ASX Announcement

Executive Appointments and Federal Government Submission to include Copper as a Critical Mineral.

KGL RESOURCES

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20 September 2023

KGL Resources Limited (KGL or the Company) (ASX Code: KGL) is pleased to announce appointments to the positions of Chief Executive Officer and Chief Financial Officer, both integral to driving development of the Jervois Copper Project.

- **Nicholas Spencer appointed KGL Chief Executive Officer (CEO) to lead the development of the Jervois Copper Project.**
- **Chris Dippenaar appointed as replacement Chief Financial Officer (CFO).**
- **These appointments are being made as KGL progresses encouraging work on the optimisation studies post the Feasibility Study and given the critical need for copper - both of which demonstrate the importance of this project at a time when chronic shortages in this critical mineral could disrupt global supply chains.**

Chief Executive Officer Appointment

Mr Spencer brings over 30 years' specific experience in mining, mine development and funding and has a track record of successfully developing and operating mining projects. Additionally, he has worked in engineering services, logistics and the aerospace industry. He has worked in Australia as well as with multinational corporations in the UK, Middle East, Asia and India. Most recently, Nick served as the Managing Director of Galaxy Gold Mines, an Indian based firm developing a portfolio of gold projects in India and Tanzania. Nick has an honours degree in Mechanical Engineering and a Master of Business Administration.

Mr Spencer will be responsible for the advancement of the Jervois project through to development and will work with Executive Chairman, Denis Wood.

Announcing the appointment of Mr Spencer as CEO, Mr Wood said:

"We have searched extensively for an appropriately qualified CEO and are delighted that Nick is joining the company. His broad experience in relation to exploration, mine development, commercial negotiations and investment management will be instrumental in driving development of the Jervois copper project and in guiding the Jervois team."

The terms of the contract with Mr Spencer as CEO are provided at the end of this announcement.

Chief Financial Officer Appointment

Mr Chris Dippenaar has been appointed Chief Financial Officer following the resignation of Ms Amy Treble.

Chris is a Fellow Chartered Management Accountant (FCMA) and Fellow Certified Practicing Accountant (FCPA) with extensive international experience and has held executive and senior commercial and finance leadership roles with various publicly listed international mining companies, including BHP, Anglo American and Harmony Gold. During his time with these companies, he provided finance leadership to various greenfield, brownfield and expansion

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projects; including BMA's Caval Ridge coal mine and AngloCoal's Grasstree coal mine in Queensland and a major reinvestment project at Harmony Gold's Hidden Valley gold and silver mine in Papua New Guinea. His mining experience includes more than 20 years of commercial and finance leadership roles in open cut and underground operations, both for coal and hard rock mining, providing reporting, risk management, corporate governance, internal control and operational support.

Copper is Critical to the Clean Energy Transition

Governments are increasingly recognising that dependence on foreign sources of critical materials creates a strategic vulnerability for their economy and military in the face of adverse foreign government actions, natural disasters, and other events that could disrupt supplies.

With chronic shortfalls in copper forecast over the next decade and challenges in supply from the traditional low-cost markets of Chile and Peru, Australia has the opportunity to grow its critical minerals wealth and become an important player in developing secure, reliable and sustainable global supply chains for copper that are internationally competitive.

Many states in Australia including the NT have recognised Copper as a critical mineral. The Australian federal government is now reviewing the Critical Minerals list and in response KGL lodged a submission on why copper should be included in this list.

Mr Wood commented that

> "KGL's Jervois Copper Project is well positioned with approvals and permits, to be one of the few projects that can be in production, subject to final investment decision, as the market is faced with a chronic shortfall in supply.
>
> Given the robust outlook for the copper market, we believe that the Jervois copper hub, a high-quality project in a Tier One jurisdiction, will play an important role in supporting jobs and new skills, local business opportunities and economic development activity in Northern Australia and provide a secure, reliable and sustainable supply of critical minerals to our strategic partners to meet their economic and national security and clean energy needs at a time when chronic shortages in this critical mineral could disrupt global supply chains."

Attached is the detailed submission made by KGL to the Federal Government.

This announcement has been authorised by the KGL's Board of Directors.

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Remuneration	**Salary**	$350,000 per annum plus statutory superannuation.
Short Term Incentives	A Short-Term Incentive (STI) is to be agreed between the Board and Mr Spencer and payment of the STI will be on an annual basis. The payment of the STI is at the sole discretion of the board and will be based on both personal and company performance. The STI may comprise of a combination of both cash and shares based on board discretion. .	
Termination	**Termination on notice** KGL may terminate the CEO employment by giving six months' notice of termination in writing; and The CEO must give the Company six months' notice of termination in writing. **Immediate termination** KGL may terminate the CEO employment without notice if KGL has reasonable grounds to suspect that the CEO has engaged in serious misconduct and/or other serious breaches of contract obligations, criminal offences, matters regarding disrepute, health and safety breaches, or bankruptcy **Redundancy** Where the CEO's employment comes to an end by way of redundancy, any entitlement to redundancy pay will be made in accordance with the National Employment Standards.	

Review by the Australian Government of Australia's Critical Minerals List

Submission by KGL Resources Ltd:

Developing the high-grade Jervois Copper Project in the Northern Territory

Contents

Background

Our critical minerals sector is well placed to **seize the opportunities of the clean energy transition** thanks to Australia's:

- rich geological reserves
- expertise at extracting minerals
- track record as a reliable producer and exporter of energy and resources.

On 20 June 2023, the Australian Government released a new national Critical Minerals Strategy that seeks to grow our critical minerals wealth, create Australian jobs in mining and manufacturing, strengthen global clean energy supply chains, and support the world to achieve net zero emissions. The path to net zero runs through the resources sector.

Its objectives are to:

- create diverse, resilient and sustainable supply chains through strong and secure international partnerships
- build sovereign capability in critical minerals processing
- use our critical minerals to help Australia become a renewable energy superpower
- extract more value from our resources onshore, which creates jobs and economic opportunities, including for regional and First Nations communities.

The strategy sets out a plan to achieve Australia's **VISION FOR 2030** to have grown **the geostrategic and economic footprint** of our critical minerals sector by becoming a **globally significant producer** of raw and processed critical minerals. The strategy has affirmed Australia's definition of critical minerals as 'metallic or non-metallic materials that are **essential to our modern technologies, economies and national security, and whose supply chains are vulnerable to disruption**'.

Critical minerals will underpin diverse, resilient and sustainable global supply chains that support:

- **industries** and **technologies** crucial for the global transition to net zero emissions
- domestic and regional **energy security**
- our **defence and economic security**.

The Strategy is expected to be an enduring framework to guide future Government policy decisions to maximise the national benefits of Australia's internationally significant critical minerals endowments.

As one of the first policy decisions under the Strategy, the Government will target **$500 million of new investment into critical minerals projects**, via the Northern Australia Infrastructure Facility.

The decision builds on the Government's wider suite of policies to support the sector, including finance through the **Critical Minerals Facility** and **National Reconstruction Fund**, investments in research and development, and **grants to help develop early- to mid-stage critical minerals projects**.

Independent modelling has found increasing exports of critical minerals and energy-transition minerals could create more than 115,000 new jobs and add $71.2 billion to GDP by 2040. However, the number

of jobs could increase by 262,600, and the increase in GDP strengthen to $133.5 billion by 2040 if Australia builds downstream refining and processing capability and secures a greater share of trade and investment.

International competition for investment in critical minerals is already intense, with **incentives announced by the United States and European Union** designed to boost investment to diversify supply chains and to decarbonise their economies.

KGL Resources Ltd welcomes the opportunity to contribute to the process established by the Australian Government to **update the Australia's Critical Minerals List as part of the Critical Minerals Strategy 2023–30**.

Australia's Critical Minerals List currently includes minerals:

- that are essential to modern technologies, economies and national security
- whose supply chains are vulnerable to disruption
- our strategic partners need
- for which Australia has potential economic geological resources.

The list was last updated on 16 March 2022. Since then, global markets and other countries' policies have evolved significantly.

Copper is **not** included on the list of Australia's Critical Minerals.

Submissions should provide evidence where possible to support your responses.

1. Is the current set of criteria still fit for purpose? The Critical Minerals List currently includes minerals:

- essential to modern technologies, economies and national security
- whose supply chains are vulnerable to disruption
- that our strategic partners need; and
- for which Australia has potential economic geological resources.

2. For minerals that are currently on the list, or minerals that should be considered for addition to or removal from the list:

a. Which technologies does the mineral feed?
b. What evidence is there of supply chain disruption relating to those minerals?
c. What market, financing, technical or other barriers affect these supply chains?
d. Are the barriers or supply chain disruption risks more acute in certain applications or levels of mineral grade or purity than others?

3. Should Australia differentiate between criticality or importance of minerals, and the capability to process them, through categories within the list or a separate category that sits alongside the list? This differentiation could reflect the size and maturity of markets and the different challenges or barriers faced.

Other countries have recognised value in establishing different categories or separate lists where minerals are prioritised. This differs from Australia's current approach and suggests that other lists are intended to serve multiple purposes (for example, to meet specific policy or research needs).

4. What lessons could be learned from other countries' approaches or the ways in which they consider their criteria for listing critical minerals?

5. What should trigger an update to the list? For example, global strategic, technological, economic or policy changes.

Executive Summary

Governments are increasingly recognizing that dependence on foreign sources of critical materials creates a **strategic vulnerability** for their economy and military in the face of adverse foreign government actions, natural disasters, and other events that could disrupt supplies.

On 31 July 2023, the US announced copper was to be included in their critical minerals as essential to the **economic prosperity** and **national defense** of the United States and to efforts to **build new and renewable energy sources, invest in semiconductors, and upgrade the U.S. electrical grid** to support the energy transition, without having to rely on geopolitical adversaries.

Copper is both strategic and critical to the **economic and national security** of Australia and our strategic partners and is essential in **modern technologies** and the decarbonization and electrification of the global economy as part of the **clean energy transition**.

- Copper is the **most critical mineral** in efforts to decarbonize and electrify the global economy and is also strategically important for the manufacture of the most promising clean energy technologies.
    - Copper is the **"metal of electrification"** and is essential to all energy transition plans.
    - **Copper is the most widely used metal in energy generation, transmission infrastructure, and energy storage**. It is the next most used metal after aluminum and steel in the construction, telecommunications, transportation, and automobile manufacturing sectors.
    - Copper is also strategically important for the **manufacture of the most promising clean energy technologies**, including applications such as wind turbines, solar panels, EV batteries, and large-scale energy storage.
    - **Clean energy technologies** are becoming the fastest-growing segment of copper demand. They are also more copper intensive. EVs use up to four times as much copper as an internal combustion engine vehicle, and copper is used ten times more by weight in an electric vehicle than lithium. Solar and onshore wind installations use four times more copper than conventional power with offshore wind requiring 10 times more copper. In addition, the weather dependent and variable output of solar and wind power creates the need to install three times more megawatts for the same amount of energy produced.
    - A World Bank analysis of the mineral intensity of 10 low-carbon energy technologies classifying copper as a critical metal found copper was essential to all 10 demonstrating that **the clean energy transition will depend very much on the availability of copper itself**.[1] According to the IEA, copper is of medium to high importance in 8/10 clean energy technologies compared to 1/10 for lithium (EV batteries).
- In addition to being critical in achieving global decarbonisation goals, copper is critical in the longer term to support **ongoing Chinese demand**, the emergence of developing economies such as **India and SE Asia**, the **digital economy** (everything from MRI's to smart phones) **and defense applications** (the same metal that powers smart phones propels smart bombs) with countries significantly increasing government spending on remilitarisation after Russia's invasion of Ukraine.
- The IEA estimates the clean energy transition will require a sixfold increase in critical minerals for clean energy technologies to achieve Net Zero by 2050 globally.

