FUTURE MINERALS FORUM

Wood Mackenzie

HOW CAN THE SUPER REGION ENABLE THE ENERGY TRANSITION?

COLLABORATION BETWEEN **GOVERNMENTS** AND **MARKETS** CAN UNLOCK THE **SUPER REGION'S METALS** AND **MINING POTENTIAL**

The Super Region — comprising Africa, the Middle East, Central Asia, and South Asia — has been at the center of global trade and economic activity for most of recorded history. More recently, the region emerged as a key player in a post-WWII era defined by globalization and the discovery, exploitation, and widespread consumption of oil. As the world now transitions to a new energy mix, the Super Region is well-positioned to remain central to the future of global economics, climate, and geopolitics.

The Super Region's central role over the coming decades will be founded on long-term dynamics. In energy, for example, oil and gas will remain a crucial part of the global economy well into the 2050s, and the Middle East will be increasingly relied upon to provide the world with affordable, reliable, and secure conventional resources as assets elsewhere move offline. Meanwhile, population growth and urbanization in the Super Region, led by Africa and South Asia, are poised to be a key driver of future economic growth. And, as the world transitions away from hydrocarbons, the Super Region has the potential to become a leader in renewable energy. Sub-Saharan Africa and the Middle East, for example, are among the most naturally endowed regions for solar generation.

But these are not the only tailwinds blowing in the region's favor. Amid seismic changes in the global energy, economic, and geopolitical order, the Super Region has another opportunity that is both attractive and consequential: the possibility for the region's governments and industry participants to produce minerals, finance projects, and manufacture products that enable the world's energy transition.

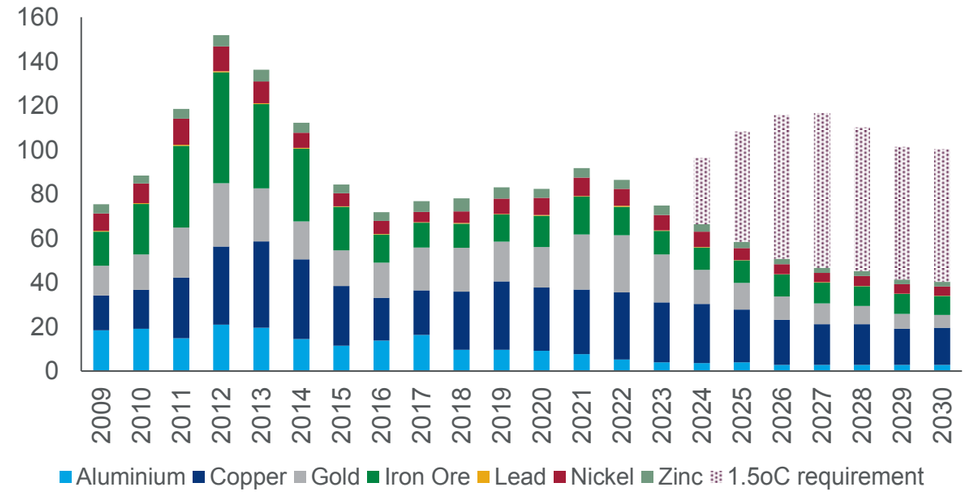
A MINERAL INTENSIVE FUTURE

Global deployment of clean energy technologies has increased dramatically in recent years and is forecast to continue growing at an explosive rate. Under a 2.5°C global warming scenario, sales of passenger electric vehicles, photovoltaic (PV) systems, and wind turbines are expected to increase by 164, 171, and 132 percent by 2030. Current and forecast sales of these technologies are driving unprecedented demand for minerals. An average electric vehicle, for example, requires six times more minerals than an internal combustion engine (ICE) vehicle, while wind energy can be up to thirty times more copper-intensive than a gas-fired plant. Overall, demand for minerals such as cobalt, lithium, and nickel is projected to increase by around 60, 300 and 90 percent, respectively, by 2040.

