Critical Minerals: Decisive Recycling

Sustaining supply chains through recycling

Critical minerals are metallic and non-metallic mineral resources that are deemed to be vital to world economies. A global transition to clean energy necessitates significant investment in new mines to secure essential minerals like copper, lithium, nickel, cobalt, and rare earths.

During the IEA Critical Minerals and Clean Energy Summit in September 2023, the importance of unlocking the potential of recycling, a theme long emphasised by the International Energy Agency (IEA), was further highlighted. Policymakers were urged to expedite policy changes regarding recycling to ensure more sustainable mineral supply chains.

The IEA is an intergovernmental organisation that provides analysis, data, and policy recommendations on energy and critical minerals to support global efforts towards achieving sustainable energy for all.

Recycling is vital for ensuring the secure and sustainable supply of critical minerals for the energy transition. While recycling cannot entirely replace the need for mining, it provides a valuable secondary supply source, reducing reliance on new mines and enhancing supply security for countries that import minerals. Scaling up recycling efforts mitigates the environmental and social impacts associated with mining and refining processes, while also preventing the disposal of waste from end-use technologies in landfills.

In essence, recycling critical minerals is crucial for building a more sustainable, secure, and resilient energy future. It plays a vital role in mitigating the environmental impacts of the energy transition, ensuring a stable supply of essential materials, and promoting a circular economy.

Global Energy and Climate Model

The IEA utilises a scenario-based approach to analyse future energy trends. This involves employing the Global Energy and Climate (GEC) Model to explore various potential pathways for global energy system's evolution, each built upon distinct assumptions. By comparing these scenarios, readers can understand the factors driving different outcomes and identify potential opportunities and challenges. Importantly, these scenarios are not predictions but rather tools for exploring different possible futures and the actions that could shape them, providing valuable insights into the future of global energy.

The key scenarios:

- Stated Policies Scenario (STEPS):
  This scenario reflects the current policy landscape, encompassing both implemented and developing energy-related policies at the national and sectoral levels as of the end of August 2024. It also incorporates planned manufacturing capacities for clean energy technologies.

  The objective is to serve as a benchmark to evaluate the potential successes (and shortcomings) of recent advancements in energy and climate policy. The disparities between the STEPS and the Announced Pledges Scenario (APS) underscore the "implementation gap" that must be bridged for nations to realise their declared decarbonisation objectives.

- Announced Pledges Scenario (APS):
  This scenario assumes the full and timely fulfilment of all climate commitments made by governments and industries worldwide as of the end of August 2024. This includes Nationally Determined Contributions, Longer-term net-zero targets, and Targets for access to electricity and clean cooking.

  This analysis aims to demonstrate how closely current global pledges align with the target of limiting global warming to 1.5°C. By comparing the APS with the Net Zero Emissions Scenario (NZE), the analysis highlights the "ambition gap" – the significant gap that must be bridged to achieve the goals of the 2015 Paris Agreement. Furthermore, it reveals the disparity between current targets and the objective of ensuring universal access to energy.