[1] World Bank. Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition (2020)

- Under the IEA's Net Zero scenario, **electricity demand grows rapidly, rising 40% from today to 2030** and more than two-and-a-half-times to 2050, while emissions from generation fall to net-zero in aggregate in advanced economies by 2035 and globally by 2040. **Renewables drive the transformation, up from 29% of generation in 2020 to 60% in 2030** and nearly 90% in 2050. From 2030 to 2050, 600GW of solar PV and 340 GW of wind are added each year. The least-efficient coal plants are phased out by 2030 and all unabated coal by 2040. Investment in electricity grids triples to 2030 and remains elevated to 2050
- S&P Global recently forecast that the rapid, large scale adoption of these technologies globally to achieve Net Zero by 2050 will result in a **doubling in copper demand from 25 Mt in 2021 to 50Mt in 2035** as growing demand for renewable energy, electricity infrastructure and electric vehicles increases alongside global carbon reduction targets, "an expansion that current trends or projects in the feasibility stage of development are incapable of meeting". The study warned of an "unprecedented and untenable" copper shortfall of 10 mm tonnes by 2035. Goehring & Rozencwaj believe S&P's "pessimistic" copper supply outlook is still too optimistic.
- Green demand is expected to represent 54% of the growth in copper demand over that period with EV's representing 65% of green demand.
- Analysts are forecasting a **long-term structural deficit in the copper market** with a shortfall to commence in 2025/2026 given the lack of new discoveries and projects in the pipeline. **Wood Mackenzie notes that 9.7 Mt of new mine supply will be required over the next decade (to 2032) from projects that have yet to be sanctioned.** That is equivalent to nearly one third of the world's current refined copper consumption or roughly **47 x Olympic Dams must be brought into production to meet 'net zero' climate targets**.
- The IEA recently noted in its comments on the copper market beyond 2024 that "existing operations are still encountering challenges, as Chile faces declining ore grade and water shortages, and protests from local communities could disrupt Peruvian supplies. Moreover, the lack of high-quality, large-scale projects in the pipeline indicates that the rate of production growth may decelerate after 2024. This implies that the market could turn into deficit if demand were to increase due to the recovery of the Chinese economy and the acceleration of energy transitions, which would have long-term price implications".
- BHP estimates that copper potentially needs around US$250 billion of investment by 2030 to address the forecast increase in demand.
- Given the 7 to 10-year time horizon required to bring a new mine into production and an average of 16 years from discovery to production, there is a serious risk that decarbonization goals of the key industrial economies which need to be met by 2030 to avoid facing **up to 2.7 degrees Celsius in global warming** will be curtailed.
- In addition to lengthy times for permitting and significant inflationary pressures, the industry is faced with human capital shortages and price volatility. A significant increase in the incentive price for copper is required to attract investment in new supply to meet forecast demand. However, this is unlikely to be in time to address the chronic shortages in copper expected to occur from the 2nd half of this decade. And the recent softening in economic growth prospects has likely further restrained investment in new supply.
- The clean energy transition is changing the dynamics of the copper market from a traditionally highly cyclical commodity to a scarce critical metal for the electrification of the global economy representing a structural change in demand.

- The IEA estimates the world will need 700 million tonnes of copper over the next 20 years to meet its Paris Agreement climate goals.
- "Richard Adkerson, Chairman and CEO of Freeport-McMoRan, the world's largest listed copper producer, recently told the Financial Times that the pace of the energy transition could be slowed as "there is going to be a very significant shortage of copper".
- **In fact, copper scarcity** may emerge as a key destabilizing threat to international security.
    - The world is not developing enough new copper deposits to meet expected demand. This, in turn, will become the focus of geostrategic interests as countries seek to gain greater access to the one metal essential for the energy transition.
    - Goldman Sachs is calling copper the new oil. And, like oil, copper will be at the centre of global competition between Western countries and the emerging autocratic bloc.
    - **Copper i**s critical to moving the global economy toward net zero emissions.
    - It's also critical to advanced manufacturing and defense systems. A 2015 US National Defense Stockpile Requirements Report noted that, by weight, **copper remains the second most widely used material in weapons platforms.**
    - Governments are increasingly recognizing that dependence on foreign sources of critical materials creates a **strategic vulnerability** for their economy and military in the face of adverse foreign government actions, natural disasters, and other events that could disrupt supplies.
- 60% of copper production is concentrated within 5 countries (Chile, Peru, China, DRC, USA) with an increasing risk of supply chain disruptions (political risk, military conflict, violent unrest and anticompetitive behaviors) and export bans (to promote use by domestic industries)
    - In Chile and Peru, governments are re-visiting existing mining leases, demanding higher royalties, and forcing companies to invest in greater local participation, including downstream processing.
    - Other key producers such as Mongolia, Indonesia and Panama are taking similar actions.
    - China and Russia are considered political adversaries and represent challenges for US national security
    - While the fifth-largest producer is the US, its ability to significantly increase output has been hampered by complex permitting processes and environment, social, and governance challenges. This has resulted in new mining projects that could have produced almost one million tonnes of copper supply being cancelled.
- China consumed 56 percent of refined copper globally in 2022 while producing 48 percent of global smelted copper and 43 percent of refined copper.
- Australia has the world's 2nd largest reserves of copper and is the 8th largest copper producer with a 4% market share. The **competitive advantage of Chile and Peru's large, low-cost porphyry mines are being eroded** by depleted reserves, lower grades, water shortages and a significant increase in the production costs and capital intensity of mines as well as increased regulatory and political risks.
    - Average production grades have fallen about 20% over the last 10 years - and 40% over the last 20 years - to about 0.6% copper. Subsequently, relative production costs have been rising, with major producers having to increase mine volumes to maintain copper production. The grades from projects under development are expected to fall further.

    - The recently released Feasibility Study for KGL's high-grade Jervois Copper Project showed a copper equivalent grade for the current JORC resource of 2.4% which compares favorably to the average production grades of 0.6% and lower for undeveloped projects today.
- Reviews by the **USA, EU, Canada, China, South Korea and India** support the view that **copper** is **both strategic and critical to economic and national security and to the clean energy transition** and each jurisdiction is implementing measures to ensure a secure and sustainable supply for their economies including for use in the fastest growing segment, transport and renewable energy, as the energy transition advances.

In 2021, Australia's two copper refineries (Townsville in Queensland and South Australia's Olympic Dam) produced about 385,000 tonnes of refined copper. Over the same period, Australian copper exports generated about $12 billion in export revenue, with $7.7 billion from copper concentrates and $4.3 billion from refined copper.

Whilst **Australia** has a significant endowment of **copper reserves ranking 2nd in the world** and the potential to be a major copper player, Geraldine Slattery, BHP President of Australian operations, recently noted that "developing copper projects in Australia is unlike Australia's iron ore and metallurgical coal endowment which were found in large quantities and close to surface…our copper resources are deeper or more remote or individually smaller in scale".

The Australian Government can play an important role in establishing supportive policy settings that help to incentivize an acceleration in investment in the exploration for copper and project development providing access to financing and strategic investments recognizing the long time frames associated with getting projects into production and the challenges associated with projects remote location, lack of infrastructure or access to skilled workers or the high cost of construction in today's strong inflationary environment. Canada is adopting similar schemes to accelerate development of priority projects.

Australia has an opportunity to become a globally significant player in the mining, production and refining of copper which is a critical mineral for the economic and national security of our country and our strategic partners and is essential in **modern technologies** and the decarbonization and electrification of the global economy as part of the **clean energy transition**. Developing Australia's capabilities in new clean energy technologies together with strategic partners can also position Australia as a diversified, reliable supplier to the manufacturing industry for clean energy technologies and for the renewable energy industry.

Comments by KGL's Executive Chairman, Denis Wood.

Meaningful progress on the clean energy transition by 2030 requires an acceleration in the adoption of electric vehicles, installation of renewable energy and battery storage and upgrading of electricity grids all of which are more mineral intensive than fossil fuels and highly dependent on a significant increase in the supply of copper which is critical to the electrification of the global economy.

With chronic shortfalls in copper forecast over the next decade and challenges in supply from the traditional low-cost markets of Chile and Peru, Australia has the opportunity to grow our critical minerals wealth and become an important player in developing secure, reliable and sustainable global supply chains for copper that are **internationally competitive**. With an ongoing focus on improving productivity, innovation and government policies that support Australia's strategic objectives of growing the **geostrategic and economic footprint** of our critical minerals sector, Australia can become **internationally competitive** as a **globally significant** producer of copper and other raw and processed critical minerals.

KGL's Jervois Copper Project is well positioned with approvals and permits, to be one of the few projects that can be **in production, subject to final investment decision, as the market is faced with a chronic shortfall in supply**.

Given the robust outlook for the copper market, we believe that the Jervois copper hub, a high-quality project in a Tier One jurisdiction, will play an important role in supporting jobs and new skills, local business opportunities and economic development activity in Northern Australia and provide a secure, reliable and sustainable supply of critical minerals to our strategic partners to meet their economic and national security and clean energy needs at a time when chronic shortages in this critical mineral could disrupt global supply chains.

Recommendations

KGL strongly believes that **copper** should be included in the Critical Minerals List given:

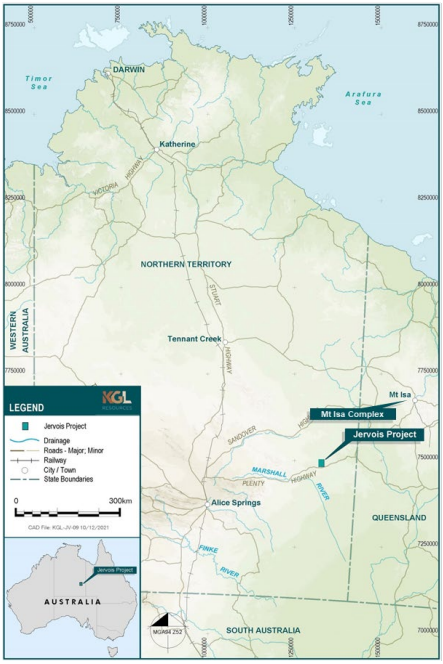
- its critical importance to economic and national security and the decarbonization and electrification of the global economy and to global supply chains
- forecasts for a doubling of copper demand by 2035 to meet Net Zero targets
- declining grades from existing mines, the lack of new discoveries, the extended time of 16 years to get projects from discovery to production resulting in a forecast for a **chronic shortfall** in supplies commencing in the second half of this decade
- risks associated with a **consolidation of supply chains** with over 50% of copper production derived from 4 countries (Chile, Peru, Congo and China) and China's share in all the manufacturing stages of solar panels (such as polysilicon, ingots, wafers, cells and modules) exceeding 80%.
- **increasing global geopolitical competition and tensions** and the impact this may have on global supply chains and the ability to develop the clean energy technologies and industries required to meet NZE targets.

Furthermore, to support the development of critical minerals industry in Australia, KGL believes the Australia Government should consider:

- substantially increasing the size of the Critical Minerals Fund, currently $2 billion. Australian mining companies are increasingly being forced to seek project funding for development projects away from traditional banks, as offtake deals, equity raisings, and government lending agencies emerge as more reliable sources of capital. According to Bridgend Capital Advisory, since peaking in 2015 aggregate exposure to resources by the 'Big 4 banks' in Australia has declined steadily to $40.4 billion in 2022, nearly $25 billion (37%) below the peak to levels not seen since 2013.
- substantially increasing grants for exploration to accelerate the discovery and development of potential copper resources which are typically found at depth, unlike the massive discoveries made in the past in Chile and Peru
- provide tax incentives to encourage exploration and development in some of the most remote and isolated areas of the country away from infrastructure and population centres
- provide funding to build regional infrastructure within proximity to mine site
- make it more attractive to explore and develop mining projects
- make it more attractive for individuals to develop skills and training for the mining industry
- make it more attractive for individuals to live in the Northern Territory and work in remote locations
- streamline approval and permitting processes which can delay projects by up to 10 years
- consider making grants to encourage the take up of green energy solutions in the mining, processing and transport of the commodity to market
- consider making grants to local businesses to support capacity building and business opportunities

KGL's Jervois Copper Project

KGL Resources Limited is an Australian mineral explorer and developer focused on the delineation and development of a **new high-grade copper hub in the Northern Territory** with its Jervois Copper Project located around 270km (linearly) east north-east of Alice Springs in the Northern Territory.



