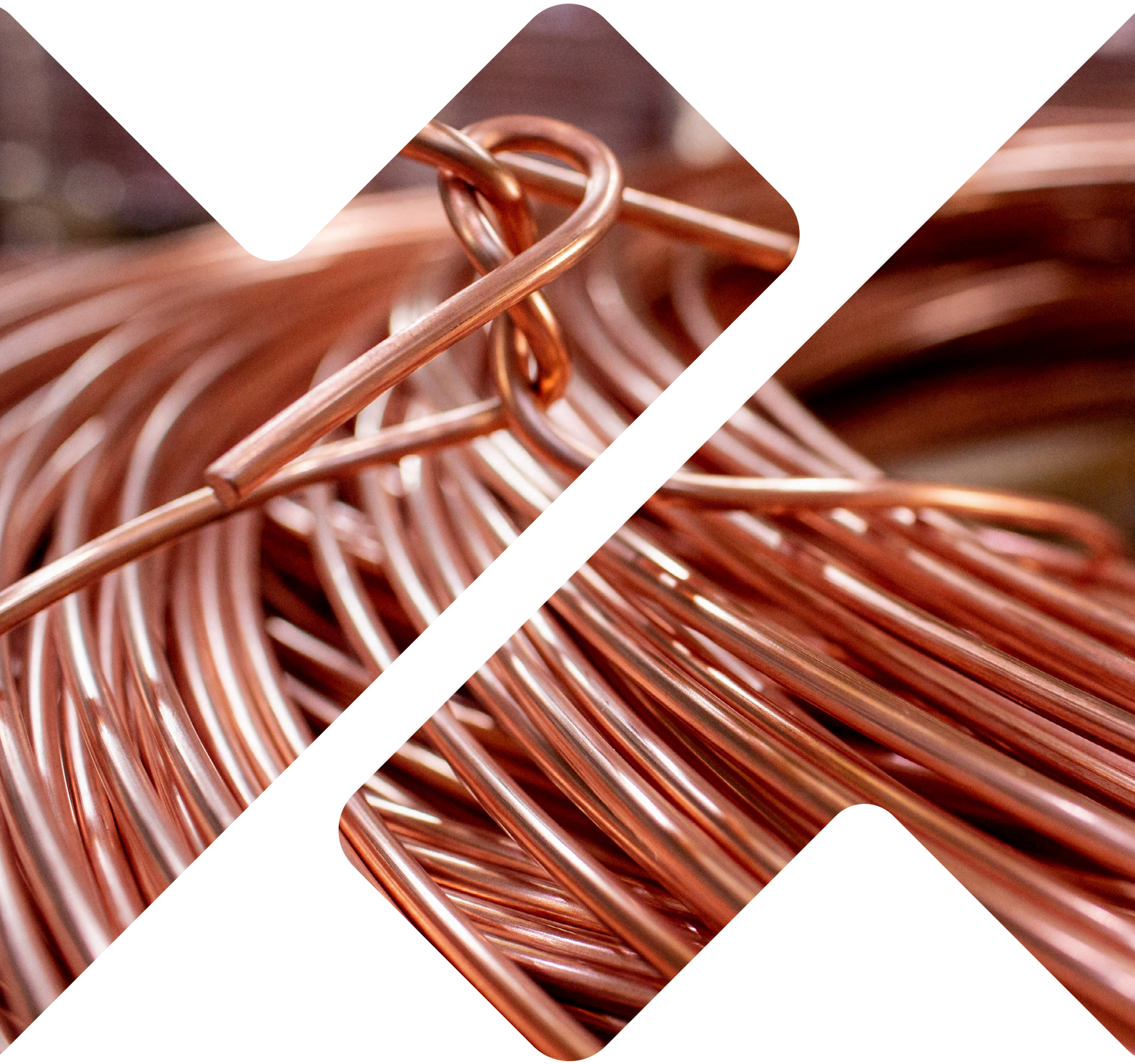

HORIZONS

High-wire act
Is soaring copper demand an obstacle to future growth?

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Copper's role in humanity's technological transformation has made it a linchpin of global economic activity. Essential to artificial intelligence (AI) data centres, defence systems, electric vehicles, and renewable energy transmission and distribution infrastructure, it is an irreplaceable, fundamental element of our low-carbon, digital future. Demand projections suggest staggering growth over the next decade.

