-time low. Depleted inventories can make commodity prices volatile and a sudden price surge can cause problems for producers, traders and consumers. Goldman Sachs estimated at the beginning of the year that copper inventories may be depleted by year-end if China had a strong COVID recovery, which hasn't happened so far.

Nevertheless, according to the world's largest producer, Codelco, copper buyers are so worried about future availability of the metal that they are seeking to secure longer-term deals than normal. There are also consumers like OEMs acquiring interest in copper mines directly.



«COMMODITIES ARE SPOT ASSETS - PRICES PRIMARILY DERIVE FROM THE CURRENT MARKET'S DEMAND AND SUPPLY DYANMICS»

Why are copper prices not higher?

Current prices don't fully reflect the anticipation of supply and demand shocks in the future because commodities price in the present (more than the future).

Because commodities are spot assets, prices primarily derive from the existing market's demand and supply dynamics rather than reflecting anticipated price trends. It's crucial to understand that commodities function as volume-driven markets. Unlike equities and bonds, their movement isn't primarily propelled by liquidity within financial markets but by consumption patterns. This is an important difference in mindset.

In general, equity analysts discount the future value of a company's cash flows. This doesn't really matter for physical commodity markets today. If a market is in a deficit today, prices go up independently of what will be in a year because there is more demand than supply. This is the often misunderstood mechanism of Backwardation (spot prices higher than future prices) and Contango (spot prices lower than future prices). Backwardation has higher spot prices because a consumer or buyer of commodities is willing to pay a premium to get delivery today. Vice versa is the situation in Contango, in general an oversupplied market, where the consumer will only buy the commodity today for a discount.

Another often quoted reason is that copper prices are seen as a good leading indicator of the economic cycle. The term "Doctor Copper" is market lingo for this base metal that is said to have a „Ph.D. in economics" because of its ability to predict turning points in the global economy. Because of copper's widespread applications in most sectors of the economy, demand for copper is often viewed as a reliable leading indicator of economic health. This demand is said to be reflected in the market price of copper. The case for copper's prescience might seem intuitive. However, copper's record as a leading indicator is pretty flimsy.

Nevertheless, copper is a very popular instrument for investors such as hedge funds to trade on risk on and risk off moments which can significantly increase its volatility in either direction.

INVESTMENT IDEA

«NUMEROUS OPPORTUNITIES EXIST TO CAPITALIZE ON THE COPPER MEGA-TREND AND REAP ITS BENEFITS»

How can an investor gain exposure to copper?

Copper is one of the most followed base metals. Numerous opportunities exist to capitalize on the copper mega-trend and reap its benefits. In terms of instruments, there is the possibility of investing in copper futures, physical copper, or mining equities directly, via active or passive funds.

Copper futures represent exchange-traded derivative contracts between two parties, outlining the acquisition or sale of copper at a predetermined price and date. Upon contract expiration, the buyer must decide between physical delivery or rolling the position forward to the subsequent month, requiring vigilant monitoring of this rolling mechanism. It's important to note that the returns from commodity futures are influenced not solely by spot price movements. Depending on the shape of the future curve, rolling the position forward may yield additional profit (Backwardation) or result in a loss (Contango). Copper futures also facilitate trading with leverage; however, it's essential to acknowledge the inherent volatility of commodity futures. Engaging with leveraged products like copper futures entails the risk of potential losses surpassing the original investment, making it unsuitable for some investors. Nonetheless, active or passive funds exist that invest in copper futures, managing aspects like the rolling mechanism and leverage factor, although such services may come with a management fee, and the consideration of counterparty risk is advisable.

Investing in physical copper presents an interesting option, although it can come with significant costs related to storage, insurance, transportation, and other related expenses. Nonetheless, within this realm, there are active or passive funds available that offer ways to invest.

«FOR THIS SECTOR, AN ACTIVE MANAGED PORTFOLIO IS THE BEST SOLUTION FOR INVESTORS»

What about mining equities?

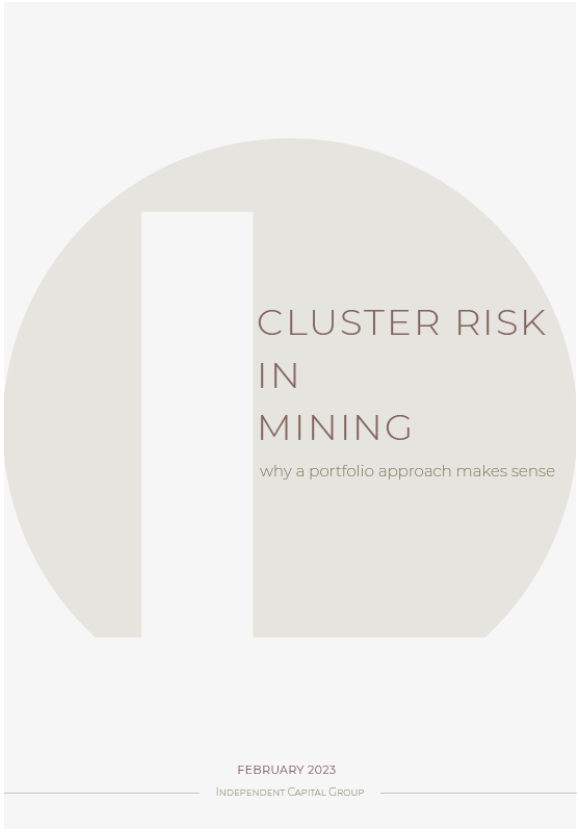
We hold a strong conviction that investors can maximize their gains by investing in a portfolio of mining equities.

