Could Constraints in Metal Supply Impede the Transition?

Alex Griffiths, Principal Analyst – Metals and Mining

October 2022

Wood Mackenzie: Built for the Energy Transition

Broad and deep – Forming an integrated energy transition view by assessing each segment, commodity, technology and market

Integrated Global Perspectives

Energy Transition Research (Global Energy and Emerging Technologies)

Investible Market Intelligence

- Regional Power & Renewables Markets
- Oils & Refining
- Global LNG & Gas
- Regional Gas Markets
- Metal Markets
- Chemicals Markets

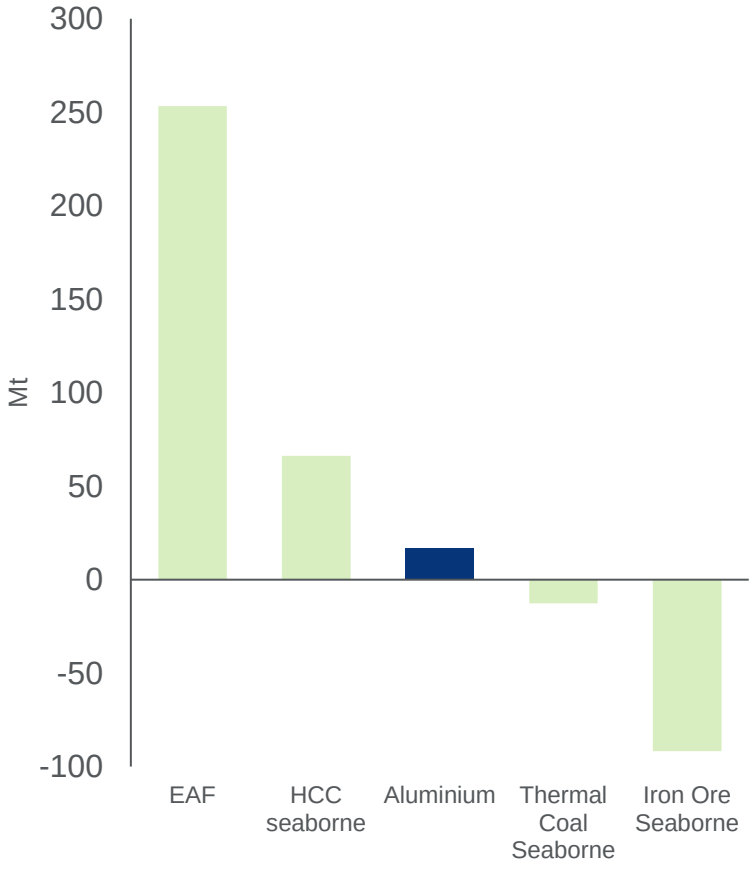
Industry Value Chain Depth: Assets, Technologies, and Costs

- Wind
- Solar
- Grid Edge
- Energy Storage
- Electric Vehicles
- CCUS
- Hydrogen
- Oil & Gas
- Metals & Mining
- Chemicals

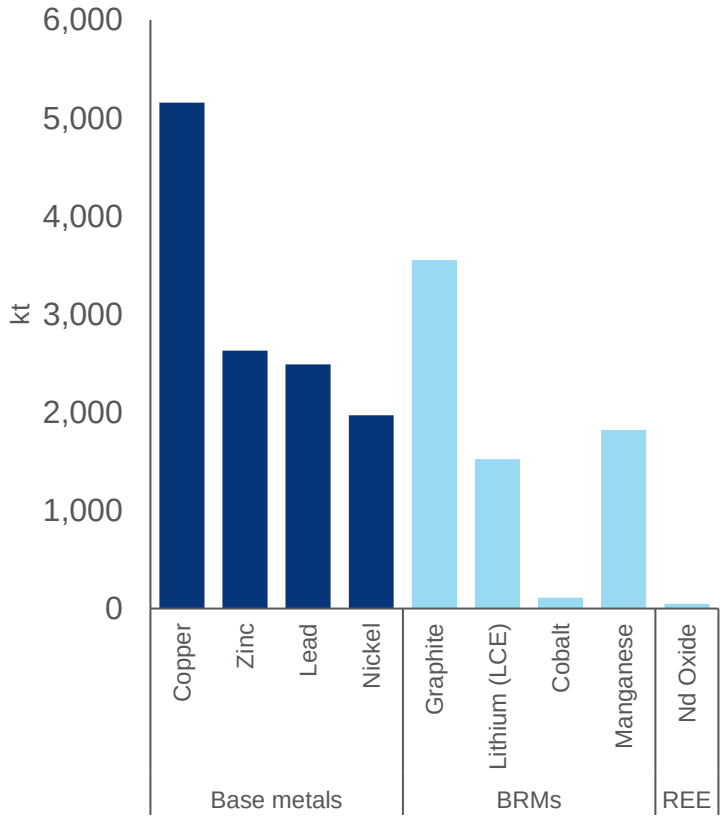
Demand to 2030 very healthy across base and energy transition metals

Even under our base case - *2.5 degree warming scenario* - demand increases will put pressure on supply.