Governments and markets around the world are slowly beginning to mobilize to meet rising mineral demand. Legislation such as the US Inflation Reduction Act and the EU Critical Raw Materials Act is pushing the needle on midstream investment. Companies are also ramping up exploration and operations for minerals linked to the energy transition. Lithium mine capacity, for example, increased 84 percent from 2020 to 2023. Nevertheless, the availability of minerals is projected to become a primary constraint in delivering a decarbonization pathway aligned with the goals of the Paris Agreement.

In our base case 2.5°C scenario, we project more than a 10 percent gap between theoretical demand and committed supply of minerals like lithium and neodymium by 2030. Meeting a 1.5°C pathway would generate even more severe shortfalls across most transition minerals. Under a 1.5°C pathway, committed supply of cobalt, lithium, and graphite by 2030 is projected to meet less than 70 percent of demand. Wood Mackenzie estimates that approximately USD 400 billion in CAPEX for mining, refining, and smelting of critical minerals is needed by 2030 to bridge the supply-demand gap and limit global temperature increases to 1.5°C above pre-industrial levels. However, it is unlikely that sufficient CAPEX will be deployed, or lead times shortened, to deliver a net-zero pathway by 2030. The resulting mineral shortfalls can delay the pace and scale of the deployment, transmission, and use of clean energy.

CAPITAL SPEND ACROSS SELECTED METALS VERSUS 1.5°C REQUIREMENT



Insufficient investment threatens to result in mineral bottlenecks that could drive up the cost and speed of the energy transition, and cause wider economic, trade, and geopolitical tensions. Wood Mackenzie has been highlighting this challenge since the Paris Agreement was signed. Recent announcements by investors like BlackRock have also lamented the lack of capital allocation, stating that the “the opportunity within this space has been massively overlooked.” [1]

Although it is unlikely that there will be sufficient quantity of all the requisite minerals and processing capacity by the end of this decade, governments and markets still have a window to scale supply of strategic minerals and to, hopefully, drag the world onto a Paris-aligned pathway in the 2030s. Wood Mackenzie believes that industry stakeholders should work on five pillars to avoid the risks ahead and ensure that the metals and mining industry can successfully enable the energy transition.

1. Buy Metals Companies If You Care About Climate, Says BlackRock - Bloomberg

FIVE ENABLING PILLARS OF THE ENERGY TRANSITION

Technologies | **Circular Economy** | **Primary Supply** | **Policy** | **Societal Buy-in**

1. **New Technologies**
   The development and commercialization of new technologies can continue to drive down costs and reduce mineral requirements. For example, a shift from NMC 111 to NMC 622 and 811 batteries over the last few years has greatly reduced cobalt demand, while improvements in lithium iron phosphate (LFP) batteries and subsequent market adaption have reduced the need for nickel, cobalt, and manganese. Meanwhile, from a supply perspective, technology will be pivotal in unlocking previously uneconomic primary and secondary resources, while helping deliver a zero-carbon footprint for metal production.

2. **Circular Economy**
   As mineral consumption increases, markets and governments must work to develop a circular economy for the future. Due to a limited "land bank" of materials, recycled volumes are currently low for various battery metals. Since many clean energy technologies will take years to be deployed and eventually come into the recycling stream, end of life feedstock will only make a major impact on mineral supply in the mid-2030s. Over the longer term, Wood Mackenzie projects that recycled supply of cobalt, lithium, and nickel could cover 88 percent, 39 percent, and 70 percent of demand from batteries by 2050, respectively.

3. **Primary Supply**
   More upstream supply and investment is required to ensure that the metals and mining industry can enable, rather than constrain, a smoother and faster energy transition. Long lead times for mining projects mean that investment must ramp up immediately. Capital cycles also indicate that investments will need to be smoothed across various years. But our data shows that pledged CAPEX will amount to less than half of necessary CAPEX for a 1.5°C pathway by 2025, with that gap widening over subsequent years. More investment is needed.

