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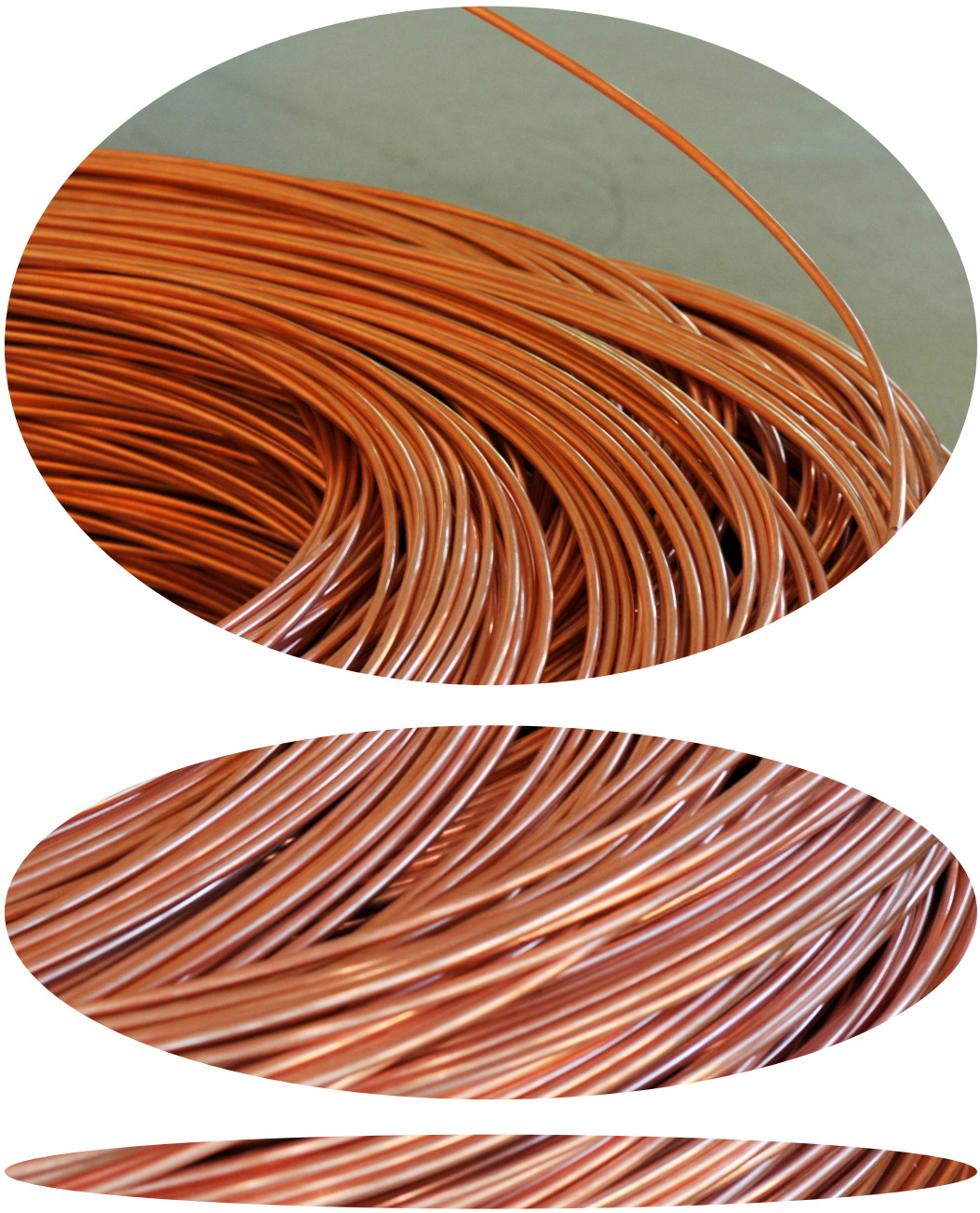
A WORD ON COMMODITIES

# COPPER, THE SWISS ARMY KNIFE OF LOW-CARBON TECHNOLOGIES



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Understanding metals

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# Understanding metals

This publication aims to make better know the fundamentals of major metals, including supply, demand, main price determinants, and structural changes afoot.

This is an overview of the key factors to grasp, quite apart from short-term market shifts.

**Completed on 11/06/2025**

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**Does copper really need an introduction?** This fascinating metal is **a veritable jack-of-all-trades for human activities.** It is an excellent conductor of heat and electricity, cold-malleable, corrosion-resistant and antimicrobial. Copper is found in the earth's crust in various forms: as sulphate minerals, in oxidated form, and even in its "native" state. It is also naturally occurring in humans, animals and plants!

## Copper datasheet

- Atomic symbol: Cu
- Melting point: 1,085 °C
- Mining output in 2024: 22.88 million tonnes. Production of refined copper: 27.6 million tonnes[1]
- Annual consumption, 2024: 27.33 million tonnes
- Properties: electrical and thermal conductor; ductile and malleable; antimicrobial; durable and corrosion-resistant; recyclable without loss of properties

Copper was discovered very early by humans, in prehistory in fact and is the first known metal in human history. It was soon mastered for daily use and, since its discovery, has become essential to human life.

Copper indeed has especially attractive properties. Its excellent electrical conductivity, exceeded only by silver, makes it an essential metal for electrification. Copper is also extremely malleable and ductile: It can be shaped and drawn out, meaning it can be transformed into plates, tubes and wires, which is why it is ubiquitous in industry.

