



CRITICAL METALS AND THEIR ROLE IN THE GREEN ENERGY, TRANSPORTATION AND AI DRIVEN FUTURE

By Rick Van Nieuwenhuyse

NET ZERO BY 2050

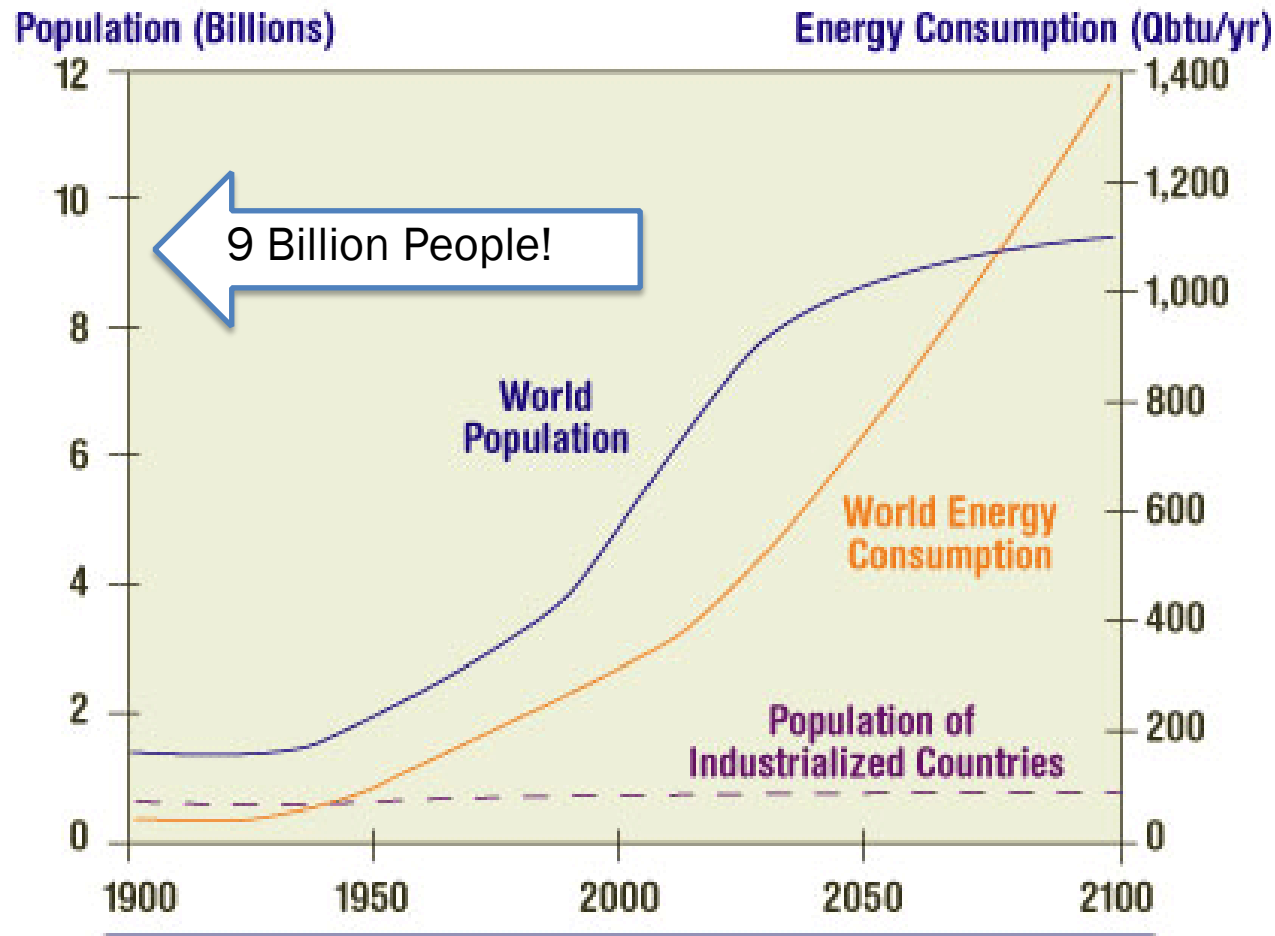
**YOU CAN'T GET
THERE WITHOUT
MINING... LOTS OF
MINING!**

**“YOU CAN AVOID REALITY
BUT YOU CAN'T AVOID
THE CONSEQUENCES OF
AVOIDING REALITY”**

AYN RAND

ENERGY CONSUMPTION KEEPS GOING UP

World Population & Energy Demand Growth



Population Projections: United Nations "Long-Range World Population Projections: Based on the 1998 Revision"
Energy Projections: "Global Energy Perspectives" ITASA / WEC



ENERGY CONSUMPTION KEEPS GOING UP

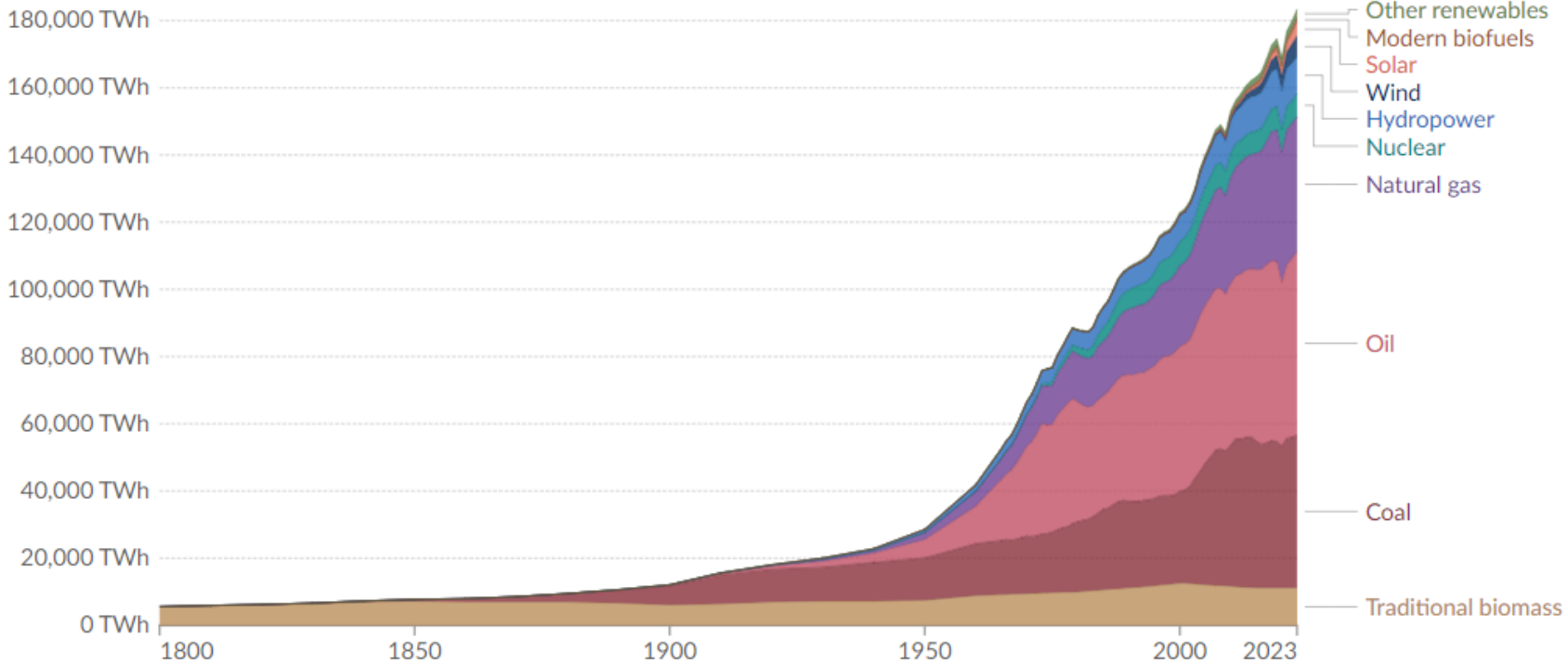
Global primary energy consumption by source

Primary energy is based on the substitution method and measured in terawatt-hours.

Our World in Data

Table Chart

Settings



1800 2023

Data source: Energy Institute - Statistical Review of World Energy (2024); Smil (2017) - [Learn more about this data](#)

Note: In the absence of more recent data, traditional biomass is assumed constant since 2015.

OurWorldinData.org/energy | CC BY

Download Share Full Screen



Source: theOilDrum.com



TYPES OF NON-CARBON TO AUGMENT ENERGY GENERATION

- Solar
- Wind
- Geothermal
- Hydro
- Hydrogen
- Nuclear



COPPER AS ENERGY

You can't produce or transfer electricity without copper and none of the other metals work without copper!