Mining companies are presently exhibiting high profit margins, demonstrating exceptional capital management, and returning unprecedented sums to shareholders through dividends or stock repurchases.

However, mining companies have company specific risks. Operational as well as geopolitical risks are important factors to consider, analyze and monitor. As we elaborated in detail in our last research report "Cluster Risk in Mining" certain commodity resources are geographically concentrated, and mining is one of the most capital-intensive industries of all. It is therefore not surprising that many companies have a certain degree of concentration.

Especially when commodities are allocated via equities, an optimal commodity mix is not possible with a single company investment.

Even Mining Majors are heavily concentrated, and this profile is also visible with passive funds in this sector. Therefore, we are persuaded that for this sector an active managed portfolio is the best solution for investors – combining small-, mid- and large-cap companies to achieve the optimal mix for investors.



To receive our report on „Cluster Risk in Mining" from February 2023 contact us at research@independent-capital.com

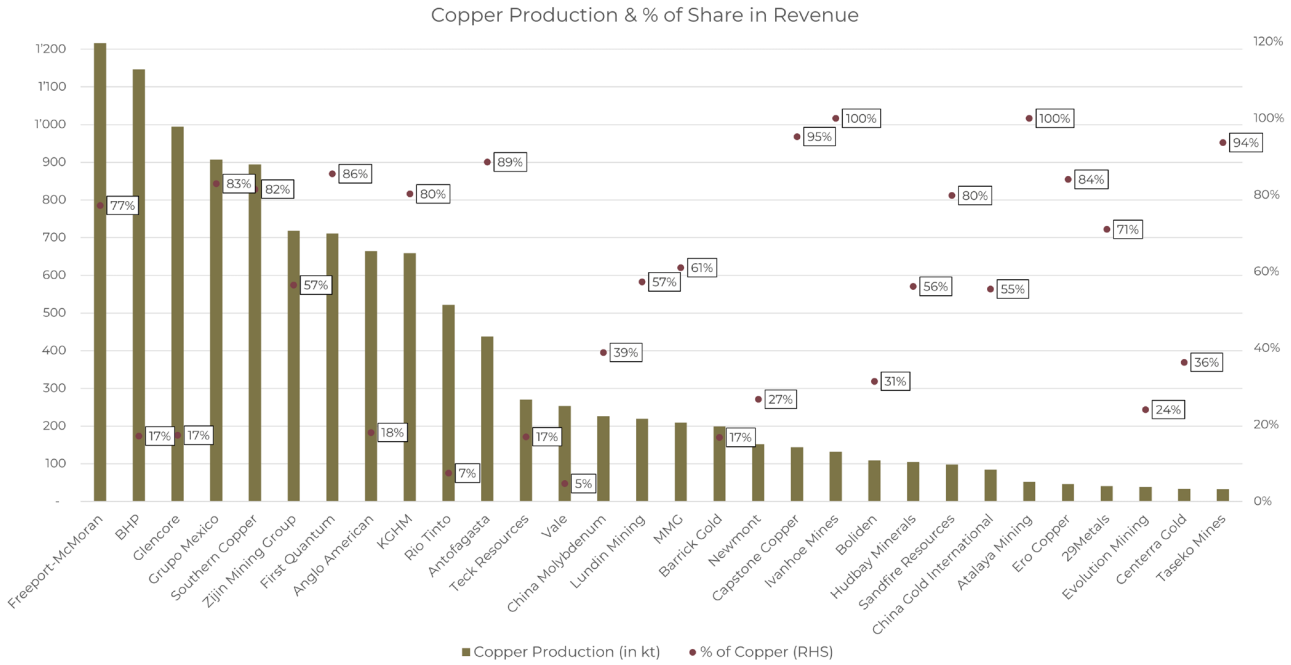
«IT'S IMPORTANT TO HIGHLIGHT THAT WHILE BHP AND GLENCORE CONTRIBUTE SIGNIFICANTLY TO COPPER OUTPUT, THE PORTION OF COPPER'S CONTRIBUTION TO THEIR OVERALL REVENUE REMAINS UNDER 20%»

What are the biggest listed copper producing companies?

For this analysis, we tapped our in-house ICG database to identify names boasting the highest absolute copper production, a substantial proportion of copper-based revenue, and scrutinized the profitability of these identified entities.

