



Dr. Gavin M. Mudd

UK CMIC, 2024 Criticality Assessment & Technological Foresight Studies

UK Foundation for Science & Technology: Critical Minerals Event
24 February 2024, London



UK Critical Minerals
Intelligence Centre

ukcmic.org



British
Geological
Survey



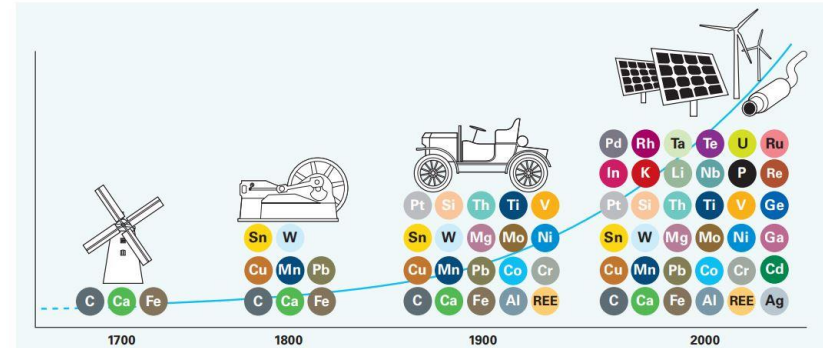
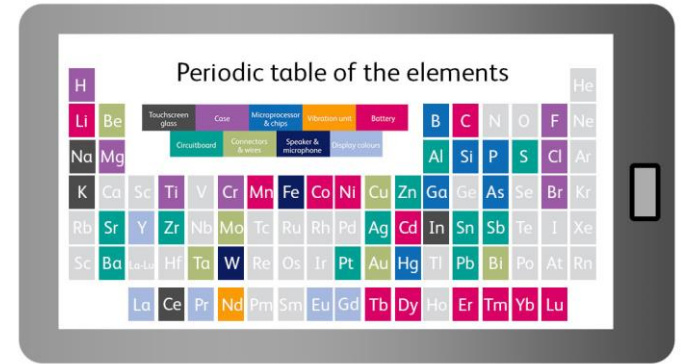
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Aims & objectives

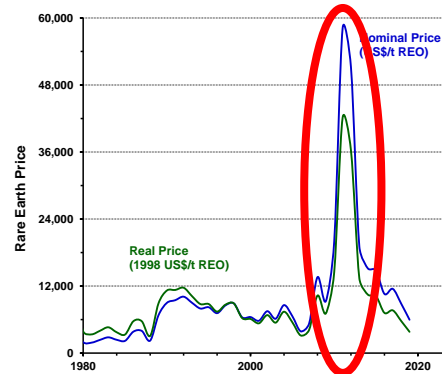
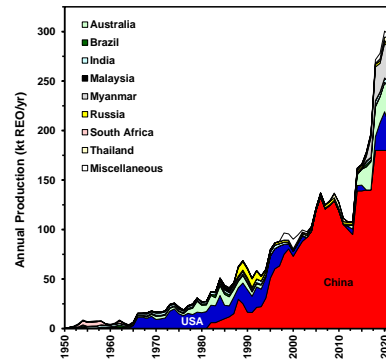
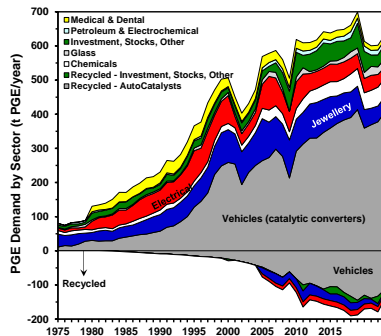
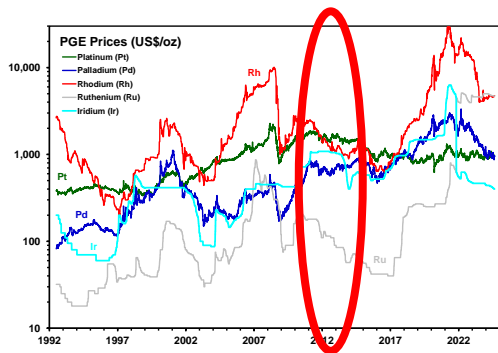
- Support the UK in securing adequate and timely supplies of the critical minerals required to reduce national security risks, achieve transition to net zero, deliver economic prosperity, and create supply chain opportunities for UK businesses;
- By providing authoritative, impartial and independent up-to-date data, information and analysis on supply-demand, stocks and flows of critical minerals essential to the UK economy, inform decision-making by government and industry, including recommendations for targeted interventions;
- CMIC is a key part of the UK Government's approach for Critical Minerals
- **Criticality is essentially risk management for supply-demand & societal objectives (especially around technological choices)**