COPPER USAGE INTENSITY (PER MW CREATED)

Conventional



Wind & Solar



Off-shore Wind



10tons



NONE-CARBON ENERGY = MORE COPPER

THE HYBRID & ELECTRIC VEHICLES

REQUIRE MORE COPPER, COBALT, GRAPHITE, LITHIUM



20 Kg of Copper

80 Kg of Copper

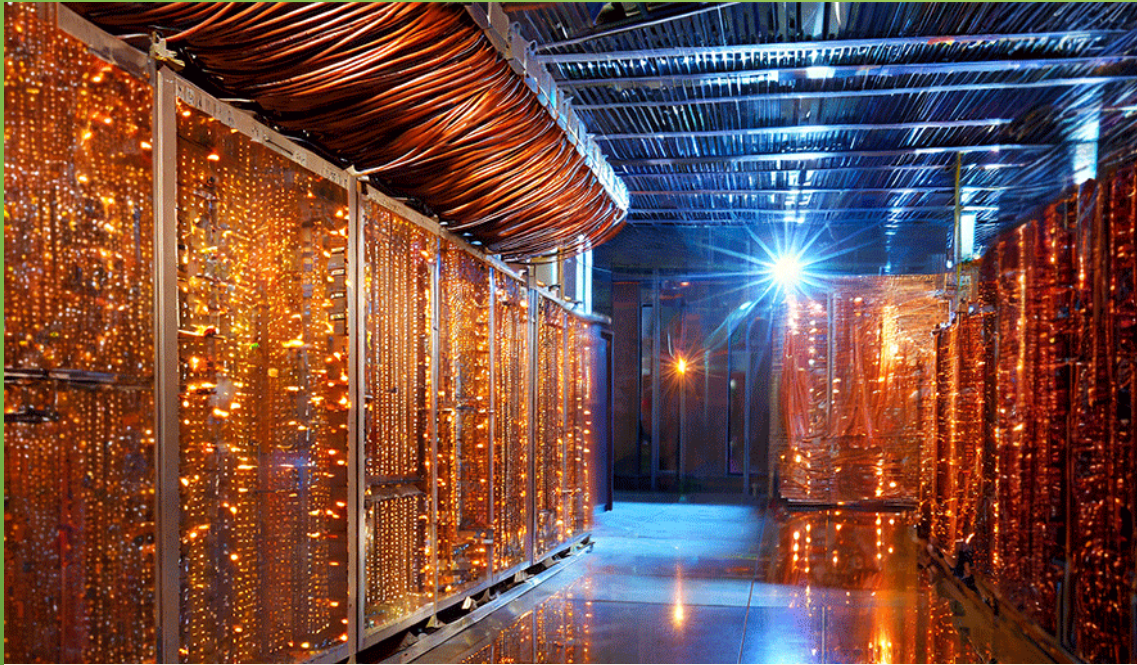
Canada's Suncor CEO sees electric vehicles disrupting oil demand as much as coronavirus, June 2, 2020
The shift to electric vehicles and other low-carbon technologies could disrupt crude oil demand on a similar scale to the coronavirus pandemic, Suncor Energy's chief executive said.

.....and more energy....another 20kg →5X !

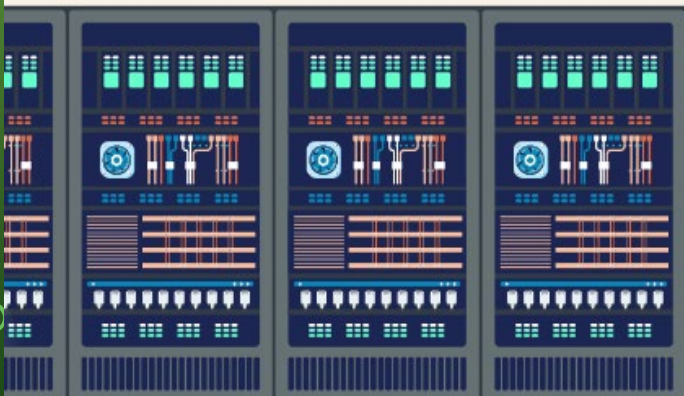


Mach E

THE CRITICAL ROLE OF COPPER IN AI DATA CENTERS



Copper Content of Data Centers



= **27 tonnes**
per MW of applied power

Microsoft's \$500 million data center in Chicago required 2,177 tonnes of copper for its construction.

Source: Data Center Knowledge and CNET

North American Data Center Infrastructure Size 2020-2040P

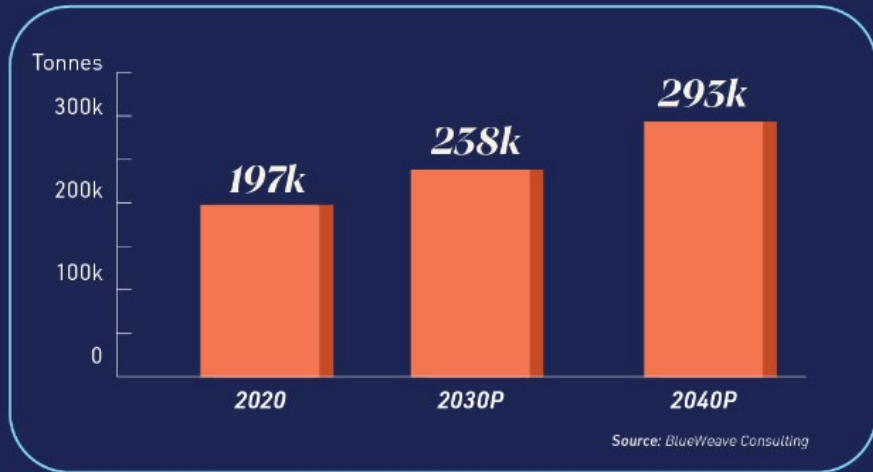
\$33B
2020

\$70B
2030P

\$185B
2040P
9.0% CAGR

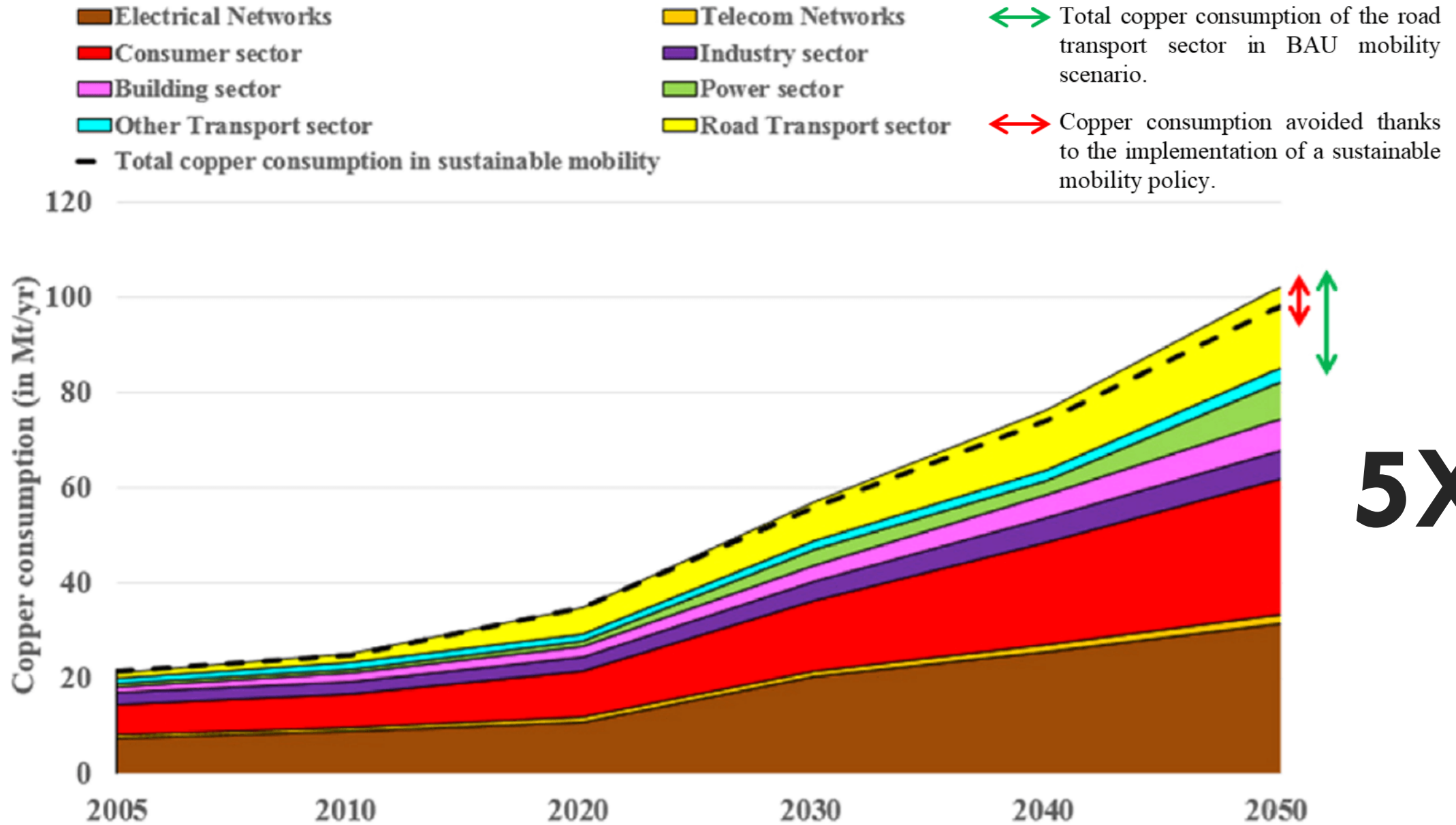
Source: BlueWeave Consulting

Copper Consumption in North American Data Centers 2020-2040P



Copper's ability to maximize the efficiency and reliability of data centers makes it an indispensable material in the modern digital age.

EVOLUTION OF COPPER CONSUMPTION IN A 2°C SCENARIO: IMPACT OF THE TRANSPORT MOBILITY SHIFT



THE VOLUME OF 2050 NET-ZERO COPPER DEMAND

TRANSITION TO ELECTRIC VEHICLES REQUIRES MINING.... A LOT OF MINING!

- To make a single 1000 lbs (1/2 ton) EV battery requires around 500,000 lbs (250 tons) of mined materials

You don't get there without mining
...a lot of mining

- To transition just the ICE vehicle fleet to electric in North America (400 Million vehicles) over the next 30 years will require 200,000,000,000,000 Pounds in mined materials (100 Billion tons) +....Europe...China.....India.....and then there's the Green Energy & AI.....way more than we have mined in human history!....



SOURCE:

<https://www.sciencedirect.com/science/article/pii/S0921344918300041>

<https://www.usgs.gov/faqs/how-much-copper-has-been-found-world>

<https://ea.blob.core.windows.net/assets/fd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf>

ENERGY
— minute —

CAN RECYCLING GET US THERE? **NO!** **THE COPPER EXAMPLE**

- We consume 28 Mt of copper annually (NOW)
- About 32% of that is Recycled Annually (~8.7 Mt/year)
- Copper has a 5 to 30 year product life use
- ➔ We already re-cycle about 80% of the copper in use
NOT A SOLUTION!
- ➔ We should recycle more....incentives and research
NOT BY 2050!

