

# The links in the critical minerals and metals value chains

Published April 25, 2024

## Wood Mackenzie

Wood Mackenzie

## Aneeka Gupta

Director, Macroeconomic Research, WisdomTree Europe

## Key Takeaways

- Commodities are increasingly called upon in greater volumes to support the transition towards improved climate and energy security.
- Aluminium, cobalt, copper, iridium, lithium, nickel, platinum, rare earth elements, tin, nickel, silver, and zinc are some of the key materials required in the transition technologies.
- This blog is intended as a primer for non-specialists interested in better understanding the links in those commodities' value chains.
- Related Products WisdomTree Strategic Metals and Rare Earths Miners UCITS ETF - USD Acc, WisdomTree Strategic Metals UCITS ETF - USD Acc, WisdomTree Strategic Metals UCITS ETF - GBP Hedged Acc, WisdomTree Strategic Metals UCITS ETF - EUR Hedged Acc Find out more

Mining companies involved in extracting critical metals and minerals will play a focal role in supporting the energy transition, as discussed in the first part of our blog series [here](#). Enabling clean energy technologies to grow at the pace and scale needed to meet global climate targets will depend on the rate at which critical minerals can be found and mined. The [WisdomTree Energy Transition Metals and Rare Earths Miners UCITS ETF \(RARE\)](#) enables investors to tap into pure-play companies that produce the most important metals for the energy transition theme.

*Source: Wood Mackenzie as of 31 March 2024*

The Energy Transition Metals Value Chain (ETMVC) includes the exploration and processing of metals, including rare earth elements (REE), used in technologies associated with the energy transition such as electric vehicles (EVs), transmission, charging, energy storage, solar, wind and hydrogen. The companies that belong to the ETMVC are identified and classified into 11 metal categories (aluminium, cobalt, copper, iridium, lithium, nickel, platinum, silver, tin, zinc, and REE) and across six subsectors (chemicals, conversions, industry, mining, refining, and smelting). The ETMVC includes companies that move through different phases, from upstream mining and extraction through various midstream transformation processes, to the end products used in renewable power plants, EVs, and other features of the lower

carbon economy. In the case of nickel, the outputs are so varied that it is best described as an industry in itself.

This blog is a primer for investors to better understand the underlying process within the ETMVC for companies providing a supply of commodities critical to the energy transition.

## What are the key sub-sectors?

### Aluminium

- **Mining:** Bauxite ore is the primary source of aluminium. Australia, China and Guinea are the largest producers of bauxite.
- **Refining:** Bauxite is refined into alumina (aluminium oxide) through the Bayer Process. Heat, pressure, and sodium hydroxide are used to separate aluminium oxide from impurities and iron ore.
- **Smelting:** Alumina (aluminium oxide) is the starting material used for smelting aluminium through the Hall Heroult process.

### Cobalt

- **Mining:** A mix of large-scale industrial miners and small-scale freelance or artisanal miners are involved in cobalt mining. The Democratic Republic of the Congo (DRC) accounted for ~70% of mine supply of cobalt in 20231.
- **Refining:** Pyrometallurgy is a refining process where high temperatures are applied to the ore, causing it to melt and the cobalt to be separated.
- **Chemicals:** Cobalt ore is treated with chemicals to extract elemental cobalt. The process, known as hydrometallurgy, dissolves the ore and separates the cobalt.

### Copper

- **Mining:** Most copper mining is open-pit (low cost, efficient, scalable) with underground mining (costly and technically challenging) also undertaken by some players. Copper ore is mined as copper sulphides and copper oxides, with the type of copper compounds determining the refining and smelting process. Chile is the world's largest copper producer, but Peru and the DRC are also key suppliers.
- **Smelting:** Smelting and refining applies primarily to copper sulphide ores, and smelting is the next step in the copper value chain after mining and beneficiation. Copper smelting involves the application of heat and chemical reducing agents to extract pure copper metal. Copper oxide ores are not smelted.
- **Refining:** After the copper ore is smelted, it is refined. Electrolytic refining is the most common refining method, whereby electricity is used to separate copper from impurities in a solution. Pyrometallurgical refining is also used to produce purer copper ore. Copper oxide ores are not smelted. Instead, they are processed through hydrometallurgy (leaching, solvent extraction, electrowinning) and are refined using electrowinning to produce a 99.9% pure copper cathode.

## Iridium

- Mining: Iridium is often found as a by-product of copper and nickel mining, so its extraction mirrors that of those metals through a mix of open-pit and underground mines. South Africa is the dominant producer of iridium in the global market.

## Lithium

- Mining: Lithium ore mining involves extraction via hard rock mining (higher costs, more energy, more sources) from ore such as spodumene, petalite and lepidolite. Lithium can also be extracted from brine sources (lower cost, slow, lower recovery), such as geothermal wells, salt lakes or hydrocarbon fields. Australia, China and Chile account for much of the world's lithium supply.
- Conversion: The lithium conversion process transforms lithium from one chemical form to another, usually to make it more suitable for various applications. The end chemicals are usually either lithium hydroxide or lithium carbonate.