Yet, while global appetite for copper may be voracious, there are serious questions over whether the mining industry can deliver the supply needed to meet the expected surge in demand. Western mining companies have been more fixated on capital discipline and achieving scale by engaging in mergers and acquisitions than on investing organically in the new copper mines needed.

This month's edition of Horizons explores the dynamics of copper supply and demand and the potential impact of the looming supply gap over the next decade. Copper prices are already lofty and could go higher still if investment in mine supply continues to lag.

Enter the demand disruptors

Under Wood Mackenzie's base case scenario, total copper demand is expected to surge 24%, to 42.7 Mtpa by 2035, primarily driven by global economic development and electrification. But while steady demand growth seems assured, there could be significant upside surprises from demand shocks.

Despite the slow pace of the energy transition, there are four powerful disruptors currently affecting copper consumption:

- **the energy transition:** electric vehicles (EVs), renewable energy and grid infrastructure
- **data centres:** the AI-driven electricity demand explosion
- **defence spending:** Europe's €800 billion military buildup
- **economic development:** India and Southeast Asia's rapid industrialisation.

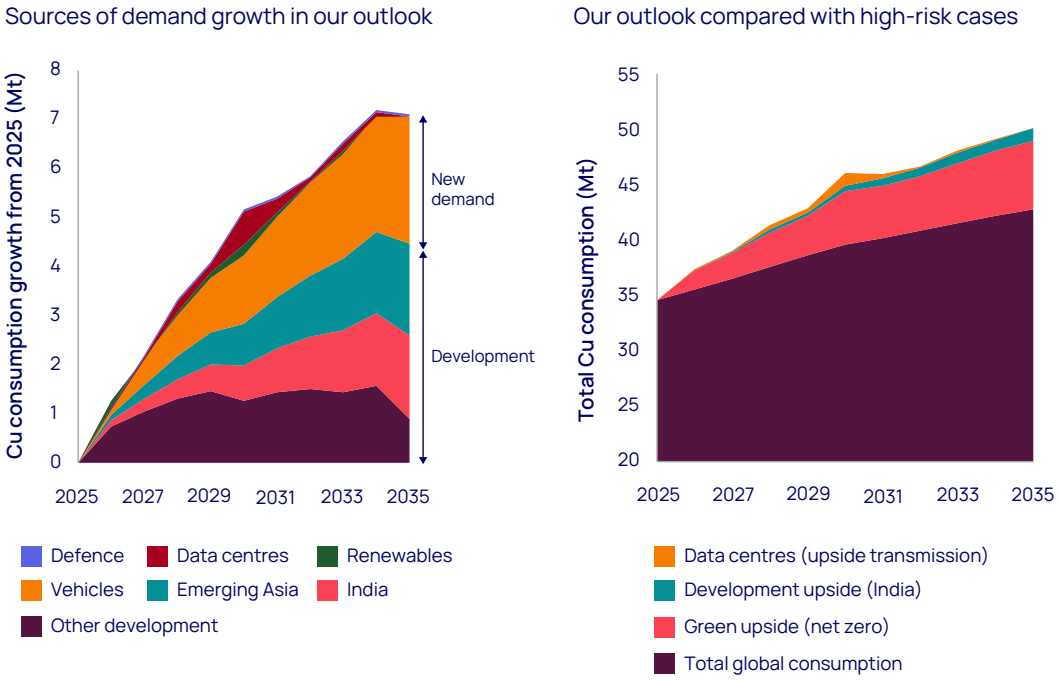
There could be significant upside surprises from demand shocks

By 2035, these four disrupting factors will account for a combined 40% of demand growth (3 Mtpa), while traditional economic development will add another 4.5 Mtpa. Importantly, however, policy developments and technological breakthroughs could trigger demand shocks at any point in time.

There are other factors to consider, too, that pose substantial upside risk:

- **a net-zero acceleration:** could add another 4.2 Mtpa in additional demand
- **India's industrial surge:** a further 2 Mtpa from manufacturing and AI centres
- **accelerated Asian development:** an additional 6 Mtpa if economic growth accelerates further.