DECEMBER 25, 8AM - 5PM

JOIN THE MOVEMENT

GABRIEL M CURRY 812-649-7700
33 POPLAR CHASE LANE



LET US

RECYCLE

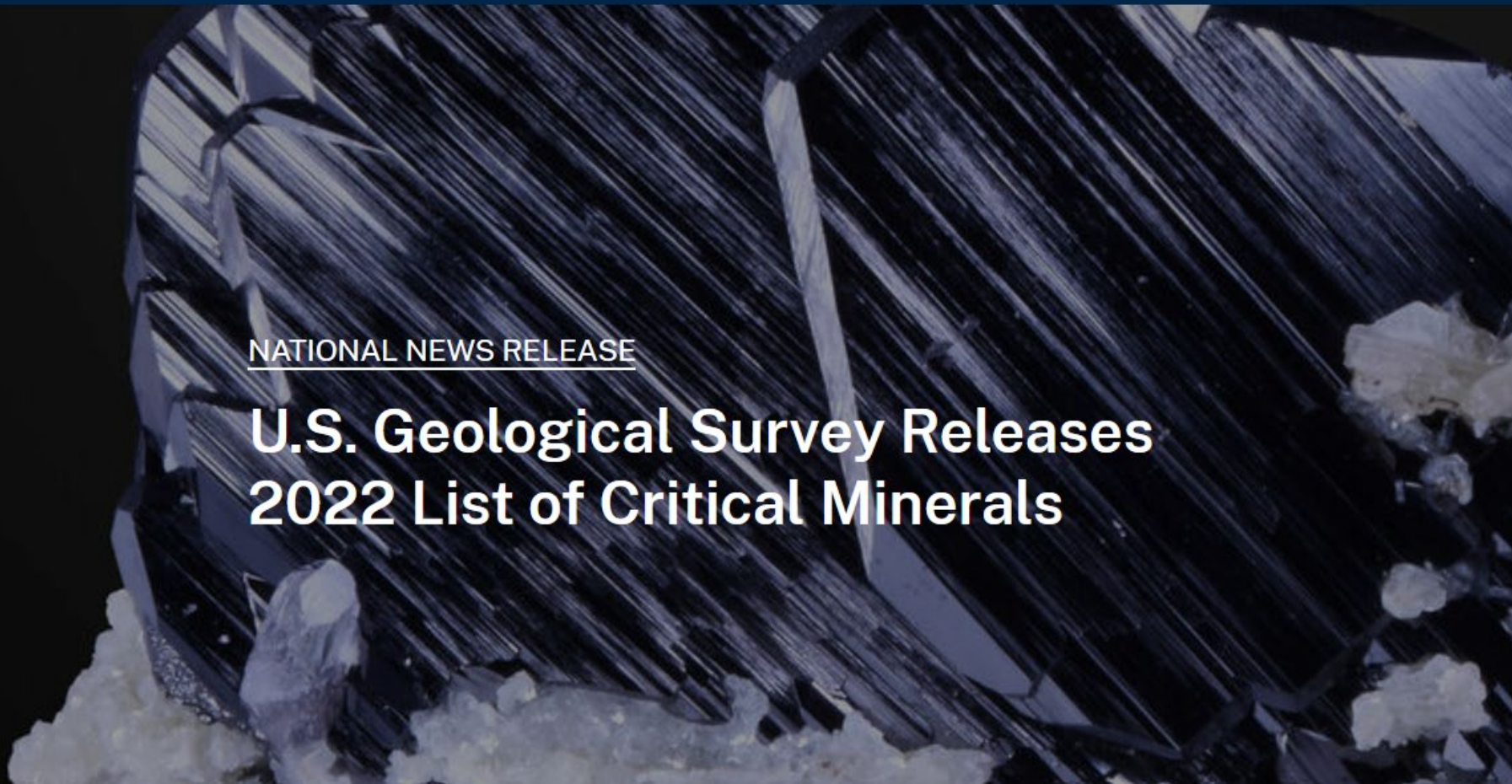
CRITICAL METALS: WHAT ARE THEY AND WHY ARE THEY CRITICAL?



[SCIENCE](#) [PRODUCTS](#) [NEWS](#) [CONNECT](#) [ABOUT](#)

NATIONAL NEWS RELEASE

U.S. Geological Survey Releases 2022 List of Critical Minerals



The Energy Act of 2020 defines a “critical mineral” as a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption. Critical minerals are also characterized as serving an essential function in the manufacturing of a product, the absence of which would have significant consequences for the economy or national security.

50

Periodic table of elements highlighting the “critical minerals”

2022 Critical Mineral																2018 List														
1 H Hydrogen Nonmetal																2 He Helium Noble Gas														
3 Li Lithium Alkali Metal	4 Be Beryllium Alkaline Earth Metal															5 B Boron Metalloid	6 C Carbon Nonmetal	7 N Nitrogen Nonmetal	8 O Oxygen Nonmetal	9 F Fluorine Halogen	10 Ne Neon Noble Gas									
11 Na Sodium Alkali Metal	12 Mg Magnesium Alkaline Earth Metal															13 Al Aluminum Post-Transition Metal	14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas									
19 K Potassium Alkali Metal	20 Ca Calcium Alkaline Earth Metal	21 Sc Scandium Transition Metal	22 Ti Titanium Transition Metal	23 V Vanadium Transition Metal	24 Cr Chromium Transition Metal	25 Mn Manganese Transition Metal	26 Fe Iron Transition Metal	27 Co Cobalt Transition Metal	28 Ni Nickel Transition Metal	29 Cu Copper Transition Metal	30 Zn Zinc Transition Metal	31 Ga Gallium Post-Transition Metal	32 Ge Germanium Metalloid	33 As Arsenic Metalloid	34 Se Selenium Nonmetal	35 Br Bromine Halogen	36 Kr Krypton Noble Gas													
37 Rb Rubidium Alkali Metal	38 Sr Strontium Alkaline Earth Metal	39 Y Yttrium Transition Metal	40 Zr Zirconium Transition Metal	41 Nb Niobium Transition Metal	42 Mo Molybdenum Transition Metal	43 Tc Technetium Transition Metal	44 Ru Ruthenium Transition Metal	45 Rh Rhodium Transition Metal	46 Pd Palladium Transition Metal	47 Ag Silver Transition Metal	48 Cd Cadmium Transition Metal	49 In Indium Post-Transition Metal	50 Sn Tin Post-Transition Metal	51 Sb Antimony Metalloid	52 Te Tellurium Metalloid	53 I Iodine Halogen	54 Xe Xenon Noble Gas													
55 Cs Cesium Alkali Metal	56 Ba Barium Alkaline Earth Metal															72 Hf Hafnium Transition Metal	73 Ta Tantalum Transition Metal	74 W Tungsten Transition Metal	75 Re Rhenium Transition Metal	76 Os Osmium Transition Metal	77 Ir Iridium Transition Metal	78 Pt Platinum Transition Metal	79 Au Gold Transition Metal	80 Hg Mercury Transition Metal	81 Tl Thallium Post-Transition Metal	82 Pb Lead Post-Transition Metal	83 Bi Bismuth Post-Transition Metal	84 Po Polonium Metalloid	85 At Astatine Halogen	86 Rn Radon Noble Gas
87 Fr Francium Alkali Metal	88 Ra Radium Alkaline Earth Metal															104 Rf Rutherfordium Transition Metal	105 Db Dubnium Transition Metal	106 Sg Seaborgium Transition Metal	107 Bh Bohrium Transition Metal	108 Hs Hassium Transition Metal	109 Mt Meitnerium Transition Metal	110 Ds Darmstadtium Transition Metal	111 Rg Roentgenium Transition Metal	112 Cn Copernicium Transition Metal	113 Nh Nihonium Post-Transition Metal	114 Fl Flerovium Post-Transition Metal	115 Mc Moscovium Post-Transition Metal	116 Lv Livermorium Post-Transition Metal	117 Ts Tennessine Halogen	118 Og Oganesson Noble Gas
		*														57 La Lanthanum Lanthanide	58 Ce Cerium Lanthanide	59 Pr Praseodymium Lanthanide	60 Nd Neodymium Lanthanide	61 Pm Promethium Lanthanide	62 Sm Samarium Lanthanide	63 Eu Europium Lanthanide	64 Gd Gadolinium Lanthanide	65 Tb Terbium Lanthanide	66 Dy Dysprosium Lanthanide	67 Ho Holmium Lanthanide	68 Er Erbium Lanthanide	69 Tm Thulium Lanthanide	70 Yb Ytterbium Lanthanide	71 Lu Lutetium Lanthanide
		**														89 Ac Actinium Actinide	90 Th Thorium Actinide	91 Pa Protactinium Actinide	92 U Uranium Actinide	93 Np Neptunium Actinide	94 Pu Plutonium Actinide	95 Am Americium Actinide	96 Cm Curium Actinide	97 Bk Berkelium Actinide	98 Cf Californium Actinide	99 Es Einsteinium Actinide	100 Fm Fermium Actinide	101 Md Mendelevium Actinide	102 No Nobelium Actinide	103 Lr Lawrencium Actinide