## Nickel

- Industry: Nickel is not just a simple case of concentrate production. There is nickel concentrate and others such as nickel pig iron (NPI), iron-nickel (FeNi), and high-pressure acid leach (HPAL). Nickel is grouped as an industry to account for all the different products. Indonesia is the world's largest nickel supplier.

## Platinum

- Mining: Most platinum mining occurs underground and is often associated with nickel mining. Surface mining does take place, but it's less common. South Africa produces the vast majority of the world's platinum.

## Rare Earth Elements (REE)

- Mining: REE mining involves the extraction of REE ores, which contain a mix of metals. As REEs are abundant in the earth's crust, removing topsoil, leaching ponds or drilling holes to pump chemicals releases ores. China is the principal producer of different REE ores and concentrates.
- Refining: 85% of global REE capacity is in China<sup>2</sup>. Refining involves various applications of heat and chemicals to separate REE from other elements contained in the ores.

## Silver

- Mining: Silver is mined from various ores, including copper, nickel, gold, and lead. Depending on the depth and the type of ore, silver ore extraction involves open-pit or underground mining methods. Mexico is the largest producer, alongside Peru.
- Refining: The refining of silver ore involves purification and conversion to the end product (bars, coins, powder) through a range of techniques including electrolysis, fire refining or chemical precipitation.

## Tin

- Mining: The two primary ways of extracting tin are surface mining from rock ores such as cassiterite and brine extraction. China is the largest tin producer by a comfortable margin.
- Smelting: Tin ore is processed to separate and concentrate the tin minerals using physical and chemical methods, such as crushing, grinding, flotation, and leaching.

## Zinc

- Mining: Zinc extraction involves open-pit or underground mining methods depending on the depth and type of the ore. China is the world's largest zinc miner, and Australia and Peru also have notable upstream extraction operations.
- Smelting: Pyrometallurgical processes involving heat and reducing agents separate zinc from other elements. The electrolytic process, based on electricity and a solution, also purifies zinc before the metal is cast into ingots or sheets.

Strong policy support alongside higher investment is paving the way for a faster shift towards clean energy to keep net zero emissions by 2050 within reach. Clean energy technologies are evolving rapidly and in lockstep we expect the ETMVC to adapt. The [WisdomTree Energy Transition Metals and Rare Earths Miners UCITS ETF \(RARE\)](#) aims to capture the opportunity from the evolving nature of the energy transition technologies and their impact on global mining companies. At present, close to 60% of the portfolio weight is allocated to companies with more than 75% revenue exposure to the energy transition metals and rare earths theme, highlighting a strong exposure to pure plays.

### Sources

1 Source: Wood Mackenzie Global cobalt strategic planning outlook Q1 2024.

2 Source: Wood Mackenzie Global rare earth element planning outlook Q1 2024.

## Important Risks Related to this Article

### IMPORTANT INFORMATION

**Marketing communications issued in the European Economic Area (“EEA”):** This document has been issued and approved by WisdomTree Ireland Limited, which is authorised and regulated by the Central Bank of Ireland.

**Marketing communications issued in jurisdictions outside of the EEA:** This document has been issued and approved by WisdomTree UK Limited, which is authorised and regulated by the United Kingdom Financial Conduct Authority.

WisdomTree Ireland Limited and WisdomTree UK Limited are each referred to as “WisdomTree” (as applicable). Our Conflicts of Interest Policy and Inventory are available on request.

**For professional clients only. Past performance is not a reliable indicator of future performance. Any historical performance included in this document may be based on back testing. Back testing is the process of evaluating an investment strategy by applying it to historical data to simulate what the performance of such strategy would have been. Back tested performance is purely hypothetical and is provided in this document solely for informational purposes. Back tested data does not represent actual performance and should not be interpreted as an indication of actual or future performance. The value of any investment may be affected by exchange rate movements. Any decision to invest should be based on the information contained in the appropriate prospectus and after seeking independent investment, tax and legal advice. These products may not be available in your market or suitable for you. The content of this document does not constitute investment advice nor an offer for sale nor a solicitation of an offer to buy any product or make any investment.**

An investment in exchange-traded products (“ETPs”) is dependent on the performance of the underlying index, less costs, but it is not expected to match that performance precisely. ETPs involve numerous risks including among others, general market risks relating to the relevant underlying index, credit risks on the provider of index swaps utilised in the ETP, exchange rate risks, interest rate risks, inflationary risks, liquidity risks and legal and regulatory risks.

The information contained in this document is not, and under no circumstances is to be construed as, an advertisement or any other step in furtherance of a public offering of shares in the United States or any province or territory thereof, where none of the issuers or their products are authorised or registered for distribution and where no prospectus of any of the issuers has been filed with any securities commission or regulatory authority. No document or information in this document should be taken, transmitted or distributed (directly or indirectly) into the United States. None of the issuers, nor any securities issued by them, have been or will be registered under the United States Securities Act of 1933 or the Investment Company Act of 1940 or qualified under any applicable state securities statutes.