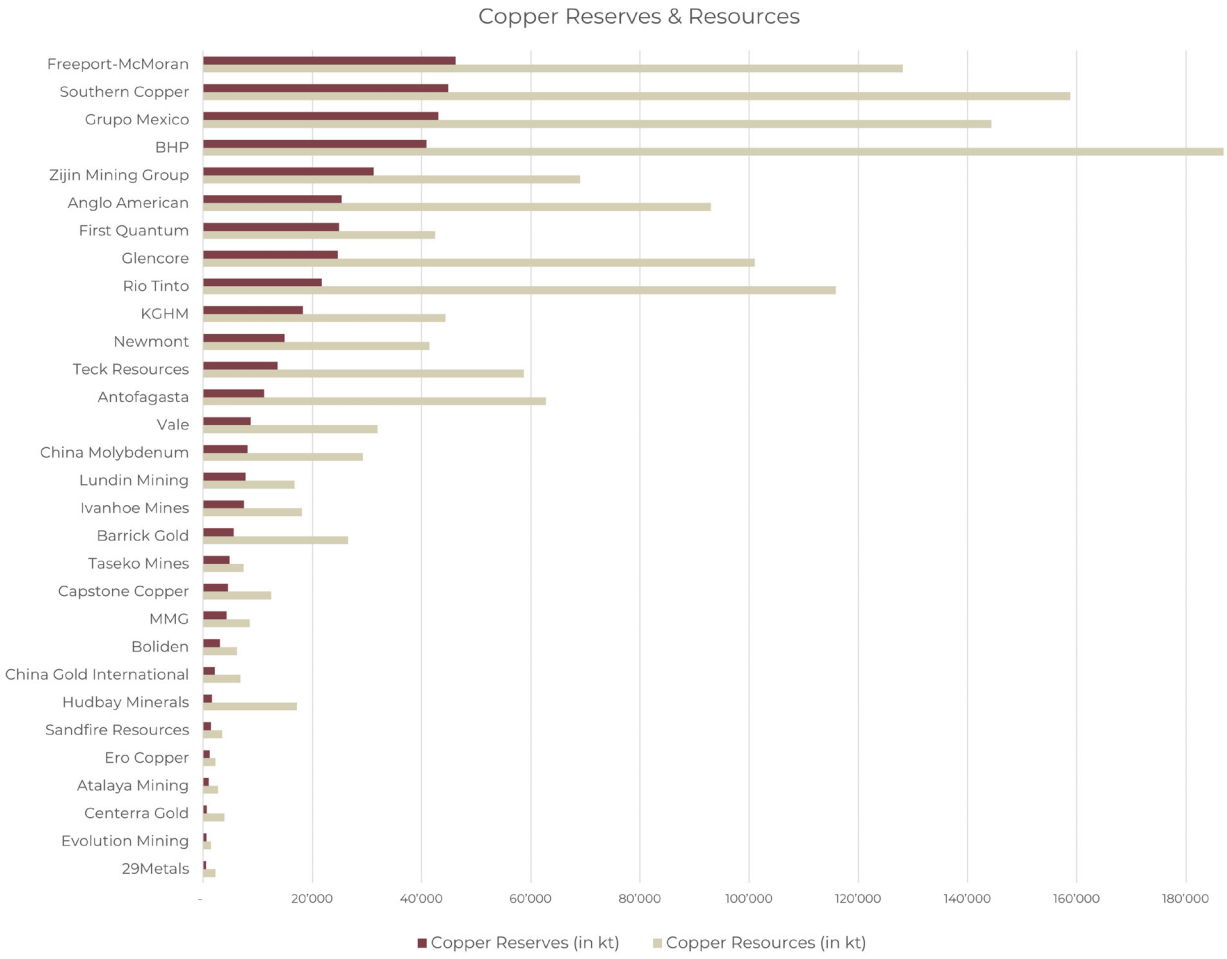
The three leading companies in terms of absolute copper production include Freeport-McMoran, the foremost publicly traded copper producer, followed by BHP and Glencore. However, it's important to highlight that while BHP and Glencore contribute significantly to copper output, the portion of copper's contribution to their overall revenue remains under 20%. Investors should consider the presence of other metals and by-products when investing in such prominent companies; for instance, BHP features iron ore as most significant product, while Glencore is associated with coal.

The total market capitalization of mining companies based on the ICG Industrial Mining Universe (258 companies) is at about $1,485bn, which compares to a total global market cap of publicly traded companies of about $108'600bn. This represents only 1.4%.



«FREEPORT CLAIMS THE LEADING POSITION IN COPPER RESERVES»

What are their reserve and resource quantities?