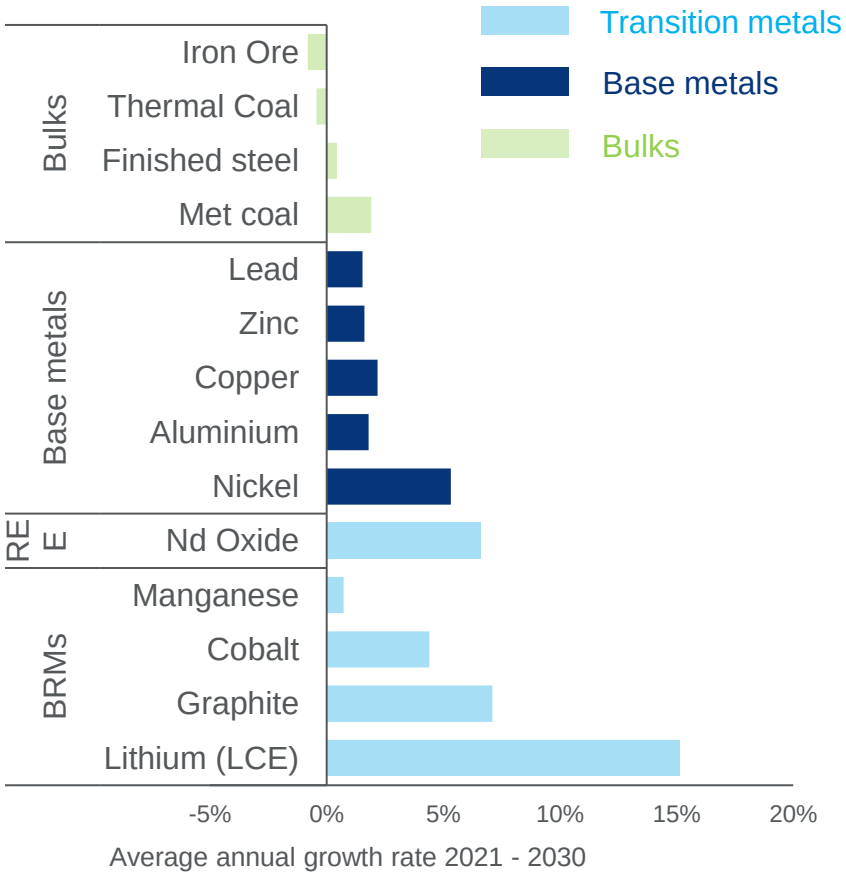
Market growth to 2030 - Bulks



Market growth to 2030 - Metals



Market growth rate comparison

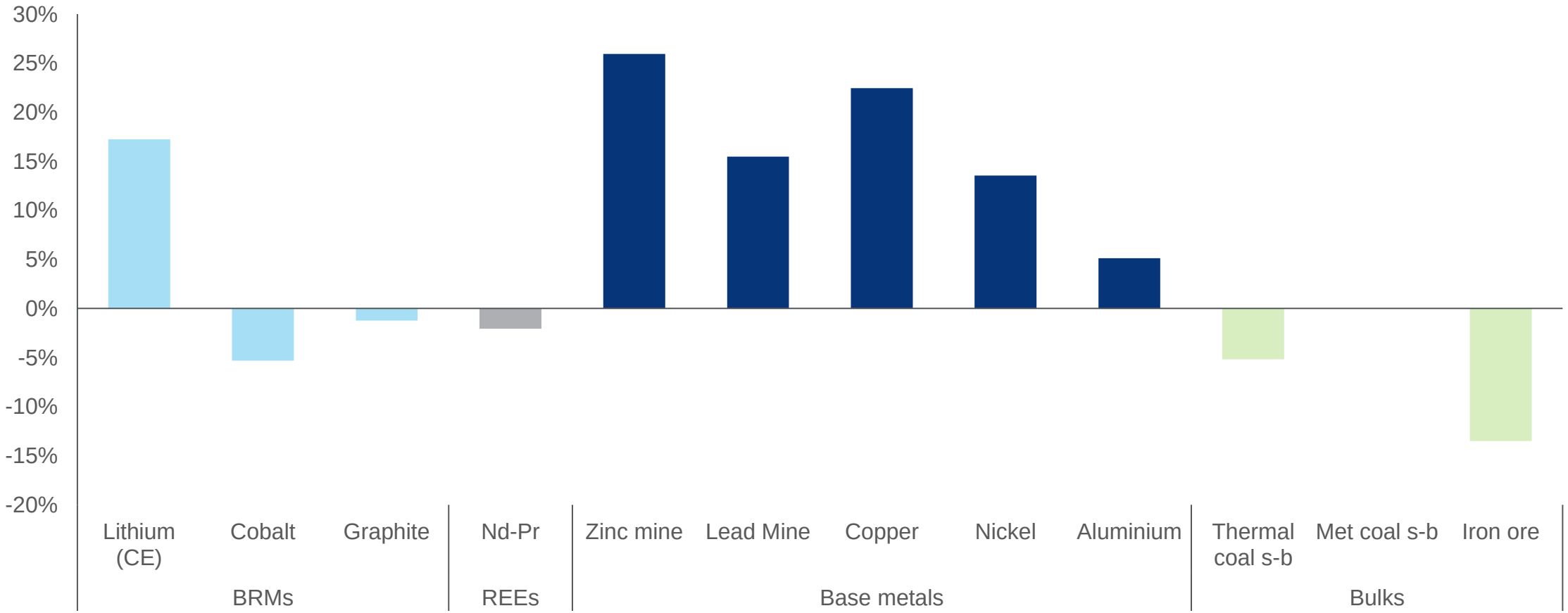


Source: Wood Mackenzie

Supply gaps become real as lead times extend and decisions are delayed

Meeting base case requirements will be “challenging” given market conditions, investment environment and project lead times that stretch to 10-15 years. ~$200bn required

2030 supply required from currently uncommitted projects (base case 2.5 degrees)



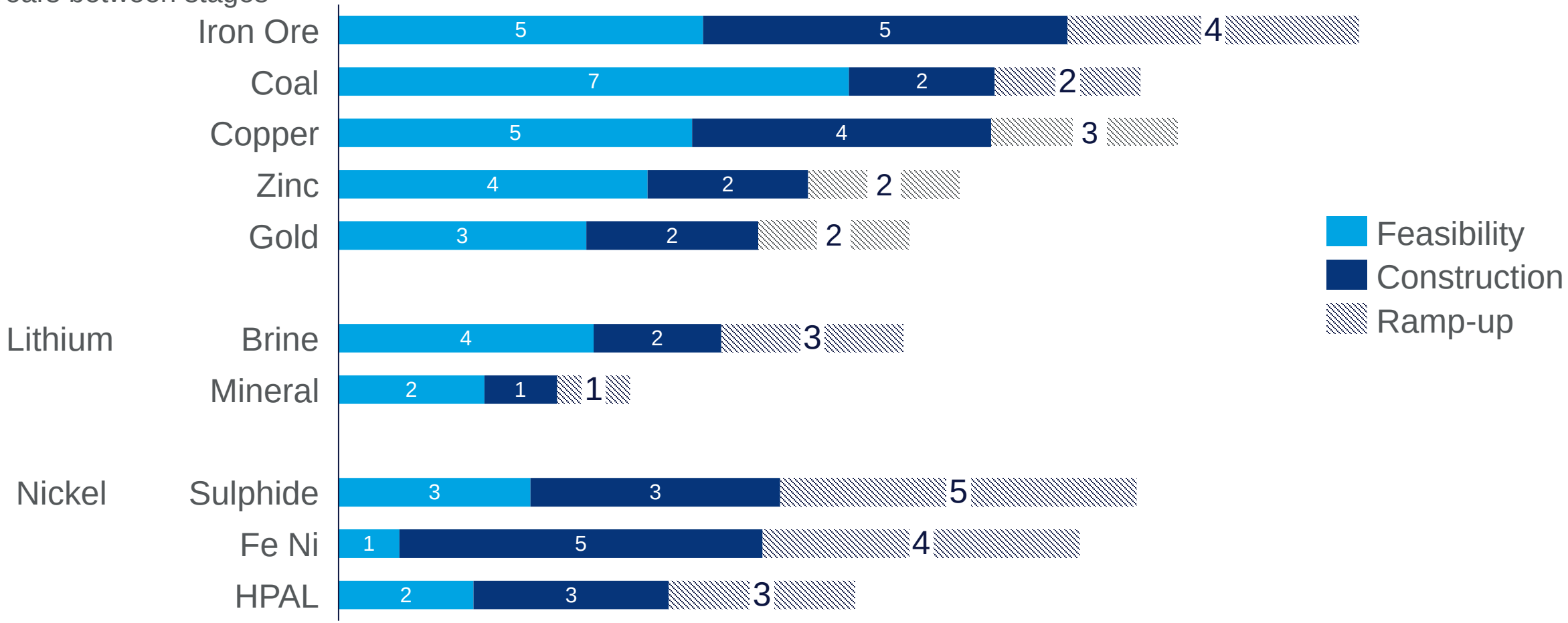
Source: Wood Mackenzie

Building back better?

Pre-construction assets in some metals may struggle to add meaningful growth this decade

Average project lead times

Years between stages



Source: Wood Mackenzie

What does it take to achieve accelerated decarbonization?