This document may contain independent market commentary prepared by WisdomTree based on publicly available information. Although WisdomTree endeavours to ensure the accuracy of the content in this

document, WisdomTree does not warrant or guarantee its accuracy or correctness. Any third party data providers used to source the information in this document make no warranties or representation of any kind relating to such data. Where WisdomTree has expressed its own opinions related to product or market activity, these views may change. Neither WisdomTree, nor any affiliate, nor any of their respective officers, directors, partners, or employees accepts any liability whatsoever for any direct or consequential loss arising from any use of this document or its contents.

This document may contain forward looking statements including statements regarding our belief or current expectations with regards to the performance of certain assets classes and/or sectors. Forward looking statements are subject to certain risks, uncertainties and assumptions. There can be no assurance that such statements will be accurate and actual results could differ materially from those anticipated in such statements. WisdomTree strongly recommends that you do not place undue reliance on these forward-looking statements.

### **Wood Mackenzie**

The views expressed in this blog are those of Wood Mackenzie, any reference to “we” should be considered the view of Wood Mackenzie and not necessarily those of WisdomTree Europe.

Wood Mackenzie, a Verisk Analytics business, is a trusted source of commercial intelligence for the world’s natural resources sector. Wood Mackenzie empowers clients to make better strategic decisions, providing objective analysis and advice on assets, companies and markets.

### **WisdomTree Issuer ICAV**

The products discussed in this document are issued by WisdomTree Issuer ICAV (“WT Issuer”). WT Issuer is an umbrella investment company with variable capital having segregated liability between its funds organised under the laws of Ireland as an Irish Collective Asset-management Vehicle and authorised by the Central Bank of Ireland (“CBI”). WT Issuer is organised as an Undertaking for Collective Investment in Transferable Securities (“UCITS”) under the laws of Ireland and shall issue a separate class of shares (“Shares”) representing each fund. Investors should read the prospectus of WT Issuer (“WT Prospectus”) before investing and should refer to the section of the WT Prospectus entitled »Risk Factors¼ for further details of risks associated with an investment in the Shares.

### **Notice to Investors in Switzerland – Qualified Investors**

This document constitutes an advertisement of the financial product(s) mentioned herein.

The prospectus and the key investor information documents (KIID) are available from WisdomTree’s website: <https://www.wisdomtree.eu/en-ch/resource-library/prospectus-and-regulatory-reports>

Some of the sub-funds referred to in this document may not have been registered with the Swiss Financial Market Supervisory Authority (“FINMA”). In Switzerland, such sub-funds that have not been registered with FINMA shall be distributed exclusively to qualified investors, as defined in the Swiss Federal Act on Collective Investment Schemes or its implementing ordinance (each, as amended from time to time).

The representative and paying agent of the sub-funds in Switzerland is Société Générale Paris, Zurich Branch, Talacker 50, PO Box 5070, 8021 Zurich, Switzerland. The prospectus, the key investor information documents (KIID), the articles of association and the annual and semi-annual reports of the sub-funds are available free of charge from the representative and paying agent. As regards distribution in Switzerland, the place of jurisdiction and performance is at the registered seat of the representative and paying agent.

### **For Investors in France**

The information in this document is intended exclusively for professional investors (as defined under the MiFID) investing for their own account and this material may not in any way be distributed to the public. The distribution of the Prospectus and the offering, sale and delivery of Shares in other jurisdictions may be restricted by law. WT Issuer is a UCITS governed by Irish legislation, and approved by the Financial Regulatory as UCITS compliant with European regulations although may not have to comply with the same rules as those applicable to a similar product approved in France.

The Fund has been registered for marketing in France by the Financial Markets Authority (Autorité des Marchés Financiers) and may be distributed to investors in France. Copies of all documents (i.e. the Prospectus, the Key Investor Information Document, any supplements or addenda thereto, the latest annual reports and the memorandum of incorporation and articles of association) are available in France, free of charge at the French centralizing agent, Societe Generale at 29, Boulevard Haussmann, 75009, Paris, France. Any subscription for Shares of the Fund will be made on the basis of the terms of the prospectus and any supplements or addenda thereto.

### **For Investors in Malta**

This document does not constitute or form part of any offer or invitation to the public to subscribe for or purchase shares in the Fund and shall not be construed as such and no person other than the person to whom this document has been addressed or delivered shall be eligible to subscribe for or purchase shares in the Fund. Shares in the Fund will not in any event be marketed to the public in Malta without the prior authorisation of the Maltese Financial Services Authority.

### **For Investors in Monaco**

This communication is only intended for duly registered banks and/or licensed portfolio management companies in Monaco. This communication must not be sent to the public in Monaco.