Mining: Metals, Minerals, Materials, Energy

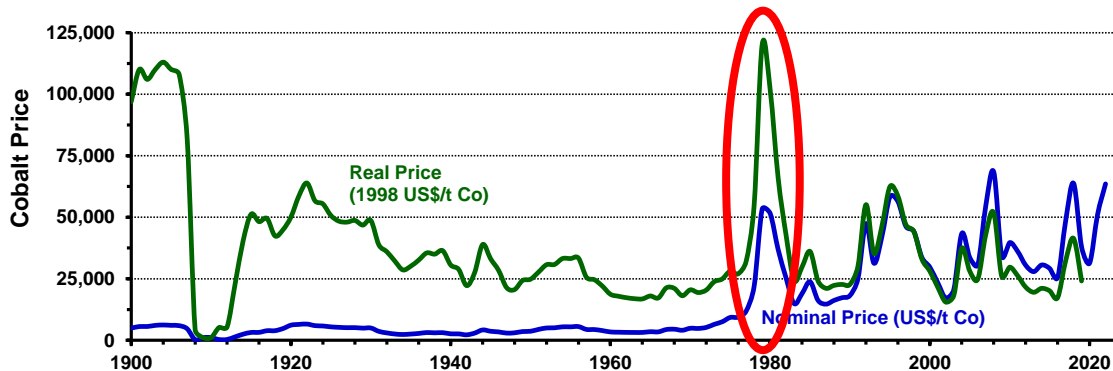
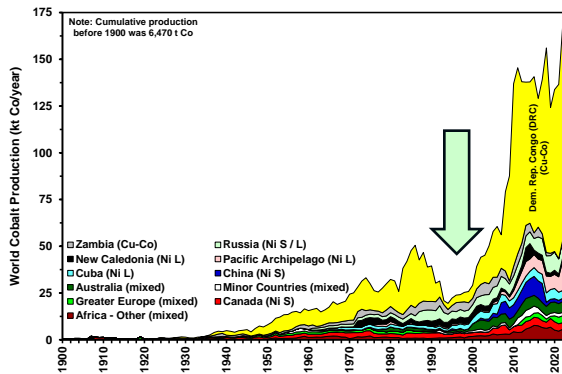
- Modern mining is vast in scale, especially compared to the 'small' mines of Agricola's era
- Society has moved from ~6 key metals to now requiring almost the entire period table of elements
- As world population & development grows, demand for metals, minerals & energy grows & grows
- Climate change is leading to significant changes in the extractives sector – fossil fuels will be phased out, new metals & minerals emerge
- Renewable energy, electric vehicles & energy storage batteries (ETC) are seeing exponential growth – meaning Li, REEs, Ga, Ge, Cd, Te, Ni, graphite, etc.
- But there are real concerns about how we mine, making sure we do it **responsibly**