Alex Griffiths, Principal Analyst – Metals and Mining

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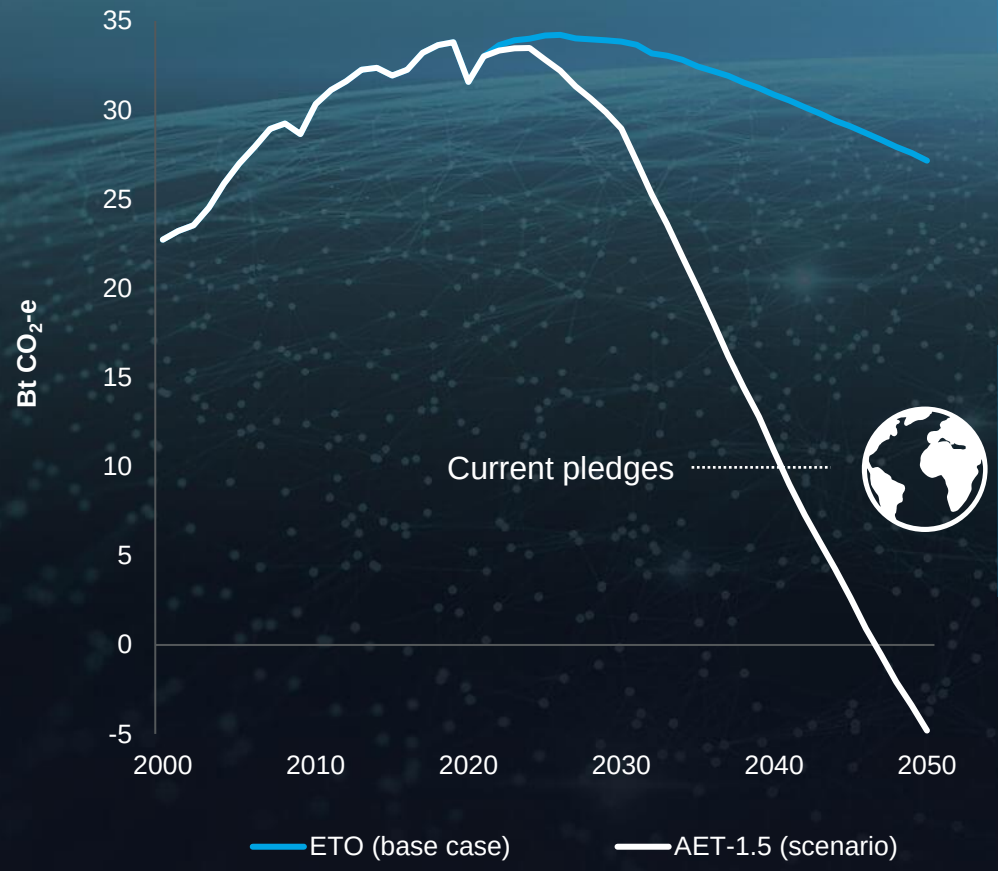
Wood Mackenzie's Accelerated Energy Transition 1.5-Degree scenario

Aligned with the most ambitious goal of the Paris Agreement

Global energy-related CO_2 emissions



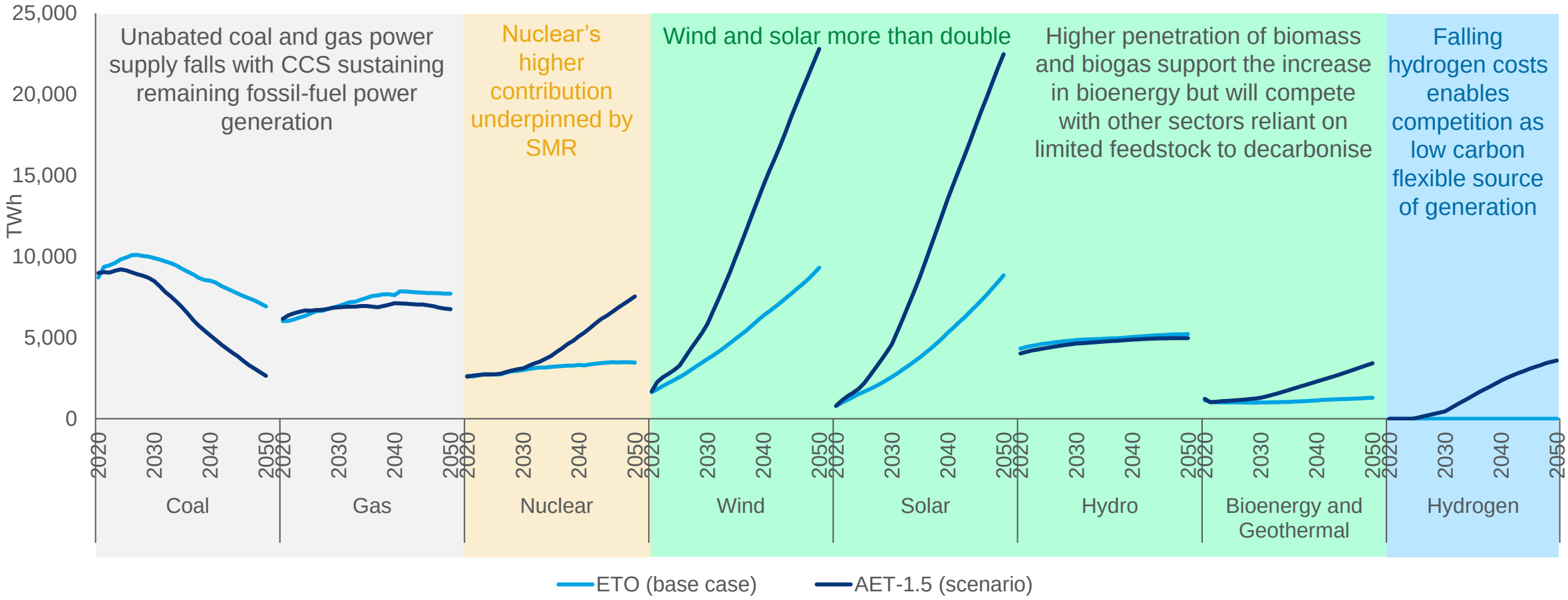
Scenario	Trajectory	Policy	Enablers
Energy Transition Outlook **(WM ETO)**	Consistent with 2.5 to 2.7 ˚C global warming	Evolution of current policies	Steady advancement of current and nascent technologies
1.5 °C Scenario **(WM AET-1.5)**	Consistent with 1.5 ˚C warming (Global net zero emissions by 2050)	Aligned with most ambitious goal of Paris Agreement	Early peak energy; rapid hydrogen and carbon removal deployment; consumer shift

Source: Wood Mackenzie

Wind and solar generation more than double in a net zero world

Generation, transmission, storage and use of low carbon energy cannot be achieved without metals. Renewable energy is more metals intensive than thermal generation