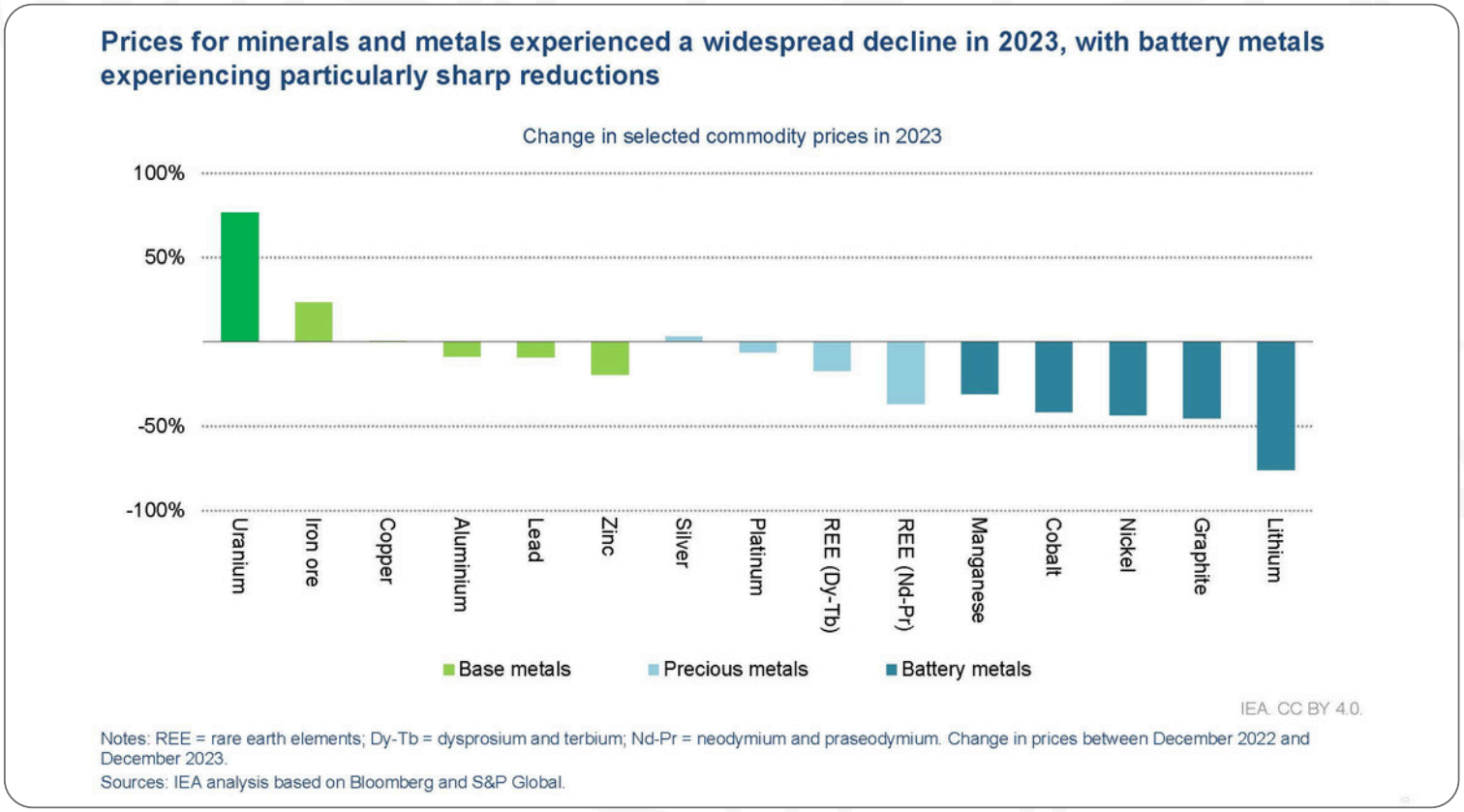
- Net Zero Emissions by 2050 Scenario (NZE):
  This scenario outlines a pathway for the global energy sector to achieve net-zero CO2 emissions by 2050. It exclusively focuses on decarbonisation within the energy sector, excluding offsets from other sectors. The scenario ensures universal access to electricity and clean cooking services by 2030.

  This analysis outlines the necessary actions across key sectors and by various stakeholders to achieve net-zero energy-related CO2 emissions by 2050 while simultaneously fulfilling other crucial energy-related sustainable development goals, such as ensuring universal access to energy.

Trajectory of critical minerals markets

In May 2024, the IEA published the "Global Critical Minerals Outlook 2024", and the analysis explored the significant increase in demand for critical minerals driven by the rapid expansion of low-emission energy sources.

- Renewable Energy Growth:
  All scenarios see a substantial rise in renewable energy capacity, with renewables dominating new power generation additions across all regions. This necessitates grid modernisation to accommodate renewable sources often located far from demand centres.
- Electric Vehicle Boom:
  Electric vehicle (EV) sales are projected to surge significantly, with sales tripling or even quintupling by 2030 depending on the scenario.
- Soaring Mineral Demand:
  The accelerated energy transition translates into a dramatic increase in demand for critical minerals. Demand is projected to double or even triple by 2030 and continue to rise significantly beyond.