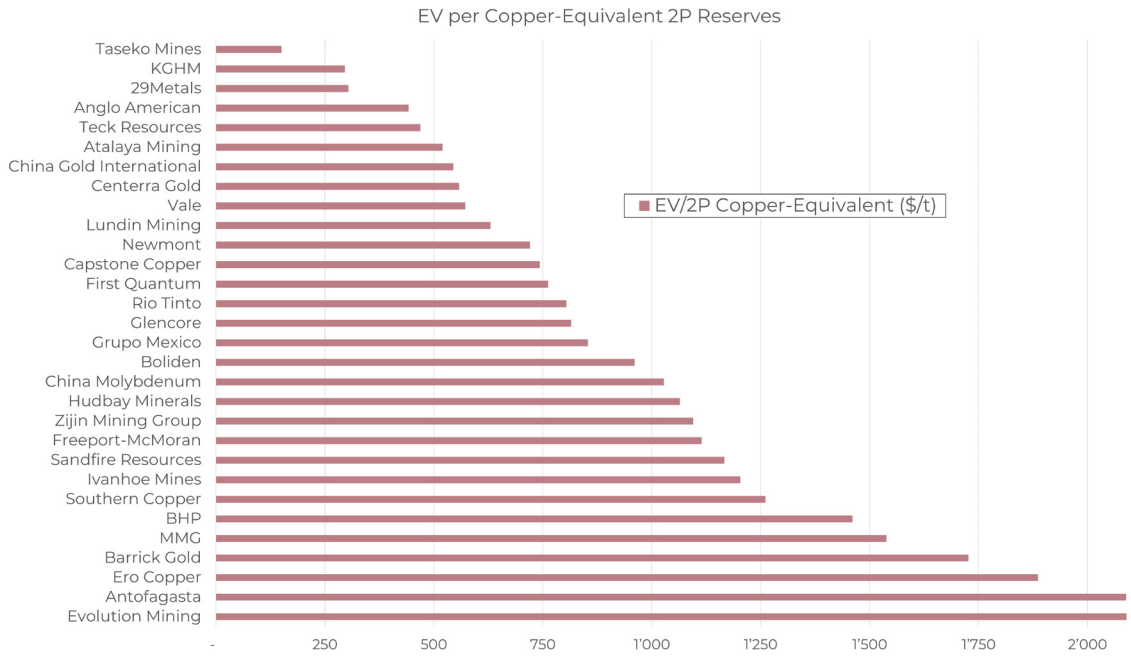


When considering Reserves and Resources, once more, Freeport claims the leading position, closely followed by Southern Copper and Grupo Mexico.

BHP also boasts a notable position with substantial copper resources, primarily attributed to its Escondida mine, which has a mine life of close to 60 years.

«MANY RESERVES COULD POTENTIALLY BE ACQUIRED FOR LESS THAN USD 1'000/T IN AN M&A»

How are the reserves valued by the market?



This calculation takes the Enterprise Value of the company divided by its 2P (Proven & Probable) copper equivalent reserves. This is in theory the price a company would have to pay, to acquire that amount of reserves below the ground. This metric is often used by the industry to look for attractive M&A targets. We may be in a point in time, where it is more attractive to acquire a company than to explore and develop a new mine. Recent M&A activity in the industry underlining this assertion.

Certain mining companies' reserves continue to be undervalued in the market. Many reserves could potentially be acquired for less than USD 1,000/t in an M&A, while resources come at significantly lower costs, albeit associated with greater uncertainty.

When examining valuations or figures such as margins and costs, utilizing a copper-equivalent (copper-Eq.) calculation makes sense because hardly any mine exclusively produces a single metal. Using the copper-eq. calculation allows companies to compare projects involving different metals and gauge their economic potential. This method evaluates assets, considering various metal market prices and their influence on project revenue.

«MANY COMPANIES GENERATE CASH MARGINS OF OVER 40%»

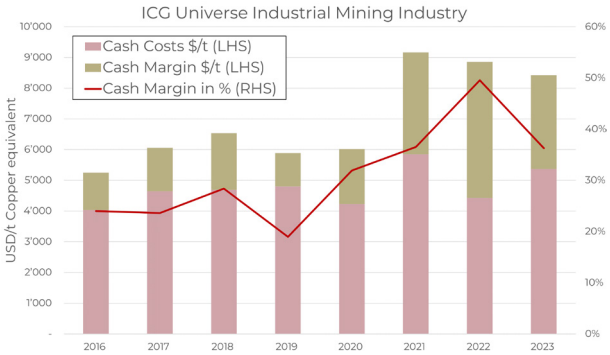
What about the profitability of these companies?

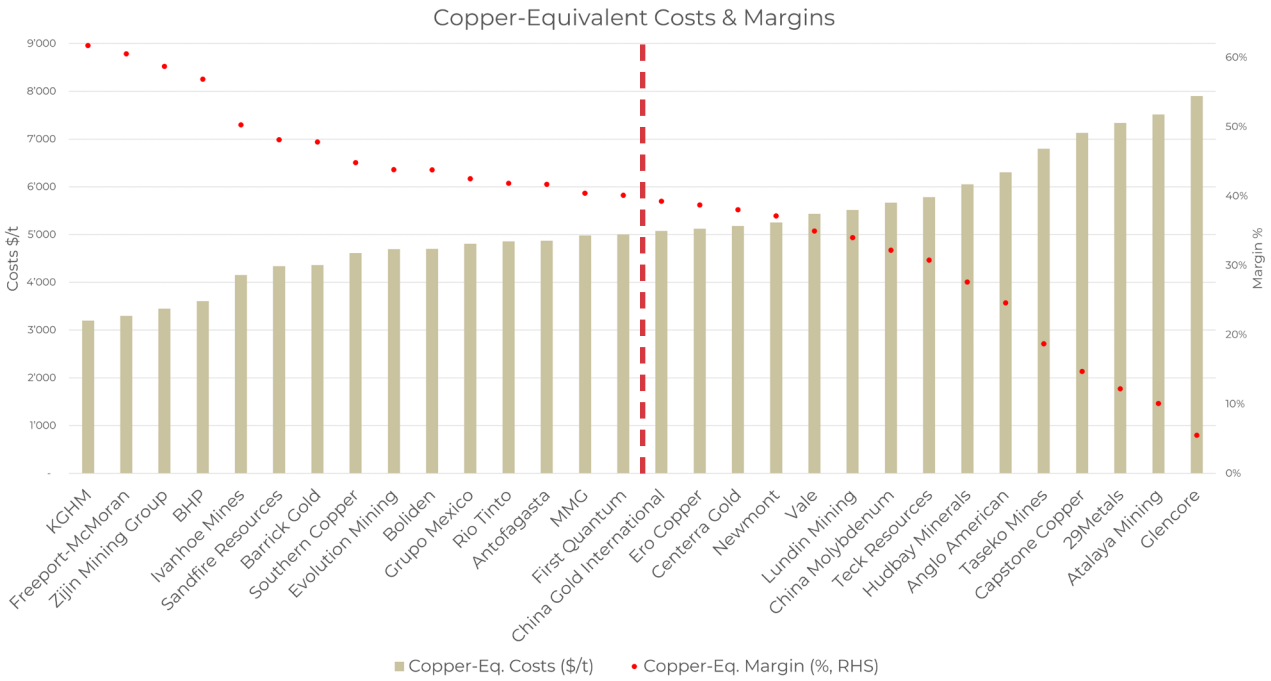
There are many companies generating cash margins above 40% at current prices.