Power supply by fuel

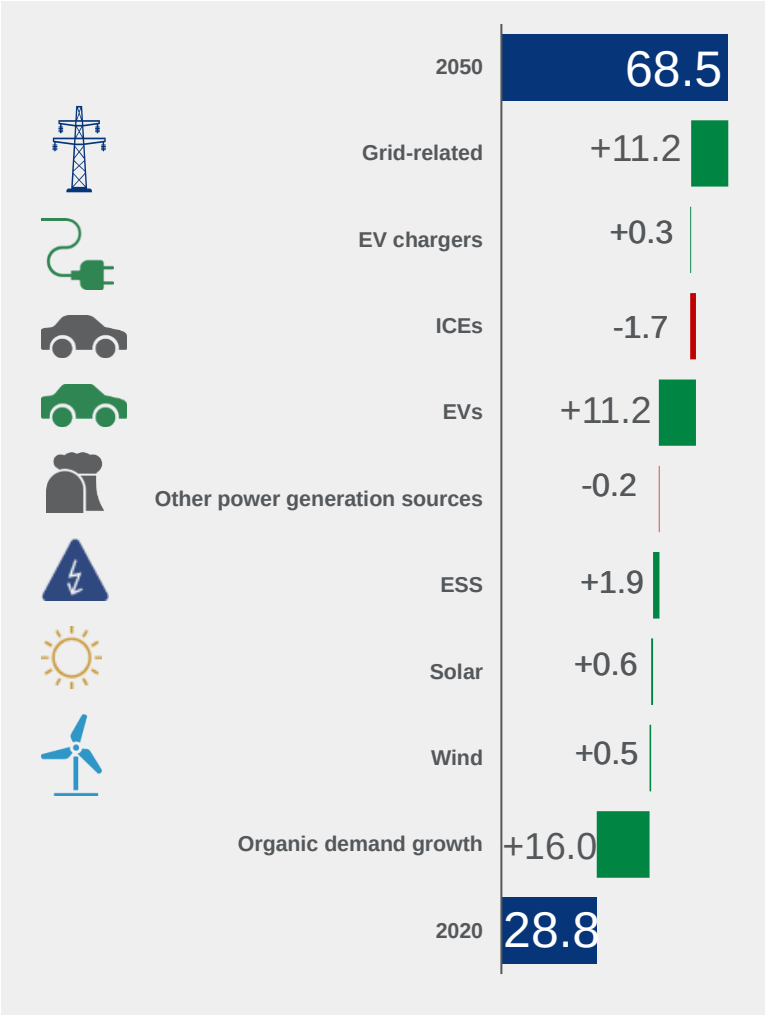


Source: Wood Mackenzie

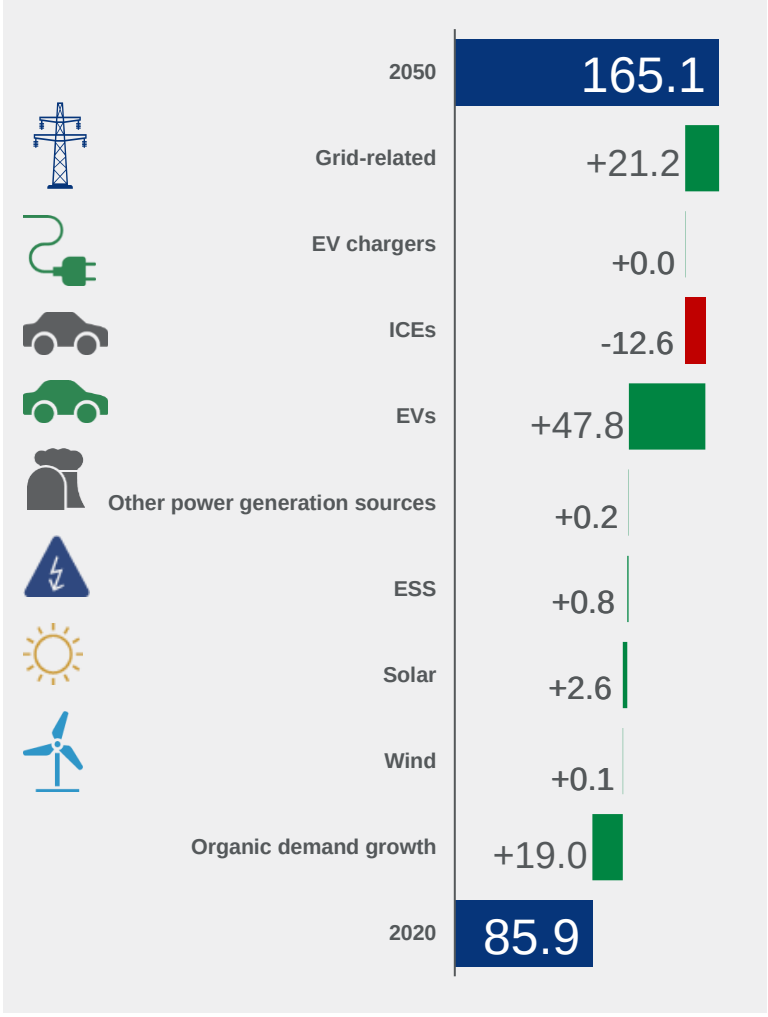
Gains to base metals consumption in a net zero world