Critical Minerals: Examples of Risks



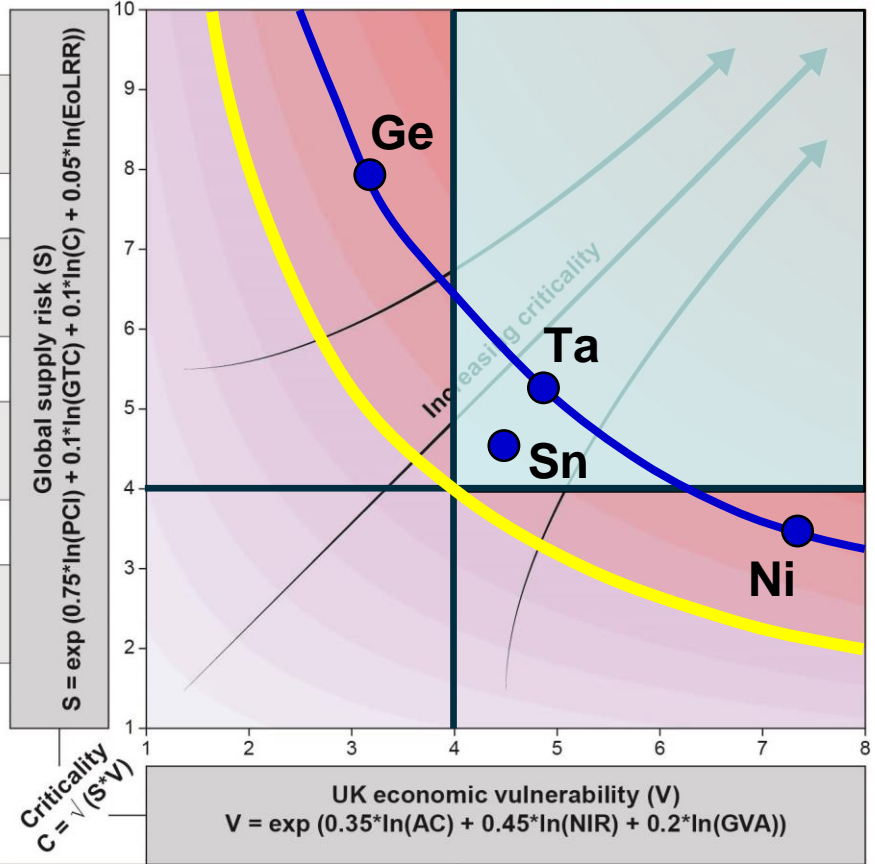
all BGS, USGS, Mudd synthesized data



UK 2024 Criticality Assessment Methodology

- Data synthesized for 2018 to 2022
- Data public domain, objective
- Methodology mostly similar to EU, etc