However, recent cost inflation is having a severe impact on miners' P&Ls, primarily driven by higher prices for energy, cement, logistics and consumables, resulting in higher operating costs and capex.

Gross cash cost across life of mine increased by 15% and capex by 25% in the last four years. It's Important to note that labor, electricity, and fuel account for approximately half of mining costs.

Nevertheless, considering the whole Industrial Mining Industry (ICG Universe of 258 companies) it's interesting to see that miners cash margins' are still above the average of the last few years.





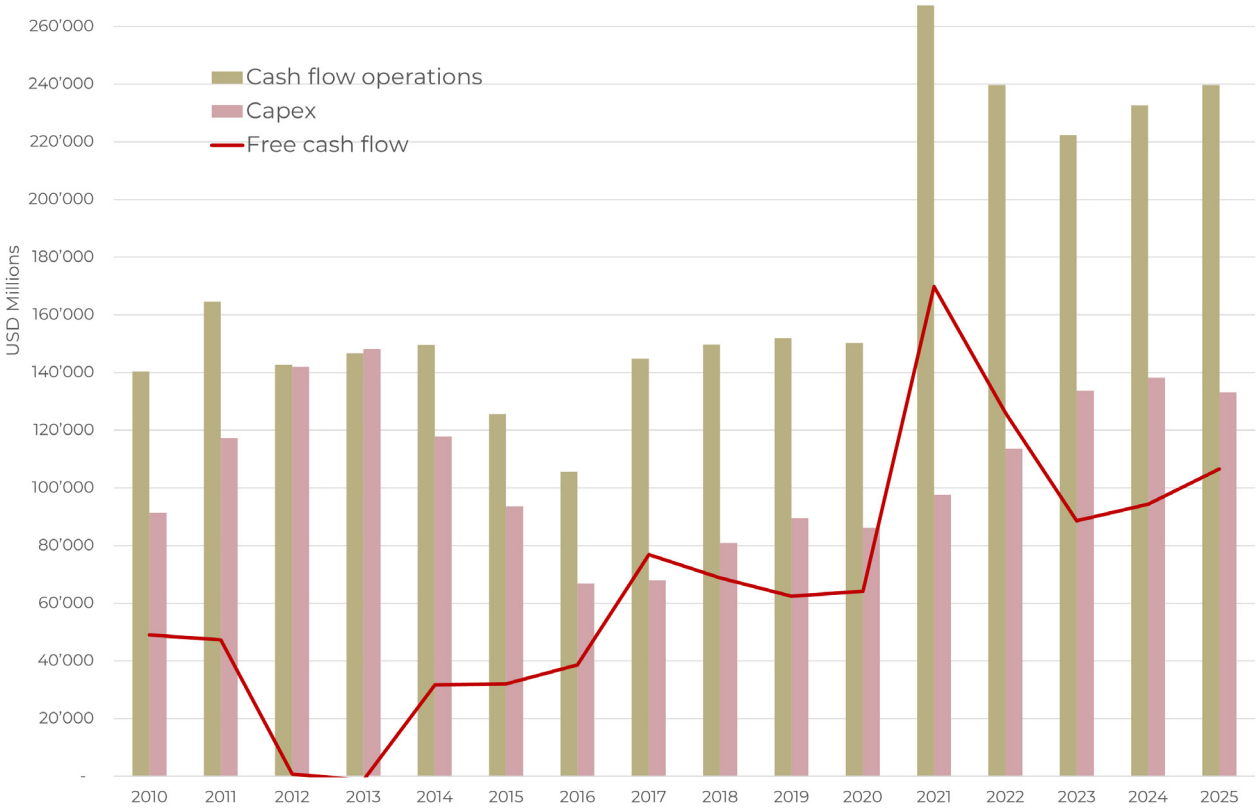
«MINING COMPANIES HAVE SEEN A BIG BOOST IN CASH FLOW FROM OPERATIONS RECENTLY»

What leads to miners being seen as cash cows?

Looking at the graph below, you'll find the combined cash flow from operations and Capex of the ICG Industrial Mining Universe. The graph displays how mining companies have seen a big boost in cash flow from operations recently, and this trend is expected to continue at historically high levels. Capex have also gone up, although not as dramatically. Mainly miners focusing on lithium and other battery materials have increased capex budgets.

Nevertheless, all this adds up to strong free cash flow for the foreseeable future.