EVs, energy storage and the grid are key demand drivers

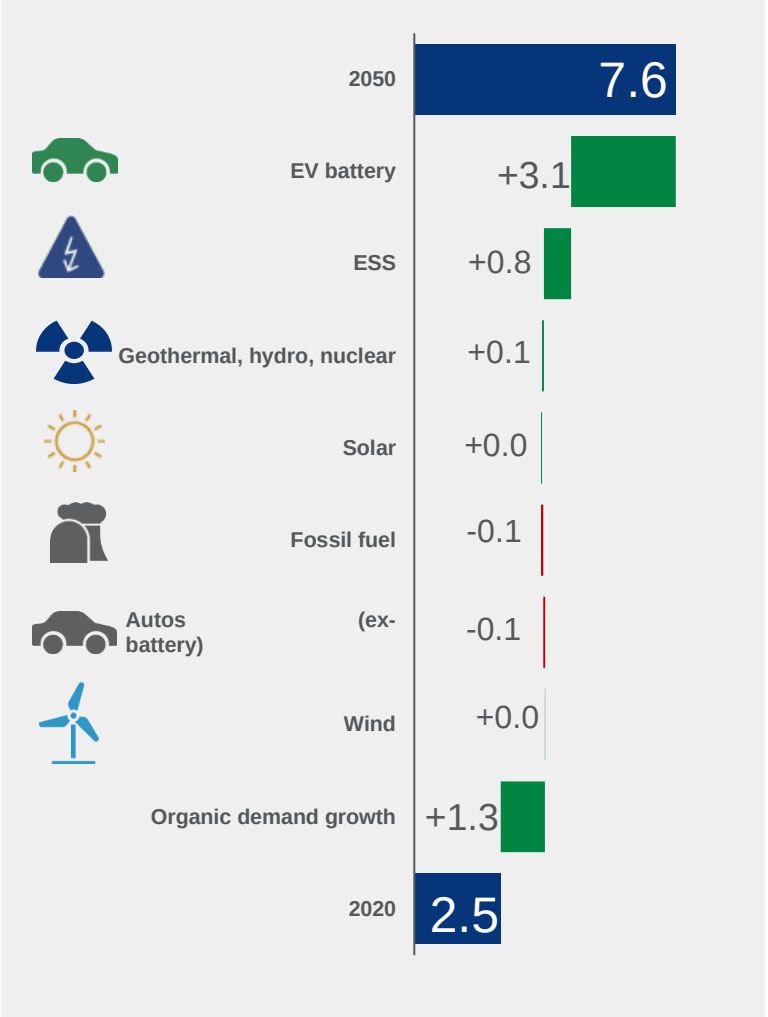
Copper, Mt



Aluminium, Mt



Nickel, Mt

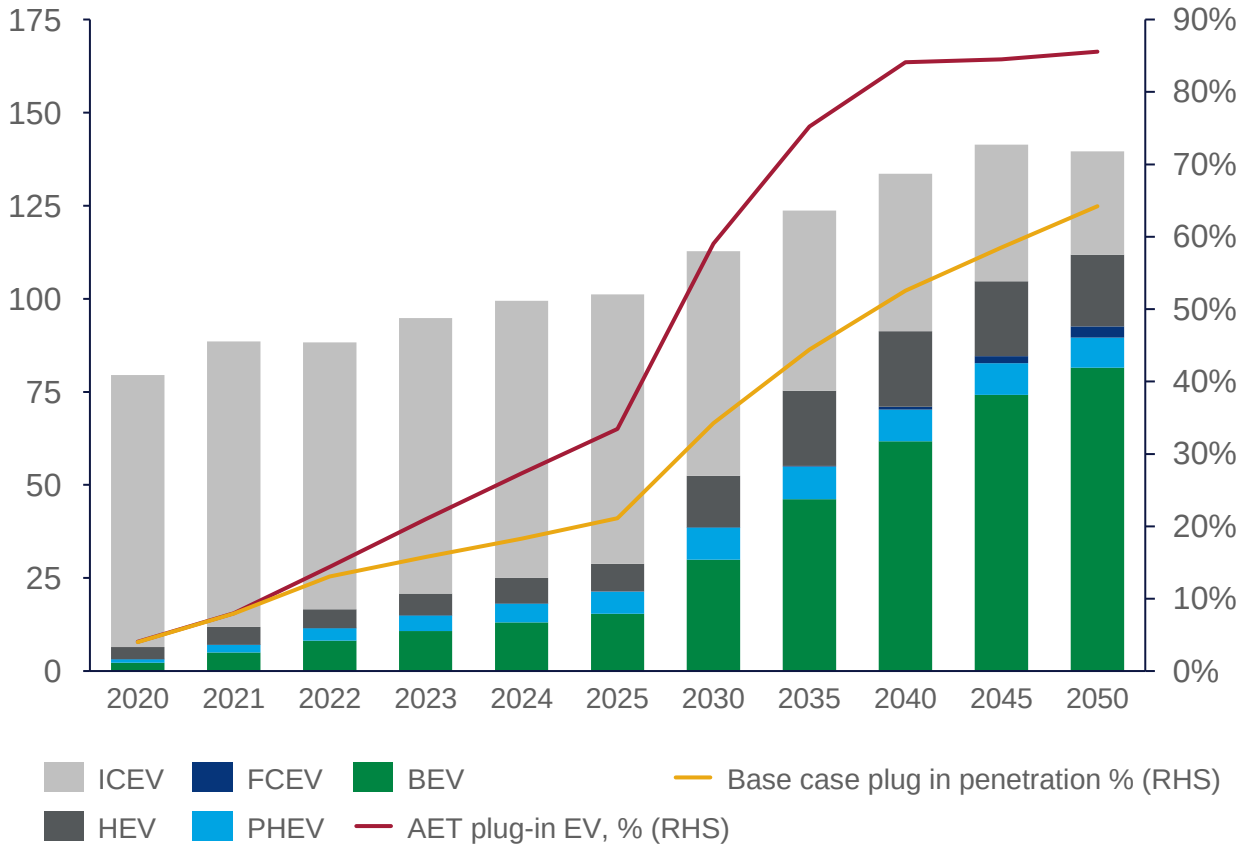


Source: Wood Mackenzie. Note: Grid/transmission and distribution analysis performed only for copper and aluminium. Demand from the segment is an upside risk for the remainder metals. Organic demand growth refers to ETO demand from other sectors that have not been captured for the purpose of this end-use analysis.

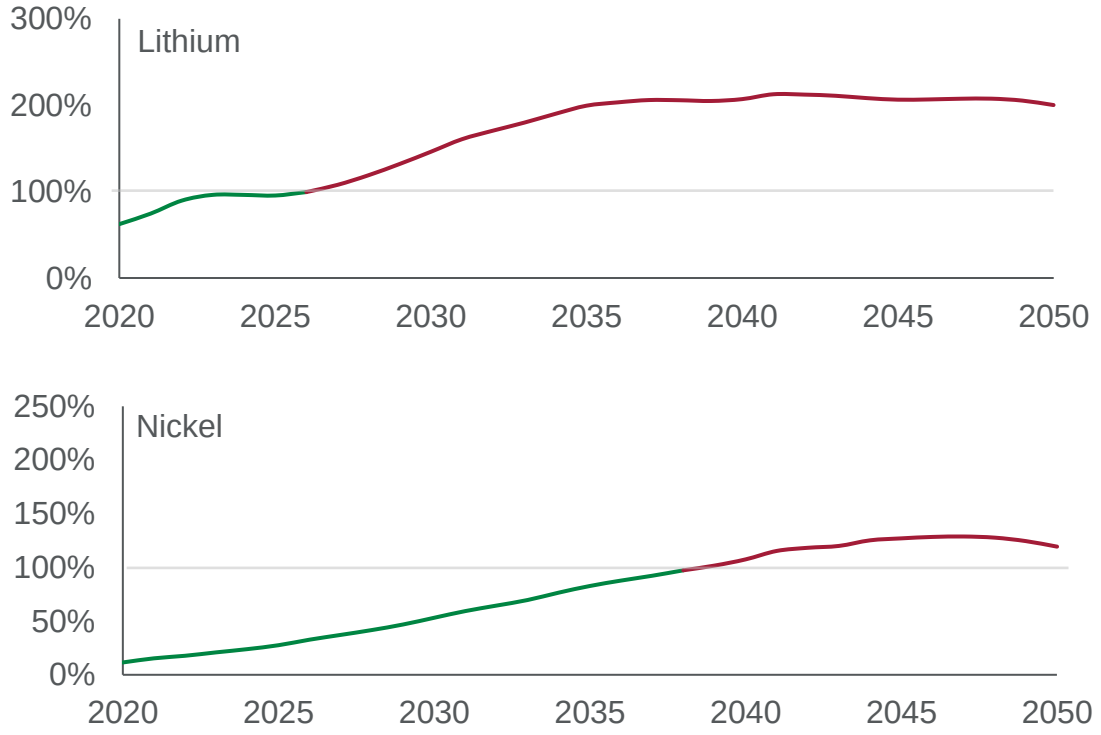
Plug-in EV sales penetration reaches 60% by 2030 in a net zero world…

…placing further pressure on metals supply

Automotive sales by powertrain, M units



Demand from batteries versus base case supply

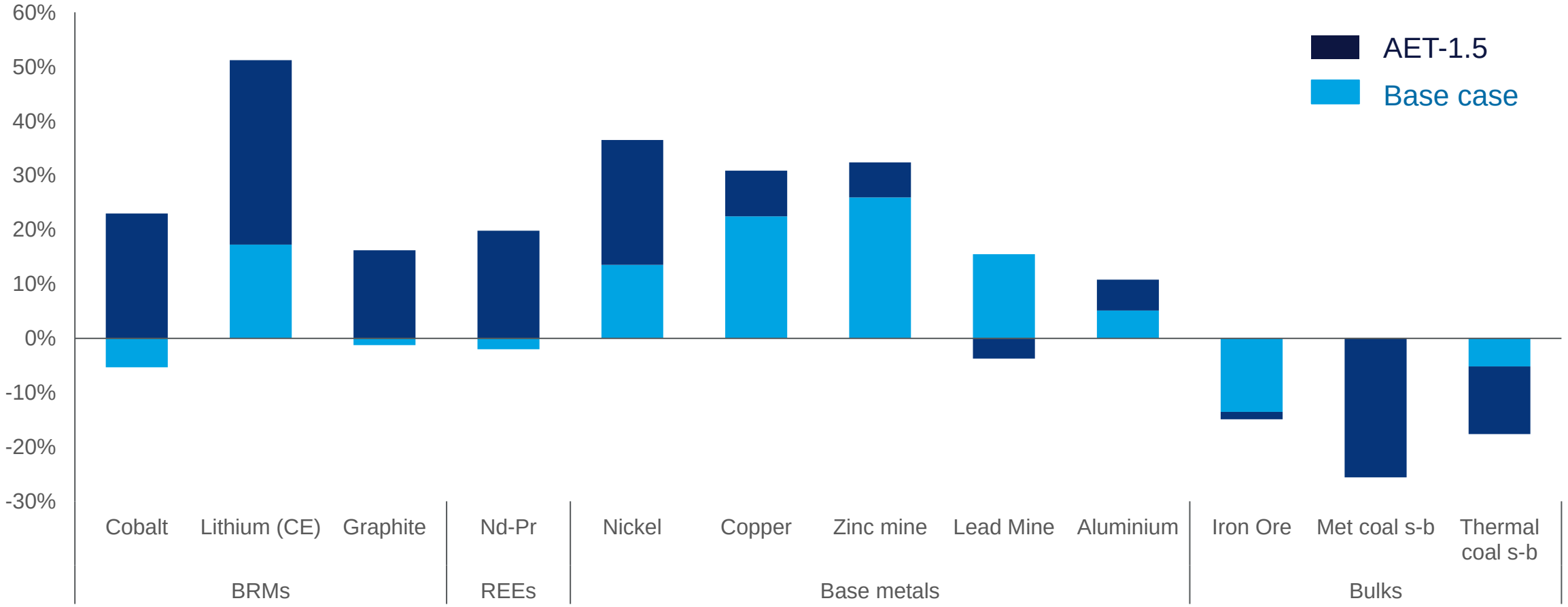


Source: Wood Mackenzie

An AET 1.5 ^{0}C trajectory places extraordinary pressure on metals supply

A massive challenge for the metals industry ~US$390 billion needs to be invested by 2030