The 2022 US list of critical minerals

 Aluminum	used in almost all sectors of the economy	 Magnesium	used as an alloy and for reducing metals
 Antimony	used in lead-acid batteries and flame retardants	 Manganese	used in steelmaking and batteries
 Arsenic	used in semi-conductors	 Neodymium	used in permanent magnets, rubber catalysts, and in medical and industrial lasers
 Barite	used in hydrocarbon production	 Nickel	used to make stainless steel, superalloys, and rechargeable batteries
 Beryllium	used as an alloying agent in aerospace and defense industries	 Niobium	used mostly in steel and superalloys
 Bismuth	used in medical and atomic research	 Palladium	used in catalytic converters and as a catalyst agent
 Cerium	used in catalytic converters, ceramics, glass, metallurgy, and polishing compounds	 Platinum	used in catalytic converters
 Cesium	used in research and development	 Praseodymium	used in permanent magnets, batteries, aerospace alloys, ceramics, and colorants
 Chromium	used primarily in stainless steel and other alloys	 Rhodium	used in catalytic converters, electrical components, and as a catalyst
 Cobalt	used in rechargeable batteries and superalloys	 Rubidium	used for research and development in electronics
 Dysprosium	used in permanent magnets, data storage devices, and lasers	 Ruthenium	used as catalysts, as well as electrical contacts and chip resistors in computers
 Erbium	used in fiber optics, optical amplifiers, lasers, and glass colorants	 Samarium	used in permanent magnets, as an absorber in nuclear reactors, and in cancer treatments
 Europium	used in phosphors and nuclear control rods	 Scandium	used for alloys, ceramics, and fuel cells
 Fluorspar	used in the manufacture of aluminum, cement, steel, gasoline, and fluorine chemicals	 Tantalum	used in electronic components, mostly capacitors and in superalloys
 Gadolinium	used in medical imaging, permanent magnets, and steelmaking	 Tellurium	used in solar cells, thermoelectric devices, and as alloying additive
 Gallium	used for integrated circuits and optical devices like LEDs	 Terbium	used in permanent magnets, fiber optics, lasers, and solid-state devices
 Germanium	used for fiber optics and night vision applications	 Thulium	used in various metal alloys and in lasers
 Graphite	used for lubricants, batteries, and fuel cells	 Tin	used as protective coatings and alloys for steel
 Hafnium	used for nuclear control rods, alloys, and high-temperature ceramics	 Titanium	used as a white pigment or metal alloys
 Holmium	used in permanent magnets, nuclear control rods, and lasers	 Tungsten	primarily used to make wear-resistant metals
 Indium	used in liquid crystal display screens	 Vanadium	primarily used as alloying agent for iron and steel
 Iridium	used as coating of anodes for electrochemical processes and as a chemical catalyst	 Ytterbium	used for catalysts, scintillometers, lasers, and metallurgy
 Lanthanum	used to produce catalysts, ceramics, glass, polishing compounds, metallurgy, and batteries	 Yttrium	used for ceramic, catalysts, lasers, metallurgy, and phosphors
 Lithium	used for rechargeable batteries	 Zinc	primarily used in metallurgy to produce galvanized steel
 Lutetium	used in scintillators for medical imaging, electronics, and some cancer therapies	 Zirconium	used in the high-temperature ceramics and corrosion-resistant alloys

Source: United States Geological Survey.

July 2022

USGS OFFICIAL CRITICAL METALS LIST

WHAT'S MISSING?

COPPER AND SILVER – TWO OF THE MOST CRITICAL METALS ...SILVER KEY FOR SOLAR PANELS AND NONE OF THE OTHER METALS WORK WITHOUT COPPER!

-  Mined for Primary Metal
-  Mined as By-Product Metal
-  Mined as Co-Product Metal
-  Mined as Co-Product - Platinum Group Metals
-  Rare Earth Metals

- ➔ Many Critical metals are mined as By/Co-Products
- ➔ We need Smelters/Hydrometallurgical facilities!
- ➔ Mining & Refining + Research for new technologies

WHAT MAKES THEM “CRITICAL”?



THE GOOD THE BAD and THE UGLY

PLAY CHAPTERS BONUS SUBTITLES AUDIO

How did they become critical?

→ Clean Air Act - 1970

→ Clean Water Act - 1972

→ 50 years of Anti-mining movement

→ Permitting Challenges

What's changed recently?

Why the rush now?

What's all the fuss about?



GLOBAL POLITICS....THESE GUYS!

BRICS

July 9, 2009 in Yekaterinsburg, Russia

Established to challenge the dollar as an exchange currency and eventually as a reserve currency.....consequences?



Meeting in Kazan, Russia
last week

SANCTIONS PLACED ON RUSSIA BY GOVERNMENTS AROUND THE WORLD

EU



- Targeting '70% of the Russian banking market'
- Export ban on equipment and technology for energy sector
- Freezing assets of Vladimir Putin's inner circle

SOUTH KOREA



- Will join international sanctions but won't consider unilateral sanctions

JAPAN



- Measures targeting exports of semiconductors
- Asset freezes placed on financial institutions
- Suspension of visas for Russian individuals

CANADA



- Sanctions against 58 individuals and entities
- Export permits for goods in aerospace and mining are cancelled

TAIWAN



- Government will 'harshly scrutinise' exports to Russia
- Will 'coordinate closely with US and other like-minded countries'

USA



- Blocking Russia's technology and defence imports
- Sanctions on Russian banks and 'corrupt billionaires'
- Blocking 12 individuals

UK



- Asset freezes on all major Russian banks including against VTB
- Prohibit all major Russian companies from raising funds in City
- Sanctions on 12 individuals

AUSTRALIA



- Sanctions on 25 individuals and four financial institutions
- Targeting entities involved in developing

NEW ZEALAND



- Prohibiting export of goods to the Russian military
- Cutting trade with Russia and imposing travel bans





Brazil-Russia-India-China-South Africa



In 2024, the member countries have expanded to 10 countries.

The five new countries that have joined are Egypt, Ethiopia, Iran, Saudi Arabia and the United Arab Emirates.

Over 40 countries, including Iran, Saudi Arabia, United Arab Emirates, Turkey, Argentina, Algeria, Bolivia, Indonesia, Egypt, Ethiopia, Cuba, Democratic Republic of Congo, Comoros, Gabon, and Kazakhstan have expressed interest in joining the forum, according to 2023 summit chair in South Africa.

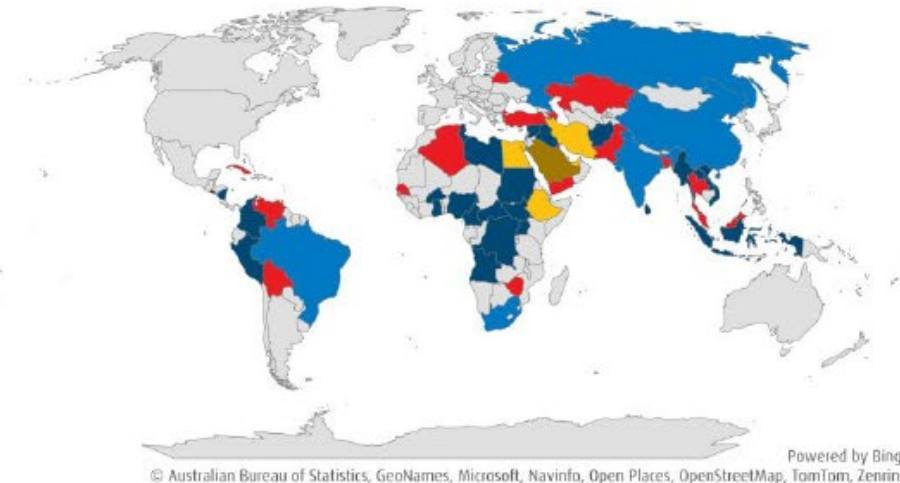
We See the Dedollarisation of Global Trade as an Underappreciated Dynamic, and an Accelerating One



China's trade pivot to emerging markets has been accompanied by increased use of the RMB for trading

BRICS+

- BRICS
- Applied for membership
- Officially invited to join
- New members
- Expressed interest in joining



The mBridge ledger system has been proposed as the trade settlement platform for an expanded BRICS bloc

WHAT ARE WE
DOING ABOUT
IT?