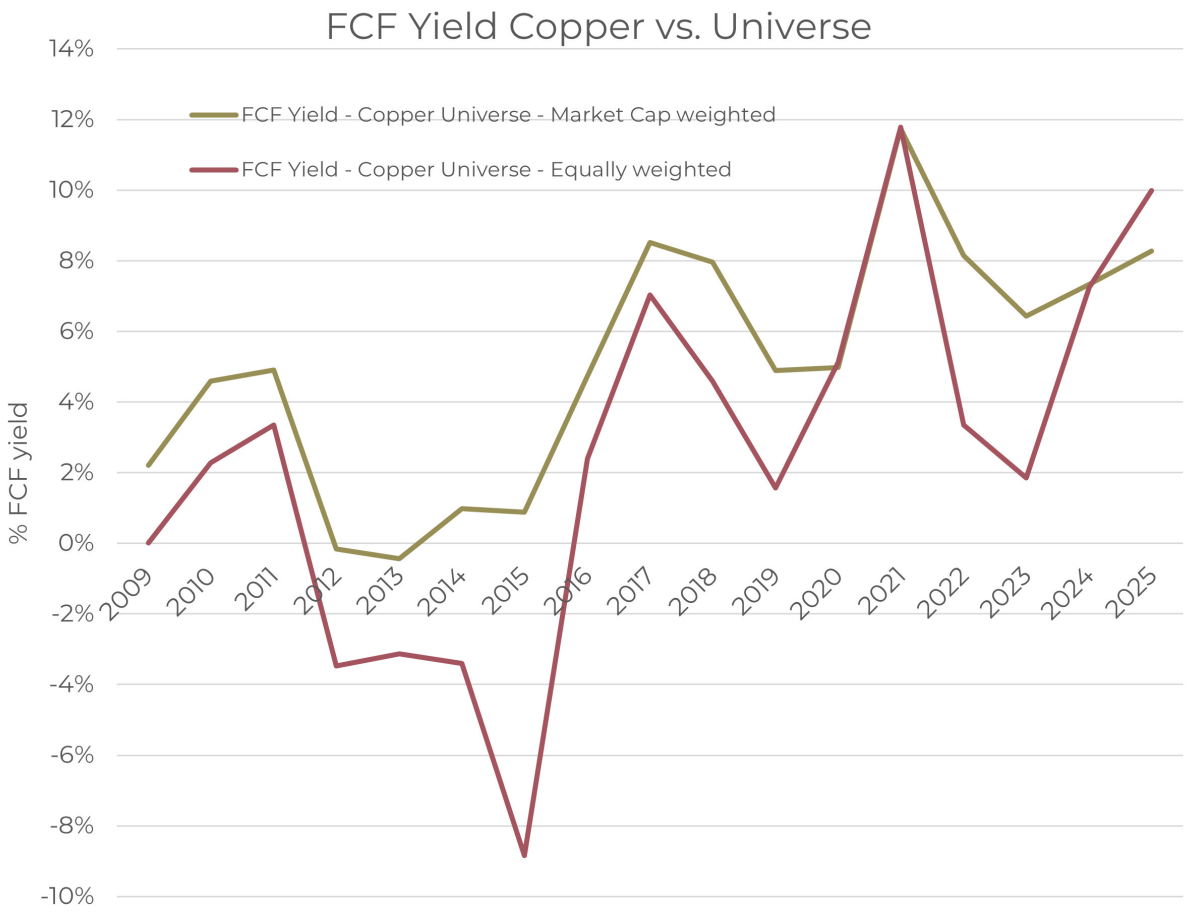
Financial Figures ICG Universe Industrial Mining Industry



«ITS INTRIGUING TO OBSERVE SIGNIFICANT VARIATIONS AT THE COMPANY LEVEL»

How does the free cash flow yield of these copper-focused firms compare to the rest of the industry?

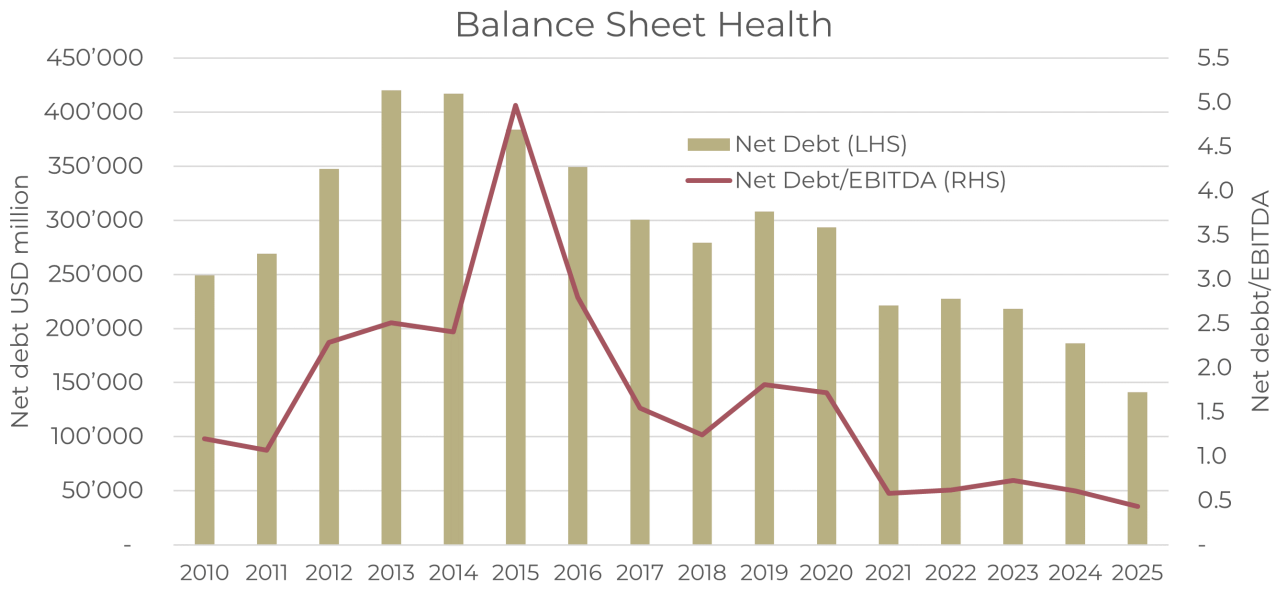
The list of the top 30 copper-related companies includes the Big Miners, and consequently, the combined market capitalization of these 30 companies ($800bn) constitutes 54% of the ICG Industrial Mining Universe total market cap ($1,485bn). The free cash flow yield closely aligns with that of the entire universe. Nonetheless, it's intriguing to observe significant variations at the company level. Larger-cap companies currently exhibit higher margins, while some smaller companies are projected to achieve higher margins in the coming years as new mines begin production.