Figure 1: Simultaneous increases in copper demand in multiple sectors



Source: Wood Mackenzie

The great switch: from combustion to connection

Copper has long played a pivotal role in electricity transmission – and now, too, in generation and geopolitics. A steady 2 Mtpa of additional supply is required to facilitate the shift to renewable energy over the next decade, which for some countries is less about decarbonisation and more about energy independence and security.

EVs (battery and plug-in hybrid) have reached critical mass, meanwhile, achieving 22% market penetration in 2025 and forecast to double to 44% by 2035. With EVs already consuming 1.7 Mtpa of copper in 2025, another 2.6 Mtpa will need to be brought to market by 2035 to supply the estimated 4.3 Mtpa that will be required that year, corresponding to 10% annual growth over that period.

Data centres: the volatility wild card

AI is set to consume an additional 2,200 TWh of electricity by 2035, according to global data-centre projects tracked by our Power team, lifting copper demand for grid infrastructure alone to 1.1 Mtpa by 2030. The catch: because copper accounts for less than 0.5% of total project costs, data-centre developers are largely indifferent to its price, paving the way for sudden demand surges and amplifying price volatility in an already constrained market.

A single year of doubled buildout could spark price spikes of 15% or more and swiftly deplete stocks. When high-value sectors shrug off input costs, commodity markets can lurch dramatically and unpredictably.

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Defence: guns over butter

Europe's decision to boost defence spending to 3.5% of gross domestic product (GDP) amid Russia's invasion of Ukraine and signs of wavering US security guarantees adds only modest direct copper demand of 25-40 ktpa over the coming decade. The real impact lies in infrastructure resilience and modernisation. With around 65% of copper consumed by industrial applications, even small defence-driven projects, such as power systems, networks and munitions, could boost demand beyond current forecasts.

Other major economies could follow suit. Japan, for instance, plans to double its defence budget by FY2027, heralding further upside. Defence firms around the world are signalling the expansion of various fighter programmes, missile-tracking systems and ammunition output, and flagging strong demand for advanced systems. Rising defence spending is quietly reinforcing copper's role in the industrial-military complex, adding pressure to an already tight market.

Asia's copper surge – from tigers to titans

India and Southeast Asia are just warming up on the economic development front, with their industrialisation set to add 3.3 Mtpa of copper demand by 2035 (corresponding to average annual copper growth of 7.8% and 8.2%, respectively). However, if they see even half of China's development trajectory, the construction industry alone would require an additional 3.0 Mtpa of copper, with electrical networks adding another 2.4 Mtpa.

Inevitable growth with explosive upside

The long-term potential for copper growth is locked in, but the convergence of electrification, AI infrastructure, defence spending and Asian industrialisation all create multiple paths to an explosion in demand. In a supply-constrained market, however, timing is everything – and various indicators point to simultaneous acceleration in numerous sectors.

In a supply-constrained market, however, timing is everything

The question, therefore, is not whether copper demand will grow, but whether the almost inevitable demand shocks will be manageable individually or happen all at once.

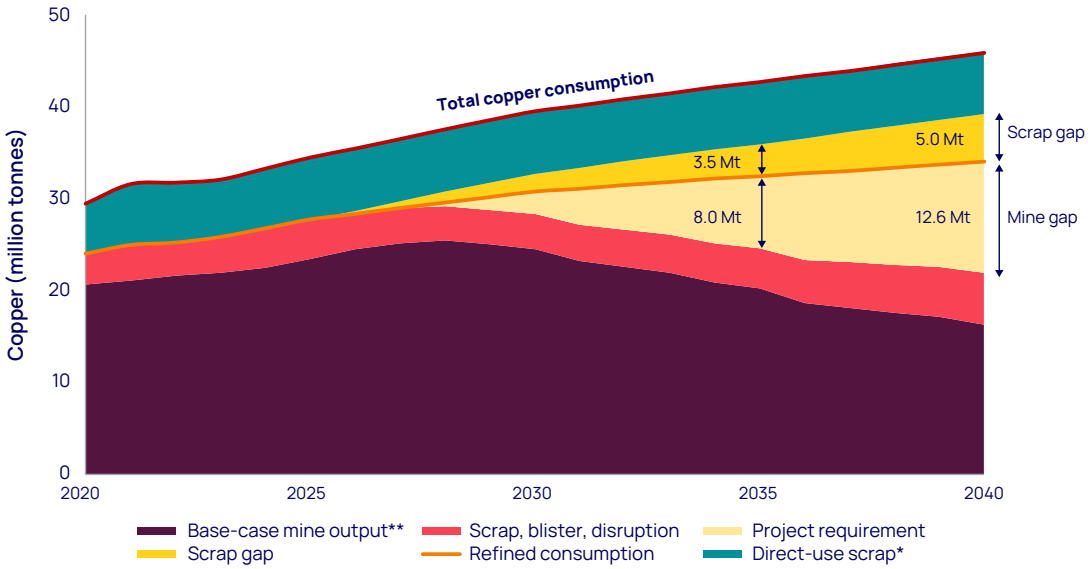
Outpaced and underfunded: the case for new investment models