Critical Minerals the U.S. Needs China For

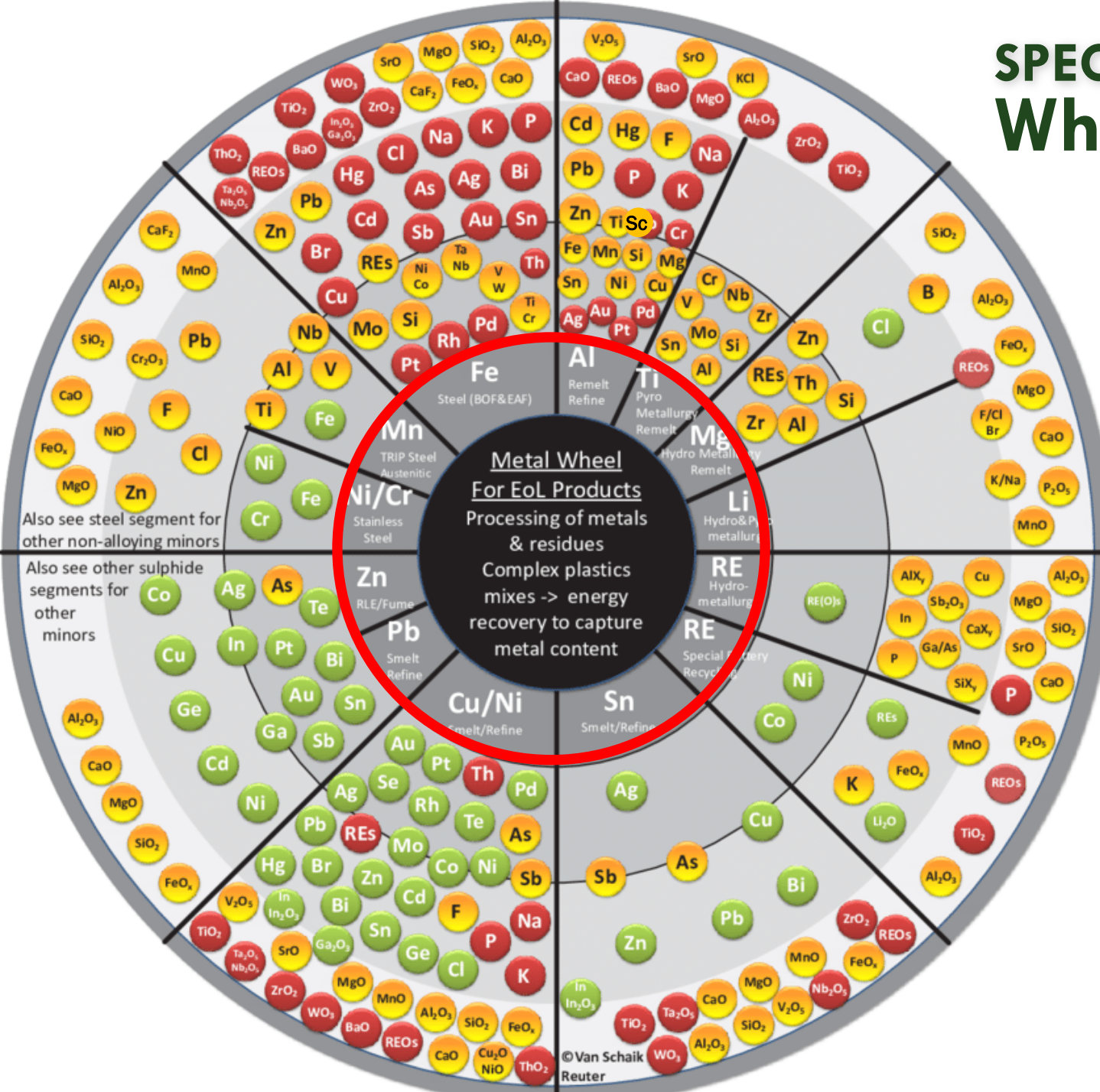


China's share of U.S. imports is based on average imports over 2018 to 2021.
Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2023, 21.



SPECIALTY/CRITICAL = BY-PRODUCTS

What metals do we mine?



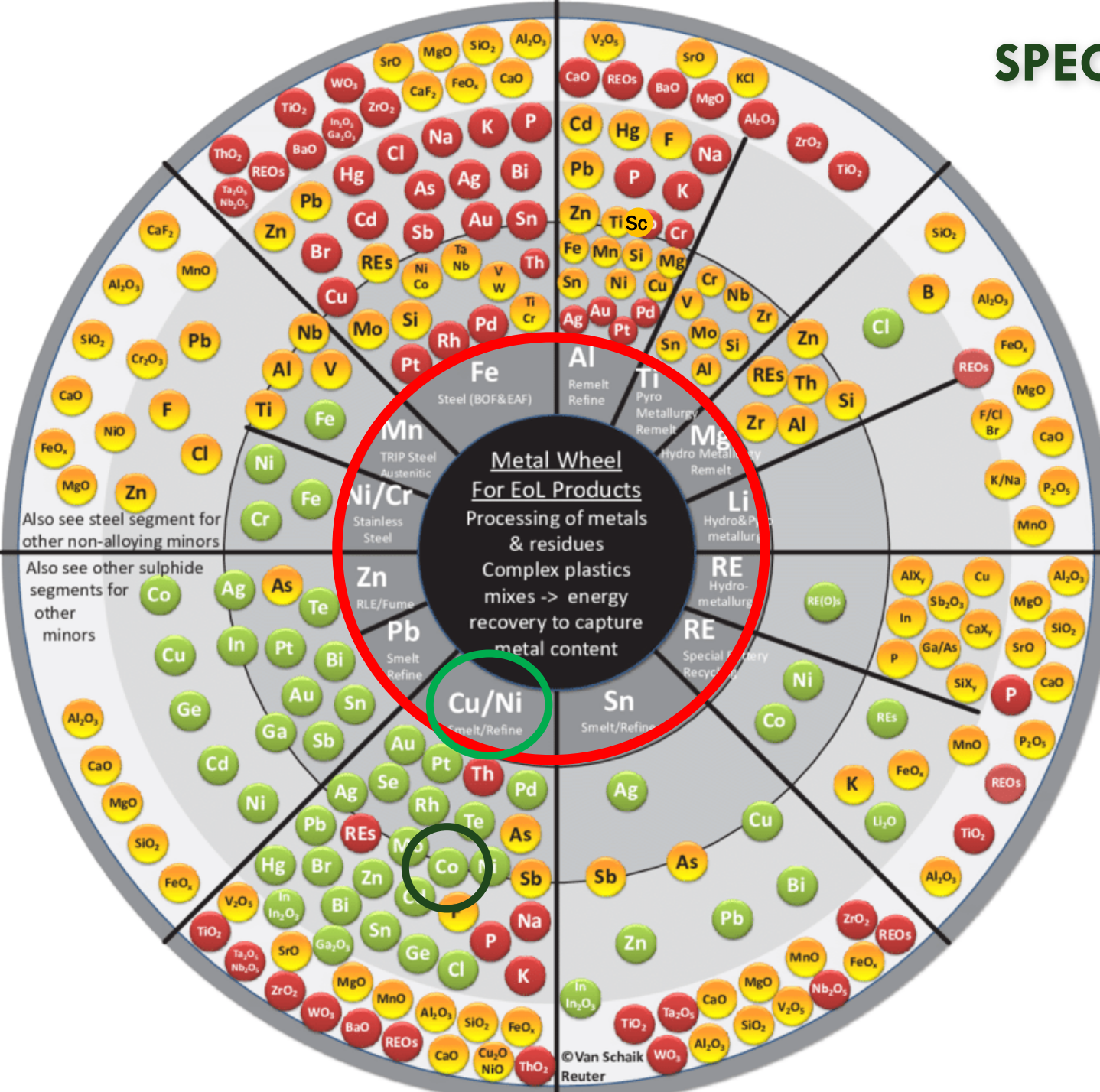
Economically viable destinations of complex EoL designed functional material combinations, scrap, residues etc. to metallurgical processing infrastructure (each segment) to produce refined metal, compounds and alloys in best available technology

- Circular Economy's carrier metals processing infrastructure**
Extractive Metallurgy's Backbone, the enablers of a Circular Economy (CE) as it also recovers technology elements used e.g. in renewable energy infrastructure, IoT, eMobility etc.
- Dissolves mainly in carrier metal if metallic (mainly pyrometallurgy)**
Valuable elements recovered from these or (dissipative) lost (metallic, speiss, compounds, alloy in EoL also determines destination as also the metallurgical conditions in flowsheet).
- Compounds mainly to dust, slime, speiss (mainly hydrometallurgy)**
Collector of valuable minor elements as oxides/sulphates/chlorides etc. and mainly recovered in appropriate metallurgical infrastructure if economical.
- Mainly to benign lower value building material products**
Relatively lower value but inevitable part of society and materials processing. A sink for metals and loss from the CE system as oxides/ compounds. Dissipative losses.

- A** **Mainly recovered element**
Compatible with Carrier Metal as alloying Element or can be recovered in subsequent Processing.
- B** **Mainly element in alloy/compound, lost if in incorrect stream/scrap/module**
With possible functionality, not detrimental to Carrier Metal or product (if refractory metals in EoL product report to slag / slag also intermediate product for cement etc.).
- C** **Mainly element lost, not always compatible with carrier metal or product**
Detrimental to properties and cannot be economically recovered e.g. Au dissolved in steel or aluminium will be lost.

Why no Uranium?

SPECIALTY/CRITICAL = BY-PRODUCTS Cobalt



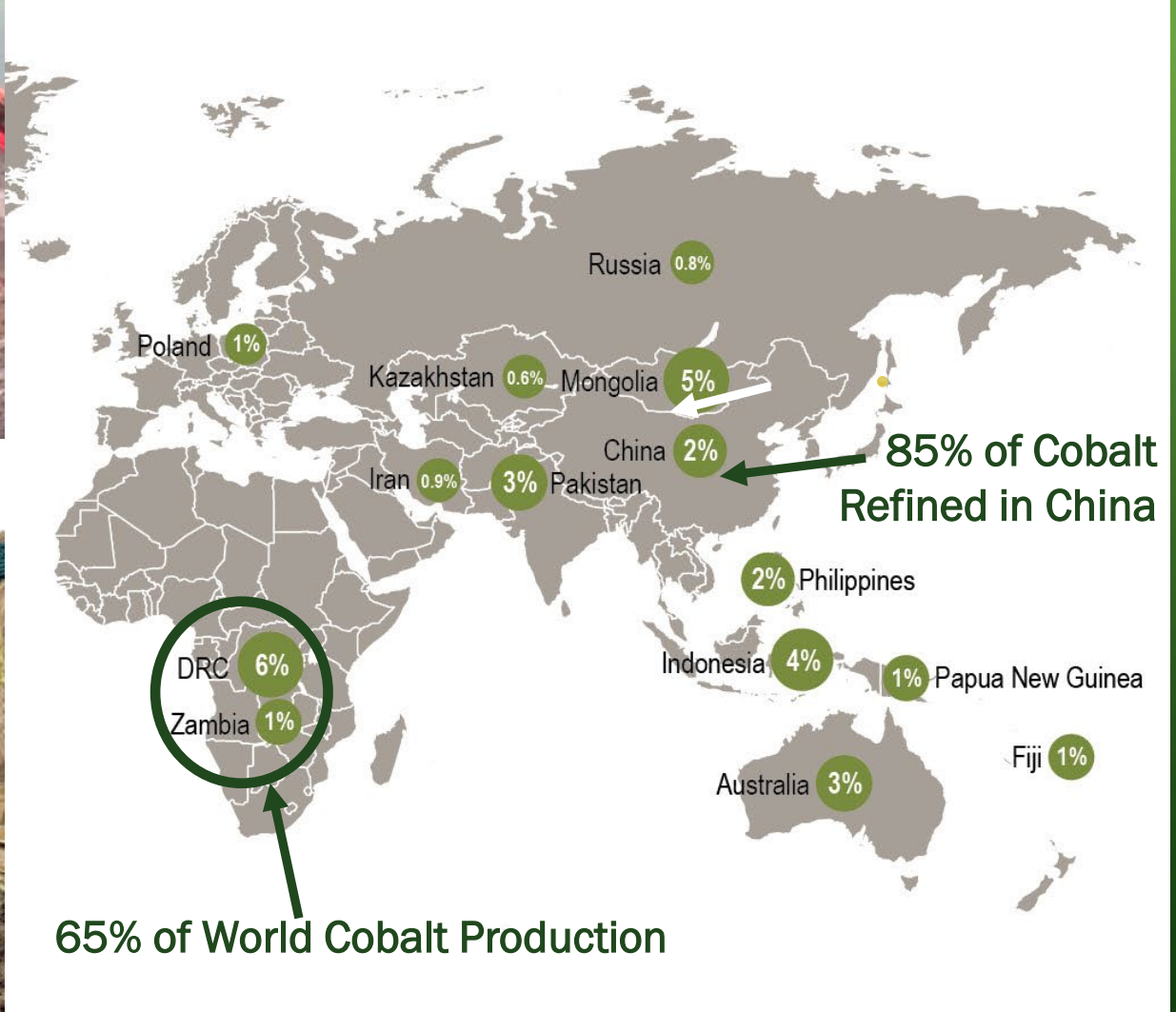
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WORLD COPPER AND COBALT SUPPLY