Lastly, its resistance to corrosion is exemplary, as it withstands the effects of water and chemicals. This last property makes it long-lived.

It is accordingly used in about 15 sectors, including housing, heating and air-conditioning, household appliances and electronics, and telecommunications. As the ultimate electrification metal, its extraordinary capacities make it the metal that is essential to the energy transition that we have undertaken to combat climate change. It is also key to the sizeable challenges of digitalisation, the artificial intelligence boom, and their huge needs for producing, storing and transporting electricity. We will also see how copper is being used in an increasing number of applications and how much demand for copper is expected to accelerate in the coming years.

## Worth knowing

The human body contains 100 mg of copper. Good news: to reach the WHO's daily recommended allowance of 2 mg/day, a person would have to eat about 100 g of chocolate each day, or, otherwise, beef liver (39 mg/kg), oysters or dried vegetables (9 mg/kg).

We will also explore the major challenges involved in producing copper, which currently runs into a number of physical laws, operational constraints and political strife. These give us an idea of the obstacles that the copper market could encounter in the coming years, driven by sharply rising demand, limited supply, and geographical concentration of this essential resource.

*[1] Or 22.9 million tonnes of primary production of copper and 4.6 million tonnes of secondary production (source: International Copper Study Group, 2025).*

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## USES OF COPPER

As the best conductor of electricity after silver and far less expensive, copper is used in many sectors of our modern world.
Electrical uses are the main drivers of demand for copper. Power generation and transmission, cables, telecommunications, electrical and electronic goods account for about 75% of total consumption of copper[2]. But it is also used to make transport equipment and infrastructures and industrial machines and possesses a wide range of other applications, some of which are less well-known to the public.

### ELECTRICITY AND ELECTRONICS

Copper is, first and foremost, used in abundance in the electrical grid, in the wires and cables that transmit electricity efficiently over long distances. Copper cables are also used in telecommunications networks (in telephone lines and electronic devices), and in the cores of printed circuit boards found in a wide range of devices, from computers to mobile telephones.

Copper is also used in electrical motors, transformers and generators, where its conductivity and heat-resistance are essential properties.

**Worth knowing**

Thanks to its aesthetics and unique colour, copper is used to build façades, doors, etc. and certain ornaments.

### CONSTRUCTION

Copper's unique properties make it a choice material in the construction industry. It is used mainly in electrical installations and plumbing. Its conductivity allows it to transmit electricity efficiently. Moreover, it is resistant to corrosion, making it ideal for plumbing pipes and guaranteeing a long service life for fixtures.

Copper is also used in heating, ventilation and air-conditioning systems, owing to its capacity to transfer heat effectively.

### TRANSPORTS

Copper is widely used in vehicle electrical systems, particularly for cables and electronic components. In addition to its conventional uses, copper demand has been driven up even more by the development of navigation, communication and onboard entertainment systems. It is also used in braking and cooling systems, where its ability to dissipate heat enhances vehicles' security and reliability. Lastly, copper is found in transport infrastructures, such as signalling cables and braking and control systems.

### INDUSTRIAL EQUIPMENT

Wherever industrial machines and equipment are found, you will find copper. Thanks to their durability and capacity to be precisely shaped, copper alloys are all used to make products such as gearings, ball bearings and turbine blades.

Copper's excellent heat transfer capacities and resistance to extreme environments make it the ideal choice for heat exchange equipment, storage tanks and vats. And its corrosion-resistant properties make it especially suitable for use in marine or other demanding environments.

**A MULTITUDE OF USES,** in fact, some of which are less known to the public:

- Copper is antimicrobial, and some coatings can kill more than 99.9% of bacteria in less than two hours. It is an alternative to plastic in medical applications.
- It can dissipate seismic energy. Copper-based devices can help mitigate damage caused by earthquakes by absorbing energy and limiting building movements.
- New, ultra-conducting copper electronic components promise important improvements in the efficiency of transport and distribution of electrical energy.

[2] *Source: International Copper Study Group, 2025.*

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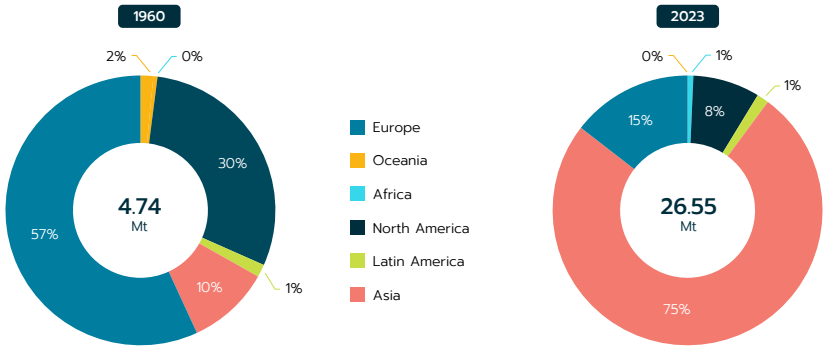
## WHO CONSUMES THE MOST COPPER?... CHINA!

The 2010s saw an impressive acceleration in China's consumption of metals, and copper was no exception. Each year China consumes almost 60% of global demand, vs. 10% in 2000[3]. This reflects the economic boom in China and the rest of Asia, which have consumed even more metals, as that boom has come with intense industrial, real-estate and infrastructure development over the past three decades.