To meet the impending supply gap over the next decade, the copper market will require an estimated 8 Mtpa or so of new capacity from greenfield and brownfield projects, as well as an additional 3.5 Mtpa from direct scrap use. Over two decades of copper-market forecasting show a steady rise in new project requirements within the next 10 years, now averaging 880 ktpa annually – double the rate from a decade ago – and accounting for an unprecedented 28% of projected base-case supply. The total cost to develop these projects is expected to exceed US$210 billion, by our estimates.

Understandably, alarm bells are ringing over the slow pace of new mine development

Understandably, alarm bells are ringing over the slow pace of new mine development. The problem is not a lack of copper in the ground – there is a robust pipeline of greenfield projects – but investment and access. Environmental permits, social opposition and technical hurdles have put many plans and opportunities on ice.

Figure 2: Mounting copper shortfall signals long-term risk



Note: * Direct-use scrap – scrap gap emerging based on 2025 recovery rates (indicating recovery rates will need to grow).
** Recovered copper basis – excludes any production disruption adjustment.

Source: Wood Mackenzie

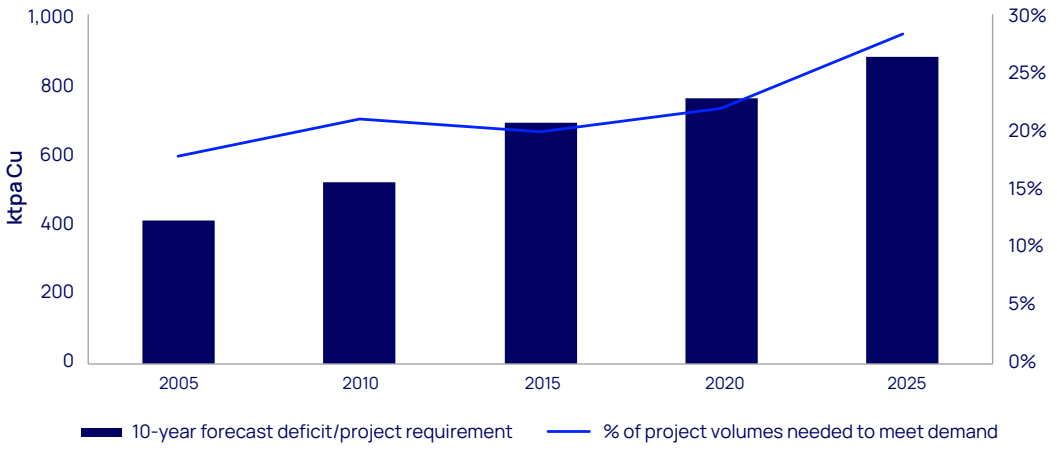
A question of risk

Western miners, constrained by investor risk appetite and environmental, social and governance (ESG) pressures, have been tentative on new mine development, preferring the regulatory stability and legal protections of Organisation for Economic Co-operation and Development (OECD) jurisdictions over higher-risk regions. Argentina is a fledgling possibility, but President Javier Milei's waning popularity could yet snuff out hopes there. The Democratic Republic of the Congo (DRC), often cast as a swing producer, faces its own hurdles in the form of cobalt oversupply and export curbs.

Meanwhile, risk-tolerant Chinese, Russian and other players are pushing ahead in higher-risk, resource-rich regions of Africa, Central Asia and beyond. The crunch is not geology, but who is willing to build where and how fast they can get projects online.