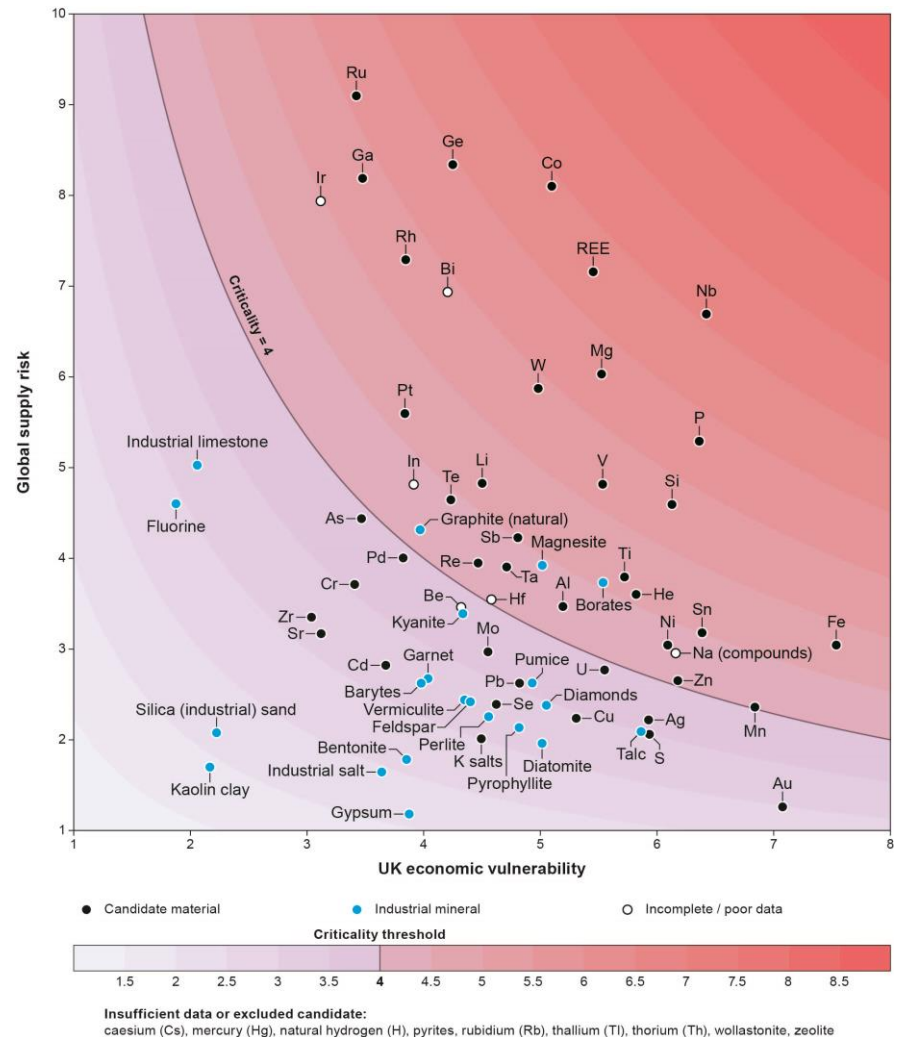
Production concentration (PC) $\sum((\%PS_{1-3}^{5yr})^2 * ESG_{1-3})$
Global trade concentration (GTC) $\sum((\%GTC_{1-3}^{5yr})^2)$
Companionality (C) $C = CMF * \log \sum (co \text{ or byproduct shares}_n)^2$
Recycling rate (EoL-CR) $\sum(\%end_use_{ij} * \%EoL-CR)$