65% of World Supply of Cobalt is mined in the DRC and 85% is processed in China



BMW – ETHICAL SOURCING OF COBALT

- BMW signed a five-year cobalt supply deal on July 10, 2020 with Moroccan miner Managem worth US\$112 million. Managem owns Bou-Azzer in the Anti Atlas mountains, the only primary cobalt mine in the world and in operation since 1930.
 - BMW says the offtake agreement, covers one-fifth of its requirements for the NCM (nickel-cobalt-manganese) cathodes in its batteries, which together with Tesla's NCA (nickel-cobalt-aluminum) represents more than 90% of the market.
 - The other 80% of the cobalt it needs comes from the Murrin Murrin mine in Australia, a Glencore(LSE: GLEN) owned operation, which makes BMW the only carmaker with a direct to mine raw material sourcing approach.
 - Roskill, a metals, minerals and chemical industry research company, estimates approximately 19.6 kt cobalt will be required and provided for by the two sole suppliers, between 2020 and 2025.
 - Annual cobalt production worldwide is only around 130,000 tonnes, mostly as a byproduct of nickel and copper mining.
 - More than 80% of the chemical processing and refining capacity of cobalt is located in China, which after Glencore, is also the largest cobalt miner inside the DRC.
 - Roskil says a core driver of BMW's direct to mine strategy has been to minimise exposure to DRC cobalt production and also to increase control, transparency and auditability of its cobalt supply.
- Another reason BMW is looking outside central Africa is that much of the DRC's cobalt is already tied up by China.



<https://www.mining.com/cobalt-price-bmw-avoids-the-congo-conundrum-for-now/>

Responsible Cobalt Initiative

Fair Cobalt Alliance



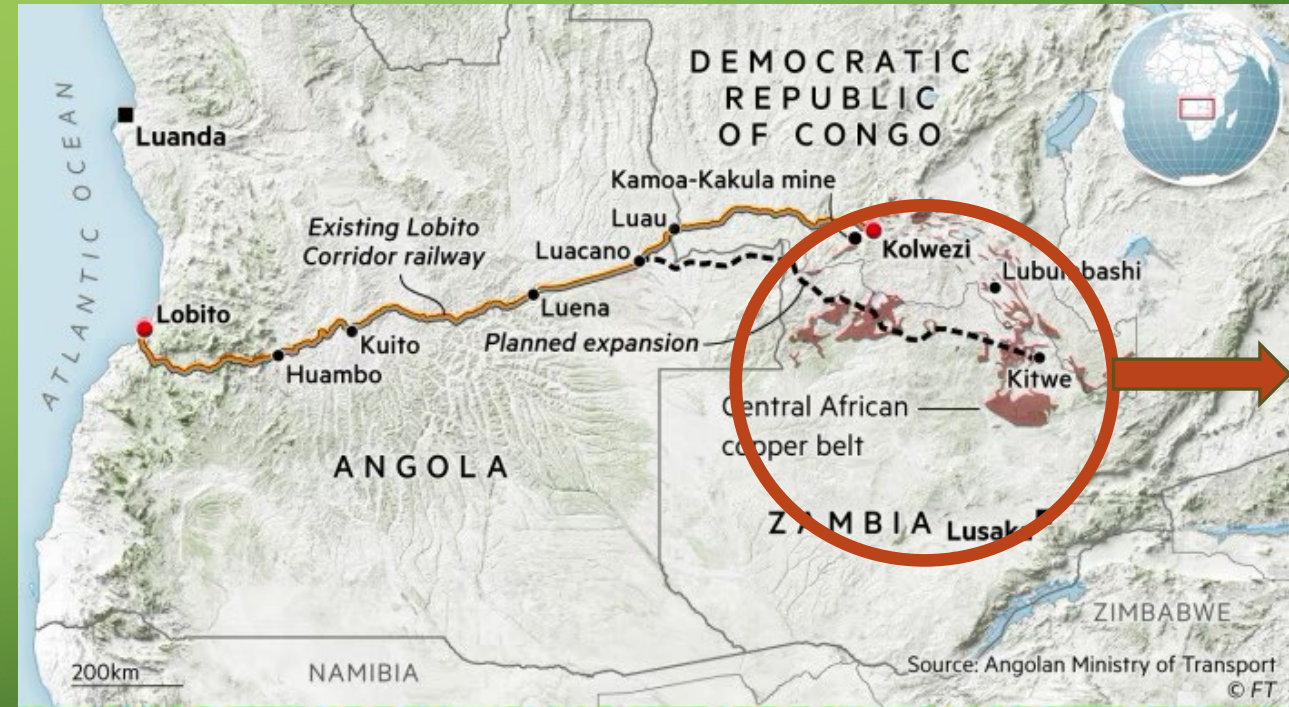
TESLA



US GOVERNMENT COMMITS TO \$100 BILLION INVESTMENT IN INFRASTRUCTURE IN SOUTHERN AFRICA ALONGSIDE OF EUROPE AND SAUDIA ARABIA

Accelerating US-African Partnership – 2022 African Leaders Summit

- The Biden-Harris Administration is over-delivering on our commitment to invest \$55 billion in Africa over three years.
- In May 2023, President Biden chose Africa for the first and flagship economic corridor under his signature \$600 billion Partnership for Global Infrastructure and Investment (PGI) initiative to address the global infrastructure gap. Since December, PGI announced U.S. investments totaling more than \$1.5 billion in the Lobito Corridor for transportation, digital access, agricultural and clean energy infrastructure projects...



Where are the ESG Principles for investing?

Where will the copper and cobalt concentrates be processed (smelted) into Cu&Co metal?

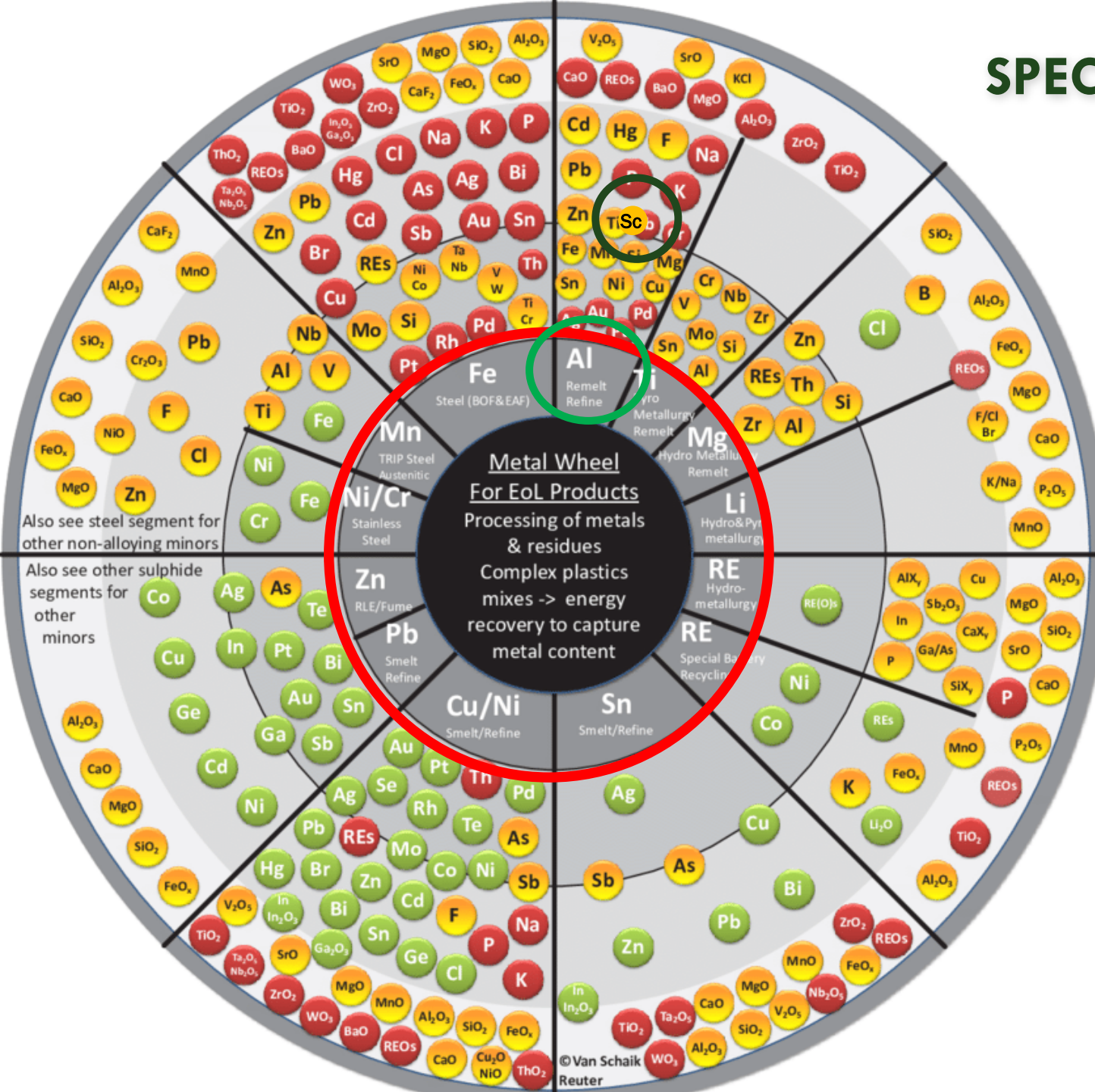
SPECIALTY/CRITICAL = BY-PRODUCTS

Scandium

Economically viable destinations of complex EoL designed functional material combinations, scrap, residues etc. to metallurgical processing infrastructure (each segment) to produce refined metal, compounds and alloys in best available technology