This expanding shortfall, which we term the 'project requirement', underscores the urgent need for increased output from both greenfield and brownfield developments to meet future supply needs. With demand accelerating and supply growth constrained by risk aversion, financing bottlenecks and geopolitical fragmentation, the imbalance is set to deepen further. This raises serious questions about long-term supply security and resilience.

Figure 3: Copper project requirement has increased over the last 20 years of forecasting



Source: Wood Mackenzie

Despite the growing need for sustained investment in supply, investor appetite for new mine development remains muted. Mining companies are increasingly favouring mergers and acquisitions over riskier greenfield or brownfield projects as a route to higher copper exposure. Recent examples include BHP's US$6.4 billion bid for OZ Minerals, Rio Tinto's consolidation of Turquoise Hill, BHP's ultimately unsuccessful attempt to acquire Anglo American and now the proposed merger between Anglo and Teck.

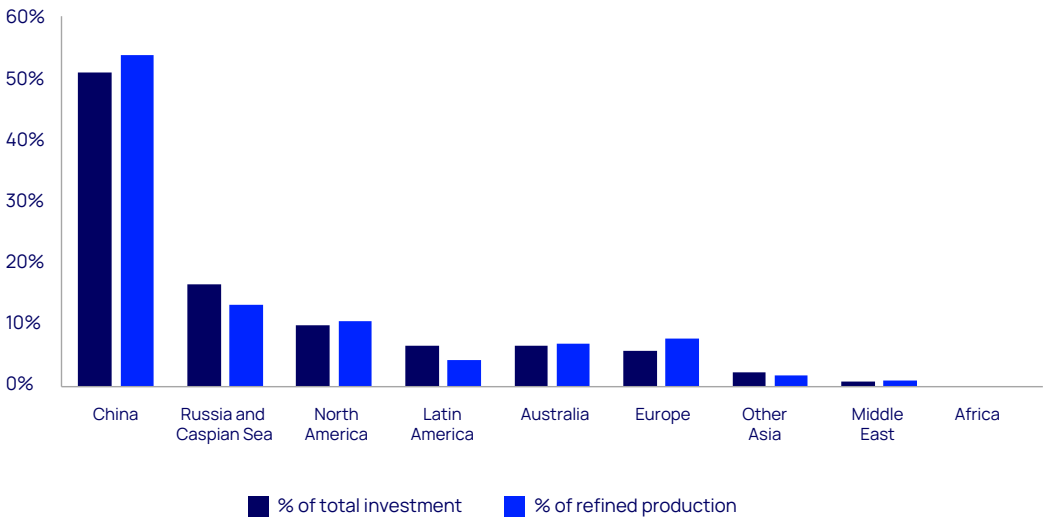
Such link-ups are framed as building stronger, more sustainable businesses with greater cash-flow potential to fund pipelines of future projects. However, they also reflect a broader investor preference for short-term returns and operational synergies rather than capital-intensive investment in large projects aimed at delivering long-term growth.

Excessively high Western hurdles

Developing large copper projects requires billions of dollars in upfront capital – and herein lies the crux. Western miners rely on private lenders, which are imposing increasingly demanding conditions. Financing terms include stress-tests at copper prices 20–30% below forecasts, high equity contributions for greenfield projects (particularly for smaller firms) and stringent ESG compliance. These constraints raise costs but, crucially, discourage investment in politically volatile jurisdictions that hold some of the richest undeveloped deposits, such as the DRC.

Chinese state-owned enterprises such as China Molybdenum (CMOC), in contrast, have access to low-cost, long-term loans from policy banks (such as China Exim Bank and China Development Bank) and operate under national strategic mandates rather than on pure profit metrics. They accept higher political risk, use infrastructure-for-resources deals and move quickly without shareholder interference. This approach has enabled China to dominate DRC copper and cobalt production, for instance, through projects such as Sicomines and Tenke Fungurume.