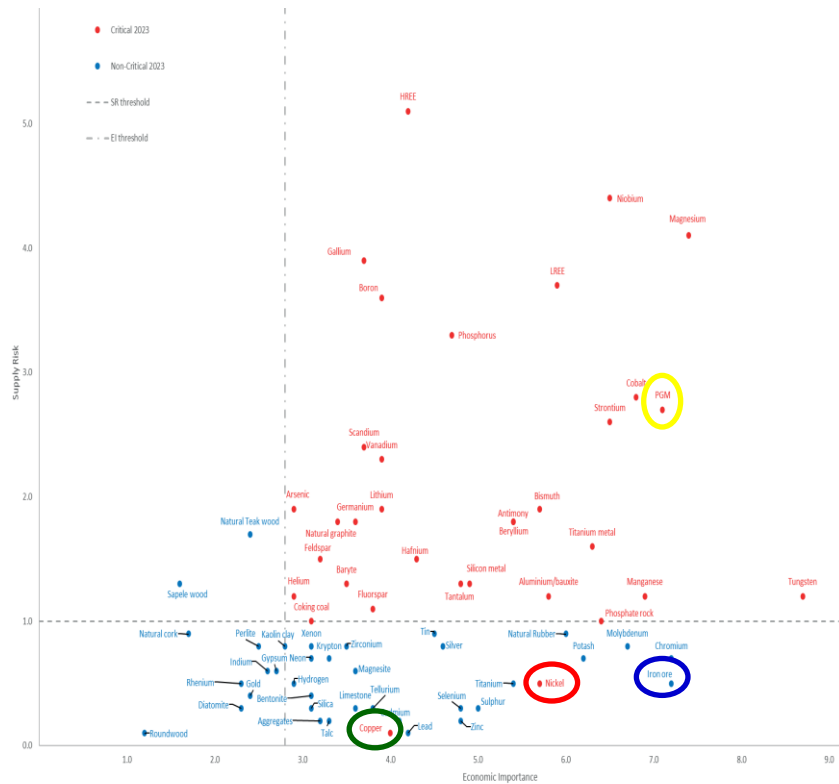
UK apparent consumption (AC) $AC = \sum(prod_{\mathcal{E}} + import_{\mathcal{E}}) - \sum export_{\mathcal{E}}$	UK net import reliance (NIR _{kg}) = $\sum(Import_{kg} - Export_{kg}) / AC_{kg}$	Gross Value Added $GVA = \sum(\%share \text{ of sector}_i * GVA_i)$
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2024 Results

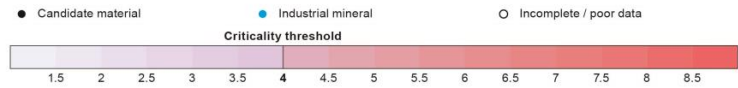
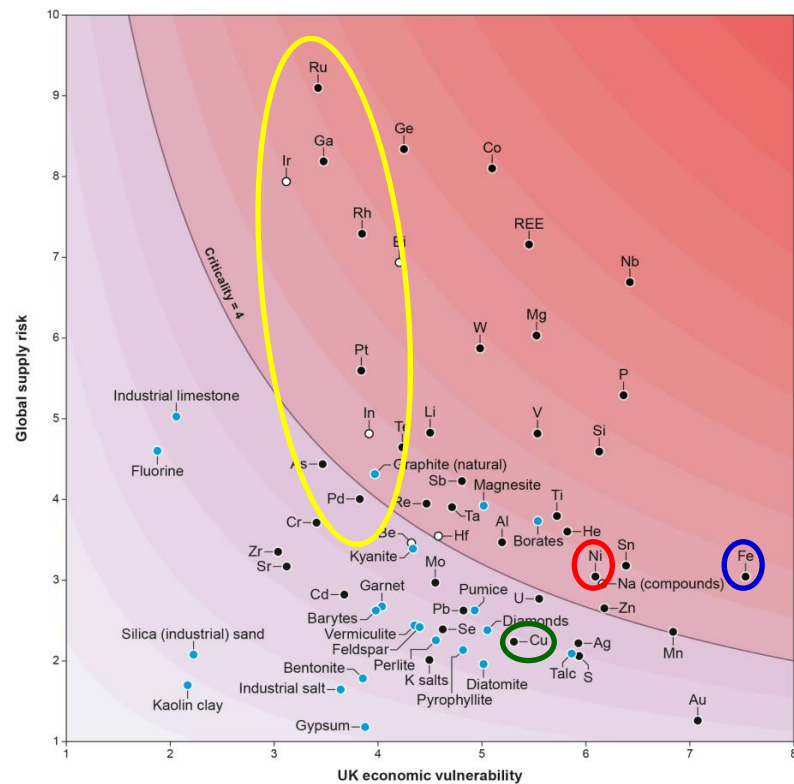
- 34 materials designated as critical minerals
- Most listed are traditional (Li, W, REE, Co, Nb, Ga, Ge, Ta, Te, etc)
- Iron is listed – arguably first time for a national assessment but plots same as EU
- Palladium just below threshold
- Copper is not listed – plots well below threshold, concerns are future supply
- Most industrial minerals plot outside threshold (some are currently mined)