Source: International Energy Agency

Clean energy technology critical mineral requirements

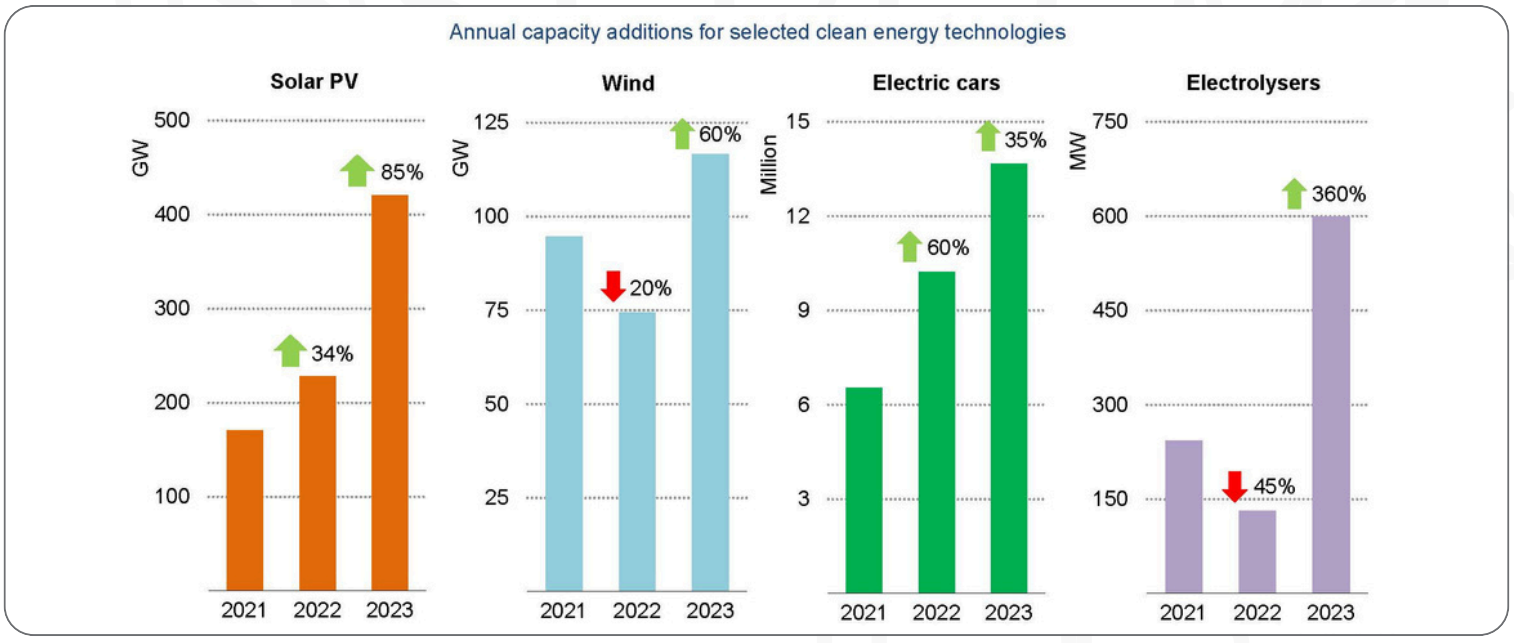
The demand for critical minerals in the deployment of clean energy technologies within clean energy varies widely. Below is a table that the IEA developed depicting the requirement of various minerals based on the importance of these minerals for a particular clean energy technology:

	Copper	Cobalt	Nickel	Lithium	REEs	Chromium	Zinc	PGMs	Aluminium
Solar PV	●	●	●	●	●	●	●	●	●
Wind	●	●	●	●	●	●	●	●	●
Hydro	●	●	●	●	●	●	●	●	●
CSP	●	●	●	●	●	●	●	●	●
Bioenergy	●	●	●	●	●	●	●	●	●
Geothermal	●	●	●	●	●	●	●	●	●
Nuclear	●	●	●	●	●	●	●	●	●
Electricity networks	●	●	●	●	●	●	●	●	●
EVs and battery storage	●	●	●	●	●	●	●	●	●
Hydrogen	●	●	●	●	●	●	●	●	●

Relative importance of minerals for a particular clean energy technology: High: ● Moderate: ● Low: ●

Source: International Energy Agency

The deployment of clean energy technologies between 2021 and 2023:



Source: International Energy Agency

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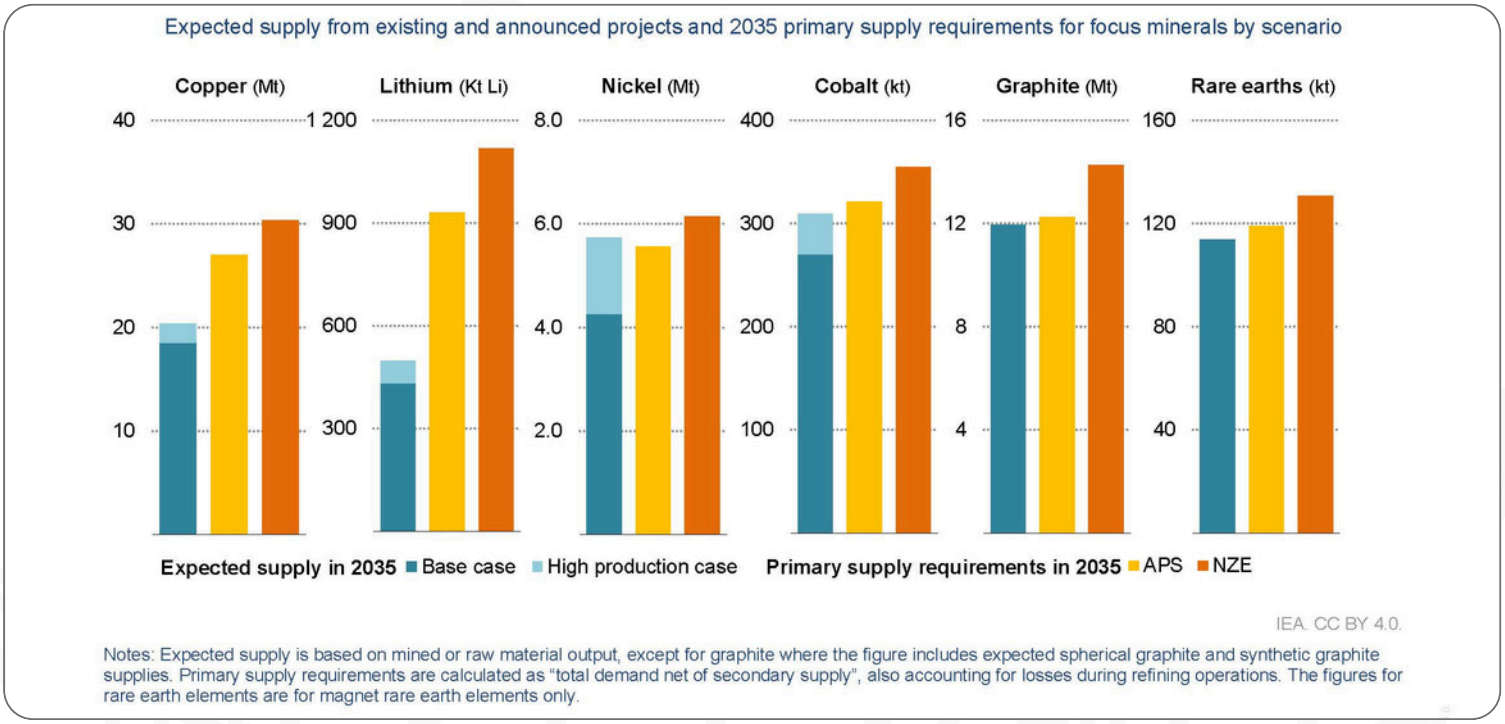
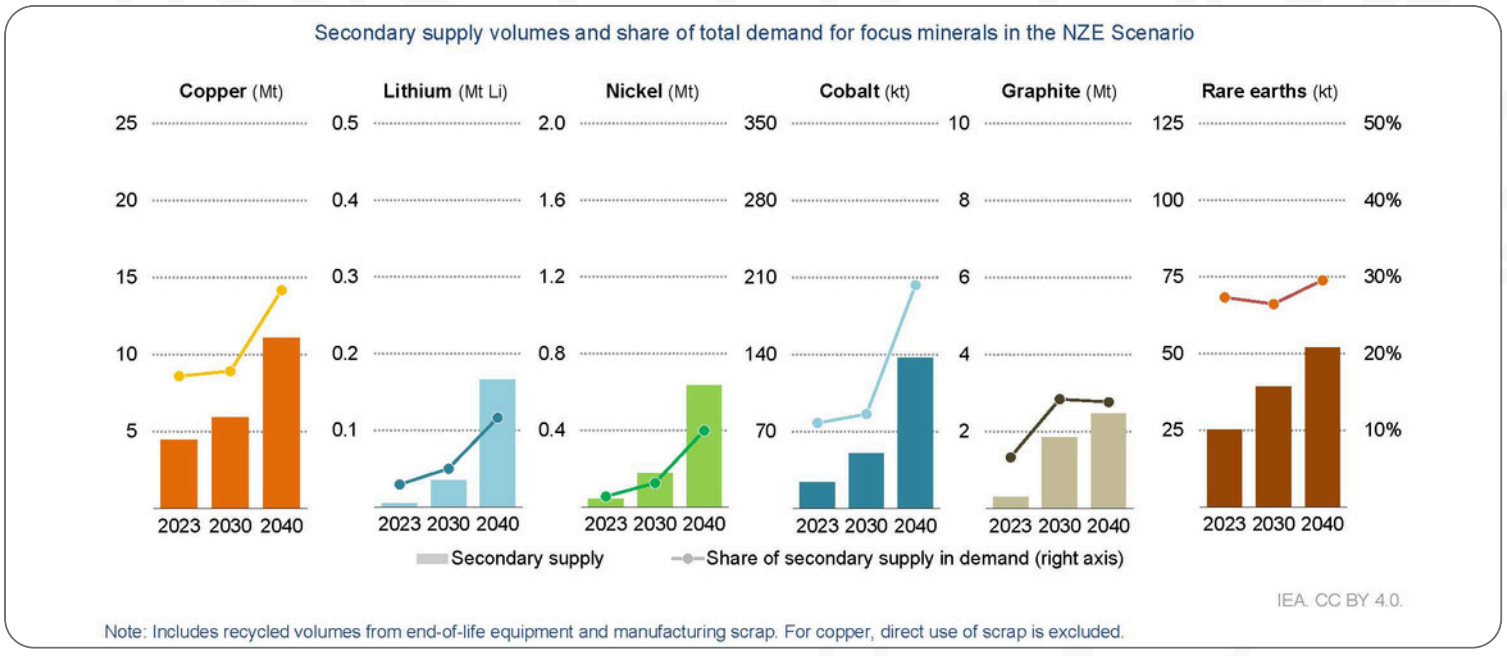
Primary and Secondary Supply Chains