Figure 4: China has dominated copper project finance in 2019-25 (US$76 billion in total)



Source: Wood Mackenzie

The copper front: Western retreat, Eastern advance

While Western companies have retreated from high-risk jurisdictions, Chinese firms continue to integrate mining, refining and manufacturing, cementing control over future copper supply chains. The rise of resource-backed competition from Russia and oil-rich Middle Eastern nations, meanwhile, adds another layer of complexity. Uzbekistan's Almalyk Mining and Metallurgical Combine, for instance, is pursuing a US$15 billion expansion to increase copper cathode production to 400 ktpa by 2030, while Saudi Arabia's Public Investment Fund is stepping up its ambition, buying several direct stakes in copper development globally.

As project costs rise and geopolitical risks grow, financing is becoming more complex

Even when major Western miners do push forward, challenges persist. Barrick Gold's long-delayed Reko Diq project in Pakistan, for example, carries a lifetime capex of US$8.83 billion, currently being financed through a consortium of international lenders, including the International Finance Corporation, the Export–Import Bank of the United States, the Asian Development Bank, Export Development Canada and the Japan Bank for International Cooperation. This reflects a broader trend: as project costs rise and geopolitical risks grow, financing is becoming more complex, increasingly reliant on multilateral support and more expensive to secure and manage. This mirrors patterns seen in upstream and other capital-intensive sectors.

Underground and under pressure

Beyond structural financing and geopolitical challenges, physical supply disruptions are an escalating concern. The industry's move towards underground mining over the next two decades underscores the significant technical and cost hurdles involved. Codelco's Chuquicamata is one example where an extraction ramp-up has been pushed back a full decade to 2040 due to engineering setbacks, geological challenges and pandemic-related maintenance delays.

Safety risks add another layer of complexity. Recent incidents at Grasberg (in Indonesia), Kamoa-Kakula (in the DRC) and El Teniente (in Chile) highlight the dangers of deeper, more intricate underground operations. At the same time, some producers are experimenting with sulphide leaching – a technology with a limited commercial track record – as an extraction method, raising questions about long-term reliability and output stability.

Compounding operational challenges are political pressures, from expropriation threats to rising resource nationalism, further clouding the investment and supply outlook.

Copper forecast: stormy with a chance of shortages

Climate change adds yet another dimension. Increasingly volatile weather patterns driven by the El Niño and La Niña weather phenomena, which often impact copper, have already caused periodic flooding and rainfall-related disruptions at major copper assets, a trend that is likely to intensify. This is something that Wood Mackenzie models using its new Synoptic database.

> The industry may need to raise its baseline assumption for annual mine supply disruptions from 5% to 6%

By our calculations, the aforementioned risks suggest that the industry may need to raise its baseline assumption for annual mine supply disruptions from 5% to 6%, effectively removing 250 to 300 kt from the market each year. That shift would heighten volatility, deepen supply shortfalls and push up copper prices during periods of strong demand.

Copper's geopolitical fault line

The trade turmoil sparked by the Trump administration's tariffs adds to the uncertainty surrounding miners' investment decisions.

Copper prices, though elevated by historical standards, arguably remain too low to incentivise the scale of investment required – at least from a Western capital markets perspective. Project incentive prices might need to exceed US$11,000/t (US$5/lb), 10% above current levels, to accelerate mine development, taking into account environmental, technical or permitting challenges, and depending on the strength (or weakness) of the dollar. Without sustained higher prices or a change in the funding model, the growth needed over the next 10 to 15 years will remain out of reach.

Conclusion: backbone and bottleneck

Copper is the backbone of electrification, digitalisation and industrial growth, but demand is outpacing supply at an alarming rate. Global total copper consumption is forecast to soar 24% over the next decade to 42.7 Mtpa, driven by industrial development and a host of new uses. EV adoption, renewable energy, data centres and defence are all copper hungry, with uncertainty in demand skewed to the upside.

Meeting demand growth by 2035 will require more than 8 Mtpa of new mine capacity plus 3.5 Mtpa from scrap. That equates to an at least 880 ktpa of new mines every year over the next decade – a breakneck pace – at a cost of more than US$210 billion. At the same time, the supply pipeline is under strain, with permitting delays, declining ore grades, limited financing and investor preference for mergers and acquisitions over greenfield projects all reining in new capacity.

> If the West wants to compete, it must stop relying on market forces alone, or at least make them work more effectively

All the while, China continues to expand its dominance through state-backed miners, while Western firms have retreated from high-risk jurisdictions. Bogged down by this slow supply response and inelastic demand, the market is exposed to shocks and persistent mismatches.

