How AI can help speed up the green energy transition

Artificial intelligence is already being deployed in the mining sector despite still being in its early stages. In theory, AI could aid the mining industry in the search for new deposits at a time when governments around the world are looking to secure supplies of critical raw materials that are essential in the green energy shift

AI technology could be key in locating resources that may have eluded more traditional geologists - and in turn, may play a pivotal role in shaping the move towards a net-zero future

More metals are needed to enable green energy future

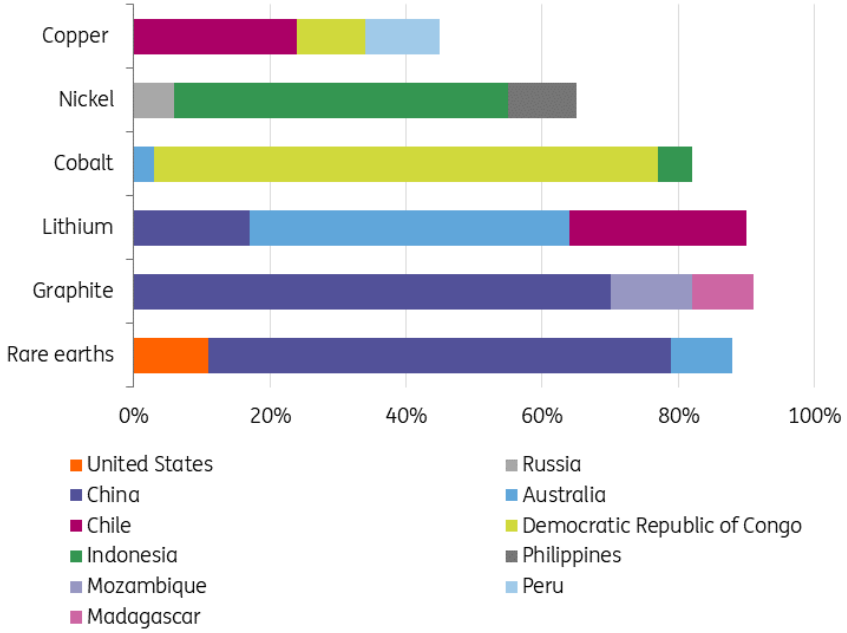
Metals are critical to all parts of the energy transition. Reaching net zero targets will require massive amounts of critical raw materials, from lithium, nickel and cobalt, which are crucial to the battery performance of electric vehicles (EVs), to copper and aluminium used in electricity networks.

To keep the world on a steady path to net zero, annual nickel supplies need to grow from about 3.4 million tonnes currently to 5 million tonnes in 2030, according to the International Energy Agency (IEA). Copper supplies must increase from 25 million tonnes to 35 million tonnes. EVs and battery storage are the main drivers of demand growth, but there are also major contributions from low-emissions power generation and electricity networks.

The cost and speed of the energy transition will be heavily influenced by the availability of critical raw materials supplies. Governments around the world are now seeking to diversify their supply,

but this is highly concentrated in a small number of countries.

Supply of critical raw materials is often very concentrated



Source: IEA, ING Research

There are likely enough minerals and metals in the earth's crust to power the green energy transition. However, exploration and discovering new deposits is very difficult and expensive.

It takes on average over 16 years to develop projects from discovery to first production, depending on the mineral, location and mine type. It takes more than 12 years to complete exploration and feasibility studies, and four to five years for the construction phase, according to the IEA.

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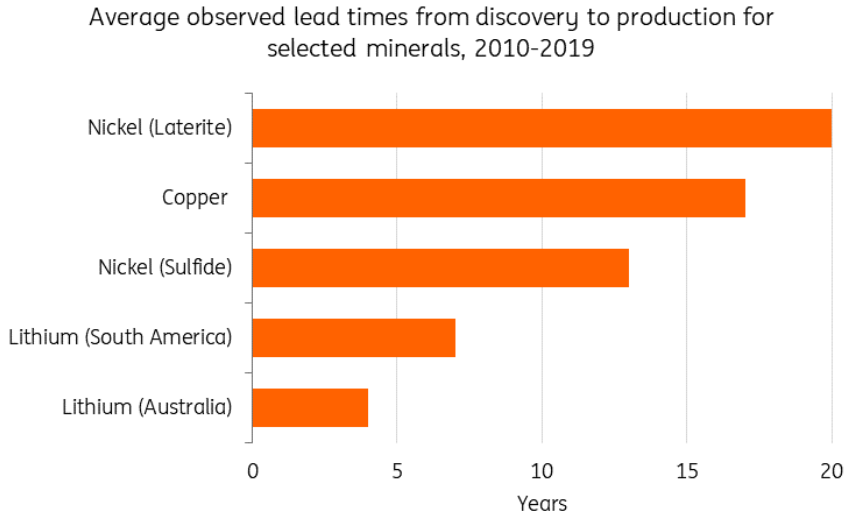


Source: IEA, ING Research

AI hunts for copper

One of the most important uses for AI in the mining industry lies within the discovery process.