The graph below depicts the expected supply from announced projects:



Source: International Energy Agency

Secondary supply from recycling will play a significant role in meeting demand growth:



Source: International Energy Agency

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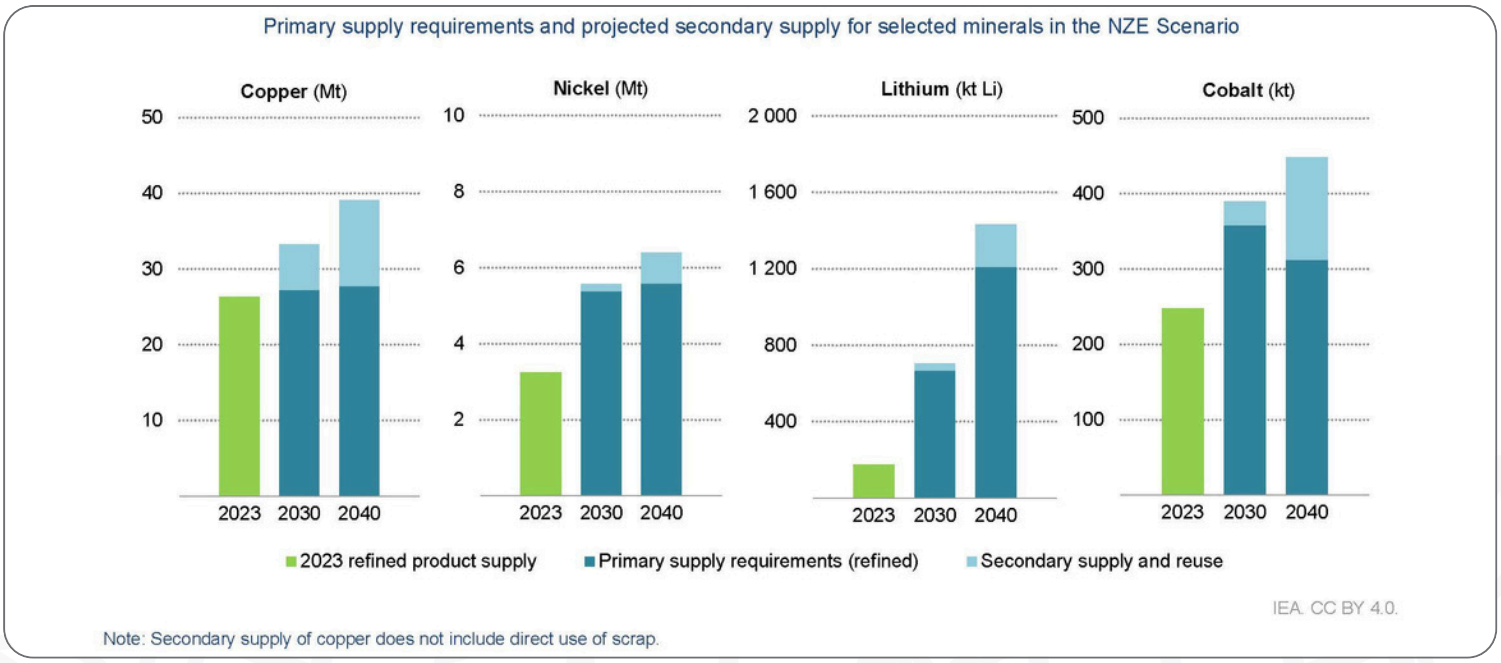
The graph below illustrates the contribution from secondary supplies:



Source: International Energy Agency

Recycling creates a secondary supply of minerals, alleviating the pressure on primary extraction through mining and refining. A strong focus on recycling offers significant advantages:

- Reduced reliance on primary sources
- Environmental benefits
- Improved waste management

While recycling will not eliminate the need for continued investment in new mineral supplies, it is projected to significantly reduce primary supply requirements for key minerals such as copper, lithium, nickel, and cobalt by 10-30% by 2040. The security benefits of recycling are particularly pronounced for regions with widespread adoption of clean energy technologies, enabling greater economies of scale.

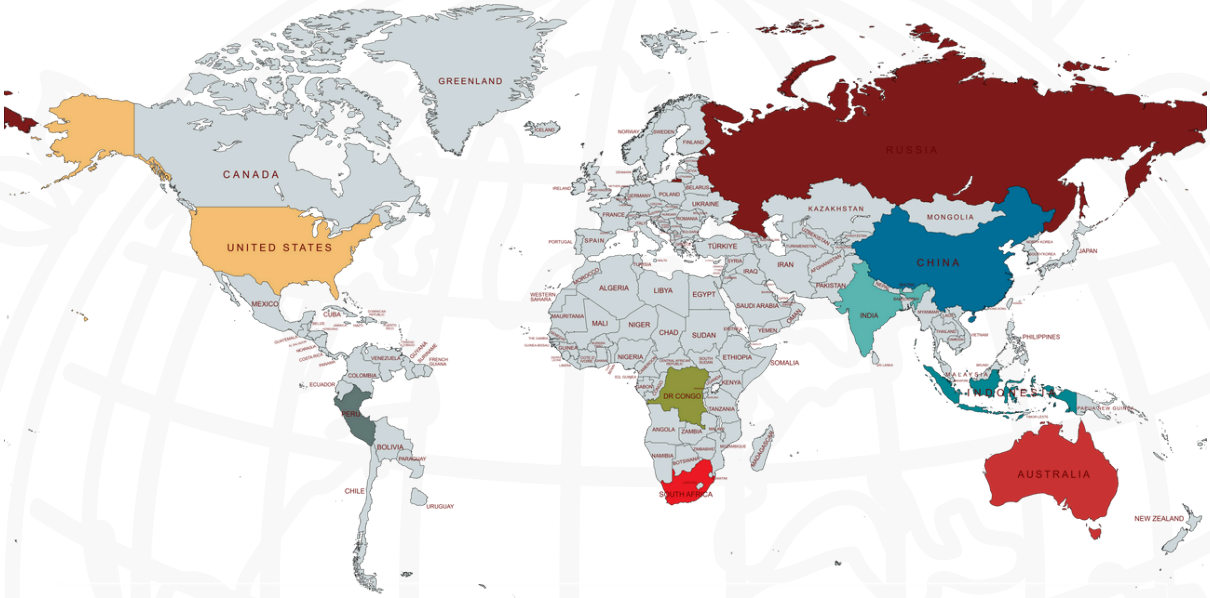
The mining industry's role in enhancing critical mineral recycling efforts could entail advancements in downstream beneficiation, as follows:

- Tailings Reprocessing (Geometallurgical practices)
- Technological Innovation for mineral recovery and refining (Hydrometallurgical processes, Leaching processes)
- Closed-Loop Systems (Maximising resource utilisation)