KGL's licensed high-grade copper project at Jervois is well positioned to benefit from the expected long term structural deficit in copper supply from 2025.

Mineralisation within the Jervois project area was discovered in the late 1920's during cattle mustering by Tom Hanlon. Mining has been undertaken at various times since then.

KGL acquired the exploration and mining leases in 2011 and since then, shareholders have funded an extensive exploration and development program at Jervois with a focus on establishing a high grade, sustainable copper mine **producing annual copper in concentrate of 30 ktpa** with a **minimum mine life of 10 years.**

The Project is now at an advanced stage of development having obtained all necessary approvals and permits and recently completed a Feasibility Study (November 2022) which demonstrated the project is technically sound and economically viable with a base case copper price of US$4.23/lb and Pre-Production Capital Costs of A$297 million despite the current strong inflationary environment and can support a high-grade copper mine with a minimum mine life of 11.25 years.

The project could come online in 2025/2026 coinciding with the forecast start of a long-term structural deficit in the copper market driven by global decarbonization targets for achieving Net-Zero emissions by 2050. Numerous industry analysts are expecting the incentive price required to meet demand to be significantly higher in coming years (Goldman Sachs assumes a price of US$5.90/lb).

KGL's development of the project will involve the extraction of existing and expanded base metal resources primarily targeting copper ore within the project area. The project contains significant high-grade copper resources, as well as silver, gold, lead and zinc in several deposits.

KGL has signed an offtake agreement with Glencore for its copper concentrate. The copper concentrate will be trucked from the mine site, about 488 kilometres by road to Mt Isa where it will be blended and refined. The haulage route consists of 213km along the Plenty Highway, planned to be sealed as part of the Outback Way initiative, a 187km unsealed section between the Plenty Highway and National Road 83 (Bourke Developmental Road) which is sealed for 88km through to Mt Isa.

Given its remote location, the Project will need to build supporting infrastructure such as an off-grid power system (with preference for solar, wind and battery with backup diesel) enabling renewable energy to provide the majority of power requirements, a 260-person village accommodation for fly in / fly out workforce and support services, borefield water production and pipeline and an airport which can accommodate the needs of a FIFO workforce.

The Jervois Project is located on the southern margins of the North Australian Craton which is home to several **world class mineral deposits** and is one of the **world's leading provinces for the production of Cu, Zn, Pb, and Ag**. It contains the world's largest zinc-lead-silver province, and major uranium, copper and gold provinces.

Jervois represents one of the **highest-grade** undeveloped copper projects in Australia. Since acquiring the deposit in 2011, KGL has used modern, cost-effective exploration methods to successfully define a JORC Resource of 23.80 Million tonnes at 2.02% Copper, 0.25g/t Gold and 25.3g/t Silver (Cu equ. 2.4%).

The Jervois and Unca Creek deposits are located along a distinctive J-shape of an outcropping mineralised system with a **strike length of some 12 km** and remain **under-explored and highly prospective** for high grade copper, gold and silver.

The greatest risk in developing new projects successfully today remains the ability to deliver on development timelines and project outcomes given the current uncertainties and challenges associated with the **strong inflationary environment, labour shortages, ongoing supply chain disruptions, rising energy prices and the war in Ukraine**. Rising interest rates are also adding to uncertainties in the macroeconomic environment.

Despite the challenging near term environment, KGL with a licensed high-grade copper project at Jervois is well positioned to benefit from the expected long term structural deficit in supply from 2025 and will continue to focus on growing the resource and optimizing key project value drivers to be ready for FID when the board believes the risks associated with being able to deliver a project on time and on budget are manageable and acceptable to shareholders.

KGL's Executive Chairman, Denis Wood, commented "We remain confident regarding the robust outlook for the copper market and believe that the **Jervois copper hub** is a high-quality project in a Tier One jurisdiction that will **play an important role** in supporting jobs and economic development activity in Northern Australia, downstream processing facilities in Mt Isa and provide a strategic supply of critical minerals for Australia and our strategic partners to meet the electrification and clean energy needs of tomorrow."

Given the lower average grades of most new projects (average grade of existing mines today is 0.6% compared to the Jervois Copper Project with a Cu Equ. grade of 2.3%) and rising costs of production in the industry, producers believe the market price for copper is currently below the incentive price required to invest in new production. This is likely to further exacerbate the shortage in supply until new production can enter the market.

The Opportunity

1. Copper is critical to the economic and national security of Australia and our strategic partners, modern technologies and the clean energy transition & faces a chronic shortfall over the next decade
2. Australia has the 2nd largest reserves in the world and ranks 8th in terms of production

Chronic Shortfalls in Copper Expected From 2nd Half of this Decade to Meet NZE Goals

Copper is the most widely used metal in energy generation, transmission infrastructure, and energy storage. It is the next most used metal after aluminum and steel in the construction, telecommunications, transportation, and automobile manufacturing sectors.

Copper is considered a critical metal in the effort to decarbonize the global economy to achieve the goal of Net Zero Emissions by 2050.

The copper market is forecast to experience a significant surge in demand over the course of the next decade, due to an acceleration in the adoption of renewable energy, electric vehicles, and associated infrastructure which all require copper.

A recent report by S&P Global estimates that demand for refined copper will double from 25 million tonnes in 2020 to around 50 million tonnes by 2035, an expansion that **current exploration trends or projects in the feasibility stage of development are incapable of meeting.**

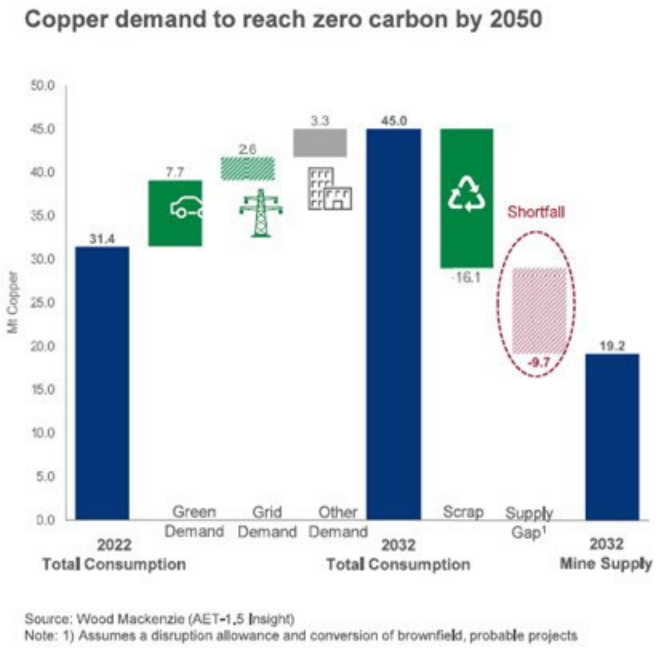
This increase in demand is in line with global carbon reduction targets and the push towards a greener economy, as virtually all governments have committed to the broad-based adoption of EVs, clean transportation, and net-zero electricity grids.

The study warned of an "unprecedented and untenable" **copper shortfall of 10 million tonnes as suppliers grapple with copper demand that will double by 2035.**

Analysts at consultancy Wood Mackenzie ("WM") recently published 'The drive for decarbonisation' forecasting demand for copper to more than double by 2050 under their accelerated energy transition 1.5-degree scenario (AET-1.5) growing from 28.8 Mt to 68.5 Mt by 2050, representing a growth rate of 2.9% per annum, with electric vehicles and the grid key demand drivers. They note that "Building electric cars and trucks, transmission lines, solar and wind farms will turbocharge demand for the metal over the next 20 years, amounting to the equivalent of 60 per cent of the current market size" and "electric vehicles will be by far the largest single sector contributing to the rise in green demand for copper over the next two decades, accounting for 55% of green demand."

WM noted that "substantial growth in new mine supply will be needed to meet zero-carbon targets. The industry will have to deliver projects at a frequency and consistent level of investment never previously accomplished."

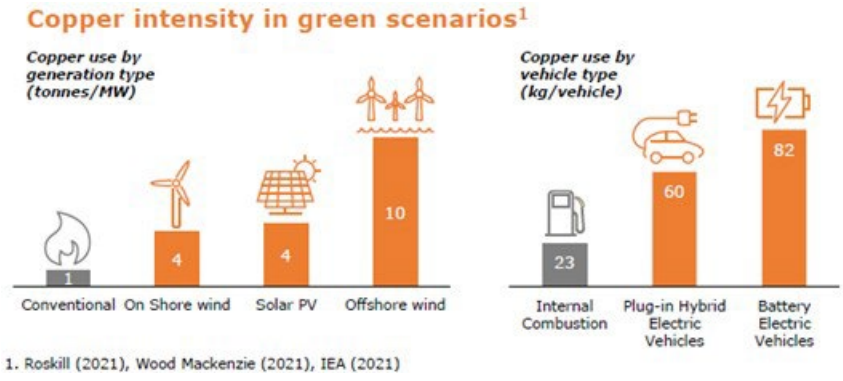
"The additional volume of copper needed means that 9.7 Mt of new mine supply will be required over the next decade (to 2032) from projects that have yet to be sanctioned."



That is equivalent to nearly one third of the world's current refined copper consumption or roughly **47 x Olympic Dams[2] must be brought into production to meet 'net zero' climate targets**.

Green demand represents 55% of the increase to 2032.

Copper intensity (the amount of copper utilized per unit of GDP) is also rising, indicating that society is becoming more copper-dependent. This trend is attributed to the shift towards greener technologies, which are highly copper-intensive. Renewable energy technologies are 4x to 10x more copper intensive than conventional energy production. In addition, the weather dependent and variable output of solar and wind power creates the need to install three times more megawatts for the same amount of energy produced.



[2] Tuesday, Jul 20, 2021 - Olympic Dam copper production increased by 20 per cent to 205,000 tonnes for the year FY21, reflecting improved smelter stability and strong underground mine performance, the company said. This was up from 172 kilotons of copper in the 2020 financial year, which was 7 per cent up on 2019. April 2023.. Olympic Dam copper production jumped 88 per cent to 156,000 tonnes for the nine months to March 31, which came as BHP conducted a major smelter maintenance campaign across the December 2021 and March 2022 quarters. This saw Olympic Dam deliver a new record for concentrate smelted across the nine-month period.

As demand from the energy transition begins to accelerate over the next few years, we are facing significant **supply challenges** arising from a combination of factors including declining grades and reserves from existing mines, a lack of new discoveries despite increased exploration budgets and an extended approval process of on average 16 years from discovery to production.

The IEA recently noted in its comments on the copper market beyond 2024 that “existing operations are still encountering challenges, as Chile faces declining ore grade and water shortages, and protests from local communities could disrupt Peruvian supplies. Moreover, the lack of high-quality, large-scale projects in the pipeline indicates that the rate of production growth may decelerate after 2024. This implies that the market could turn into deficit if demand were to increase due to the recovery of the Chinese economy and the acceleration of energy transitions, which would have long-term price implications”.

The International Energy Agency estimates the world will need 700 million tonnes of copper over the next 20 years to meet its Paris Agreement climate goals.

The longer-term prospects for copper are supported by global decarbonisation goals, ongoing Chinese demand, the emergence of India, and remilitarisation after Russia’s invasion of Ukraine.