4. **Policy**
   Numerous variables, including demand uncertainty, long lead times, regulatory uncertainty, and market opacity, are preventing mineral markets from operating optimally and achieving the necessary speed, scale, and diversity. Governments must continue to aggressively employ policy to ensure that markets function properly and that mineral supply is prepared to meet growing demand from the energy transition.

5. **Societal Buy-in**
   As policies and markets encourage new supply, societal buy-in will be crucial for a just and successful path to net zero. The metals and mining industry has a dual challenge of addressing its troubled history of social and environmental performance, while simultaneously communicating mining's role in paving the way for economic growth and a net-zero world. The industry's ability to gain societal buy-in will dictate whether upstream and midstream projects maintain a social license to operate over the coming decades. Currently, an increasing number of activists and communities believe that mining and processing of minerals is the problem and not the solution to a low-carbon future. Societal BANANAism (Build Absolutely Nothing Anywhere Near Anything) is a growing trend.

Over the coming years, the Super Region can play a role in developing all five pillars of the energy transition. But decision makers now have a historic opportunity to leverage the region's comparative advantages and decide which pillars it should focus on. That decision will depend on considerations of economic growth and the energy transition, as well as the increasingly competitive global landscape.

THE GREAT COMPETITION

The energy transition is not just about challenges and collaboration, but also opportunity and competition. Advanced economies are moving quickly to strengthen their five pillars to capture future opportunities. These efforts are not misplaced. Wood Mackenzie estimates that power and renewables will represent a USD 20 trillion investment opportunity in a base case 2.5°C scenario. In a net-zero world, the opportunity could be even higher. A new economic prize is at stake.

In addition to economic rewards, mineral producers will also enjoy geopolitical advantages. Countries with robust mineral supplies can protect themselves from supply shocks. They can also use market power to wield diplomatic influence. And countries which manufacture and deploy clean energy technologies — and secure the minerals in those technologies — will be less exposed to the specter of energy insecurity.

The geopolitics of minerals are particularly pronounced due to China's dominance of mineral refining and technology manufacturing.

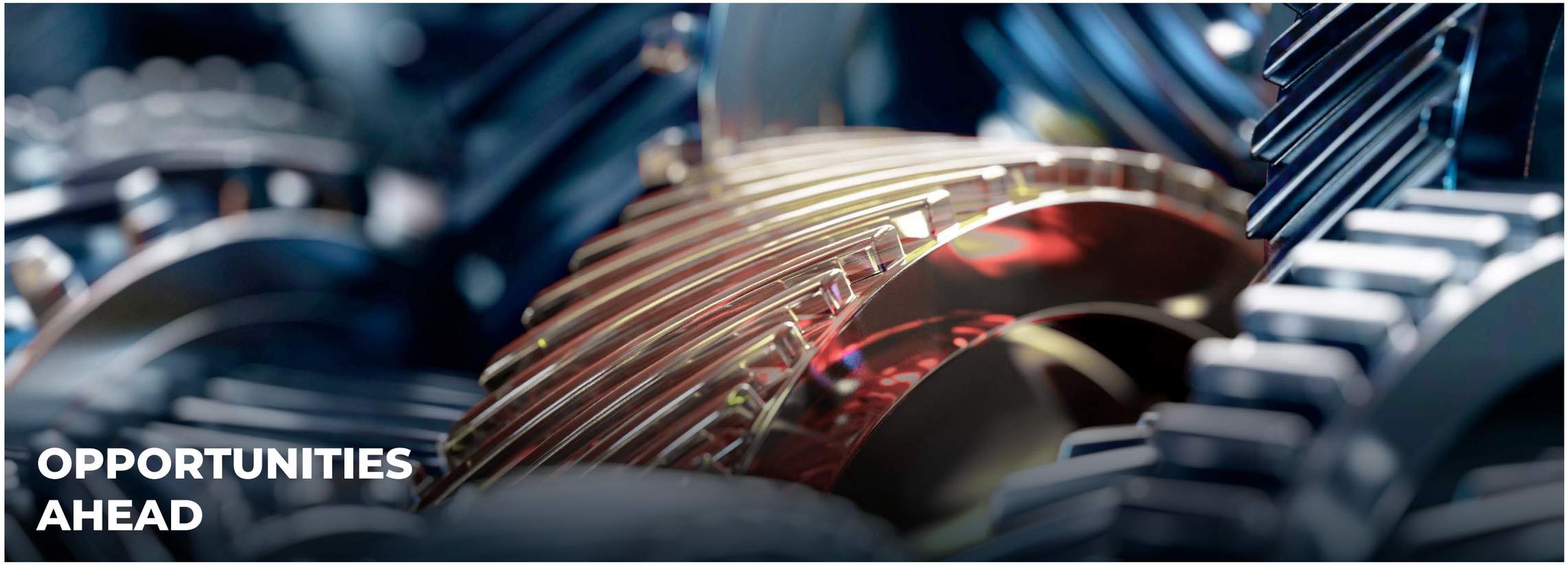
In the lithium-ion battery supply chain, for example, China controls 74, 67, 84, and 52 percent of global refining capacity for cobalt, lithium, nickel, and synthetic graphite, respectively, and 80, 74, and 79 percent of global anode, cathode, and battery capacity, respectively.