2030 supply from uncommitted projects (% of market): Base case and AET 1.5

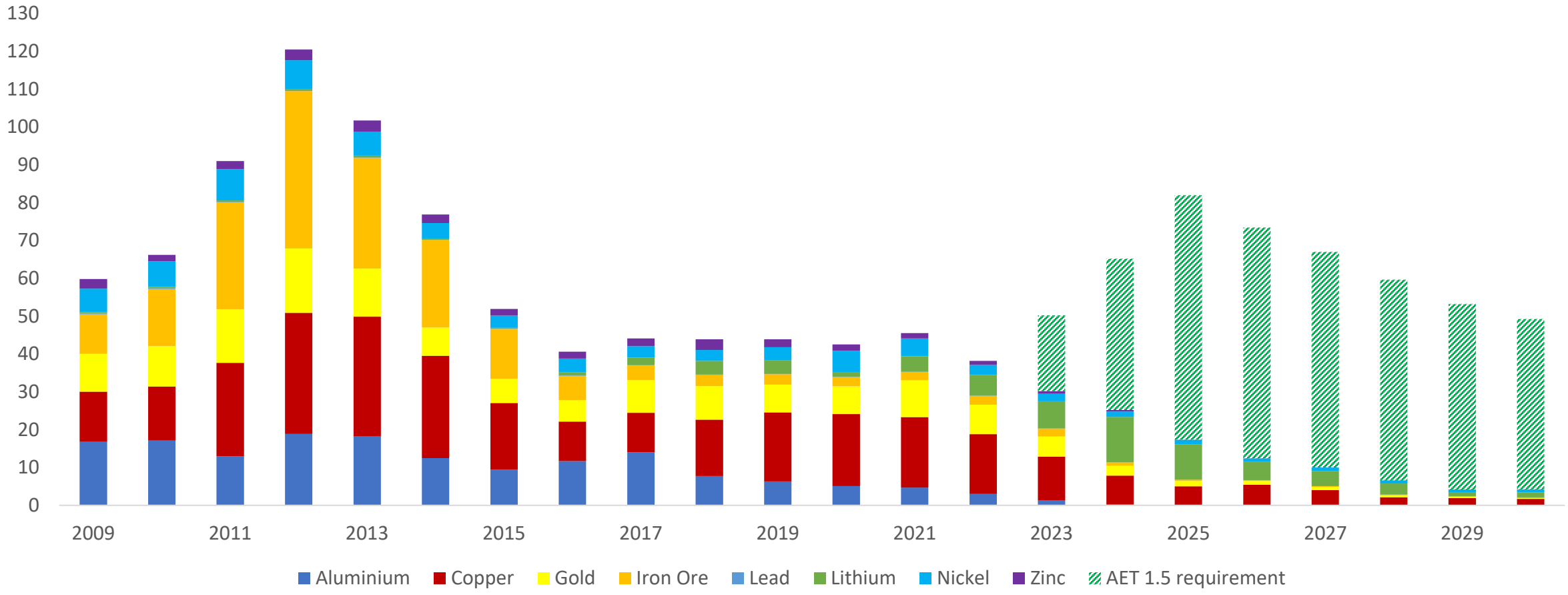


Source: Wood Mackenzie

Industry under-investment is stark

Capex needs to accelerate aggressively to deliver the metals for a Paris-aligned pathway

Global Metals investment Capex ($Bn)



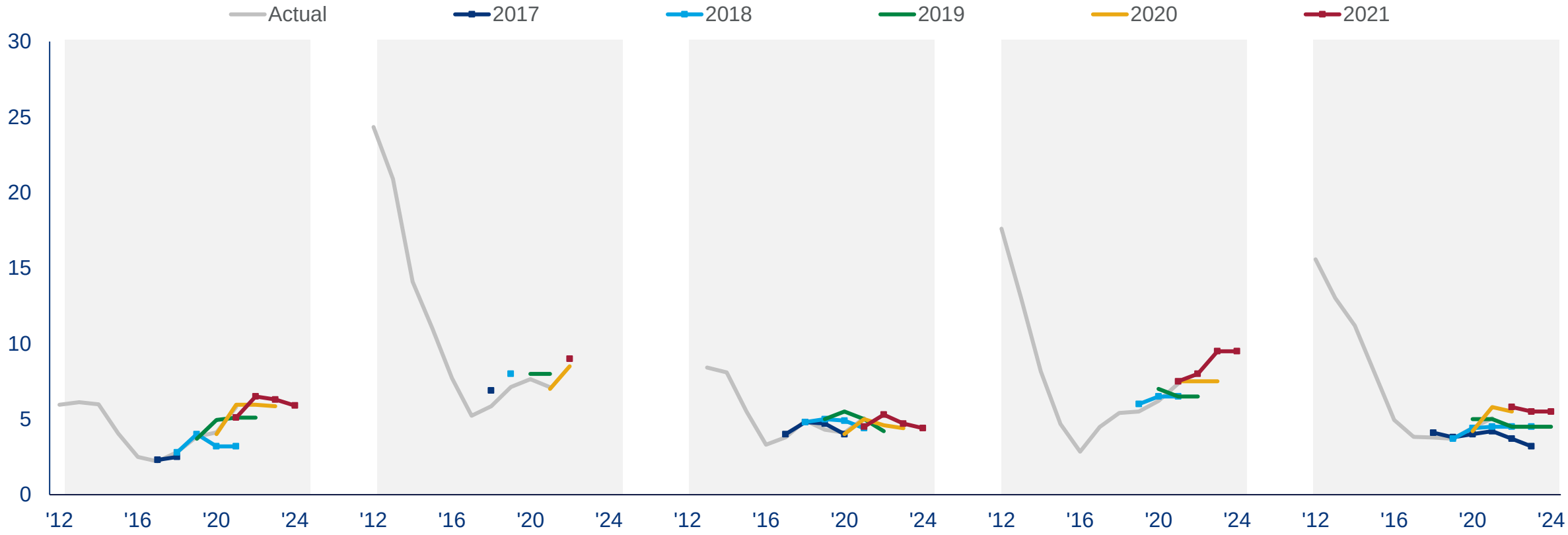
Source: Wood Mackenzie, AET 1.5 requirement for Aluminium, alumina, copper, nickel, zinc, lithium

Disciplined disciples: the Miners are keeping the purse strings tight

Capex guidance is rising with decarbonisation investment and sustaining capital spend but still well below levels of the last peak and commodity markets have grown

Capex guidance

US$bn nominal



Source: Factset, Wood Mackenzie

What metals supply challenges do we face?