The positive outlook for copper prices in the longer term remains intact. Glencore plc's CEO, Gary Nagle, stated that a "huge" copper shortage will impact global supply between now and 2030, **with a projected cumulative gap between demand and supply of 50 million tonnes between 2022 and 2030**. Goldman Sachs forecasts that copper could hit $10,500 a tonne in the near term before reaching $15,000 by 2025, also the view of Citigroup analysts.

BHP estimates that copper potentially needs around US$250 billion of investment by 2030 to address the forecast increase in demand.

A significant increase in the incentive price for copper is required to attract the required investment in new supply to meet forecast demand. **However, this is unlikely to be in time to address the chronic shortages in copper expected to occur from the 2nd half of this decade.** And the recent softening in economic growth forecasts has likely further restrained investment in new supply.

Australia Ranks 2nd in Copper Reserves and 8th in Copper Production [3]

Copper is the most critical metal required for the clean energy transition and Australia has an extraordinary opportunity to grow our market share in copper production from the 8th largest producer (4%) given Australia ranks 2nd in terms of copper reserves.

The major industrial countries have recognized that copper is not only a strategic but critical metal required for the clean energy transition and the **manufacture of the most promising clean energy generation, transmission, storage and end-use technologies**, including solar panels, wind turbines, power electronics, lighting, and electric vehicles and is likely to experience chronic shortfalls from 2025.

Expanding our copper production in the face of increasing deficits provides an excellent opportunity to grow our critical minerals wealth, create Australian jobs in mining and manufacturing, strengthen global clean energy supply chains, and support the world to achieve net zero emissions.

According to the United States Geological Survey (USGS), Chile — the world's largest copper producer — produced 5.39 MMt in 2022 and has the largest reserves, estimated at 190 MMt, or 21.3% of the world's total. Peru, the second-largest producer, at 2.2 MMt in 2022, has the third-largest reserves behind **Australia (97 MMt or 10.8%)**, with 81 MMt, or 9% globally.[4]

Whilst **Australia** has a significant endowment of **copper reserves ranking 2nd in the world** and the potential to be a major copper player, Geraldine Slattery, BHP President of Australian operations, recently noted that "developing copper projects in Australia is unlike Australia's iron ore and metallurgical coal endowment which were found in large quantities and close to surface…our copper resources are deeper or more remote or individually smaller in scale".

This compares with mines in Chile such as the giant Escondida deposit, discovered in 1981, which hosts the world's largest copper mine producing around 1 million metric tons of copper in 2022 and which has been operating continuously since commencing production in late 1990. However, due to reserve depletion and declining grades, the world's largest copper mine appears to have reached a peak and its production in 2025 is expected to be at least 5% lower than today. The mine is also faced with exponential rises in capital expenditures needed to mine lower and lower-grade ore.

With global consumption forecast to grow from 30 Mt in 2021 to over 60 Mt by 2050, mine production would need to more than double from 21 Mt in 2021 with the balance to be met an increase in the recycling rate.

Most of the world's major copper deposits are located in Latin America. **Chile and Peru produce approximately 40% of the world's copper output** and have significant **unexploited potential** to **help reduce the shortfall between supply and projected demand**. However, after almost 25 years of production from low-cost giant porphyry systems, the competitive advantage of Chile and Peru and their ability to grow production is being challenged by depleted reserves, lower grades, more complex geology, water shortages, significant cost inflation, and increased regulatory and political uncertainty with discussions of nationalizing "strategic assets" such as lithium, copper and precious metals and increasing taxes. In addition, miners are struggling to access concession land in Chile, while in Peru, they

[3] https://www.ga.gov.au/digital-publication/aimr2022/world-rankings: Geoscience Australia - *World ranking for Australia's mineral resources (EDR) and production as at December 2021.*

[4] S&P Global Market Intelligence: Chile and Peru's copper for energy transition (5 April 2023)

face lengthy procedures to obtain permits. Increased enforcement of environmental, social and governance standards is likely to make it more difficult to obtain the social license to operate in Chile and Peru while encouraging more protests or lengthy court challenges affecting mining projects.

In 2022, China and the Democratic Republic of Congo accounted for a 10% of global production each.

The top 10 supply countries are Chile, Peru, China, DRC, USA, Russia, Indonesia, Australia, Zambia & Mexico accounting for 78% of global production. [5]

Australia has hosted some of the largest Cu-Au deposits in the world, including Olympic Dam, Broken Hill, Mt Isa, Telfer and Tennant Creek. The five largest copper producers in Australia as of 2021 were Olympic Dam, Mt Isa and the more recent discoveries of the Cadia Valley Province Cu-Au deposits discovered in the 1990's which entered production in 2013, the Prominent Hill mine which was discovered in 2001 and entered production in 2009 and the Carapateena mine which was discovered in 2005 and produced its first copper concentrate in 2019.

As an example, the Mt Isa Inlier is one of the richest base metal provinces in the world. The Mount Isa Pb-Zn-Ag deposit was discovered in 1923. Copper mineralisation was discovered by drilling in the late 1920s. The Mount Isa copper orebody as a whole covers an extent of over 4kms and a vertical extent of 1800 metres (Lilly et al, 2017). Economic copper ore commences beneath the Pb-Zn-Ag ore system at vertical depths of 1000-1800m. Copper mining commenced briefly during 1943 during World War II but was closed down in 1944 and wasn't recommenced until the discovery of the 1100 orebody in 1954 with a drill hole intersection of 202 m @ 2.2% Cu. Since then, additional ore bodies have been discovered.

Mt Isa has been producing significant tonnages of high-grade copper from the Mt Isa copper ore body for the last 70 years. However, its ageing Mount Isa operations have become increasingly difficult to mine, with the value of its smelter and refinery – which also process limited quantities of third-party product – largely at the mercy of Australia's soaring energy prices. Australia produced only 10.2 per cent of Glencore's 1.06 million tonne copper output in 2022, with its three Mount Isa copper mines, plus the smelter and refinery, accounting for about 70,500 tonnes of that total.[6]

While companies globally have increased copper exploration budgets over the past several years this has not led to a meaningful increase in the number of recent major discoveries. The last decade delivered the lowest discovery rate for 30 years. With copper demand expected to outpace refined copper production, the industry is not making enough new, high-quality discoveries to support the long-term pipeline.

In terms of the grades of copper mined, global reserve grades have been on the decline for the last two decades. Adding to the long-term problem of declining numbers of discoveries is the declining grade of unmined copper ore bodies. Average production grades have fallen about 20% over the last 10 years - and 40% over the last 20 years - to about 0.6% copper. Subsequently, relative production costs have been rising, with major producers having to increase mine volumes to maintain copper production. This has been felt particularly in Chile, the world's largest copper producing country, affecting production volumes and mining and processing costs, with further declines in the grade of mined ore expected.

[5] U.S. Geological Survey, Mineral Commodity Summaries, January 2023

[6] Australian copper absent from Glencore boss's Teck merger pitch (August 7, 2023: The Australian)

The clean energy transition is changing the dynamics of the copper market from a traditionally highly cyclical commodity to a scarce critical metal for the electrification of the global economy representing a structural change in demand similar to what happened with the increase in demand for iron ore created by China urbanization. As happened with the iron ore market where pricing increased 5-fold, we can expect to see a significant increase in the cost curve for new supply to meet new demand as we transition to a low carbon economy with market price adjustments to reflect the scarcity in new supply. A recent S&P Global report[7] acknowledges that massive new supply must come online in a timely way otherwise the goal of Net Zero Emissions by 2050 will remain out of reach.

Risks and Challenges

One of the most obvious risks is stated clearly in S&P's recent report - *"The Future of Copper: Will the looming supply gap short-circuit the energy transition?" (July 2022).*

Like many countries, Australia has set an ambitious goal of achieving an 82% share of power generation with renewable energy by 2030, up from 27% today. The IEA said in April that **Australia's decarbonization efforts needed to be stepped up considerably** to reach its aim of increasing the share of low-carbon power generation by 2030 from renewable energy.

On 12 July 2023, Net Zero Australia released its final report focused on the steps needed to make sure the country is on track by 2030 to achieve net zero emissions by the global target date of 2050 which stated that **Australia must find $1.5 trillion by the end of the decade to meet 2050 green targets in an effort experts say would need to mirror the reconstruction of Europe after World War II**.

The report says that nearly 50 gigawatts of planned and committed renewable energy generation falls well short of the 230GW estimated to be needed by 2035, and that a **drastic acceleration of both onshore and offshore wind developments would be needed to provide future power**.

The report finds that Australia will need to both speed up and broaden its decarbonisation efforts to reach net zero emissions by 2050, including a whole-of-economy approach that includes more options, stronger investment drivers and a far larger pipeline of renewable energy and other transition projects.

"The modelled capital requirement – **$1.2 trillion to $1.5 trillion of commitments by 2030, and $7 trillion to $9 trillion by 2060) will not be met at the current rate; the gap is enormous**," according to study co-author Chris Greig, a senior research scientist at Princeton University in the US.

The report says that level of spending would make the energy transition one of the biggest and fastest economic transformations in global history. It would be an effort which would be in line with the US-led Marshall Plan to rebuild Europe after World War II, Professor Batterham said.

Net Zero Australia's modelling suggests the skilled workforce needed to install and run new generation assets, transmission lines, and associated decarbonisation efforts will need to double to at least 200,000 people by 2030 and reach 700,000-850,000 by 2060 – up to 4 per cent of Australia's estimated total workforce.

[7] S& P Global. The Future of Copper: Will the looming supply gap short-circuit the energy transition? (July 2022)

A more pessimistic view on the clean energy transition globally is provided in a report by Associate Research Professor Simon Michaux from Geological Survey of Finland GTK (2021) who concludes that current planning for the phasing out of fossil fuels has significantly underestimated the size of the task[8]. Current expectations are that global industrial businesses will replace a complex industrial energy ecosystem that took more than a century to build. The current system was built with the support of the highest calorifically dense source of energy the world has ever known (oil), in cheap abundant quantities, with easily available credit, and seemingly unlimited mineral resources. The replacement needs to be done at a time when there is comparatively very expensive energy, a fragile finance system saturated in debt, not enough minerals, and an unprecedented world population, embedded in a deteriorating natural environment. Most challenging of all, this has to be done within a few decades. It is the author's opinion, based on the new calculations presented in the report, that this will likely not go as planned. The report concludes that replacing the existing fossil fuel powered system (oil, gas, and coal), using renewable technologies, such as solar panels or wind turbines, will not be possible for the entire global human population. There is simply just not enough time, nor resources to do this by the current target set by the World's most influential nations.

In any case, **without access to copper**, the decarbonization goals of the key industrial economies will not be met by 2030 and scientists believe we will be **facing up to 2.7 degrees Celsius in global warming**. This warming means far more erratic weather conditions and global temperature records being reached. We will see more extreme weather systems, with large flooding, forest fires and droughts, all of which can impact both communities and wildlife.

Because of the material intensity of low-carbon technologies, any potential shortages in mineral supply could impact the speed and scale at which certain technologies may be deployed globally.