«THE INDUSTRY IS GENERATING MORE EBITDA IN A YEAR THAN THE TOTAL OUTSTANDING DEBT IT CURRENTLY HOLDS»

How healthy are the balance sheets?

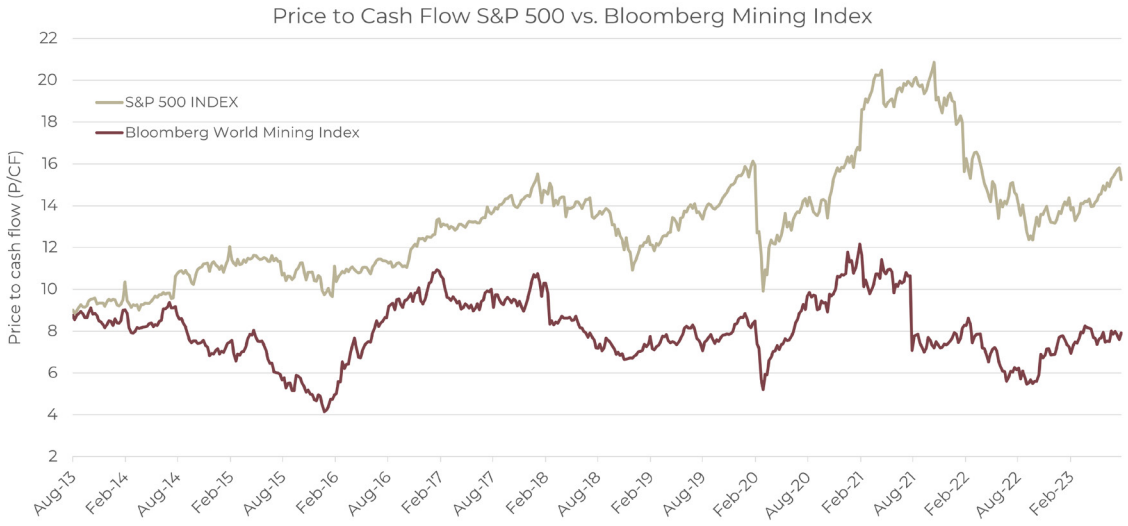
It's worth mentioning that the ICG Industrial Mining Universe financial position has significantly improved in recent years. The industry managed to reduce its debt at an unprecedented rate. Presently, the total net debt for the industry stands at approximately $215bn. This figure is anticipated to drop by another 35% within the next two years. The net debt/EBITDA ratio is at an all-time low of 0.7x, a stark contrast to its level of over 5x back in 2015. To put it differently, the industry is generating more EBITDA in a year than the total outstanding debt it currently holds.

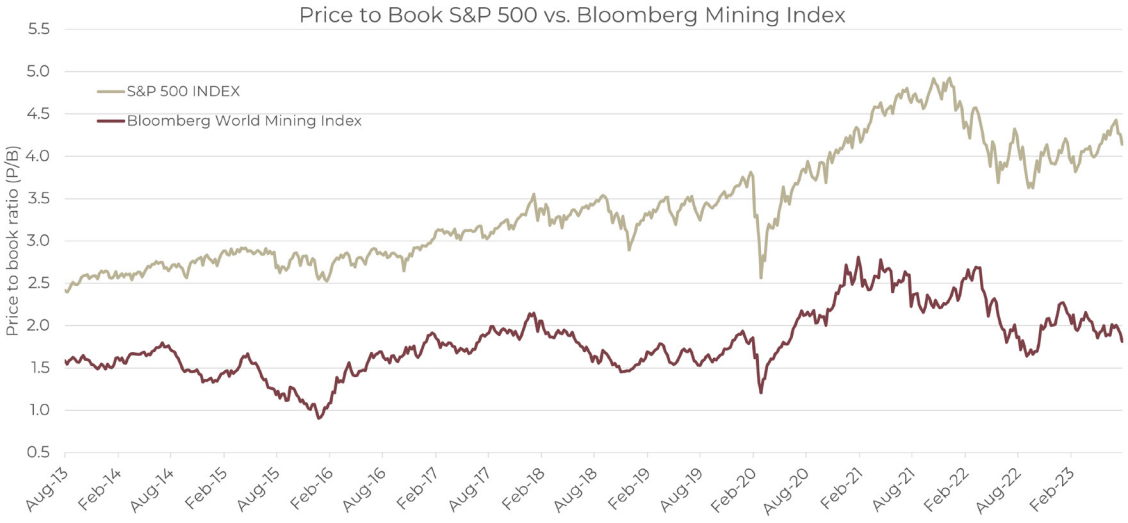


«MINING COMPANIES ARE STILL HEAVILY UNDERVALUED»

How appealing are the stock valuations for these companies?