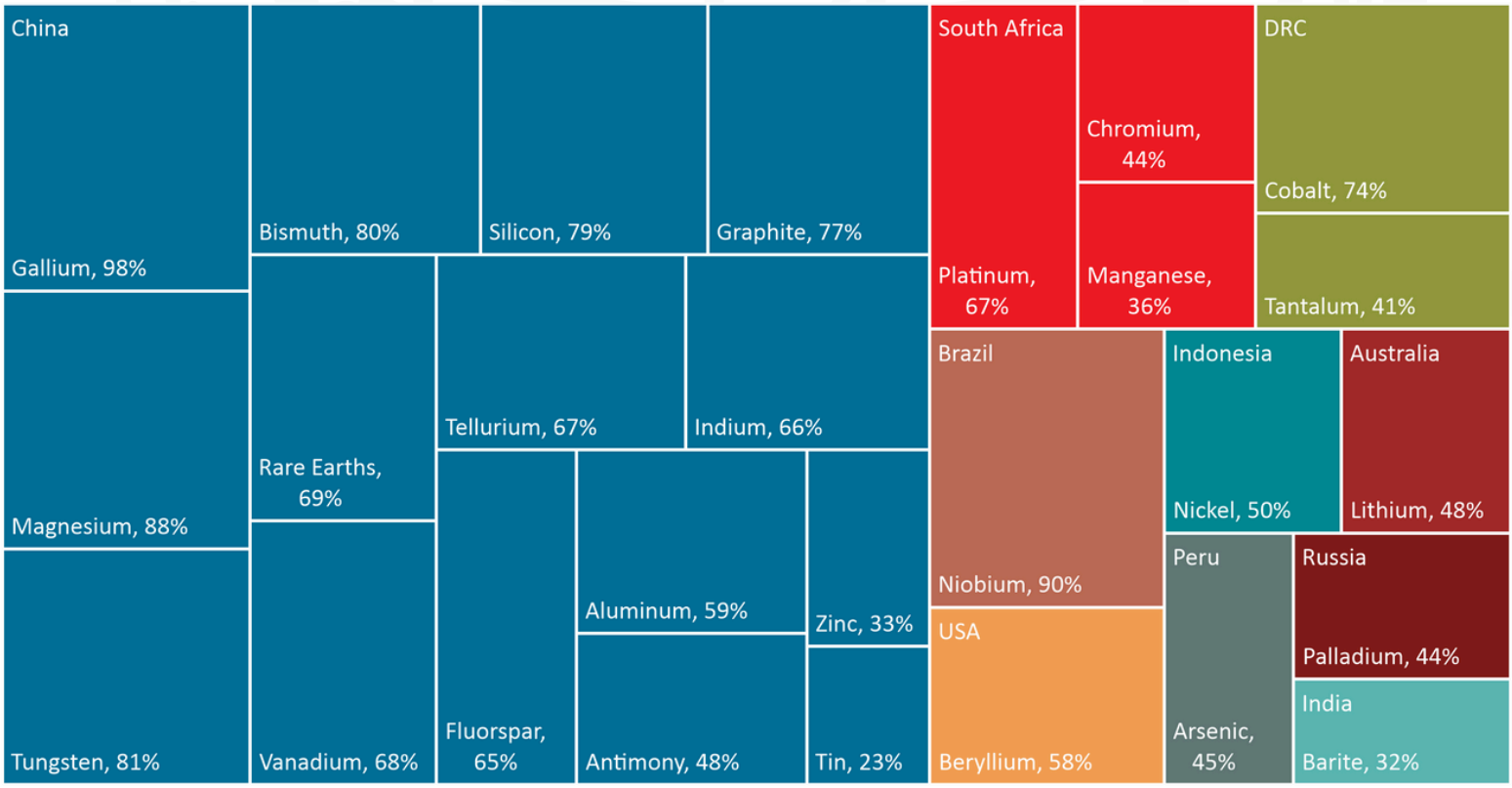
Critical Minerals by majority producing country as of 2023

Various minerals have been classified as being critical to world economies. According to Statista, South Africa was the majority producer in 2023 of the following critical minerals:

- 74% of all Platinum requirements
- 44% of all Chromium requirements
- 36% of all Manganese requirements



Australia Brazil China DRC India Indonesia Peru Russia South Africa USA



Source: Statista

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Key supply challenges

There are concerns regarding the reliable supply of critical minerals amongst the increasing demand for these minerals. Some of these supply concerns include:

- Volatile commodity prices
- Production geographically concentrated with potential geopolitical risks and export restrictions
- Lengthy project development time from discovery to first production
- Declining ore quality impacts costs on extraction, processing, waste and carbon emissions
- Addressing ESG, particularly environmental performance of energy-intensive operations
- Expanding sustainable water sourcing risks

Selected minerals face unique supply challenges:

- Cobalt
  - Large geographical concentration of production in the DRC, and refining in China
  - Small-scale subsistence/artisanal mining of cobalt
  - Approximately 90% of cobalt produced is as a by-product of nickel and copper mining, and new supply is dependent on new project developments of nickel and copper operations
- Copper
  - Little to no substitution options for copper in electrical applications
  - Declining ore quality and reserves exhaustion of current operations
  - Increased production costs, emissions and waste due to declining ore quality
  - Water sourcing risks in South America and Australia
- Lithium
  - Financial pressure on chemical production and small-scale producers due to lengthy low commodity prices
  - Geographical concentration of chemical production in China
  - Water sourcing risks in South America and Australia
- Nickel
  - Increasing environmental burden regarding emissions and tailings disposal
  - Limited substitution options due to high production costs or emissions
  - Production delays and cost overruns in high-pressure acid leaching projects

Source: International Energy Agency

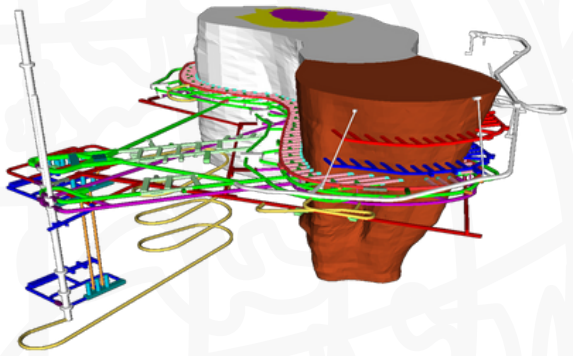
VBKOM's Role

Globally, the mining industry is one of the most vital contributors when it comes to economic growth, but at what environmental cost?

For years, the mining and minerals industry has been classified as one of the biggest users of electricity and natural resources, such as water. It is also one of the biggest contributors to carbon emissions and negative environmental impacts, such as erosion, water pollution, and habitat modification.

A renewed focus on Environmental, Social, and Governance (ESG) principles alongside the clean energy transition is being driven through corporate governance and financial reporting standards within the mining industry. Environmental sustainability and conservation are two of the most topical elements of ESG and two of the aspects that are usually most evident or measurable when change is implemented.

Environmental conservation is not a new concept, but it is one that the mining industry has been taking more seriously than ever before. Mining strategies have changed enormously in the past decade to include comprehensive environmental management systems, alternative mine planning, and greater emphasis on mine closures and mine rehabilitation.



Globally, mine designs deliberately focus on minimising the impact on the environment in a sustainable manner. Environmental and regulatory considerations are taken more seriously by all stakeholders and investors.

It is no longer just about the bottom line. It is about investing responsibly in the future of our people's lives and environment. VBKOM aims to assist the mining industry in extracting the critical minerals required for the clean energy transition responsibly and strategically through our multi-disciplinary services offering.

VBKOM has encountered many projects that are short of funds and do not have access to the right resources to find the right investors – or the projects are not adequately geared to be presented in their best possible light.

We have also encountered many potential investors and investment companies who are searching for the correct project to invest in. These entities often lack exposure to a project's true realisable potential and seldom find a project that aligns with their investment capacity and long-term aspirations.

Our progressive approach to project promotions includes reviews by geologists and engineers experienced in assessing project potential in all exploration, mining and engineering spaces.

Our Value Proposition

VBKOM is a provider of innovative business and technical consulting services and solutions for the mining and capital-intensive industries. We challenge ourselves to apply fresh thinking and to utilise our experience and technology in pioneering ways to deliver forward-thinking solutions.

Due to VBKOM's diverse pool of expertise, we can offer our clients specialised skills within a one-stop-shop culture. Our engineering, risk, and project management capabilities as well as simulation and decision support expertise, make us an ideal partner to the mining, petrochemical, and construction industries.

Our focus on long-term client relationships, combined with our technical skills, ensures that our clients can fully optimise their value chain.

At VBKOM, the quality of our work is guided by a simple philosophy – our success is driven only by the success of our clients and the achievement of our professionals. Our technical expertise comes unrivaled by using cutting-edge technology and the most advanced computer modelling systems on the market. Our capacity and continuity have earned us the trust of some of the world's most prestigious mineral resource companies. Staying true to our core values; utilizing our vast project-specific experience and qualifications; and applying proven world-class methodologies and processes, makes the VBKOM team a dynamic, flexible, and innovative team with a track record standing as solid proof of our competitive edge in our field.

We look forward to adding value to your company.

VBKOM website and social media website:

Sources

- International Energy Agency, accessed 18 December 2024, 9 January 2025
- Statista, accessed 13 December 2024

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