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Red Mud

RECOVERING SCANDIUM FROM WASTE PRODUCT

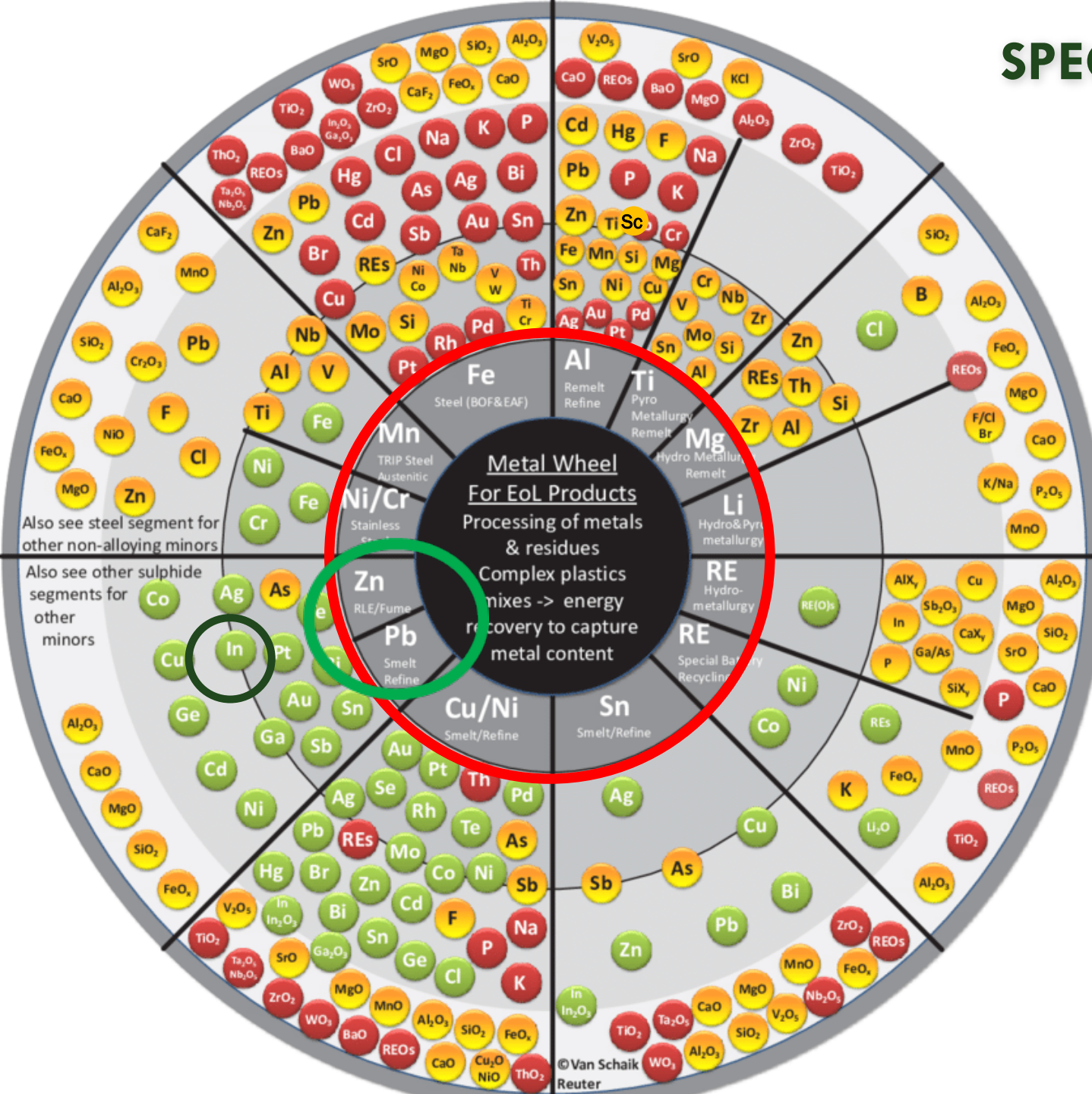
- **Scandium occurs in the waste product of aluminum processing – referred to as Red Muds**
- **A new source of the Scandium-Aluminum alloy will create a market's "Pull Demand" and grow the appetite for the product.** However, the scandium that Rio Tinto is planning to produce is only a fraction of the market's demand, as their waste streams only contain **15 - 20 ppm** scandium, and it will likely be used by their internal aluminum division to produce high-value scandium-aluminum alloys. Therefore, it is opening up opportunities for our Crater Lake Scandium Project, also located in the heart of the aluminum production area of Quebec.
- **This development will stimulate new product and R&D activities related to scandium in the province,** providing it with global leadership in the space.
- **The Rio Tinto's announcement is an important sign of support and recognition** of the importance of scandium as a next-generation aluminum alloy additive, while the Canada-US Collaborative Agreement on Critical Metal Development will provide incentives to the Governments to support the development of the sector.
- **Scandium Oxide** is priced at ~\$5000/kg. Red Muds have already been mined and milled so just the extraction costs apply to produce scandium oxide.
- **However, need Low-cost energy**