Comparing the UK & EU Critical Minerals Lists



EU 2023 Criticality Study



Insufficient data or excluded candidate: caesium (Cs), mercury (Hg), natural hydrogen (H), pyrites, rubidium (Rb), thallium (Tl), thorium (Th), wollastonite, zeolite

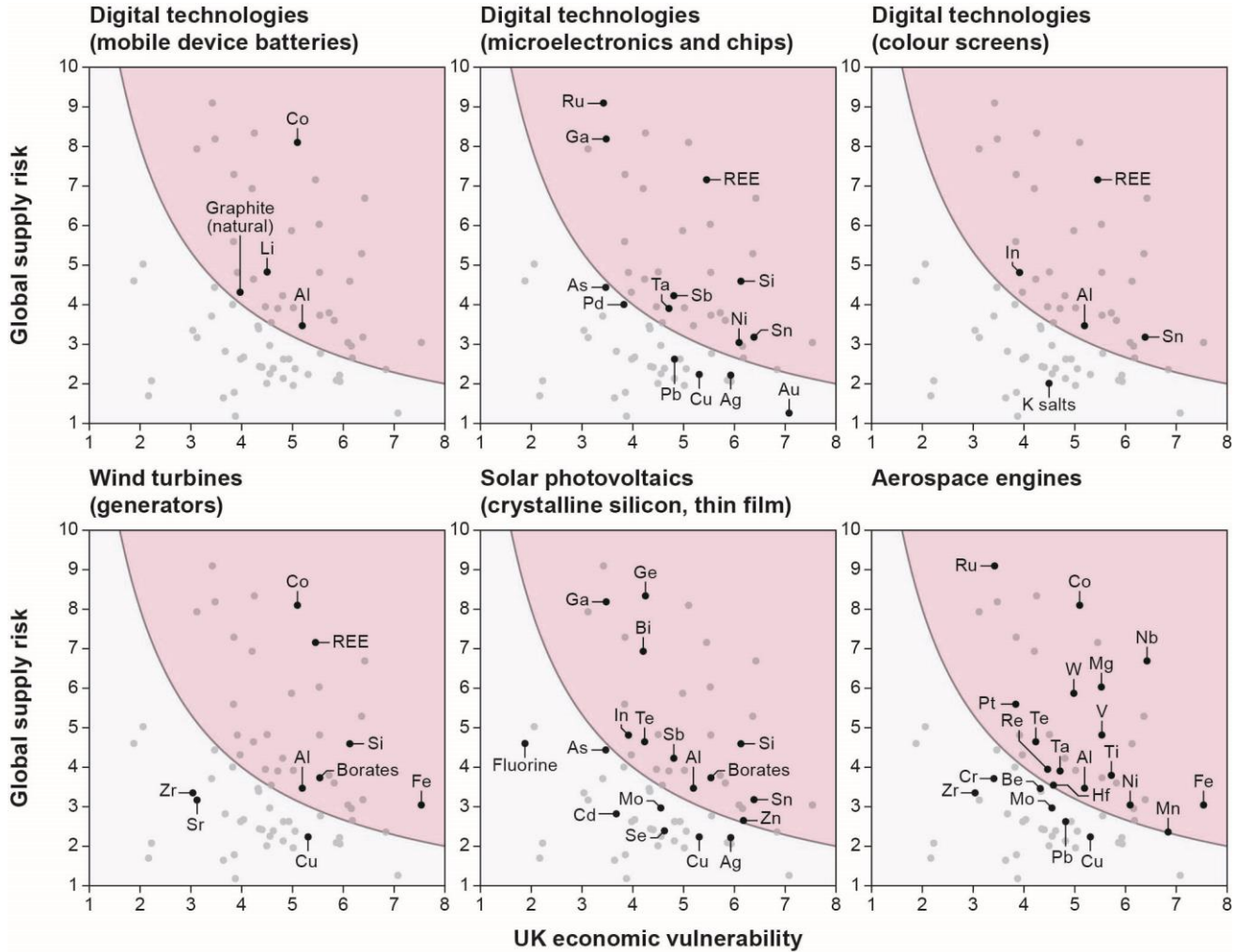


Key Technologies & Materials



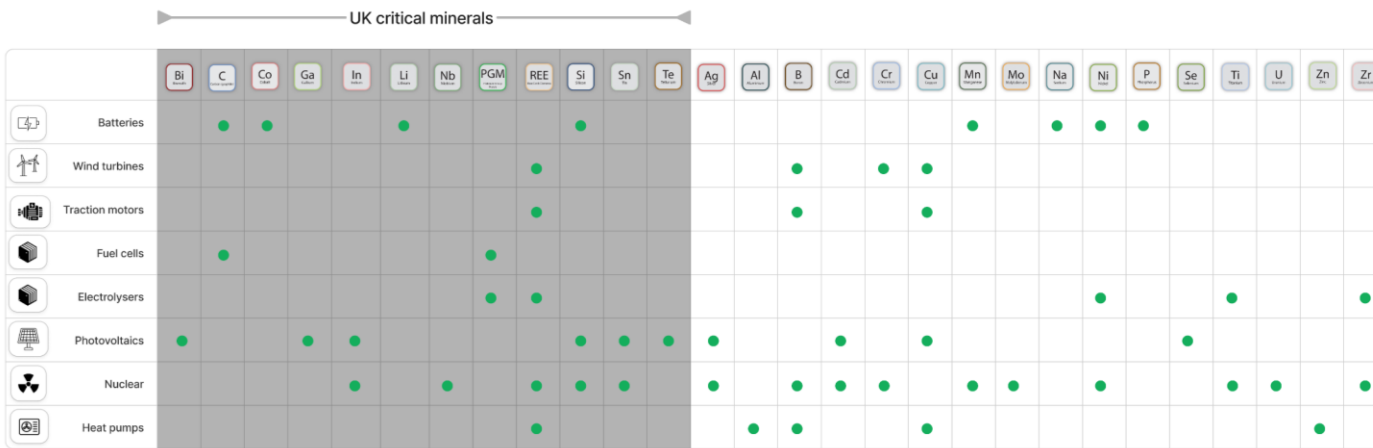
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- Many materials plot above threshold
- Still various materials below threshold too