Copper mines currently in operation are nearing their peak due to declining ore grades and reserves exhaustion. For example, the world's largest copper mine, Escondida in Chile, has already reached its peak and its production in 2025 is expected to be at least 5% lower than it is today.

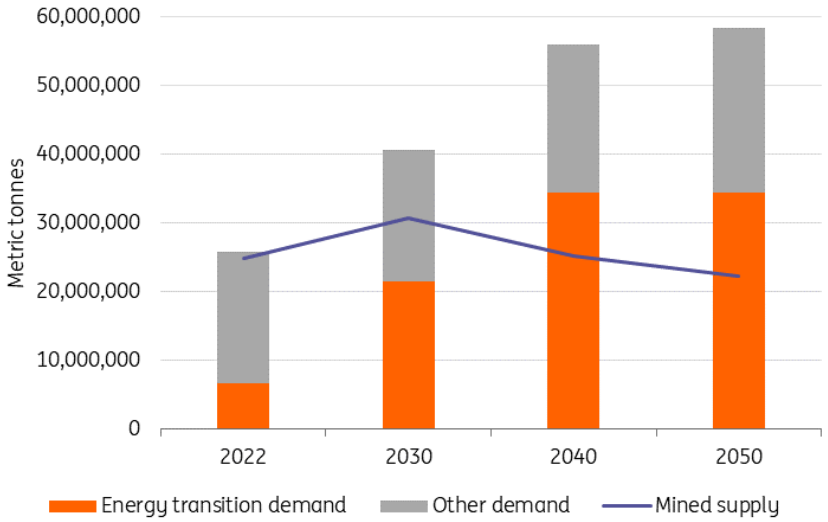
Meanwhile, mining companies are facing increasing social and environmental scrutiny. Most recently, in Panama, Canada's First Quantum mine has ignited massive protests in the country and has been forced to shut down activity. Cobre Panama copper mine is one of the world's largest sources of copper, accounting for 1% of global copper output. In Peru, protests also threaten to dent the supply outlook for copper. Mining projects in Peru have long been met with opposition from communities across the country that are concerned about potential damage to the environment and water resources.

> *If no new copper discoveries are brought online, the market could be facing an extended supply shortfall*

At the same time, there is a lack of high quality large-scale projects in the pipeline that could push the copper market into deficit as demand from the green energy sector continues to grow. Global copper mining is expected to decline from 25 million tonnes in 2022 to 22 million tonnes in 2050, according to BNEF, if current reserves are not replaced with new geological discoveries and projects. At current rates, the production of copper will peak by 2029 and start to decline as mines begin to reach the end of their lives, BNEF expects.

If no new copper discoveries are brought online, the market could be facing an extended supply shortfall. In turn, this would lead to elevated copper prices over a longer timeframe, which eventually would lead to a slowdown in the adoption of green energy technologies due to higher costs and a shortage of critical raw materials.

At current rates, production of copper will peak by 2029



Note: Demand is estimated in a Net Zero Scenario by 2050. Mined supply does not include secondary supply from recycling. Source: BNEF, ING Research

This has pushed mining companies to adopt AI technologies in search of the green energy metal. Copper is used in everything – from EVs to wind turbines and power grids. In EVs, copper is a key component used in the electric motor, batteries, and wiring, as well as in charging stations. There's also no substitute for the use of copper in EVs or wind and solar energy.

KoBold Metals, a mining startup that uses AI to explore for materials key to energy transition, discovered a huge copper deposit in Zambia earlier this year – the largest deposit found in the African country for a century. This deposit alone can provide enough copper for over 100 million EVs.

Historically, more than 99% of exploration projects fail to turn into actual mines, according to KoBold. This is where AI comes in.

99% Mineral exploration projects that fail to become mines

In medieval Germany, kobolds were mythical underground spirits that lived in caves and mines. These creatures also gave name to the key green metal, cobalt.

California-based KoBold, founded in 2018 and backed by Bill Gates, Jeff Bezos, Michael Bloomberg,

Richard Branson and Ray Dalio, has been drilling at its Zambian permit for a little over a year. Zambia is Africa's second-largest copper producer.

> *The world's biggest copper mine, Escondida, produced more than a million tonnes of copper last year*

KoBold has recently compared the Mingomba project's potential to that of the Kamoa-Kakula mine, developed by Ivanhoe Mines, and China's Zijin Mining Group in the Democratic Republic of Congo, which produced around 400,000 tonnes of copper last year and at full capacity it will be able to produce 620,000 tonnes annually. For comparison, the world's biggest copper mine, Escondida, produced more than a million tonnes of copper last year.