SHARE OF THE USE OF REFINED COPPER BY RÉGION, 1960 VS. 2023




Source: ICSG

China's traditional drivers of development have now slowed down considerably. Heavy industry and infrastructure are more mature, while the real-estate sector is overleveraged and overbuilt against a backdrop of demographic ageing, and is still trying to dig itself out of a serious downturn. This industrial slowdown has hit China's demand for copper hard. The Chinese construction sector consumed 2 million tonnes of copper in 2024, 30%off its peak in 2021[4].

However, a very interesting development has arisen in China, one that is representative of the veritable revolution currently in progress on the copper market: despite the slump in these industrial sectors, copper demand in China has continued to grow in recent years. This has been driven by the boom in new uses of copper, driven by new sectors, particularly in the energy transition, which are now undermining the major equilibria of this market.

## AN OBVIOUS LINK TO THE ENERGY TRANSITION

To try to combat ongoing climate change and limit the rise in temperatures and its dramatic consequences on ecosystems such as human activities, we must reduce extraction and use of fossil fuels as much as possible. Fossil fuels still account for 82% of our consumption of primary energy and for 70% of greenhouse gas emissions[5]. Keep in mind that we have no other choice here: doing nothing and allowing global warming to reach 5 or 6 degrees could cost 50% of global GDP between 2070 and 2090[6]. We have no other choice but to undertake this transition, and to do rapidly...

However, to rid ourselves of fossil fuels, we will have to in continue and accelerate the roll-out of the lower-carbon energy sources available to us, led by renewable energies. Massive development of wind, photovoltaic, hydroelectric and nuclear power are some solutions that are the easiest to implement. Apart from generating primary energy, electrifying transports is one way to end our vehicles' dependence on fossil fuels.

All these new sectors have one thing in common: they are far more metal-intensive than fossil-fuel production and use.

Among these essential materials, copper may be the most prominent of all metals useful for the energy transition. As a very good conductor of electricity, it is used to capture, transmit and store energy in almost all low-carbon technologies.

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[3] *Source: Global X ETFs, Bloomberg, 31 December 2022.*
[4] *Source: Citi Bank, June 2025*
[5] *BP statistical review, 2022*
[6] *Source: Institute and Faculty of Actuaries, January 2025; https://actuaries.org.uk/news-and-media-releases/news-articles/2025/jan/16-jan-25-planetary-solvency-finding-our-balance-with-nature/*

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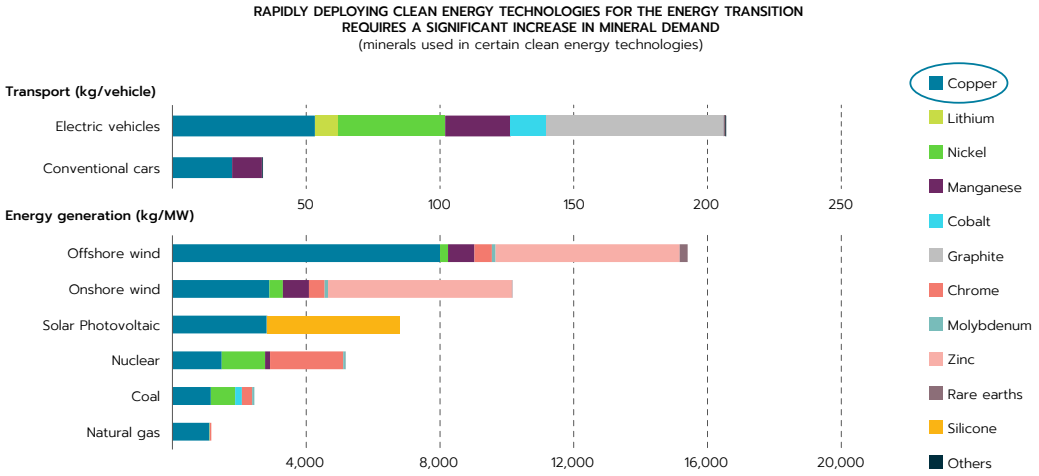
## THE SWISS ARMY KNIFE OF THE ENERGY TRANSITION




Remarks: kg = kilogramme; MW = megawatt. Not including steel and aluminium.
Source: IEA

### PHOTOVOLATIC

Copper plays an important part in renewable energy equipment. It is not only a very good conductor of electricity but also an excellent heat conductor. Its capacity to transfer heat effectively is now used in solar panels. Copper is an essential component in their heat exchangers, as it helps captures and transport energy. Copper electrical cabling is also used to conduct electricity captured by the solar cells. A solar power plant consumes an estimated total of between 2.5 and 7 tonnes of copper per megawatt of installed capacity[7].

### WIND-POWER

Copper is just as important to wind power: a typical 660 kW turbine contains about 350 kg[7]. In the alternator, copper is used to convert the mechanical energy captured by wind into electrical energy. Copper coils are also found in transformers, which switch voltages. Offshore wind-power parks are known for using even more copper than onshore parks, due to the additional cabling needed to transport energy to the coast.

**Worth knowing**
Depending on its size, a wind turbine contains 1 to 5 tonnes of copper.

**Worth knowing**
An electric vehicle contains about four times more copper than a conventional ICE vehicle: 80 to 100 kilos, vs. about 20 kilos.

### ELECTRIC VEHICLES

Copper is now present in large quantities in the batteries of hybrid and electrical vehicles. High-performance copper cables transmit energy rapidly from the battery to the engine. Copper electrical wires are also widely used in charging stations, as their excellent conductivity makes charging efficient.