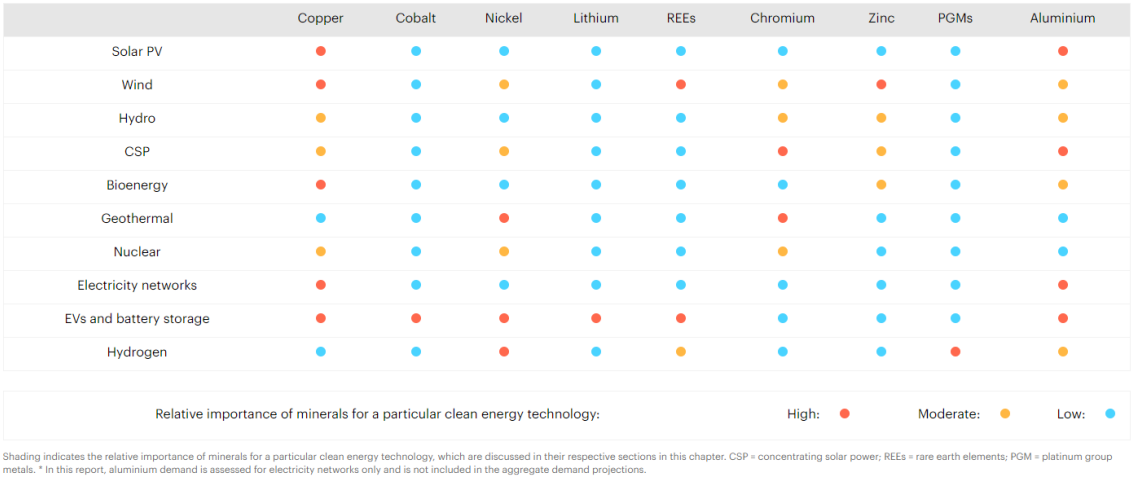
Numerous commentators are warning of a chronic shortfall in copper required to drive the energy transition and carbon zero over the next 10 years including Doug Kirwin, an independent consulting geologist and one of the earliest geologists to work at the Oyu Tolgoi deposit in Mongolia, who was recently quoted as saying that "There's just not enough copper deposits being found or developed."

According to the IEA, an energy system powered by clean energy technologies differs profoundly from one fueled by traditional hydrocarbon resources. Solar photovoltaic (PV) plants, wind farms and electric vehicles (EVs) generally require more minerals to build than their fossil fuel-based counterparts. **A typical electric car requires six times the mineral inputs** of a conventional car and an **onshore wind plant requires nine times more mineral resources than a gas-fired plant**. Since 2010, the average amount of minerals needed for a new unit of power generation capacity has increased by 50% as the share of renewables in new investment has risen.

Significant investments will need to be made to transition to clean energy and diversify global supply chains to reduce reliance on any one supplier.

[8] Assessment of the Extra Capacity Required of Alternative Energy Electrical Power Systems to Completely Replace Fossil Fuels. Simon Michaux, Associate Research Professor, Geological Survey of Finland. (2021)

Critical mineral needs for clean energy technologies



Source – IEA (2021): The Role of Critical Minerals in Clean Energy Transitions

A World Bank analysis of the mineral intensity of 10 low-carbon energy technologies classifying copper as a critical metal found copper was essential to all 10 demonstrating that the clean energy transition will depend very much on the availability of copper itself.[9]

BHP Australian President, Geraldine Slattery, recently noted, "In a plausible upside case, we estimate there could be well over 400 million electric vehicles on the world's roads in 2030 – up from about 16 million today. Building those vehicles could require up to 26 million tonnes of copper. That does not include the materials that will be required to charge them or produce the zero-carbon electricity that will power them".

Wood Mackenzie's accelerated transition scenario (AET 1.5) suggests primary copper demand will exceed 40 Mt pa by 2050 and they estimate a required investment in copper projects of around **US$23 billion per annum to be sustained over the next 30 years ($690 billion)** if there is to be enough supply to reach the zero emissions target by 2050.

Another key risk is the **sustainability and security** of global supply chains.

China's investments in metals and mining overseas are set to hit a record high this year, as the nation strives to secure vital resources and maintain its position as the world's leading producer of electric vehicles, batteries, solar panels, and wind turbines. China is the largest copper refining country, with around 40% market share and represented 55% of world copper usage in 2021. China's share in all the manufacturing stages of solar panels (such as polysilicon, ingots, wafers, cells and modules) exceeds 80%.

Given the recent lessons learned from China's ban on Australian imports, China's recent ban on the export of critical minerals as well as Europe's over-reliance on Russian gas, countries are increasingly focused on the sustainability and security of their global supply chains.

[9] World Bank. Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition (2020)

The renewable energy industry is acutely aware of the risks of over reliance on China for sourcing components for wind and solar panels.

An additional risk in the development of the critical minerals industry and downstream processing capabilities is **Australia's tight market for resources, including workers**. The enormous investments required to achieve the clean energy transition are set to drive a huge increase in the requirements for these minerals. The clean energy transition will also drive enormous competition for skilled workers and workers more generally. The skills shortage could hamper the world's ability to achieve net-zero emissions, according to Antonio Scala, head of people and organization for Italian utility Enel SpA's renewables, thermal generation, infrastructure and networks divisions.

In a recent report "Skilling Australian Industry for the Energy Transition", research showed the transition to renewable energy will create jobs for ~194,000 workers by 2050 and will require an additional 59,300 workers before 2030. The report also says that if Australia pursues rapid industrial decarbonisation through coordinated action, $427B will be spent to install 221GW of clean energy capacity by 2050 which could support up to 1.22 million construction jobs and 130,000 O&M jobs across Australia between 2025 to 2050.

This does not address the workforce requirements of the mining industry which the clean energy transition is relying on to meet its decarbonization goals and develop alternative clean energy products for the domestic and international markets.

As noted in the Government's 2023-2030 Critical Minerals Strategy documents, Australia is competing in an increasingly challenging and competitive labour market, with the OECD reporting labour markets globally have tightened across countries and sectors (OECD 2022). In early 2022, Europe reported 1.2 million open job roles across all sectors. According to one estimate, the US Inflation Reduction Act will create demand for 5.9 million new jobs in US clean energy and manufacturing over the next decade (Pollin et al, 2022). In Australia, there are nearly 440,000 vacant positions, including more than 10,000 in the mining sector and more than 25,000 in the manufacturing sector (ABS 2023). Canada is proposing to increase new permanent residents by 1.45 million over the next three years, including 500,000 people in 2025.

McKinsey found that Australia has seen mining job vacancies more than double since February 2020, while Australian labor demand for mining operations and projects will require 24,400 new workers by 2026. However, the market is forecast to supply only about 16,000 workers in that time frame, indicating that vacancies will likely continue to rise for Australian miners.

Skills shortages coupled with a reluctance of young people and recent graduates to join the mining sector present a real risk for the sector more broadly but also for the critical minerals industry. The challenges associated with attracting skilled workers to the mining industry and to remote locations within Australia will need to be overcome as well as solutions developed to maintain international competitiveness give the relatively high cost of Australian labor which will require an increased focus on identifying opportunities for productivity improvements and innovation in the industry.

Global Perspectives: Copper is Strategic and Critical to the Clean Energy Transition

United States of America

It has been acknowledged that the assured supply of critical minerals and the resiliency of their supply chains are essential to the **economic prosperity** and **national defense** of the United States. The United States is heavily dependent on foreign sources of critical minerals and on foreign supply chains resulting in the potential for strategic vulnerabilities to both our economy and military.

In 2017, the US government sought to address this problem and reduce the Nation's vulnerability to disruptions in the supply of critical minerals, preparing the following report: **A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals.**

"When executed, this strategy will improve the ability of the advanced technology, industrial, and defense manufacturing sectors that use critical minerals to adapt to emerging mineral criticality issues; reduce risks for American businesses that rely on critical minerals; create a favorable U.S. business climate for production facilities at different stages of critical mineral supply chains; and support the economic security and national defense of the United States; all of which will reduce the Nation's vulnerability to critical mineral supply disruptions".

The US Geological Survey describes as both **strategic and critical those minerals essential to the economic and national security of the US; and where the US is dependent on imports for most supply.**

The U.S. Department of Energy released an updated review on the 31 July 2023:

"Critical Materials Assessment to Evaluate Supply Chain Security for Clean Energy Technologies".

The U.S. Department of Energy (DOE) released its 2023 Critical Materials Assessment, which evaluated materials for their criticality to global clean energy technology supply chains. Based on the results of the Assessment, DOE has determined the 2023 DOE Critical Materials List of **energy-specific critical and near-critical materials through 2035**. In addition to informing crosscutting DOE priorities including the Critical Materials Research, Development, Demonstration, and Commercialization Application Program (RDD&CA), the DOE Critical Materials List will inform eligibility for tax credits under the Inflation Reduction Act 48C.

The Assessment focuses on key materials with **high risk of supply disruption that are integral to clean energy technologies**. The final list includes aluminum, cobalt, **copper**, dysprosium, electrical steel (grain-oriented steel, non-grain-oriented steel, and amorphous steel), fluorine, gallium, iridium, lithium, magnesium, natural graphite, neodymium, nickel, platinum, praseodymium, terbium, silicon, and silicon carbide.

"As our nation continues the **transition to a clean energy economy**, it is our responsibility to anticipate **critical material supply chains needed to manufacture our most promising clean energy generation, transmission, storage and end-use technologies**, including solar panels, wind turbines, power electronics, lighting, and electric vehicles," said Alejandro Moreno, Acting Assistant Secretary for DOE's Office of Energy Efficiency and Renewable Energy (EERE). "Ultimately, identifying and mitigating material criticality now will ensure that a clean energy future is possible for decades to come."

Because material and technology markets are global, this Critical Materials Assessment features a global scope, placing U.S. domestic interests within that context. For each of the critical materials identified in this Assessment, DOE will develop an integrated strategy to address material-specific risks.

The review by the US follows similar reviews by the **EU, Canada, India and China** which also concluded that **copper is critical to the clean energy transition and to support the new clean energy technologies as well as to** economic security and national defense.

European Union

The European Commission has been issuing a list of critical raw minerals since 2011 which is updated every three years. The most recent list of critical minerals was published on 16 March, 2023.

The EU has made a commitment to support the sustainable supply of critical metals and minerals, including copper, and has identified potential funding opportunities and tax incentives to support companies in this sector.

The report states that copper is used in very large quantities of 20Mt in 2020 for electrification across all strategic technologies. Its supply is very well diversified; therefore, it has not been considered critical before. However, it is difficult to substitute due to its superior performance in electrical applications.

The European Commission has expanded its list of critical minerals to include copper and manganese and has also launched a strategic minerals list to support the March 16 publication of its proposed Critical Raw Materials Act. The lists were published March 16 as an annex to the proposals for a European Parliament and Council regulation to establish **a framework for ensuring a secure and sustainable supply of critical raw materials for use in transport and renewable energy as the energy transition advances.** The proposed lists need to be approved by the European Parliament and member states before becoming law.

The following raw materials shall be considered **strategic**, the EC said in its launch proposal: bismuth, boron – metallurgy grade, cobalt, **copper**, gallium, germanium, lithium – battery grade, magnesium metal, manganese – battery grade, natural graphite – battery grade, nickel – battery grade, platinum group metals, rare earth elements for magnets (Nd, Pr, Tb, Dy, Gd, Sm and Ce), silicon metal, titanium metal and tungsten.

"The **strategic importance** shall be determined based on the relevance of a raw material for the **green and digital transition as well as defence and space applications**, taking into account: (a) the amount of strategic technologies using a raw material as an input; (b) the amount of a raw material needed for manufacturing relevant strategic technologies; (c) the expected global demand for relevant strategic technologies," the EC said in its document.

While there is an overlap between strategic and critical minerals, **strategic minerals are generally considered to be those needed for supply chains and to support a nation's output**.

Strategic minerals are "what you need to give you security of supply," according to a definition by Keith Coughlan, executive chairman of European Metals Holdings, a mineral exploration and development company advancing the Cinovec vertically integrated battery metals project in Czech Republic. This is one of five lithium mine projects currently under preparation or development in the EU.

Critical materials

The EC said the following raw materials shall be considered **critical**: antimony, arsenic, bauxite, baryte, beryllium, bismuth, boron, cobalt, coking coal, **copper**, feldspar, fluorspar, gallium, germanium, hafnium, helium, heavy rare earth elements, light rare earth elements, lithium, magnesium, manganese, natural graphite, nickel – battery grade, niobium, phosphate rock, phosphorus, platinum group metals, scandium, silicon metal, strontium, tantalum, titanium metal, tungsten and vanadium.