Observing the Price-to-Cash Flow (P/CF) chart of the Mining Universe derived from the Bloomberg World Mining Index and contrasting it with the S&P 500 Index, a notable and, in our view, seemingly unjustified gap becomes evident. A similar gap is evident in the Price-to-Book ratio of the Mining Industry compared to the S&P 500 Index.

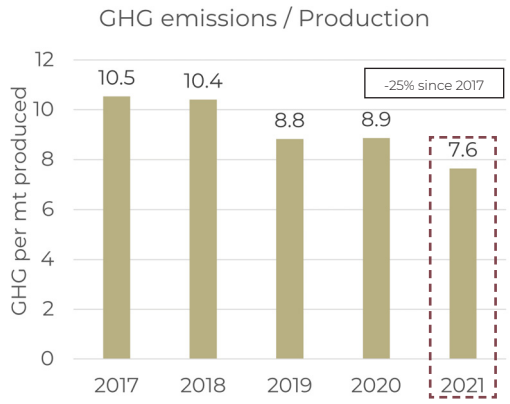




«MINING COMPANIES ARE ACCTIVELY TAKING MEASURES TO TACKLE ESG CONSIDERATIONS»

What about the consideration of ESG factors in mining investments?

Amidst a rising concern among environmental groups and indigenous communities regarding the potential detrimental impacts of mining, local governments are adopting an increasingly cautious stance by either withholding or withdrawing licenses for mining operations. Thus, it becomes crucial for both the mining industry and governments to prioritize measures aimed at mitigating adverse environmental effects. Employing strategies for environmental management and fostering innovation becomes essential.



Mining companies are actively taking measures to tackle ESG considerations, which are reflected across various aspects we have analyzed. A snapshot of these efforts above and to the right, demonstrating visible strides in reducing greenhouse gas emissions and adopting water-efficient metal extraction practices. Mining companies are under immense pressure from governments, investors, and society to enhance their ESG metrics. An increasing number of these companies are making commitments to reduce emissions - while these advancements are noteworthy, their significance is often underestimated. Paradoxically, the challenge arises as copper itself is a pivotal raw material for global ESG initiatives like decarbonization and electrification. If obtaining social and environmental licenses for the construction and operation of new mines becomes more difficult, resulting in delays and disruptions, the deficit in copper could grow substantially. This, in turn, hampers efforts to achieve decarbonization goals, creating a complex dilemma for the industry and global sustainability efforts.

for a more comprehensive insight into ESG-related aspects, we invite you to explore our dedicated ESG quarterly report

CONCLUSION

The global copper market is evolving rapidly and presents investors with tremendous opportunities. This report highlighted the complex supply-demand dynamics that characterize the market and offered insights into the current state of global copper producers.

As the race toward net-zero accelerates and widespread electrification gathers momentum, copper demand is soaring and is set to continue this trajectory. Copper is essential for the extension of power grids and a key component in most "green" applications, from EVs, photovoltaics to windmills. There is a near perfect correlation between electricity generation and refined copper consumption. This booming demand outlook has raised concerns of whether supply can keep pace. Given structural underinvestment in the sector, slowed exploration efforts, and diminishing ore grades, a significant shortfall is looming by the end of the decade. The concentration of copper production in countries like Chile and Peru raises further concerns about geopolitical and environmental risks. While leading copper mines today still contribute significantly to global supply, the industry may face future disruptions if new mining capacity is not developed soon. The incentive price for new projects currently lies at ~ $9,000/t. This price may reach $13,000/t by 2030 to tackle supply deficits.

For investors, the current dynamics of the copper market offer significant upside potential, especially through a diversified and actively managed portfolio of equities. Natural resource producers are in a sweet spot right now. They are achieving historically high profit margins, maintaining healthy balance sheets, and their valuation metrics remain low. We believe that valuations of mining stocks do not yet properly reflect the structural supply deficit that is on the horizon. Looking at the present, the recent drop in mining share prices can be understood in light of the challenges China is facing. Indeed, there might be additional short-term risks that could push prices down further. However, taking a long-term view, we believe it is more important that the fundamental data remains consistent. As this report has shown, this is certainly the case. Given the seemingly unstoppable push toward green technologies, future demand growth for metals like copper looks strong. Coupled with persistent supply constraints and low inventories, we believe commodity prices and mining stocks will rebound.

The fact that we are engaging in more conversations than ever before is showing us that the interest of both institutional and individual investors for mining equities is returning – this is a very encouraging sign to us.

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Independent Capital Group Basel has been involved in commodity and energy investments for over 20 years - we are happy to help you with inputs on the markets, specific companies and with tailor-made investment strategies along the “Road to Green” to find the commodity allocation you are looking for.

Thank you for your trust

APPENDIX

This research paper used informations and data from the following institutions: Alpine Macro, Bloomberg, BMO, Chile Ministry of Finance, Credit Suisse, CRU, Deutsche Bank, Energy Transition Council, GBM, Goldman Sachs, International Copper Study Group, International Energy Agency, Jefferies, JP Morgan, Markit, RFC, Ambrian, S&P Global, Scotiabank, UBS, US Department of Energy, USGS, Wood Mackenzie , Company Data & Independent Capital Group.

If you would like to see a specific dataset, please do not hesitate to contact us at research@independent-capital.com.