These dynamics, alongside massive economic opportunity, have led Western nations, including the United States, European Union, Australia, and Canada, to enact a wide range of policies to attract investment, incentivize production, and capture strategic stages of supply chains. In East Asia, Japan and South Korea — two countries short on natural resources — recognized the strategic importance of minerals decades ago, investing in foreign mining assets to secure feed for downstream manufacturing. South American countries are also attempting to capture more value from minerals through a recent wave of nationalistic policies. Meanwhile, China, the primary producer in many mineral supply chains, seeks to remain one step ahead of its competitors as it invests heavily across all stages of mineral supply chains.

Despite these initiatives, policy focus on midstream processing has failed to generate major inroads, while core challenges in the upstream stage of supply chains remain largely unaddressed. In the copper market, for example, there is an implied gap of five million tons between base case supply and projected demand in ten years' time. Meanwhile, the rate at which projects are being committed to is slowing and falling short of the 700 kt a year required to fill the implied supply gap. With lead times for mine feasibility, construction, and ramp up stretching more than 15 years, supply is not on track to meet demand.

But in other cases, intense competition between countries is making it difficult for new entrants to competitively produce. Our data show that LFP cathode production is continuing to expand even in an oversupplied market. LFP cathodes could see a continued supply surplus through 2035, creating difficult market conditions for new entrants.

Taken together, these trends generate three implications for the Super Region. First, countries in the region have economic and geopolitical incentives to invest in minerals. Second, many segments of mineral supply chains remain uncrowded; investments in these areas could offer benefits to investors while supporting the global climate agenda. And third, competition between countries is increasing. First movers and countries with competitive advantages will win out in the most contested areas of supply chains. The Super Region must act quickly and prioritize where it can compete most effectively.



OPPORTUNITIES AHEAD

The Super Region possesses comparative advantages that can enable it to become an important producer of minerals and related clean energy technologies, and to become a counterweight to China's dominance of the energy transition ecosystem.

In terms of mineral resources, few areas in the world can match Africa, which hosts 79, 44, and 21 percent of global cobalt, manganese, and natural graphite reserves, respectively, in addition to substantial resources. Many of these deposits are of extraordinary geologic quality. In the Democratic Republic of Congo (DRC), for example, copper and tin grades are well above the global average. The DRC also produces 65 percent of global cobalt due to its world class deposits. But much of the international community continues to see the DRC as uninvestable due to ESG considerations.