### THE ELECTRICAL GRID, A GIANT OF THE ENERGY TRANSITION

The electrical grid is the veritable backbone of the energy transition, as well as of our current electricity uses and the digitalisation of economies. But its development needs are often ignored. And yet, the grid alone is already driving a massive increase in demand for copper. At windfarms and at solar power arrays, vast networks of copper wire are used to transmit and distribute energy to local grids. Charging stations for electrical vehicles, electrification of industrial facilities – all these new installations have to be connected to the grid. As a result, the grid will have to be rolled out massively to address the decentralisation of production to come.

The electrical grid requires investment not just for new equipment. The existing grid is, in many cases, decrepit and needs urgent refurbishment. The US grid, for example, is 60 years old on average, but in some states, it is over a century old. It is notoriously vulnerable to extreme weather events, with the system failing during a rough winter in Texas in 2021, or causing the recent fires in California, with awful consequences. Not to mention the fact that the conventional grid is not suited to the intermittency that is characteristic of renewable energies and will therefore have to be upgraded.

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[7] *Source: International Copper Study Group, The World Copper Factbook 2024.*

The authorities are aware of these challenges and are accelerating projects in the sector. In the US, annual investments are expected to rise by 40%, from an annual average of 103 billion dollars between 2020 and 2023 to 145 billion dollars between 2024 and 2027[8]. In China, investments are expanding the grid and making it a smart grid, able to manage intermittency and shifts in electricity demand. The Chinese government invested 80 billion dollars in the grid in 2023, 80 billion in 2024, and 89 billion in 2025[9].

## Worth knowing

The International Energy Agency estimates that the world's current 70 million km-long grid would have to double in size, to 150 million kilometres to meet new needs... or the distance between Earth and the Sun!

### THE DIGITAL REVOLUTION

Copper's importance is well-known in construction, electrical appliances and renewable energies. But in addition to the traditional economy and the energy transition, other, in-depth transformations are underway, including in the digital revolution. So, it is worth looking at how the digitalisation of our world is also driving an increase in copper demand.

The spectacular progress of AI[10], the Internet of objects[11] and cloud computing[12] have generated unprecedented demand for data storage and processing power. This strong growth is driving the development of datacentres[13] worldwide, which have become the true pillars of our digital economy.

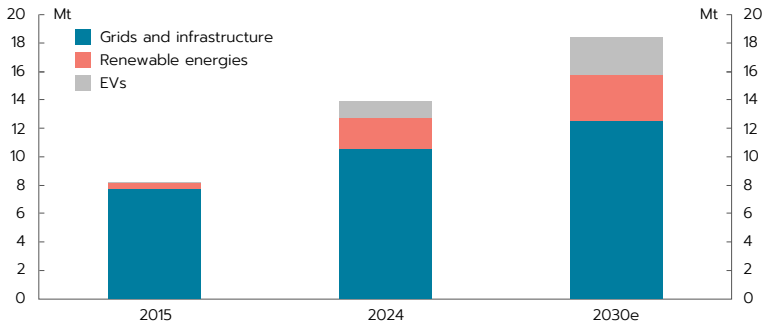
Copper is essential to the proper functioning of datacentres and plays a crucial role in their electrical cabling, cooling systems and network infrastructure. Copper's conductivity and reliability make it essential to maintaining the performances and high degree of availability required by these installations.

BHP, a mining company,[14] estimates that demand for copper from AI alone will amount to 3.4 million tonnes annually by 2050, driven mostly by the needs of datacentres, computer chips and microprocessors. For, the complex algorithms underlying AI require considerable computing power and, in turn, high-performance computer chips and a large quantity of copper both to conduct electricity and to dissipate heat efficiency in datacentres, where data are stored and processed. According to BHP, datacentres alone will account for 7% of global demand for copper by 2050. This increase is about equivalent to the combined annual output of the world's current four largest copper mines.

As we have seen, electrification is being rolled out massively in many areas. Electricity's share of global energy consumption is expected to rise from 20% in 2023 to 50% in 2050, according to the International Energy Agency[15].

Copper demand in electrification is constantly on the rise. It accounted for 40% of annual consumption in 2023, a figure expected to hit 44% in 2025[16].

COPPER DEMAND FOR ELECTRIFICATION




Sources: IEA, CRU, Wood Mackenzie, Goldman Sachs Global Investment Research, 2025

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[8] *Source: Goldman Sachs, February 2025.*
[9] *Sources: Statista, Reuters, January 2025.*
[10] *Artificial intelligence (AI): all theories and techniques developing complex IT capable of simulating certain traits of human intelligence, such as reasoning and learning and others.*
[11] *The Internet of Things or IoT) is the interconnexion between Internet and objects, places and physical environments.*
[12] *Cloud computing is a technology for using the resources of IT servers remotely, via internet.*
[13] *A datacentre is an infrastructure composed of a network of computers and storage spaces.*
[14] *https://www.bhp.com/news/bhp-insights/2024/09/how-copper-will-shape-our-future*
*Companies are mentioned solely for informational purposes and not as an offer to sell, or a solicitation to buy, securities.*
[15] *Source: IEA, https://www.iea.org/energy-system/electricity, Juillet 2023*
[16] *Source: IEA, CRU, Wood Mackenzie, Goldman Sachs Global Investment Research, 2025.*