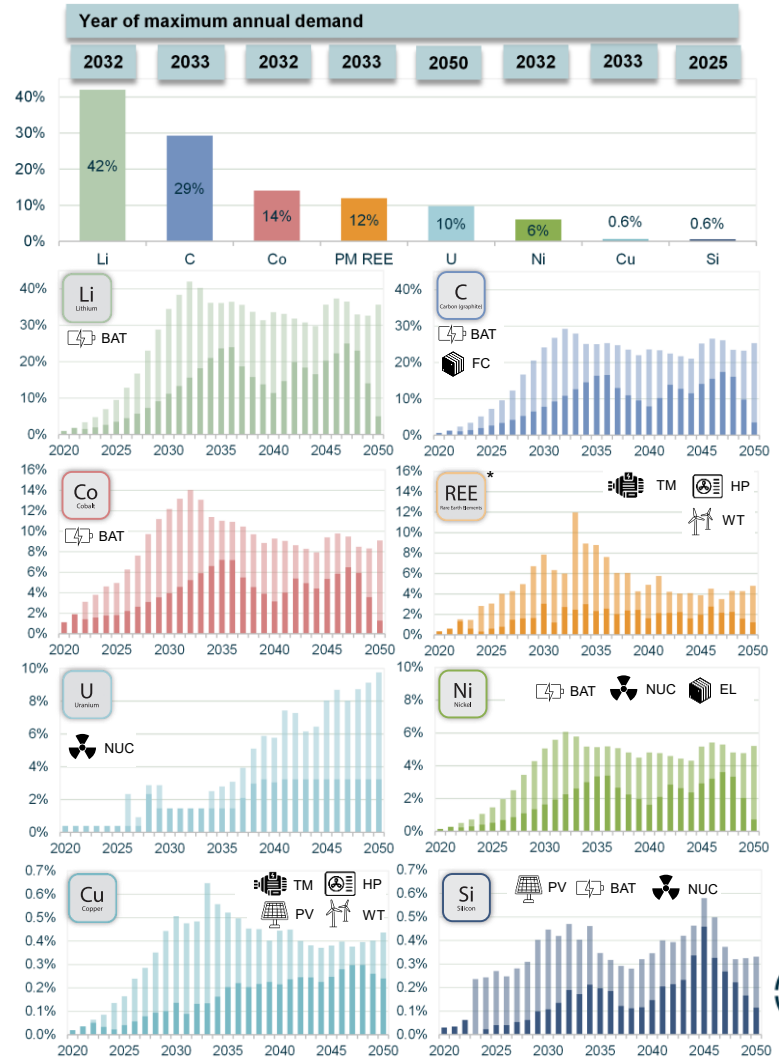
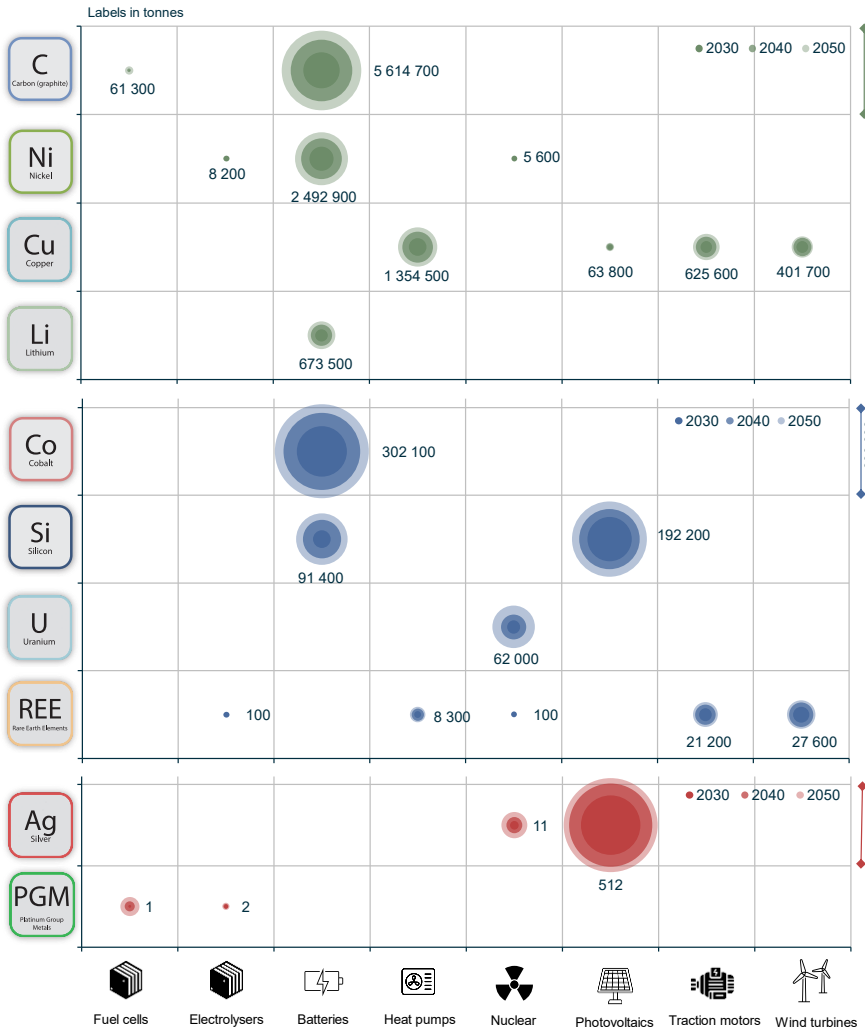
Key Technologies Assessed Through Foresights