The Middle East also has much to offer, including capital, established investment vehicles, and experience financing and executing long-term projects. The region hosts sovereign wealth funds that control trillions of dollars and have extensive experience investing abroad in physical infrastructure and, in some instances, mining. This expertise can be leveraged to invest in mineral supply chains at home and throughout the Super Region. The Middle East can also play a critical role in decarbonizing steel due to its technological edge in producing direct reduced iron, cheap renewable energy and natural gas, available land, and existing trade and logistic networks. The announced mega hubs to supply iron ore will help provide supply of high-grade agglomerated products and unlock a new ecosystem. In fact, Wood Mackenzie estimates that the Middle East could account for around 30 percent of global direct reduced iron production by 2050, with the potential to become a global trader of green ferrous metallics.

South Asia has significant potential on another front — demand. India, for example, is forecast to add 152 GW in solar capacity by 2030. Battery electric vehicle and plug-in hybrid electric sales in India could also amount to over 19 million vehicles by 2050, fueling substantial growth in mineral demand. South Asia's emergence as a center of demand, in addition to its competitive labor force, low capital costs, and access to ports, make it a logical destination for midstream and downstream operations in mineral supply chains.

Other areas of the Super Region are similarly strategic. In Central Asia, for example, Kazakhstan boasts significant reserves of strategic minerals such as chromite, manganese, and uranium.

UNFULFILLED POTENTIAL

When compared to global competitors, individual countries in the Super Region face major challenges to independently expand their presence in mineral supply chains.

In Africa, finance is a binding constraint. Much of the continent remains geologically underexplored due to an immature financial ecosystem and high perceptions of risk. The cost of capital also limits the project pipeline and prevents the continent from reaching its full potential. Lending interest rates in key mining jurisdictions like the DRC and Zambia are 23 and 10 percent, respectively, compared to 3 and 4 percent in the United States and China.[1] Capital constraints hinder the development of resources and supporting infrastructure like electricity, railroads, and ports.

The problem is quite different in the Middle East. While Middle Eastern countries have access to capital and mineral resources, they lack sizable reserves and production. The Middle East currently produces 35 percent of global oil but does not produce meaningful quantities of cobalt, nickel, lithium, nor graphite.

Much of South Asia, meanwhile, lacks the financial vehicles of the Middle East and the mineral resources of Africa. This creates difficulties for sourcing the raw materials needed to meet countries' mineral demand and fuel the region's anticipated growth in manufacturing capacity.

1. World Bank

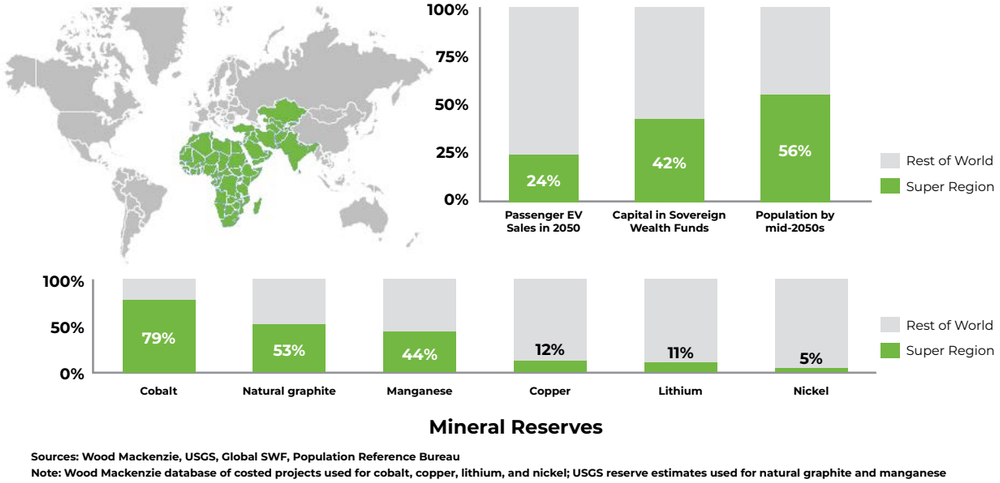
CHARTING A PATH FORWARD

Moving forward, Wood Mackenzie believes that the hidden strength of the Super Region, and the key to unlocking its potential, lies in collaboration. Individually, most countries in the Super Region lack the full set of capabilities to effectively compete across the entire value chain of clean energy technologies. But together, countries in the Super Region can leverage their complementarities to generate lasting comparative advantages.