Critical minerals are typically defined as those needed for **military, industrial or commercial purposes, including at a government or national level, used for instance in renewable energy, defense equipment, medical devices, electronics and agriculture. In addition, the term critical can be used to refer to minerals or metals that risk going short**.

"Critical Raw Materials (CRMs) are those raw materials which are economically and strategically important for the European economy, but have a high-risk associated with their supply," said the EU's Critical Raw Materials Alliance, an industry body.

The EU launched a critical minerals list **in 2020** which included 30 metals or minerals, not including copper or manganese. Natural rubber -- included in the original list -- has now been dropped.

The US Geological Survey describes as both **strategic and critical those minerals essential to the economic and national security of the US; and where the US is dependent on imports for most supply.**

Hildegard Müller, president of German Automotive Association VDA, said "concentrating on a list of strategic raw materials is basically right – this directs the focus to the raw materials for the urgently needed climate technologies."

"The fact that a Critical Raw Materials Board is to identify strategic raw materials projects that will then benefit from **faster approval procedures** and **easier financing** is also an important step in the right direction," Müller added.

The European Raw Materials Fund is seeking billions of euros through public and private investments with plans to launch in early 2023, Reuters reported June 17, citing Bernd Schaefer, CEO of EIT Raw Materials, a European Union-backed initiative.

The new fund will invest in critical minerals projects and help finance plans by the EU to produce one-fifth of its own rare earth magnets by 2030, according to the report. It is expected to launch with €2 billion.

The European Raw Materials Fund has already held discussions with private groups such as pension funds and other institutions. However, the region will require investments exceeding €100 billion to produce enough critical minerals, according to Schaefer.

"If you look at the enormous investment needed for raw materials, €100 billion to €150 billion needs to be invested to cope with the challenges of electrification," Schaefer said at the World Materials Forum in France.

The EU will support investments in Europe but is also establishing partnerships on critical raw materials with Canada, Ukraine, Namibia and Kazakhstan. And advancing in discussions with other countries."

South Korea

South Korea faces a challenging situation as it pursues ambitious plans for the future, particularly in electric vehicles (EVs), batteries and semiconductors — industries that rely heavily on critical minerals. Concurrently, Seoul must navigate the economic and geopolitical factors associated with these essential resources.

As critical minerals have the potential to impact South Korea's economic prosperity and national security, the country recognizes existing constraints and is strategizing to build partnerships, diversify and secure supply chains for these materials.

Sunrise sectors, such as electric vehicles, batteries and solar energy, have the potential for rapid growth. But they also require **critical minerals like cobalt, nickel, lithium, copper and rare earth materials**. In addition, pressure from its own pledge to transition toward a clean energy model is another consideration in Seoul's strategic planning.

Trade, Industry and Energy Minister Lee Chang-yang presided a conference on February 27, 2023 at the Lotte Hotel Seoul to discuss strategies for securing critical minerals and measures to stabilize the supply chain.

The Korean Ministry of Trade, Industry and Energy (MOTIE) defines 33 elements as critical minerals. The definition reflects the significance of these minerals to Korea's advanced industries such as semiconductors and batteries. It also reflects the inherent supply chain risks of these elements.

The 10 elements in bold are essential for Korea's EV and semiconductor industries.

- **Lithium, nickel, cobalt, manganese, graphite**, niobium, copper, aluminium, silicon, magnesium, molybdenum, vanadium, tin, titanium, tungsten, antimony, bismuth, chromium, lead, zinc, gallium, indium, tantalum, zirconium, strontium, selenium
- Rare earths: **lanthanum, cerium, neodymium, terbium, dysprosium**
- Platinum: platinum, palladium

Competition to secure resources like critical minerals and rare earth materials will **intensify further as economies prioritize sustainable growth models and economic prosperity.**

In recent years, South Korea has engaged in high-level diplomacy to achieve greater strength in these areas. It has addressed its dependence on China for critical mineral supplies by joining multilateral initiatives such as the Minerals Security Partnership, which focuses on bolstering critical mineral supply chains and catalyzing investments from governments and the private sector. The MSP initiative involves 12 nations, including Australia, Canada, France and resource-rich African countries.

Additionally, Seoul has sought mineral partnerships with countries like the U.S., Kazakhstan, Indonesia, Canada, Ecuador, Mongolia and Australia.

South Korea has also initiated a cooperative strategy with the European Union through the Critical Raw Materials Act. This law is primarily designed to fortify Europe's supply chain, particularly focusing on refining, processing and recycling critical raw materials.

Following the enactment of the U.S. Inflation Reduction Act (IRA), the government has undertaken targeted interventions within the battery industry. Seoul has facilitated a range of incentives, including

tax credits on investments, augmented credit lines, interest rate reductions and decreased insurance premiums, contributing to the preservation of competitiveness in an evolving global political environment.

Kia recently inaugurated the country's first electric vehicle (EV) manufacturing plant south of Seoul, and the automaker will be a key part of the Yoon administration's goal to make the **ROK a top three global EV manufacturer by 2030.**

While constraints associated with the U.S. alliance, such as the limitations imposed by the CHIPS Act and disruptions from the IRA, are likely to persist, South Korean corporations like LG and Hyundai have already worked to diversify their supply chains. This includes new and expanded investments in the U.S. aiming to take advantage of the growing EV market there. **Projections suggest U.S. market share for electric vehicles will rise from 26.5% to 69% from 2021 to 2025, accounting for 44% of global EV battery demand.**

Seoul has adopted a diversified strategy that extends beyond advanced economies to include emerging markets such as India. South Korea has committed to investing $1.5 billion in India to produce electric vehicles and the development of related ecosystems.

Korean electric vehicle (EV) manufacturers and their battery suppliers are developing battery supply chains that will drive demand for Australia's critical minerals and new downstream processing industries and deliver significant economic benefit to Australian industry.

Canada

Critical minerals represent a generational opportunity for Canada's workers, economy, and net-zero future. They are the foundation on which modern technology is built. From solar panels to semiconductors, wind turbines to advanced batteries for storage and transportation, the world needs critical minerals to build these products. **Simply put, there is no energy transition without critical minerals**, which is why their supply chain resilience has become an increasing priority for advanced economies.

Critical minerals are strategic assets that contribute to Canada's prosperity and national security. They are essential to military and security technology supply chains for national security, as well as other value chains of critical importance to Canada's economic security and prosperity.

Non-market economies are taking increasingly aggressive steps to further cement their control of critical minerals markets and achieve foreign policy goals. Geopolitical events such as war and trade disputes are also increasingly affecting global mineral markets, adding to price volatility and supply uncertainty. Heightened trade barriers and weaker access to markets create bottlenecks along supply chains and result in trade disruptions.

Among the critical minerals essential for priority supply chains, advanced manufacturing, clean technologies, and zero-emission vehicles, **six hold the most significant potential for Canadian economic growth. These are: lithium, graphite, nickel, cobalt, copper and rare earth elements.**

While these minerals represent the greatest opportunity to fuel Canadian domestic manufacturing and will be the focus of most investment, many other minerals also present significant prospects for the future. Where critical minerals are not used solely for domestic manufacturing, there is value to be

captured by increasing exports to allies and expanding domestic refining, processing, and components manufacturing over the medium to long term.

Mining is typically very capital-intensive, and new mines can take anywhere from 5 to 25 years to become operational. Mining companies, particularly junior companies, face the challenge of raising the private investment required to conduct their operations. In rural, northern, and remote regions, infrastructure gaps also hamper mineral development. To boost or develop new mine production, and to do so in a **cost-effective and environmentally responsible manner**, the Government of Canada will look for opportunities to **partner with the private sector in financing new projects, support building the necessary infrastructure for priority deposits, advance innovation to improve efficiency and environmental performance, strengthen Indigenous engagement, and streamline regulatory and permitting processes.** The mining industry is investing in green technology to lower the environmental footprint, efficiency, and safety of new and existing mines.

While country-specific lists differ in their composition internationally, there is a shared view that critical minerals:

- have few or no substitutes;
- are strategic and somewhat limited commodities; or
- are increasingly concentrated in terms of extraction and, even more, in terms of processing location.

Every stage of the critical mineral value chain presents an opportunity for Canada, from exploration to recycling and everything in between. To fully seize this opportunity, we must ensure that value is added to the entire supply chain, including exploration, extraction, intermediate processing, advanced manufacturing, and recycling.

Canadian Innovation, Science and Industry Minister François-Philippe Champagne has announced the criteria for projects eligible for funds available through the Strategic Innovation Fund (SIF) that aims to accelerate investments in critical mineral projects. The proposed fund, announced in the 2022 Budget, will make available C$1.5-billion in funding.

Champagne states that the qualifying projects must focus on critical minerals processing, manufacturing and recycling; however, mining projects that show exceptional innovation benefits and strong vertical integration to grow domestic value chains will be considered.

These future projects must meet specific criteria and target one or more of the 31 minerals Canada has identified as **"critical", with priority given to the six most significant minerals: lithium, graphite, nickel, cobalt, copper and rare earth elements.**

Critical Mineral	Value Chains	Major Application	Examples of Specific Products
Lithium	Clean technologies and defence and security technologies	Batteries, glassware, ceramics	Rechargeable batteries (phones, computers, cameras, and EVs); hydrogen fuel storage; metal alloys (military ballistic armour; aircraft, bicycle, and train components); specialized glass and ceramics; drying and air conditioning systems.
Graphite	Clean technologies	Batteries, fuel cells for EVs	Metal foundry lubricants, vehicle brake linings, metal casting wear, crucibles, rechargeable battery anodes, EV fuel cells, electrical motor components, frictionless materials, pencils.
Nickel	Clean technologies and advanced manufacturing	Stainless steel, solar panels, batteries, aerospace, and defence applications	Metal alloys (steel, superalloys, non-ferrous alloys), jet and combustion engine components, rechargeable batteries (phones, computers, EVs), industrial manufacturing machines, construction beams, anti-corrosive pipes, cookware, medical implants, power plant components.
Cobalt	Clean technologies	Batteries	Battery electrodes; metal alloys; turbine engine components, automobile airbags; catalysts in the petroleum and chemical industries; drying agents for paints, varnishes, and inks; magnets.
Copper	Clean technologies and advanced manufacturing	Electrical and electronics products	Power transmission lines, electrical building wiring, vehicle wiring, telecommunication wiring, electronic components.

Japan

In 2018, Japanese Ministry of Economy, Trade and Industry released Critical minerals Report, that identified the following 31 minerals as critical minerals: antimony, beryllium, chromium, cobalt, copper, diamond, fluorite, gallium, germanium, gold, indium, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, phosphorus, platinum group metals, rare earth, rhenium, silver, strontium, tantalum, tin, titanium, tungsten, vanadium, zinc, zirconium.

China

In 2016, the Ministry of Land and Resources of China released National Mineral Resources Planning (2016- 2020), which identified 24 strategic minerals as critical minerals to improve supply capability and utilization level. These minerals include 6 energy minerals (coal, coalseam gas, natural gas, oil, shale gas, uranium), 14 metal minerals (antimony, aluminum, chromium, cobalt, copper, gold, iron, lithium, molybdenum, nickel, rare earth, tin, tungsten, zirconium) and 4 nonmetallic minerals (crystalline graphite, fluorite, phosphorus, potash).

It can be found minerals that are recognized as critical by a certain economy are usually vital to other economies. Critical minerals listed by major economies in the world have a high degree of coincidence. These critical minerals play an important role in the strategic emerging industries and high-tech industries born in the new round of industrial revolution. These industries are also important pillar industries for Chinese development.