Batteries	Wind turbines	Traction motors	Fuel cells	Electrolysers	Photovoltaic	Nuclear	Heat pumps
Lithium-ion batteries (LIB)	Gearbox-Double-fed Induction generator (GB-DFIG)	Permanent magnet synchronous motors (PMSM)	Proton Exchange Membrane (or Polymer electrolyte) fuel cells (PEMFC)	Alkaline electrolysers (AEL)	Passivated emitter and rear contact (PERC)	Pressurised Water Reactors (PWR)	Air-Source Heat Pumps (ASHP)
Sodium ion batteries (SIB)	Gearbox-Permanent Magnet Synchronous Generator (GB-PMSG)	Alternating current induction motors (ACIM)		Proton Exchange Membrane electrolysers (PEM)	Silicon heterojunction (SHJ)	Small Modular Reactors (SMR)	Ground-Source Heat Pumps (GSHP)
	Direct Drive-Permanent Magnet Synchronous Generator (DD-PMSG)	Wound rotor synchronous motors (WRSM)		Solid Oxide electrolysers (SOEC)	CIGS and CdTe thin film cells		
	Direct Drive-External Excitation Synchronous Generator (DD-EESG)			Anion Exchange Membrane electrolysers (AEM)	III-V/Si thin film tandem solar cells		



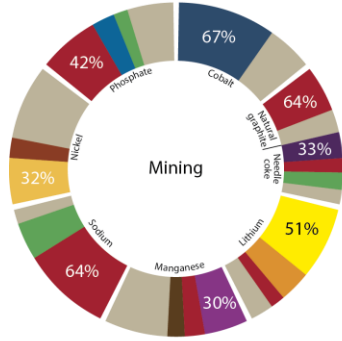
● Elements included in the analysis

Key Foresight Results #1

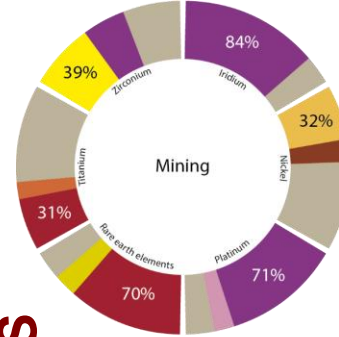
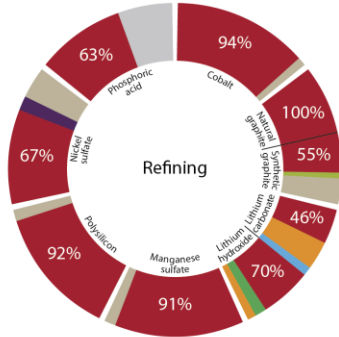


Key Foresight Results #2

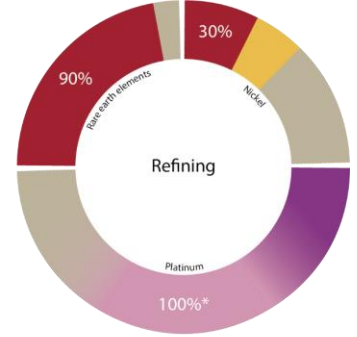
EV BATTERIES



- China
- DR Congo
- Philippines
- Gabon
- Japan
- India
- Morocco
- Indonesia
- USA
- Australia
- Argentina
- Other
- Mozambique
- Chile
- South Africa



- China
- Philippines
- Canada
- Australia
- Myanmar
- Russia
- Indonesia
- South Africa
- Other

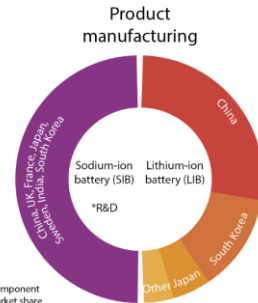


*The segment size of platinum does not depict market share

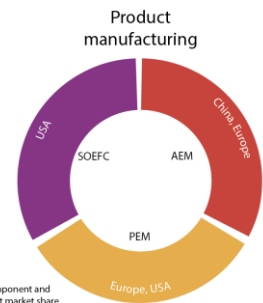
ELECTROLYSERS



Note: segment size of component chart does not depict market share



Note: segment size of component and product charts do not depict market share



Summary

- 2024 criticality assessment is UK's most comprehensive to date - 82 raw materials assessed in detail
- Revised methodology and curve allows better justification of critical minerals
- 34 materials now designated as critical minerals – iron included but not copper and palladium
- Remaining 48 materials remain as a watch list

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Key Areas of Recommendations

- more detailed study of midstream & material flows (esp. secondary flows)
- need better ways to assess trade barriers
- deep dive studies on Cu, Fe, Ta, W plus ICT and/or quantum computing
- need to improve pre-competitive data to boost domestic production potential
- rapid response analyses
- continuing support for all aspects of critical minerals research & development