This is particularly important within an era of great power competition between Eastern and Western political blocs. Experience from the Cold War shows that resource-rich countries often fail to achieve optimal outcomes when forced to choose sides. Rather, markets function best when investors, producers, and consumers have high levels of optionality. More collaboration and capital flows in the Super Region can lead to negotiating power and sustainable development. They can also enable markets to navigate geopolitical risks and function more efficiently. Working together, the Super Region can effectively compete with North America, South America, Europe, China, and the rest of Southeast Asia.

Pooling the Super Region's natural resources, financial capital, and consumer base can lead to transformative outcomes for the region, its governments, and its people. The Super Region hosts 79, 53, and 44 percent of strategic minerals like cobalt, natural graphite, and manganese, respectively. Meanwhile, Wood Mackenzie estimates that the Super Region will constitute 24 percent of global sales of electric vehicles by 2050, holds approximately 42 percent of the capital in the world's sovereign wealth funds, and will comprise 56 percent of the global population by the mid-2050s.

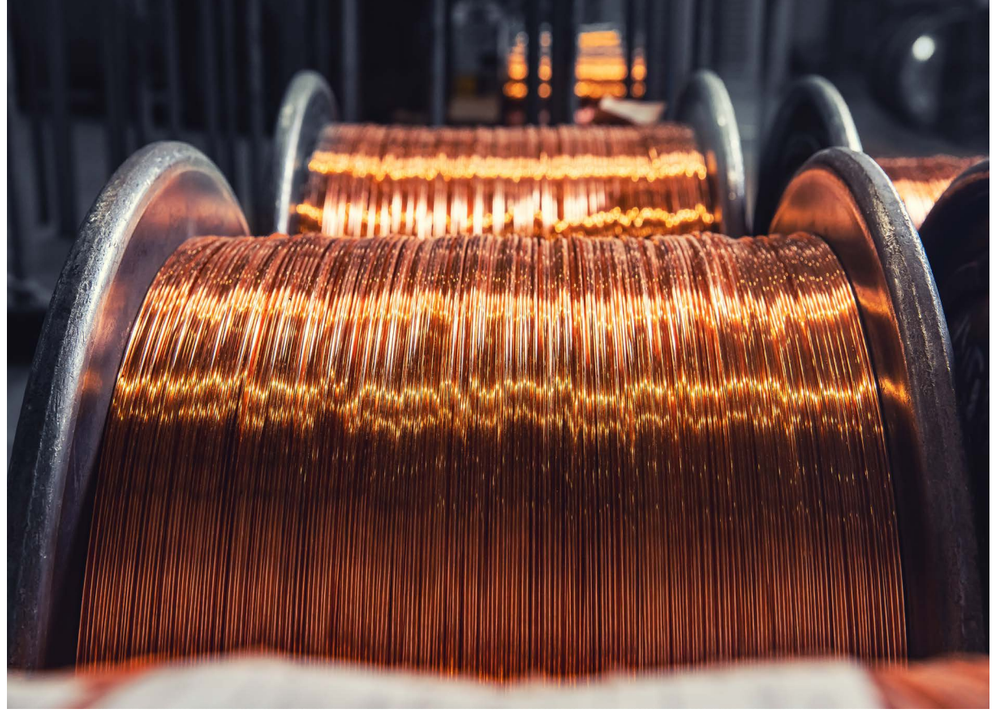
POOLED RESOURCES OF THE SUPER REGION



Sources: Wood Mackenzie, USGS, Global SWF, Population Reference Bureau
Note: Wood Mackenzie database of costed projects used for cobalt, copper, lithium, and nickel; USGS reserve estimates used for natural graphite and manganese

Unlocking the region's potential will require uniting four key variables: resources, capital, demand, and capabilities. If the Super Region can collaborate across all four variables, it can become a formidable metals and mining powerhouse, driving the energy transition and economic development.