Emerging economies are accelerating their industrialization, which results in a continuous growth of the global demand for critical minerals. Traditional manufacturing industries in China have entered the peak period of production capacity. The vigorous development of emerging industries will drive the demand for critical minerals to stabilize at a high level.

India

On 28th June 2023, Union Minister of Coal, Mines & Parliamentary Affairs Shri Pralhad Joshi unveiled the **first ever report of the country on "Critical Minerals for India"**, prepared by an expert team constituted by the Ministry of Mines. Complementing the efforts of the Ministry, Shri Joshi pointed out that it is for the first time India has identified the comprehensive list of critical minerals taking into account the requirements of sectors like defence, agriculture, energy, pharmaceutical, telecom etc.

In addition to addressing vulnerability in the supply chain, India's focus on clean energy and lower emissions has further amplified the significance of critical minerals. From electric vehicles to renewable energy systems, these minerals play a pivotal role in accelerating the transition towards a greener and more sustainable future. As an emerging global economic powerhouse, it is essential to understand and harness the potential of critical minerals to fuel the country's growth, competitiveness, and sustainable development. By developing a comprehensive understanding of India's critical mineral resources, this work empowers policymakers, researchers, and industry stakeholders to make informed decisions and drive the clean energy revolution.

Critical minerals are those minerals that are essential for economic development and national security. The lack of availability of these minerals or concentration of extraction or processing in a few geographical locations may lead to supply chain vulnerabilities and even disruption of supplies.

The future global economy will be underpinned by technologies that depend on minerals such as lithium, graphite, cobalt, titanium, and rare earth elements. These are essential for the advancement of many sectors, including hightech electronics, telecommunications, transport, and defence. They are also vital to power the global transition to a low carbon emissions economy, and the renewable energy technologies that will be required to meet the 'Net Zero' commitments of an increasing number of countries around the world. Hence, it has become imperative to identify and develop value chains for the minerals which are critical to our country

Based on the three-stage assessment process mentioned above and also considering important parameters such as resource/ reserve position in the country, production, import dependency, use for future technology/ clean energy, requirement of fertilizer minerals in an agrarian economy, the Committee has identified a set of 30 critical minerals. These are Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, Lithium, Molybdenum, Niobium, Nickel, PGE, Phosphorous, Potash, REE, Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium and Cadmium.

India has recently become the newest partner in the coveted Mineral Security Partnership (MSP) to bolster critical mineral supply chains. The evolving geo-political situation presents an opportunity for India to benefit from the diversification of global supply chains. The last few years have exposed multinational firms and countries to unprecedented risks due to global trade tensions, pandemic-induced supply chain disruptions, and the conflict in Europe. Firms were exposed to the risk of concentrating their production in a single country. Therefore, given the global policy uncertainty, multinational firms are gradually exploring strategies to diversify their production bases and supply chains.

Russia

Russia was ranked the 6th largest copper producer in 2021.

Russian Sanctions and the Impact on Global Supply Chains (S&P Global): *21 July 2023 - US places Russian major copper producer UGMK on SDN list.* Author: Ekaterina Bouckley

The Office of Foreign Assets Control, a financial intelligence and enforcement agency of the US Treasury, has added Russian major copper producer Ural Mining and Metallurgical Company to its Specially Designated Nationals and Blocked Persons List (SDN). Ural Mining and Metallurgical Company -- UMMC, and also referred to as UGMK in Russia -- is one of the country's three major copper producers alongside Nornickel and Russian Copper Company, and can produce over 400,000 Mt/year of copper cathode, up to 250,000 Mt/year of zinc and 20,000 Mt/year of lead.

In October 2022, the UK imposed sanctions on UGMK shareholder Iskander Makhmudov, prompting the London Metal Exchange to suspend the placing on warrant in LME warehouses in the UK of any metals from the Russian company.

Since the US's copper imports come from Canada, Chile and Mexico, being placed on the SDN list will first and foremost **affect Russia's trade with the EU** because of the threat of so-called secondary sanctions the US may apply to foreign partners in case of non-compliance with SDN obligations, according to a Moscow-based industry analyst who spoke on condition of anonymity. He noted though that Russia's copper exports to Europe began to decline in late 2022 without any sanctions, simply because European buyers voluntarily started to buy other origins.

"Russia used to supply up to 300,000 Mt/year of copper to the European Union [while its exports to China are at least twice as much], but since the end of 2022, the volumes have reduced significantly as some European clients chose to forego the Russian metal," the analyst said.

For instance, Europe's largest copper producer Aurubis said as early as Q2 2022 it was no longer buying copper feeds from Russia. EU procurements from Russia have fallen this year. From January-April, the bloc imported 24,496 Mt of Russian refined copper and copper alloys, down 33% year on year, according to Eurostat. In 2021 and 2022, imports of Russian-origin copper totaled 292,000 Mt and 301,637 Mt, respectively.

Substituting has gone well because only a small proportion of the European market needs replacing, the analyst said. "The EU uses 3 million Mt/year of copper and Russian supply covered only 10% of this demand. The figure looks even smaller when compared with the global copper market of 26 million Mt/year."

The volume is significant for Russia though. Europe used to be a major outlet for Russian smelters absorbing little under a third of the country's 1 million Mt/year copper output. However, Russia is pivoting its copper trade to Asia, according to the analyst. "70% of the global copper production is consumed in Asia; the region will buy any tonnage Russia has to offer especially given some deficit in the world copper market," the analyst said. Since the beginning of this year Nornickel has been delivering a significant part of its copper production from Murmansk to the Moroccan port of Tangier, which has become the company's new hub for copper exports, instead of Rotterdam.

Key Takeaways

Copper is both strategic and critical to the clean energy transition.

Copper is also a vital raw material in the ongoing urbanisation and industrialisation of the world's developing economies.

- Copper is essential in efforts to decarbonize and electrify the global economy to achieve the goal of Net Zero Emissions by 2050.
    - Copper is the **"metal of electrification"** and is essential to all energy transition plans.
    - **Copper is the most widely used metal in energy generation, transmission infrastructure, and energy storage**. It is the next most used metal after aluminum and steel in the construction, telecommunications, transportation, and automobile manufacturing sectors.
    - Copper is also strategically important for the **manufacture of the most promising clean energy technologies**, including applications such as wind turbines, solar panels, EV batteries, and large-scale energy storage. **Clean energy technologies** are becoming the fastest-growing segment of copper demand. EVs use up to four times as much copper as an internal combustion engine vehicle, and copper is used ten times more by weight in an electric vehicle than lithium.
    - A World Bank analysis of the mineral intensity of 10 low-carbon energy technologies classifying copper as a critical metal found copper was essential to all 10 demonstrating that **the clean energy transition will depend very much on the availability of copper itself**.[10] According to the IEA, copper is of medium to high importance in 8/10 clean energy technologies compared to 1/10 for lithium (EV batteries).
- Copper has the following properties – conductivity, ductility, efficiency, corrosion resistance and recyclability - that make it perfect for EVs, renewable energy and energy storage.
- Copper is the material of choice in a wide range of domestic, industrial and high technology applications. Copper is one of the best electrical and thermal conductors among the metals.
- Due to its high conductivity, copper is commonly used in wires, electromagnets and printed circuit boards as the electrical conductor of choice and in heat exchangers as a thermal conductor.
- IBM and others are using copper instead of aluminum in the most powerful computer chips they manufacture. Because of copper's superior electrical conductivity, this technology enables conductor channel lengths and widths to be significantly reduced. The result is much faster operating speeds and greater circuit integration - 400 million transistors can be packed onto a single chip. Power requirements are now reduced to less than 1.8 volts, and the chips run cooler than ever before.
- Given the higher ampacity (current-carrying capacity) of copper over aluminum wire of the same diameter, it is the material of choice for generators, transformers, and electric motors, where a compact design is usually required; ampacity is the maximum current a conductor can carry without surpassing its temperature rating. Technological advancements in the electronics sector caused an increase in demand mainly for circuit materials. These are widely used today in various communication devices such as mobile phones, smart tablets, and internet devices.

[10] World Bank. Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition (2020)

- Copper plays a vital role in the **digital economy and telecommunications industry.** From its electrical and thermal conductivity to its malleability and high strength-to-weight ratio, copper is a reliable and cost-effective choice for telecommunications. It is also resistant to corrosion, which makes it a great choice for both indoor and outdoor installations. Copper, in addition to assisting in the delivery of the internet at faster and faster speeds, provides excellent optical properties. Previously, it was thought that only fiber optics would be able to handle massive bandwidths.
- **Copper also plays a vital role in the aerospace and defense industries.** A 2015 US National Defense Stockpile Requirements Report noted that, by weight, **copper remains the second most widely used material in weapons platforms**, and as a previous Department of Defense report indicates, the inability to source copper has already resulted in a "significant weapon system production delay for DoD." The same is true of copper by-products molybdenum and tellurium – making copper the only primary metal whose absence has affected multiple weapons systems. The same metal that powers smart phones propels smart bombs.
- In the **aerospace sector**, copper's high electrical conductivity makes it a preferred choice for electrical wiring and connectors in **aircraft, spacecraft, and defense systems**. It ensures efficient transfer of electrical signals and power, ensuring smooth communication and power distribution within electronic systems.
- Copper-nickel alloys, commonly known as cupronickel, are commonly used in heat exchangers and cooling systems in aircraft engines and propulsion systems. The high thermal conductivity of copper aids in dissipating heat effectively, maintaining optimal operating temperatures in these systems.
- Radio frequency (RF) and microwave components, such as antennas, waveguides, and coaxial cables, in aerospace and defense systems utilize copper due to its low signal loss and good transmission properties. Copper's ability to conduct signals effectively is crucial for communication and radar systems in these industries.
- Electro-mechanical systems, including actuators, solenoids, and motors, also make use of copper components due to their conductivity and magnetic properties. These components are vital for various mechanical operations in aerospace and defense systems.
- Certain structural components in aircraft and defense equipment require high strength and wear resistance, which is achieved by using copper alloys like beryllium copper. These components play critical roles in ensuring the structural integrity and performance of these systems.
- Printed circuit boards (PCBs) in aerospace and defense electronics are fundamental parts of electronic systems. Copper traces on PCBs allow for efficient signal transmission and power distribution, contributing to the reliable functioning of electronic devices.
- Copper-based bearings and bushings are utilized in aerospace and defense applications that demand low friction and wear resistance. These components help reduce mechanical friction and extend the life of moving parts, ensuring smooth operation and increased longevity.
- Certain types of munitions and ammunition casings also employ copper alloys due to their high machinability and ballistics performance. These copper components are vital for reliable and efficient ammunition production.
- Copper alloys, such as phosphor bronze, aluminum bronze, silicon bronze, copper-chromium alloys, copper-zirconium alloys, and copper-tungsten, offer a range of properties suitable for

various aerospace and defense applications. These alloys are chosen based on their unique characteristics, such as corrosion resistance, wear resistance, strength, and thermal conductivity.

- Copper-nickel alloys, like C70600 (90-10) and C71500 (70-30), are essential for marine environments in defense applications. They provide outstanding corrosion resistance, making them suitable for naval vessels, submarines, and offshore platforms. In aerospace, these alloys are used in cooling systems that encounter harsh environments.
- Other major drivers of demand include strong growth in building and construction from ongoing **urbanisation and industrialisation of the world's developing economies** supported by population growth, a rising middle class and globalization.
- Globally, China is the largest user of copper with 54% of demand in 2021 and a critical actor in the energy transition, representing between one-fourth and one-third of the global demand for these technologies, depending on the sector considered. China's share of the copper market is forecast to decline to 42% as the developing economies of Asia (ex-China) and India increase their intensity of copper use.
- Governments are increasingly recognizing that dependence on foreign sources of critical materials creates a **strategic vulnerability** for their economy and military in the face of adverse foreign government actions, natural disasters, and other events that could disrupt supplies.
- On 31 July 2023, the US announced copper was to be included in their critical minerals as essential to the **economic prosperity** and **national defense** of the United States and to efforts to build new and renewable energy sources, invest in semiconductors, and upgrade the U.S. electrical grid to support the energy transition, without having to rely on geopolitical adversaries.