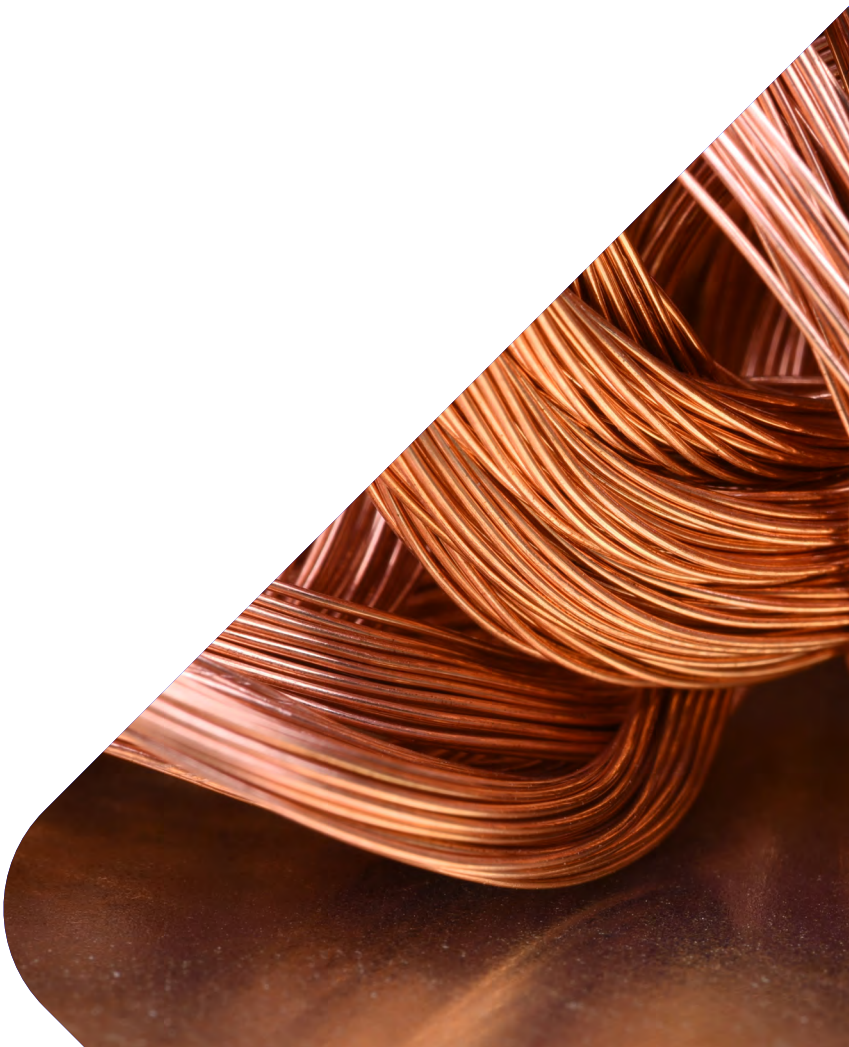
If the West wants to compete, it must stop relying on market forces alone, or at least make them work more effectively. Governments and industry need to pool resources, back high-risk projects and build public-private consortia that can move as fast as Chinese state-owned enterprises. The Reko Diq project, stalled for decades, illustrates why decisive intervention is critical.

Direct investment in mining, refining and processing beyond streams and royalties is essential, along with tax incentives and co-investment funds for early-stage exploration. Long-term offtake deals, strategic stockpiles and infrastructure-for-resources partnerships under G7 or European Union initiatives can give miners certainty and host countries a real alternative.

Half-measures and parochial agendas will not suffice. The West must overcome its risk aversion and act concertedly and strategically to secure the critical-mineral supply chains of tomorrow and mitigate the looming risks of undersupply. From Detroit to Shenzhen, the impacts of commodity supply-chain disruptions and the industry's inability to deliver will be acutely felt.

The West must overcome its risk aversion and act concertedly and strategically

Under accelerated economic growth scenarios, lagging copper supply raises risks, setting the stage for sustained periods of higher prices to incentivise new volumes and moderate demand. Technical, political and climate-driven disruptions only amplify these structural vulnerabilities, reinforcing copper's role as a strategic bottleneck.



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