Unlocking the Super Region's Metals and Mining Potential



In such a future, the Super Region would connect its capital to the development of infrastructure and the exploration, mining, and refining of minerals. Producers and consumers, supported by host governments, would leverage regional demand to negotiate offtake agreements and attract downstream production. And countries would build centers of excellence to facilitate knowledge sharing and innovation.

Countries have already started moving toward these aims. Maaden, Saudi Arabia's state mining company, has voiced plans to engage in substantial overseas activity, the UAE recently announced an investment of USD 1.9 billion in four mining assets in the eastern DRC, and India's foreign investment vehicle, KABIL, is looking at ways to secure foreign mineral supplies for India's growing downstream industries.

However, collaboration between countries is also generating difficult questions that remain unresolved. In Guinea, for example, the UAE and Guinean government have partnered to create the Guinea Alumina Corporation, which has generated more than USD 1.4 billion investment, thousands of new jobs, and more than 13 million tons of annual bauxite production. But there is still much debate around how to best share economic benefits and how much beneficiation should take place domestically. The "value add" debate is not a new one, but it is becoming apparent that the economic or employment benefits of moving downstream may not always justify the costs that are required to localize capacity.

Overall, the Super Region's recent initiatives show new levels of intent and potential, while simultaneously embodying larger questions on which operations to target, where different parts of value chains will be located, and how the ensuing profits will be shared. New ideas and solutions are needed.

A PLATFORM FOR SUCCESS

The Super Region has been a major player on the global stage for more than two millennia. We believe that it has the right mix of advantages to continue in that vein. But a more proactive approach is needed for the region to grasp the opportunity in front of it. This is particularly true within metals and mining, where the Super Region's potential remains largely untapped and hinges on cross-border collaboration.

As a starting point, international convening mechanisms can provide a platform for industry, civil society, and government to plan a roadmap for the future. Themes like cross-border investment, technology manufacturing, and policy incentives will be key to building partnerships. Initial dialogue can focus on topics like centers of excellence and skills development, which can build scaffolding for more difficult follow-on conversations around benefit sharing and investment.

Such efforts will require not only goodwill and relationships, but also new questions and strategies. If the Super Region is to grasp its full potential, we believe that actors throughout the metals and mining industry today should focus on answering three key questions:

1. What role should different countries play in mineral supply chains given their respective strengths, weaknesses, and priorities?
2. What are the most attractive opportunities for countries in the Super Region to maximize complementarities, pool comparative advantages, and overcome constraints?
3. What types of structures are needed to facilitate cooperation in the Super Region, and how can countries navigate competing interests to find arrangements that are economically and politically beneficial to all parties?

Grappling with these questions will require actors within the Super Region to think critically about their advantages, needs, and role within a broader regional supply chain. The answers will not come easily. But the Super Region’s success in answering these questions, and in pursuing collaboration, will help determine its role in the rapidly evolving metals and mining industry, and perhaps even in the future of the global economic, energy, and geopolitical order.

Wood Mackenzie is the global research, insights and consultancy business for renewables, energy and natural resources.

In the middle of an energy revolution, businesses and governments need reliable and actionable insight to lead the transition to a sustainable future. That's why we cover the entire supply chain with unparalleled breadth and depth, backed by over 50 years' experience in natural resources.

Today, our team of over 2,000 experts operate across 30 global locations, inspiring customers' decisions through real-time analytics, consultancy, events and thought leadership. Together, we deliver the insight they need to separate risk from opportunity and make bold decisions when it matters most.

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