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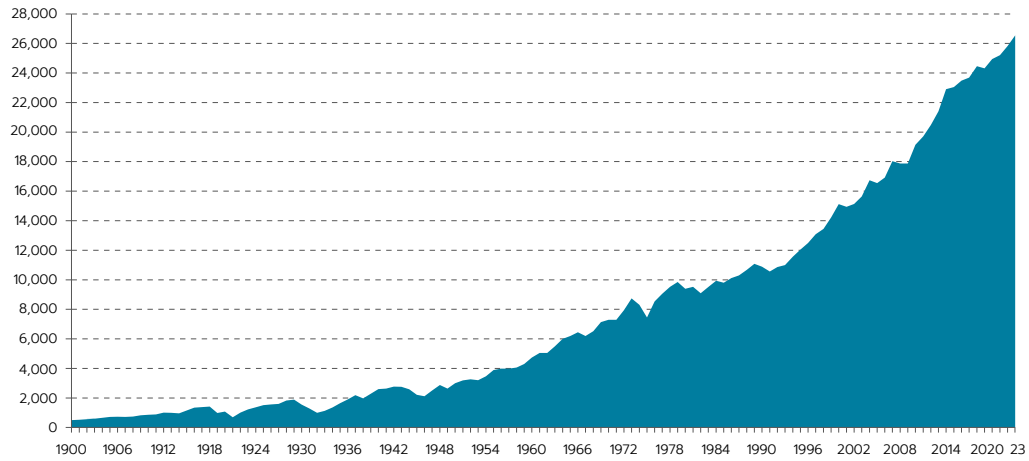
## DR COPPER IS DEAD, LONG LIVE DR GREEN!

As we have seen, copper is above all a metal for economic development, due to the key role it plays in sectors such as construction, infrastructure, transport, electrification and household appliances. Consumption of it has therefore been historically correlated to economic activity, so much so that economists have nicknamed it "Dr Copper". Trends in copper demand and prices serve as a bellwether of global economic health. For decades, demand has therefore naturally tracked the pace of economic growth, even in the most mature countries, driven by ongoing construction and innovations.

UGLOBAL USE OF REFINED COPPER, 1900-2023
(thousands of metric tonnes of copper)




Source: ICSG

But this correlation has now been shaken to the core by the boom in new uses of copper, which have reduced copper consumption's dependency on the economic cycle.

This phenomenon has been in spectacular display in recent years in China. By 2024, China had been marked by the Covid 19 epidemic and the government's "zero Covid" policy, and burdened by a real-estate slump and a slowdown, mainly in industry and construction. This resulted in a steep drop in copper consumption in these sectors: copper demand in construction, for example, fell by 10% on the year[17].

However, China is also accelerating the roll-out of new energy transition sectors, including photovoltaic, wind and electrical vehicles. These booming new sectors are generating very heavy demand for copper, so much so that Chinese demand for refined copper expanded by 4% on the year. New demand has thereby more than offset declining demand in traditional sectors. This is a major shift for the market: the correlation between copper and economic activity is giving way to a more structural demand that is expanding fast and more sustainably.

We therefore believe that the megatrend of electrification should help transform demand for copper. In fact, it will drive almost all growth in demand until 2030. The electrical grid alone is expected to account for more than 50% of this growth, thus adding the equivalent of a country like the United States to global demand for copper[17].

## DO WE HAVE ENOUGH COPPER? WHY ARE SHORTAGES FORECAST?

### RESERVES, RESOURCES

To answer this question, we have to look at the planet's copper reserves and resources.

Reserves are the term for deposits that have been discovered, evaluated and deemed technologically and economically exploitable. Resources are far greater and include reserves, discovered deposits that are potentially profitably in the event of higher prices or technological breakthrough, and deposits that have not been discovered but are anticipated based on preliminary geological studies.

According to the US Geological Survey (USGS), copper reserves amounted to about 1,000 million tonnes (Mt) in 2023. Identified and undiscovered copper resources were estimated in 2015 at about 2100 Mt and 3500 Mt, respectively[18]. These latter estimates do not include copper resources identified on seafloors, which are hard to mine for the moment.

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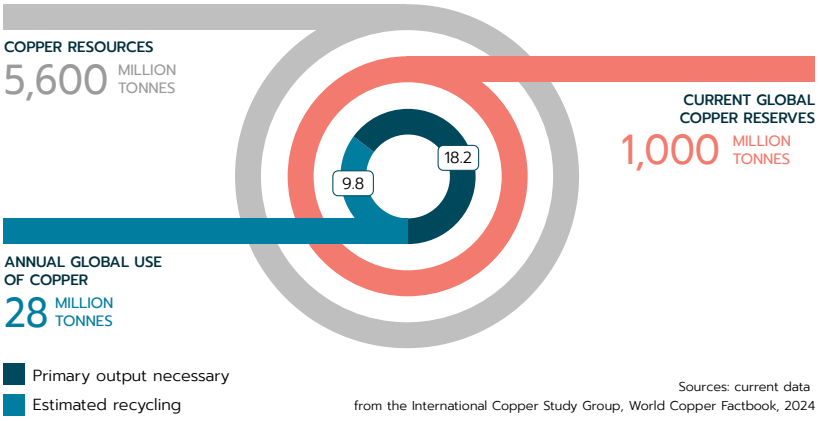
[17] *Source: Goldman Sachs, 2024*
[18] *Source: United States Geological Survey [USGS], 2020; https://internationalcopper.org/fr/sustainable-copper/about-copper/cu-demand-long-term-availability/, and International Copper Study Group, World Copper Factbook 2024.*




So, there is theoretically enough copper in the ground to meet our current needs and, more importantly, our future needs. However, most existing resources are expected to be used up by the energy transition, whose copper-intensive technologies are likely to cause a boom in demand.