Alex Griffiths, Principal Analyst – Metals and Mining

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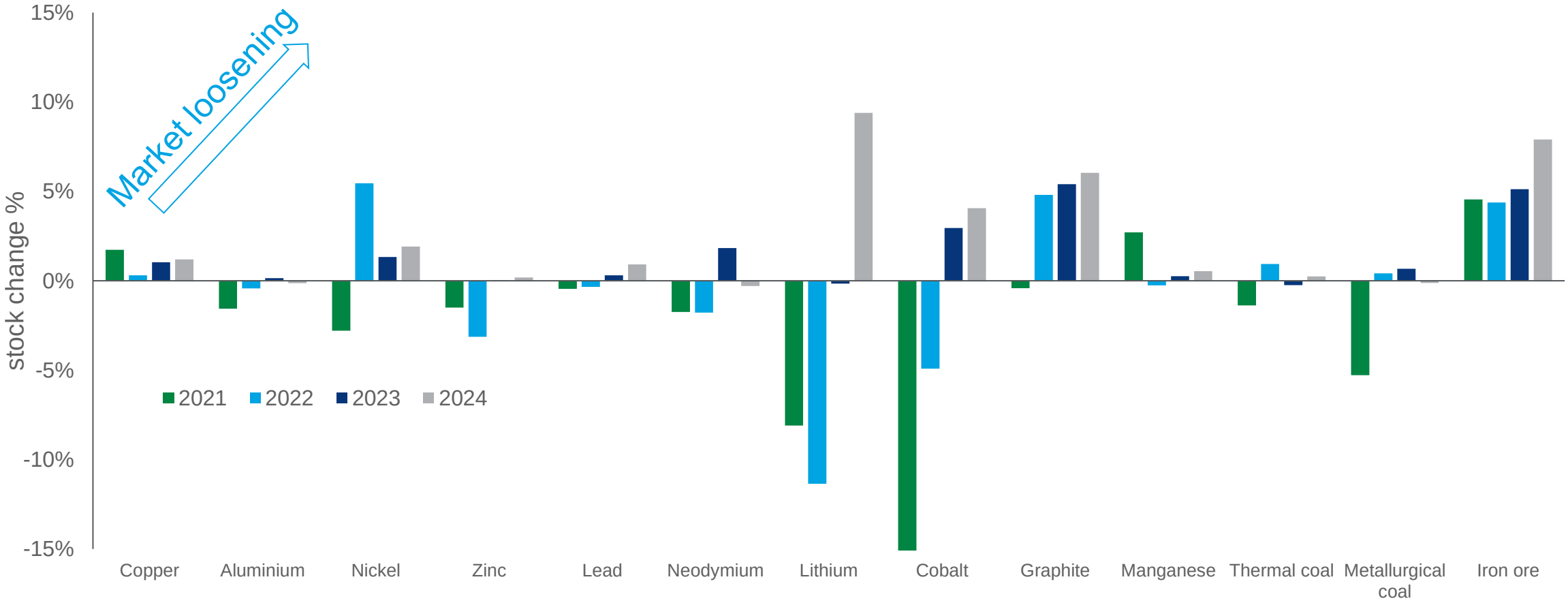
Do market fundamentals support the investment thesis?

Pent up demand, economic recovery, restocking, hoarding and some green growth are supporting demand whilst supply chain issues and Ukraine crisis constrain supply but an economic slowdown looms

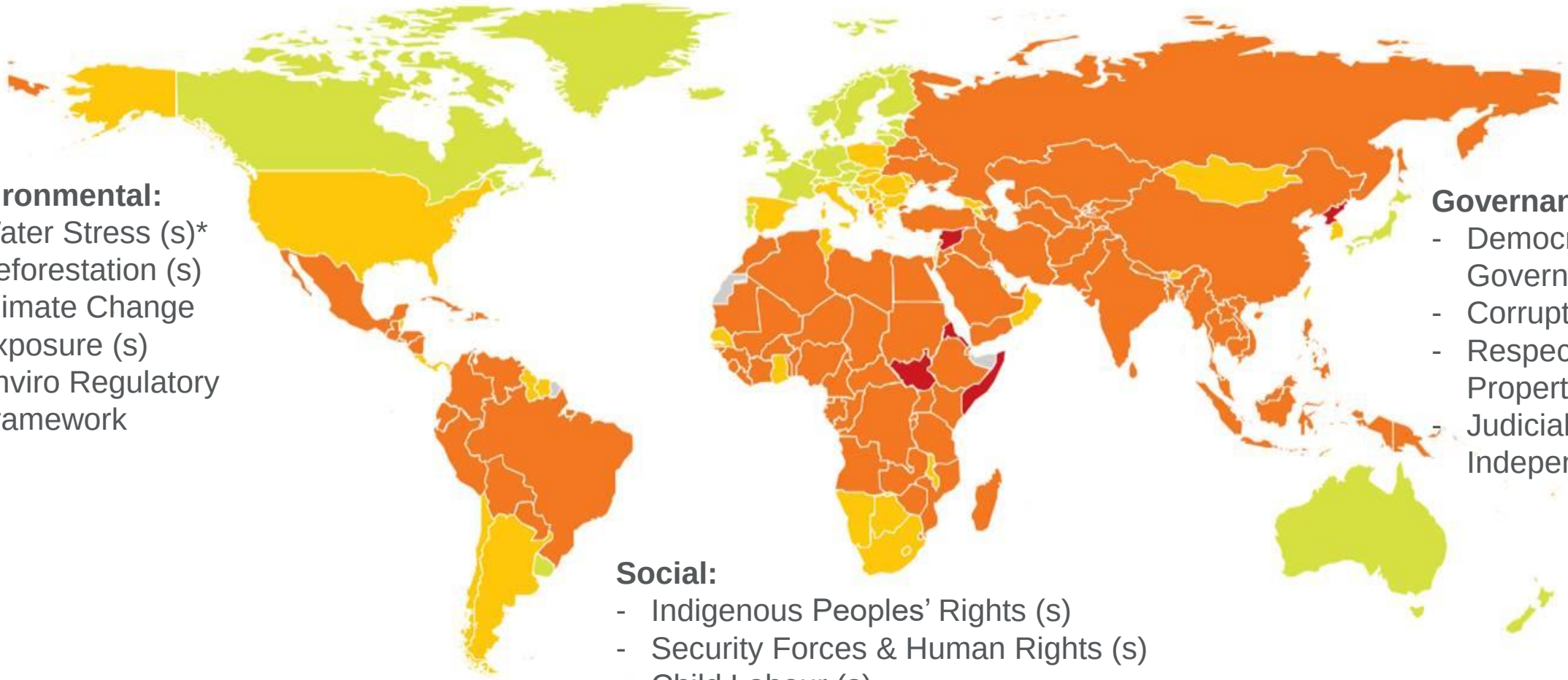
Stock change as a percentage of the market 2021-2023



Source: Wood Mackenzie, July STOs

Meeting future supply requirements will entail investment in countries that exhibit significant ESG risk with longer lead times

Few mining jurisdictions offer low ESG risk opportunities. Resource nationalism on the rise in Latin America and investors are risk averse



Environmental:
- Water Stress (s)*
- Deforestation (s)
- Climate Change Exposure (s)
- Enviro Regulatory Framework

Governance:
- Democratic Governance
- Corruption
- Respect for Property Rights
- Judicial Independence

Social:
- Indigenous Peoples' Rights (s)
- Security Forces & Human Rights (s)
- Child Labour (s)
- Freedom of Association (s)