The clean energy transition will drive an enormous increase in demand for copper.
"An expansion that current trends or projects in the feasibility stage of development are incapable of meeting".

- Under the IEA's Net Zero scenario, **electricity demand grows rapidly, rising 40% from today to 2030** and more than two-and-a-half-times to 2050, while emissions from generation fall to net-zero in aggregate in advanced economies by 2035 and globally by 2040. Renewables drive the transformation, up from 29% of generation in 2020 to **60% in 2030** and nearly 90% in 2050. From 2030 to 2050, 600GW of solar PV and 340 GW of wind are added each year. The least-efficient coal plants are phased out by 2030 and all unabated coal by 2040. Investment in electricity grids triples to 2030 and remains elevated to 2050
- A recent S&P Global report[8] acknowledges that massive new supply of copper must come online in a timely way otherwise the goal of Net Zero Emissions by 2050 will remain out of reach. Under these accelerated forecasts refined copper demand (excluding direct scrap) will accelerate steeply through 2035 to almost double from 25 Mt in 2021 to 49 Mt by 2035, an expansion that current exploration trends or projects in the feasibility stage of development are incapable of meeting. The forecast requires a doubling of mined copper production from 21 Mt to approximately 40 Mt assuming the balance can be met by an increase in recycling rates.
- Green demand is expected to represent 54% of the growth with EV's accounting for 65% of new green demand.

- Low-carbon technologies typically have high and diverse mineral resource requirements compared to conventional counterparts. In fact, analysts estimate that the lean energy transition to 2050 will require a six fold increase in the amount of raw materials required. EVs use up to four times as much copper as an internal combustion engine vehicle, and copper is used ten times more by weight in an electric vehicle than lithium. Solar and onshore wind installations use four times more copper than conventional power with offshore wind requiring 10 times more copper. In addition, the weather dependent and variable output of solar and wind power creates the need to install three times more megawatts for the same amount of energy produced.
- Wood Mackenzie notes that 9.7 Mt of new mine supply will be required over the next decade (to 2032) from projects that have yet to be sanctioned. That is equivalent to nearly one third of the world's current refined copper consumption or roughly 47 x Olympic Dams must be brought into production to meet 'net zero' climate targets
- Wood Mackenzie's accelerated transition scenario (AET 1.5) suggests primary demand will exceed 40 Mt pa by 2050 and they estimate a required investment in copper projects of around **US$23 billion per annum to be sustained over the next 30 years ($690 billion)** if there is to be enough supply to reach the zero emissions target by 2050.

Forecasts of chronic shortfalls by 2025 will curtail the decarbonization goals

Key industrial economies need to meet decarbonization goals by 2030 to avoid facing up to 2.7 degrees Celsius in global warming

- The Biden administration plans to eliminate fossil fuels as a form of energy generation in the U.S. by 2035. The White House set out a target of 80% renewable energy generation by 2030 and 100% carbon-free electricity five years later.
- Previous clean energy initiatives have targeted EV30@30 (30% of new passenger car sales in 2030) or roughly 27 million new electric vehicle sales in 2030. Based on this target, S&P Global have concluded that there simply are not enough copper mines being built or expanded to provide all the copper needed to produce the 27 million electric cars they have forecast to be sold annually by 2030
- However, the IEA's Net Zero by 2050 report has concluded that 60% of new passenger cars must be EVs by 2030 with 300 million electric cars on the road for the world to be on a trajectory for net zero by mid-century, with all cars being so by 2050.
- The Biden administration is proposing strict new automobile pollution limits that would require as many as two-thirds of new vehicles sold in the U.S. to be electric by 2032, a nearly tenfold increase over current electric vehicle sales. The EPA projects that at least 60% of new passenger vehicles sold in the U.S. would be electric by 2030 and up to 67% by 2032.
- In mid-2021, BHP was forecasting 25 per cent of global vehicle sales in 2030 would be electric vehicles. It now expects 60 per cent of vehicle sales will be electric in 2030, rising to 80 per cent by 2035 and 90 per cent by 2040.

Copper scarcity may emerge as a key destabilizing threat to international security

- The world is not developing enough new copper deposits to meet expected demand. This, in turn, will become the focus of geostrategic interests as countries seek to gain greater access to the one metal essential for the energy transition.
- Goldman Sachs is calling copper the new oil. And, like oil, copper will be at the centre of global competition between Western countries and the emerging autocratic bloc.

Global Perspectives – Major Industrialised Economies Agree Copper is Critical

Major Industrial Economies (including our major trading partners) agree that Copper is Critical and Strategic - Global Perspectives

- Reviews by the **USA, EU, Canada, China, South Korea, Japan and India** support the view that **copper** is **both strategic and critical not only to the clean energy transition** but also to their economic prosperity and security. Each jurisdiction is implementing measures to ensure a secure and sustainable supply of critical minerals for use in transport and renewable energy (and defense applications) as the energy transition advances.
- Copper demand from emerging economies such as India and SE Asia is growing driven by increasing industrialization and urbanization.

Australia can become a globally significant player in the global supply chains for copper

- Copper is the most critical metal required for the clean energy transition and Australia has an extraordinary opportunity to grow our market share in copper production from the 8th largest producer (4%) given Australia ranks 2nd in terms of copper reserves.
- The major industrial countries have recognized that copper is not only a strategic but critical metal required for **economic and national security** and the **clean energy transition** and the **manufacture of the most promising clean energy generation, transmission, storage and end-use technologies**, including solar panels, wind turbines, power electronics, lighting, and electric vehicles and is likely to experience chronic shortfalls from 2025.
- Expanding our copper production in the face of increasing deficits provides an excellent opportunity to grow our critical minerals wealth, create Australian jobs in mining and manufacturing, strengthen global clean energy supply chains, and support the world to achieve net zero emissions.
- The competitive advantage of Chile and Peru's large, low-cost porphyry mines are being eroded by depleted reserves, lower grades, water shortages and a significant increase in the cost of production and capital intensity of mines as well as increased political risks.
- 60% of copper production is concentrated within 5 countries (Chile, Peru, China, DRC, USA) with an increasing risk of supply chain disruptions (political risk, military conflict, violent unrest and anticompetitive behaviors) and export bans (to promote use by domestic industries)
    - In Chile and Peru, governments are re-visiting existing mining leases, demanding higher royalties, and forcing companies to invest in greater local participation, including downstream processing.
    - Other key producers such as Mongolia, Indonesia and Panama are taking similar actions.
    - DRC is the 3rd largest producer of copper. Ongoing political instability, coupled with a deepening economic crisis, is fueling civil unrest and political violence in various parts of the country. The unstable political and security situation continues to negatively impact the economy, making the DRC a difficult environment for foreign investors despite the

tremendous natural resources the country has to offer, particularly cobalt and copper. Chinese firms have been buying control of DRC mines to ensure supplies of raw material for cobalt refining.
    - While the fifth-largest producer is the US, its ability to significantly increase output has been hampered by complex permitting processes and environment, social, and governance challenges. This has resulted in new mining projects that could have produced almost one million tonnes of copper supply being cancelled.
    - China and Russia are considered political adversaries and represent challenges for US national security
- China consumed 56 percent of refined copper globally in 2022 while producing 48 percent of global smelted copper and 43 percent of refined copper. China's share in all the manufacturing stages of solar panels (such as polysilicon, ingots, wafers, cells and modules) exceeds 80%.
- Australia is the 8th largest producer of copper. In 2021, the two copper refineries (Townsville in Queensland and South Australia's Olympic Dam) produced about 385,000 tonnes of refined copper. Over the same period, Australian copper exports generated about $12 billion in export revenue, with $7.7 billion from copper concentrates and $4.3 billion from refined copper.
- Australia has the potential to become an internationally competitive and globally significant copper producer.
- According to Patrick Gibbons, a partner at corporate advisory firm Orizontas, the Australian copper sector employs about 9000 people, mostly in regional Australia. **Tripling the size of Australia's copper production, smelting and refinery output** would result in a highly paid workforce of about 30,000, or 100,000 when indirect jobs are included. To achieve this, governments should focus on offering better exploration incentives, faster mine approval processes (without diminishing our already rigorous environmental standards), internationally competitive low carbon energy supplies, developing workforce capabilities, and incentives to build downstream processing capabilities – including metals production.
  (Source: AFR - BHP's bid for OZ Minerals shows why copper is the new oil -.9 August, 2022)

KGL is well positioned.

With approvals and permits, KGL to be one of the few projects that can be **in production as the market is faced with a chronic shortfall in supply**

- The recently released Feasibility Study for the high-grade Jervois Copper Project showed a copper equivalent grade for the current JORC resource of 2.3% which compares favorably to the average production grades of 0.6% and lower for undeveloped projects today
- The FS demonstrated the project was technically robust and financially viable at the long term forecast copper price of US$4.23/lb
- The project has significant benefits in terms of creating jobs for 260 people with opportunities for jobs and economic activity for the local community and the Northern Territory

Development of Secure and Internationally Competitive Supply Chains are Critical for Ensuring a Resilient Clean Energy Transition and Energy / Economic Security

- China accounts for 40% of global copper refining and China's share in all the manufacturing stages of solar panels (such as polysilicon, ingots, wafers, cells and modules) exceeds 80%.

- Countries are critically analyzing the main vulnerabilities and comparative advantages they face in the supply chains of EV batteries, solar PV panels, and wind turbines as well as for other advanced manufacturing technologies (e.g. semiconductors, defense applications).
- Australia has two copper smelters and refineries.
- Copper concentrate is smelted into copper anode at Glencore's Mt Isa smelter. This 99.7% pure copper anode is transported by rail and road to Glencore's copper refinery in Townsville.
- Glencore's copper refinery at Townsville produces up to 300,000 tonnes a year of 99.995% pure copper cathode—the primary raw material used to produce copper wire, cabling and many other products we use every day. The impurities left after electrolytic refining contain other valuable minerals including silver and gold, which we also export to customers around the world from the Port of Townsville.
- BHP's Olympic Dam operations also include a copper smelter and refinery and a recovery circuit for precious metals.
- Copper's principal first use is as wire rod, accounting for almost three quarters of total copper consumption. Wire rod is used as the starting point for numerous wire and cable applications across the major end use markets of construction, electrical and electronic products, and industrial machinery.
- Ongoing innovation is targeting processing technologies with the potential to economically unlock known low-grade copper sulphide resources, copper bearing waste and tailings.

Developing Australia's capabilities in new clean energy technologies together with strategic partners can also position Australia as a diversified, reliable supplier to the manufacturing industry for clean energy technologies and for the renewable energy industry as well as for other advanced manufacturing industries such as the defense industry.

Competent Person Statement and Copper Equivalent Calculation.

The Jervois Resources information were first released to the market on 14/09/2022 and complies with JORC 2012. The company confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. The company confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcement.

The Jervois Reserves information were first released to the market on 10/11/2022 and complies with JORC 2012. The company confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. The company confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcement.

Copper Equivalent Calculation

CuEq = Cu grade + [((Ag price x Ag rec) / (Cu price x Cu rec)) + ((Au price x Au rec) / (Cu price x Cu rec))]

Metal	Grade	Unit	Recovery %	Market Price	CuEq %
Cu	2.02	%	92.2	$8,388	2.02
Ag	25.3	g/t	71.3	$23.42	0.18
Au	0.25	g/t	51.2	$1,942	0.10
				2.30%	Cu Equiv