The Institut Français du Pétrole et des Énergies Nouvelles (IFP-IN), for example, estimates that, even with a high recycling rate of about 40%, more than 90% of proven resources may have been consumed by 2050[19]. Barring major technological breakthroughs in mining methods, copper prices will have to rise significantly for reserves to continue to grow.

The real question, in fact, is this: can copper be mined rapidly enough to keep up with the pace of growth in demand? The answer is not so clear-cut.

## THE DIFFICULTIES OF COPPER MINING

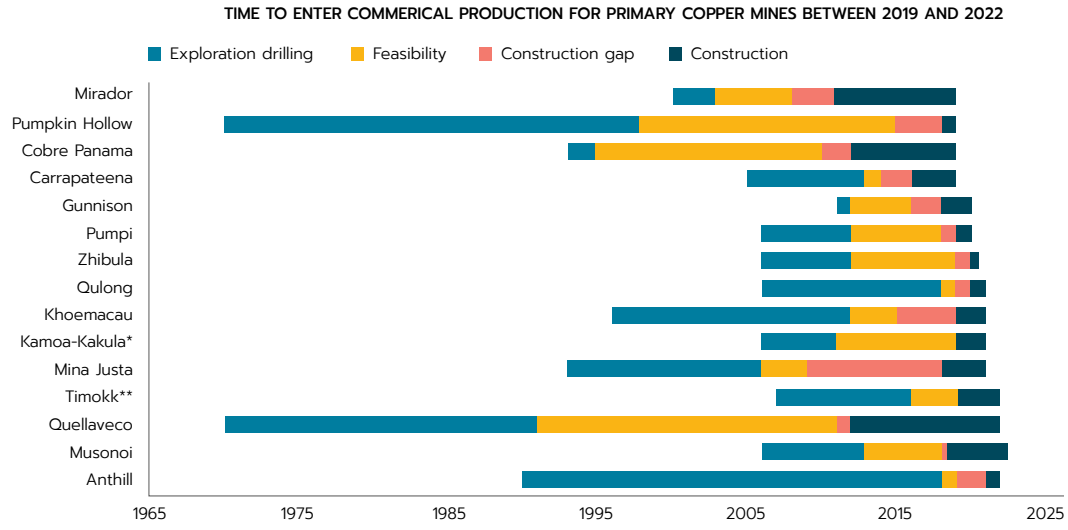
Growth in copper demand – driven by mere economic growth but mostly by the implementing of the energy transition and future electrification needs – requires drastically increased output of copper. It may seem obvious that when producers see more orders coming in, they increase supply to fill those orders. However, a set of geological, technological, financial, extra-financial and geopolitical factors make it more challenging that it might seem to accelerate production.

### Long timeframes

First of all – and this is an essential point – the time needed for opening a new mine. A mining project unfolds in four main stages: 1/ exploration, i.e., studying a project's potential in terms of output and economic value; 2/ feasibility, which is the phase of obtaining permits and authorisations; 3/ construction of the mine itself and its related infrastructures (roads, processing plants, a refinery in some cases, etc.); and 4/ production. All in all, it currently takes an estimated 15 to 20 years to launch production of a new deposit and no less than 10 years for the projects that are the fastest to implement. This is due mainly to the phase of negotiations and permits, which can last several years.

Copper is in the average, in that it takes an average of 17.6 years[20]. To open a new mine.

The first obstacle to adapting copper supply to demand is therefore time!




As of 16 February 2023
* Construction of the Kamoa-Kakula mine began in 2019, prior to the announcement of the definitive feasibility study, in 2020.
** The construction of Timok began in June 2018, prior to the announcement of the feasibly study of the Timok upper zone, in mid-2019.
Source: S&P Global Market Intelligence


[19] *Global identified copper resources in 2010 + resources not discovered in 2013, in a scenario of atmospheric warming of 2°C above preindustrial levels. Source IFPEN, https://www.ifpenergiesnouvelles.fr/article/copper-transition-energetique-metal-essentiel-structurel-and-geopolitique*
[20] *Source: John Lindberg, ICMM Policy & Public Affairs Lead, February 2025.*

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## Natural depletion

Like fossil fuels, mining faces the natural depletion of resources, i.e., when the ore concentration of extracted materials diminishes over time. This phenomenon is especially marked in long-mined regions, where the richest deposits have already been depleted. For example, average copper content has fallen from 2% in 1900 to 0.7% in 2020, and is expected to fall further, to 0.5% by 2030. This rarefaction is causing an expected decline in output: according to BHP, mines will produce about 15% less copper in 2035 than in 2024.