> *New technology could be key in locating resources that may have eluded more traditional geologists*

KoBold gathers data – including satellite imagery and drilling results, as well as old PDFs and hand-painted maps on linen – and then uses AI technology to build out maps of the Earth's crust. These are used to search for potential deposits of metals needed for the green energy transition. Algorithms applied to the data collected determine the geological patterns that indicate a potential metals deposit. KoBold says its technology can locate resources that may have eluded more traditional geologists and can help decide where to acquire land and drill.

The company aims for its first output at the Zambian site by the early 2030s. It is currently completing resource estimates and pre-feasibility studies that will be key in deciding whether or not to turn it into an operational mine.

Mingomba is not the only project KoBold is working on. The company is exploring more than 60 other areas in search of green energy materials, including in Australia, Canada and the US. Last year, it announced it had discovered deposits of lithium in South Korea, Australia, Namibia, Quebec and Nevada.

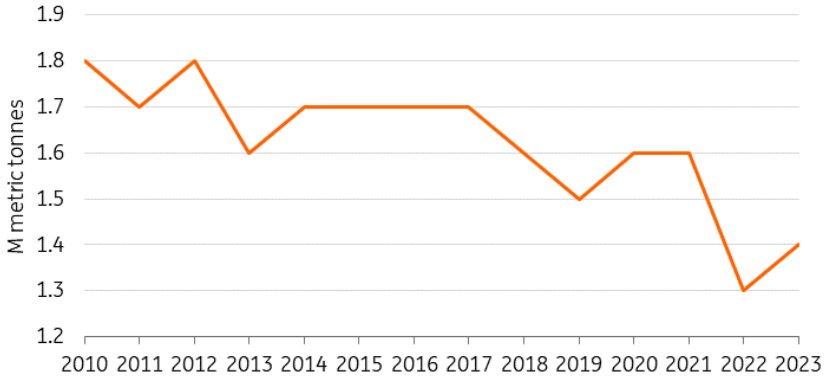
In South America, another AI-enabled mining exploration company, Boston-based VerAi, has tracked down ore containing copper, gold and silver in Chile and Peru. VerAi has trained its AI systems to search for minerals like lithium, cobalt, nickel, copper, zinc, gold, silver and molybdenum. VerAi develops models or profiles based on existing economic deposits, and then uses that library of profiles to search through datasets to identify locations with the same pattern that could have been missed by traditional exploration methods. Once drilling commences, the company's technology reportedly causes close to no environmental damage, minimising water waste and preventing soil contamination. VerAi claims it can shrink the exploration window from three to four years to two months while cutting costs from $3-$5 million to $250,000.

AI helps Codelco boost copper volumes

Meanwhile, Chile's copper miner Codelco is using AI to boost volumes at its mines that are among the world's largest and oldest. Extracting metal content from lower-grade ores requires more energy, applying upward pressure on extraction and processing costs and CO_2 emissions.

Codelco is struggling to return production to pre-pandemic levels of about 1.7 million tonnes a year by the end of the decade from around 1.3 million tonnes last year, which marks the lowest level in a quarter century amid ageing assets and declining ore grade.

Codelco's copper output is the lowest in a quarter century



Source: Cochilco, Codelco, ING Research

Codelco introduced a digital data centre in 2020 that uses machine learning to combat dropping grades, rising expenses, and growing environmental concerns.

The Chilean miner said its AI platform is adding about 8,000 metric tonnes of copper, or $80 million in annual earnings, at its Chuquicamata mine – one of the largest open-pit copper mines that has been operating for over 100 years. The AI system uses a stream of data on extracted ore to enhance processing, for example, through the use of blending. Codelco is now looking to introduce AI systems at its other mines.

Also at Escondida, BHP teamed up with Microsoft last year to boost production from the world's largest copper mine using AI and machine learning. The use of digital technology is expected to improve copper recovery at the mine and generate more value from the existing resource. BHP uses real-time data from the copper concentrators in combination with AI-based recommendations from Microsoft's machine learning platform, which then gives plant operators the ability to adjust variables that affect ore processing and grade recovery.

AI adoption in mining will continue to grow

To reach net zero targets, the supply of critical metals needed for the energy transition will have to be ramped up rapidly to meet growing demand. Over time, we expect the adoption of AI to continue to grow in mining, with the application of new technologies rising within in the sector as companies strive to remain competitive.

In theory, AI technologies could help mining companies find and explore new sources faster to

prevent future shortages – and with less damage to the environment and communities than the traditional mining methods.

For copper in particular, as ore grades decline at existing mines and fewer new copper deposit discoveries are made, technologies like AI, machine learning and data analytics could be used in the discovery and extraction processes to help meet the increasing demand for the metal that is critical in enabling a net-zero future. That is if investment in the sector grows and mining companies are willing to embrace new technology.

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