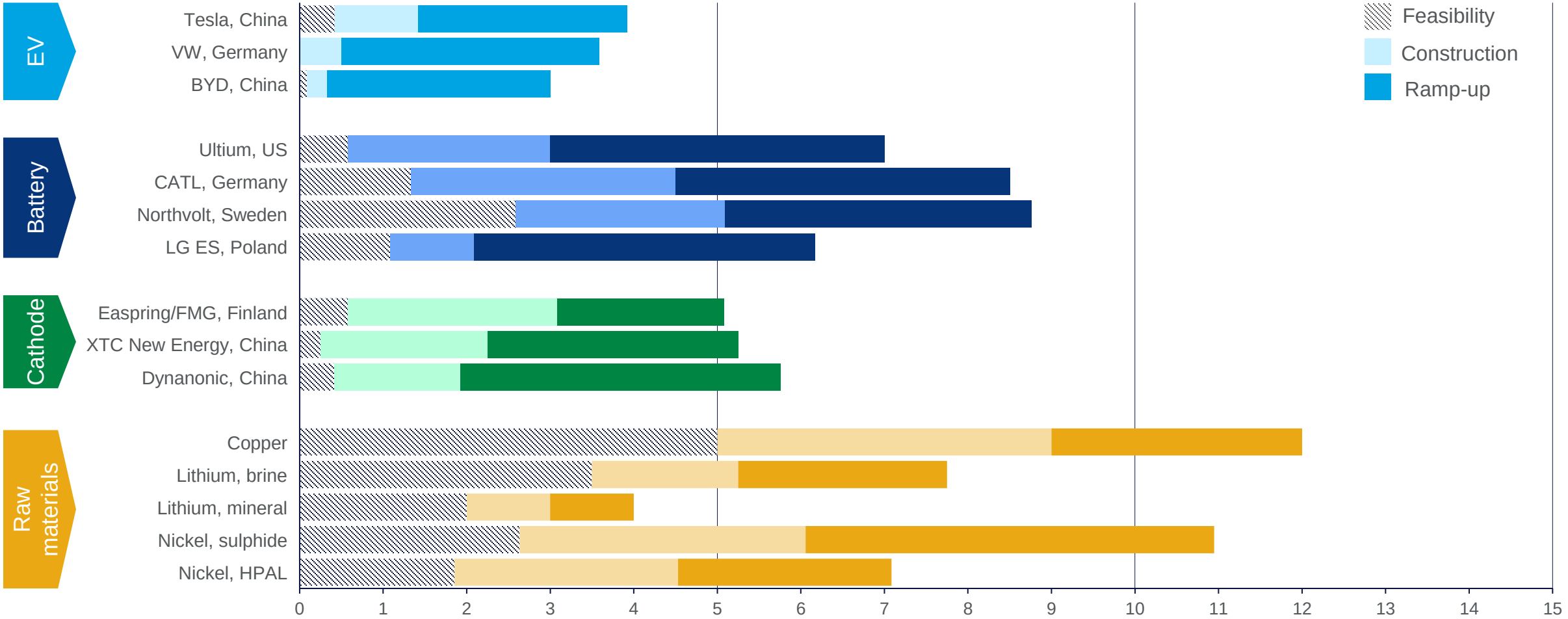
**(s) – subnational*

Source: Verisk Maplecroft, 2022

Time is not on our side

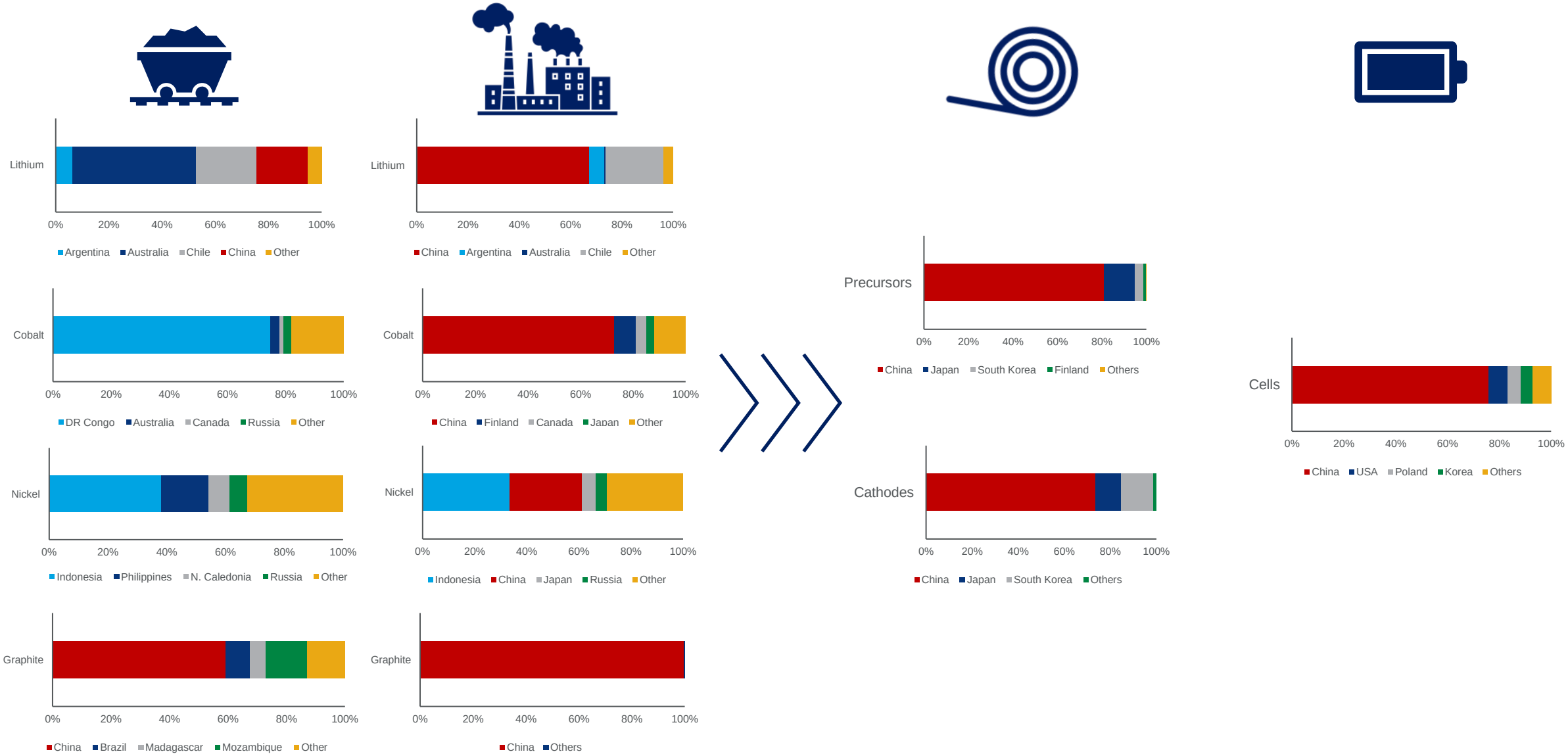
Lead times throughout the supply chain are long

Project lead times



Source: Wood Mackenzie

China Dominates the battery raw material supply chain bringing risks!



Source: Wood Mackenzie

Q&A

Wood Mackenzie

A Verisk Business

Alex Griffiths

Principal Analyst, Metals & Mining – Wood Mackenzie

Biography

Alex has been in the industry since 2007 – both in the pit and at the desk.

Alex joined Wood Mackenzie in 2016. Alex is a metals and mining generalist. He works with buy-side clients, curating data and research specifically for their individual needs. He researches timely and relevant industry topics, has acted as an expert witness and collaborates on consultancy assignments.

Alex has an intimate knowledge of the mining industry having spent seven years working as an onsite resource geologist in outback Australia. Alex has also worked as an iron ore technical marketing consultant for a business intelligence group, and as a teacher of Physics.

Alex holds an MBA from the Australian Institute of Business, a BSc from the University of Liverpool, a Post Graduate Certificate of Geostatistics from Edith Cowan University and a PGCE (Physics) from the University of Leeds.

Alex is an experienced an acknowledged speaker and is regularly quoted by respected media.

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