**AVERAGE COPPER CONCENTRATION IN ORE, WORLDWIDE**

| | |
|---|---|
| 1900 | 2.0% |
| 2000 | 1.0% |
| 2020 | 0.7% |
| 2030 | 0.5% |

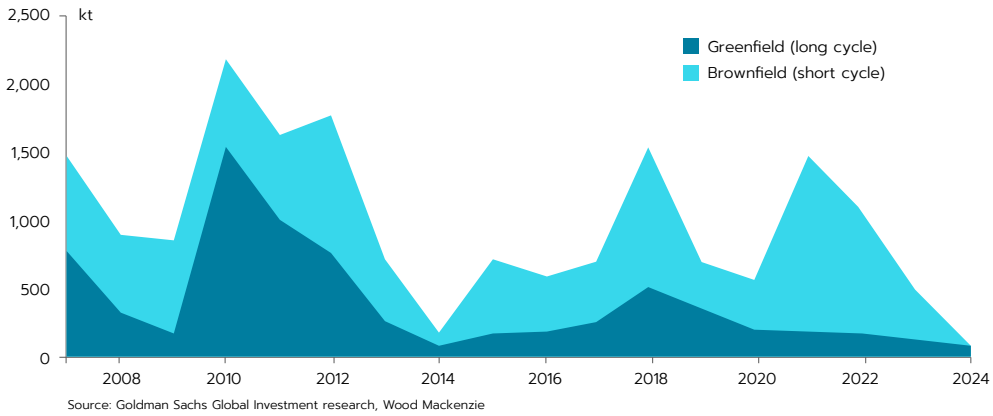
*Source: Bloomberg New Energy Finance*

*"**Most of the high-grade stuff's already been mined,**" says Mike McKibben, an associate professor of geology at University of California, quoted recently by NPR. "**So, we have to go after increasingly lower-grade material that costs more to mine and process**".*

## Project financing

The mining sector requires heavy, long-term and uncertain investments that are exposed to economic cycles. Because of the long lag time between project launch and production start, mines may end up beginning operations during a market downturn, thus undermining their profitability. This cyclical phenomenon, called "boom and bust"[21], is now pushing companies to opt for financial stability, acquisitions and dividends instead of new mining projects. Moreover, investors are putting in less money, as they are now more cautious with regards to market volatility[22], political risks, and ESG standards. As a result, exploration spending has fallen to 10 billion dollars, vs. 36 billion dollars in 2012.

**COPPER PROJECTS FINANCED**




Source: Goldman Sachs Global Investment research, Wood Mackenzie

Let's not overlook the fact that mining operations are capital-intensive and accordingly highly exposed to interest rates. Higher financing costs therefore discourage new project launches.

## The regulatory and political environment

Mining companies are facing numerous political and geopolitical constraints that make their operations challenging and more expensive. Deposits are often found in unstable countries, in which corruption, unpredictable regulations and growing claims by governments on mining profits prolong the obtaining of permits and exacerbate the risks. Some governments raise taxes on mining activities or even nationalise them, as occurred recently in Indonesia, Mali and Chile. Not to mention the conflicts with local communities and NGOs concerned about environmental impacts. The Cobre Panama mine, which closed in 2023 after street demonstrations and a court ruling, is a good example of this, especially as it accounted for 1.5% of global copper output.

## Operations are more expensive

Mining companies are being hit by a steep rise in their costs, due to several factors, both structural and temporary. Conflicts with local governments lead to contract renegotiations, additional taxes, and sometimes heavy fines, as was the case with Barrick Gold[23] in Mali, which was forced to pay 438 million dollars in 2025. In addition, lower ore concentrations means more material must be mined to obtain the same quantity of metal, thus automatically raising costs. And, lastly, rising energy costs (+33% in five years) and the shortage of skilled labour in a sector that workers deem unattractive, exacerbate the financial pressure on mining companies.

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[21] *Expansion and slowdown*
[22] *Volatility is a measure of fluctuations in value of an asset and, hence, its risk. It is calculated mathematically in terms of standard-deviation of the asset's profitability.*
[23] *Companies are mentioned solely for informational purposes and not as an offer to sell, or a solicitation to buy, securities.*

### Recycling

And then there is the issue of recycling. Unlike non-recyclable raw materials such as oil and agricultural produce, metals can be reused without losing their properties. Even so, the recycling rate remains low. For example, only 10 to 25%[24] of copper is recycled into new production. This is due first of all to the very low recycling rate of consumer goods (which seldom end up in recycling chains, making it sometimes difficult to extract metals from smartphones, for example). Other major consumers of copper, such as construction, industry or electrical grids feature higher recycling rates but also very long immobilisation times. Copper used in an electrical grid cable, for example, will be immobilised for decades, as will that in the plumbing of a building or the blades of a wind turbine.

So, recycling will not be enough to meet copper demand, for two reasons: 1/ demand will continue to rise, due to population growth, product innovation, and economic development; and 2/ in most applications, copper will be immobilised for a long time. Meeting future demand for metals will therefore require a combination of raw materials from mining and recycled materials.

### Resources are sufficient but extraction is far too slow

So, the issue is not abondance of resources, which look sufficient to meet the increase in demand expected on the copper market. Rather, it is the pace and challenges of mining, its costs and the multitude of constraints that are today hindering the possibilities to accelerate production.

The best way to reverse this situation rapidly is a price adjustment. Prices that are truly incentivising could encourage the launch of major projects, despite the difficulties and uncertainties endemic to this sector.

### Incentive price

One requirement for mining companies is the prospect of clear and sufficient high profitability. Many mining groups have already announced that copper prices will have to rise far higher to get them to launch new mining projects. For example, Ivan Glasenberg, former CEO of Glencore[25], at a conference in May 2021 stated that *"You will need $15,000 copper to encourage a lot of this more difficult investment. People are not going to go to those more difficult parts of the world unless they're certain."*

Robert Friedland, founder and co-president of Ivanhoe Mining[25], mentioned the same level of incentive: *"We probably need about $15 000/t, stable for a long period of time, before the industry can really gear up and build those giant mines".*[26]

### A market of physical equilibria

Another remark regarding prices: if all these difficulties are well known by the market and repeated incessantly by the heads of the largest mining groups – and they are – why don't copper prices rise more rapidly?

This is due to the nature of raw materials markets, which are physical markets dominated by manufacturers and not financiers. Forward contracts have relatively short maturities, as their main purpose is to allow sellers of raw materials and industrial buyers to hedge their risks over the duration of a production cycle. This makes it hard for prices to reflect long-term trends. If investors caused a sharp disconnection between the cash price of an asset and its forward price, that would be an opportunity for producers or buyers to hedge at an attractive price. In the event of a steep rise in forward prices, producers would sell their goods, causing prices to correct downward; and in the event of a steep drop, buyers would buy up goods on the cheap, thereby supporting prices.

So, unlike more conventional financial assets, such as company shares, which price in future revenues over a long period, metal prices reflect, above all, supply-demand equilibrium at time T.

However, once disequilibrium is in place, the inertia that is inherent to the mining production cycle can cause it to take hold. The best way to correct this is a price adjustment, which encourages or discourages production. The US investor Rick Rule, a veteran of commodities markets, has made it a mantra: *"The cure for high prices is high prices. The cure for low prices is low prices"*. In the event of a supply shortage and heavy demand, prices would have to adjust upward sufficiently high to incentivise more mining production... with the well-known time lag for launching production.



[24] *Source UNEP, Environmental Risks and challenges of anthropogenic metals flows and cycles, 2013.*
[25] *Companies are mentioned solely for informational purposes and not as an offer to sell, or a solicitation to buy, securities.*
[26] *Interview Bloomberg, December 2023.*

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## KEY POINTS

**The transition towards low-carbon technologies is driving a robust increase in global demand for copper,** a trend accelerated even more by the phenomenal boom in artificial intelligence and digital technologies.

**These trends are causing a true disruption in the copper market,** driving demand that will not seek out substitutes but will come on top of existing consumption.

It is against this backdrop that CNRS[27] has made the following estimate: to meet this massive increase in future demand, the mining sector over the next 30 years will have to extract as much metal as man has extracted in the past 70,000 years.

**The key issue to this equation, as we have seen, is how fast supply can expand.**

Copper production's many stages, technicity and complexity of operations lay bare the constraints that the mining sector is facing, including costs, operational risks, and heavy investments.

The **geological reality** is also challenging. Declining ore content in deposits means that more has to be extracted to produce the same amount of copper. This factor is beginning to impact annual copper production, which is no longer able to expand significantly.

Lastly, **tensions surrounding supplies of metals** needed for the energy transition and for the current technological turning points have made governments of producer countries aware of the potential wealth offered by these deposits. This is making mining contract negotiations more challenging.

This accumulation of factors has one major consequence: **it now takes more than 17 years to open a new copper mine.**

So, there are lots of obstacles. According to geological surveys, current resources are enough to meet current demand and, even more important, future demand. However, production startup times make an increase in output unlikely in the coming years. **So, the issue is the mining industry's ability to extract metal rapidly enough to keep up with demand.**

The International Energy Agency puts it this way: **meeting future demand would require opening, in the next few years, 25 mines of a size equivalent to the average of the 80 existing ones.** And given the time lag to commissioning, such projects would have to be confirmed by an investment decision… by 2025.

However, few exploration projects are on the drawing boards, due to high costs, capital intensity, hard-to-get supplies of water and electricity, resistance by stakeholders and the lack of major discoveries.

**Production could therefore remain close to current levels in the coming years.** This recalls the words of Mark Carney, then governor of the Bank of England, in 2015 regarding the "tragedy of the horizon", i.e., today's decisions can make a difference to challenges faced in the near future.

**If we remain on this trajectory, and barring a drastic adaptation by the mining sector, the copper market could very soon plunge into a potentially irreversible loss-making situation.**

[27] *Centre National de la Recherche Scientifique, étude https://lejournal.cnrs.fr/articles/le-sous-sol-le-grand-oublie-de-la-transition-energetique*

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## APPENDIX


**INTERNATIONAL COPPER ASSOCIATION**
https://internationalcopper.org/fr/sustainable-copper/about-copper/cu-demand-long-term-availability/

**INTERNATIONAL COPPER GROUP**
https://icsg.org/copper-factbook/

**S&P GLOBAL**
https://www.spglobal.com/market-intelligence/en/news-insights/research/copper-miners-enjoy-high-profits-but-development-capital-expenditure-lag

**STREETWIDE REPORTS**
https://www.streetwisereports.com/article/2022/10/27/copper-the-most-important-metal-were-running-short-of.html

**BHP**
https://www.bhp.com/news/bhp-insights/2024/09/how-copper-will-shape-our-future

**MINING VISUALS**
https://www.miningvisuals.com/post/copper-mining-costs-rise-from-2019-to-2023-a-brief-overview

**INTERNATIONAL ENERGY AGENCY**
https://iea.blob.core.windows.net/assets/ffd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

**STATISTA**
https://www.statista.com/statistics/302453/china-state-grid-corporation-grid-expansion-investment/

**REUTERS**
https://www.reuters.com/business/energy/chinas-state-grid-outlays-record-887-bln-investment-2025-2025-01-15/