RioTinto

SPECIALTY/CRITICAL = BY-PRODUCTS

Indium



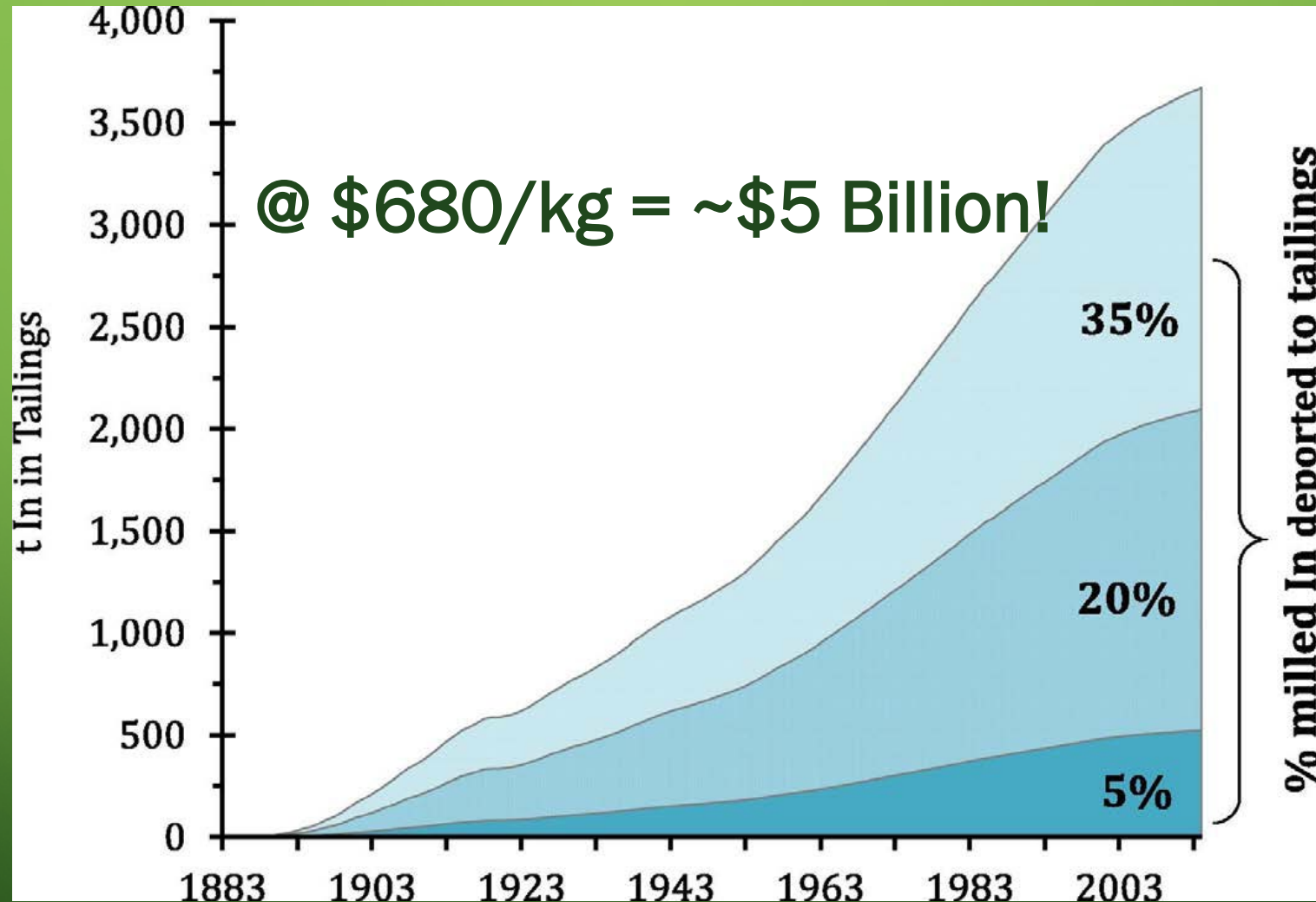
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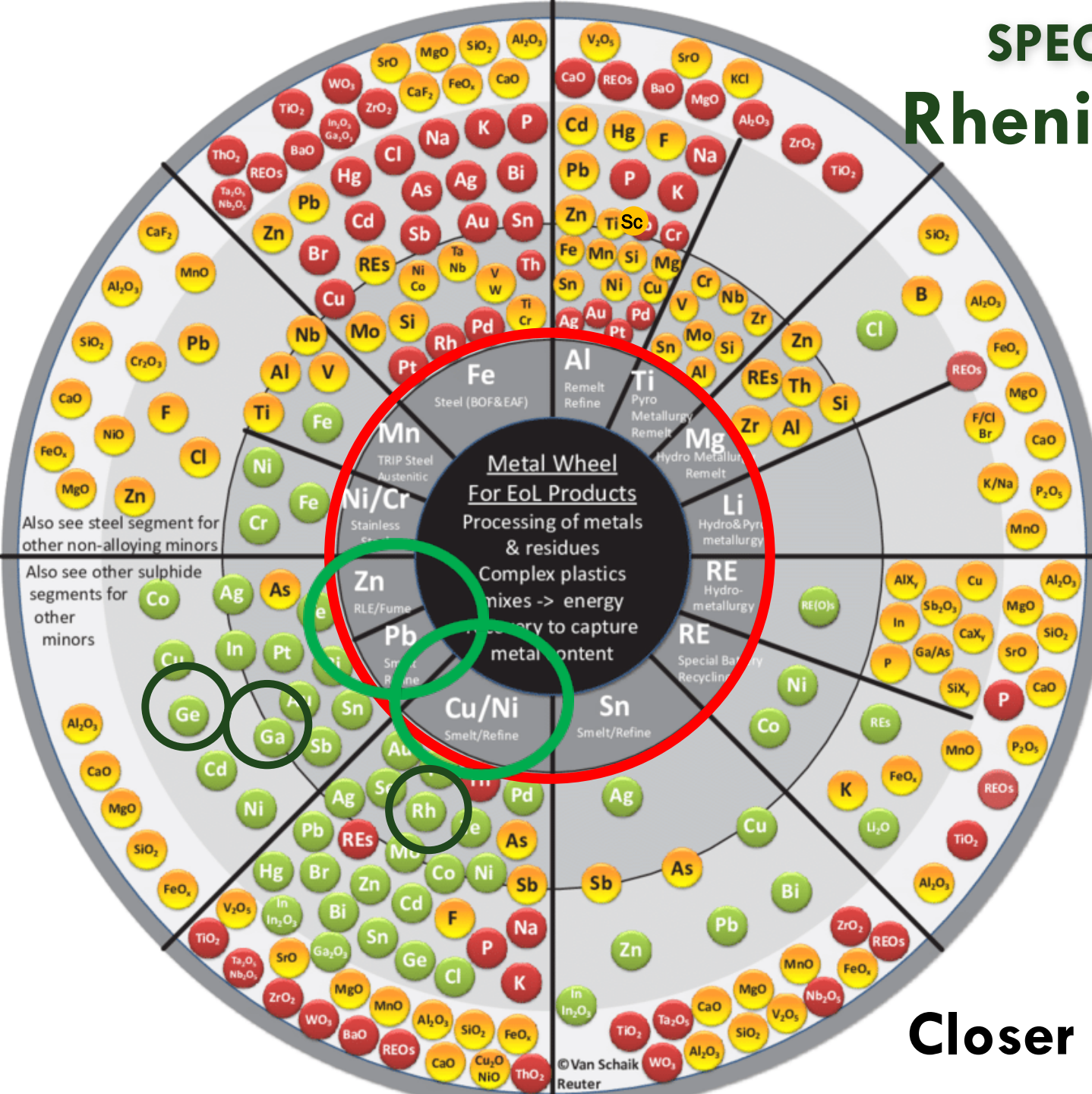
Research Opportunity

ESTIMATES OF AMOUNT OF INDIUM DEPORTING TO TAILINGS FROM LEAD-ZINC PROCESSING IN AUSTRALIA



SPECIALTY/CRITICAL = BY-PRODUCTS

Rhenium-Germanium-Gallium



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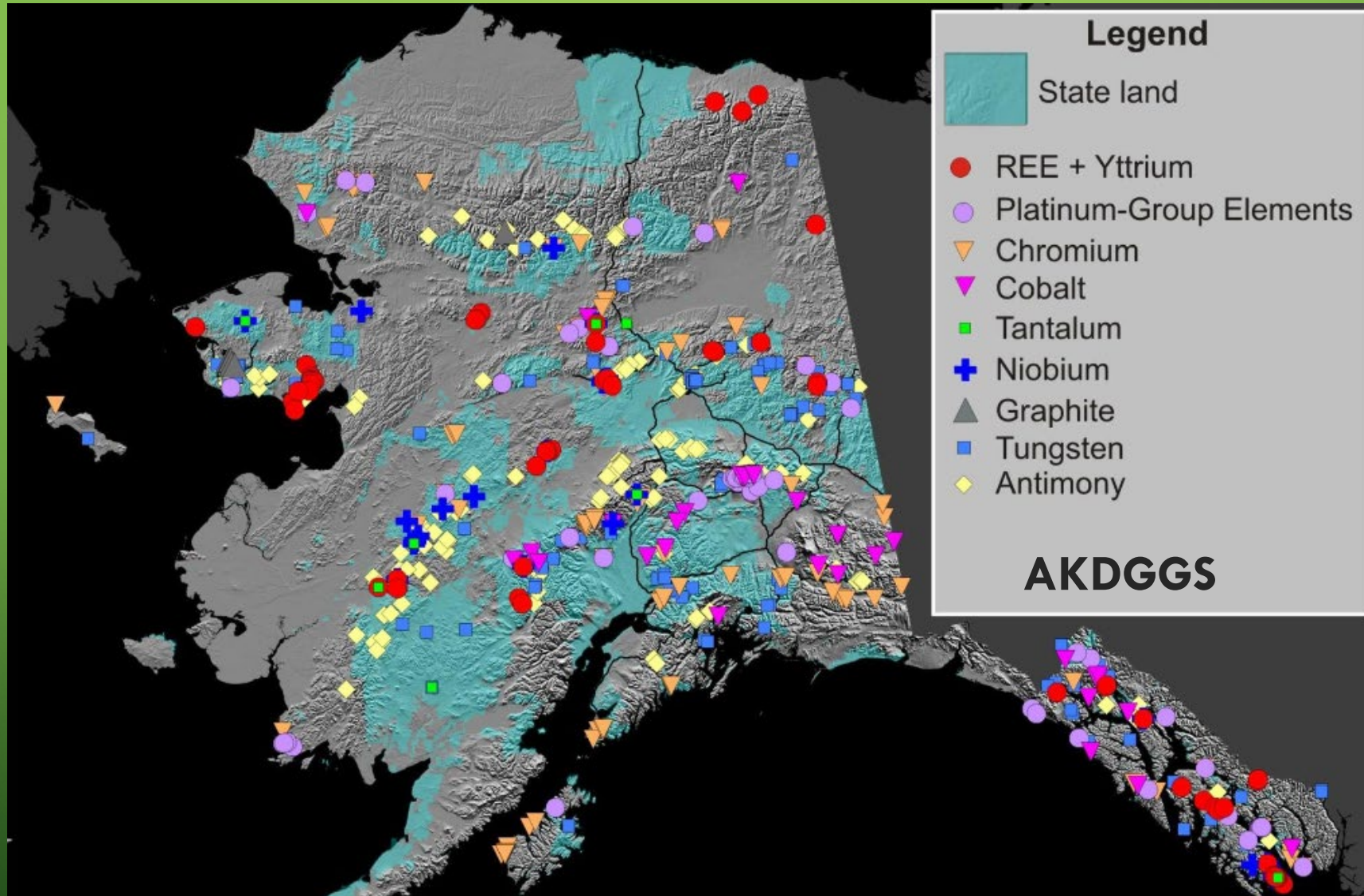
Closer to home in Alaska and the US

GERMANIUM, RHENIUM, AND GALLIUM AS BY-PRODUCT METALS



- Extraction may or may not take place at smelters/refineries
 - Red Dog Pb-Zn mine in NW Alaska produces Germanium (US\$2,200/kg) as a by product
 - the US produces no Gallium – China 90% Potentially could be extracted from Zinc ores, Bauxite and Coal...Gallium @ US\$7500/kg and consumption of Ga is expected to grow 10X by 2032 → Let's figure it out!
- Don't have a good handle on reserves/resource
 - Sierrita Copper mine in Arizona produces Rhenium but does not report either a resource or reserve for Rhenium (US\$2,844/kg)

BRINGING IT BACK HOME TO ALASKA



US GOVT POLICY CONUNDRUM



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND
MANAGEMENT

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BLM Alaska Mining and Minerals



<https://www.blm.gov/programs/energy-and-minerals/mining-and-minerals/about/alaska>

Biden administration makes final decision rejecting Ambler Access Project in Alaska

A BLM record of decision made formal the rejection announced in April, and the agency also backs continued ban on development for 28 million acres

BY: YERETH ROSEN - JUNE 28, 2024 1:14 PM



MINERALS ARE CRITICAL TO A RENEWABLE FUTURE



Alaska holds untapped resources

Renewable energy, next-gen battery and fuel cells, and ultra-strong, ultralight materials all depend on mineral resources.

Determining what the nation has and the feasibility of responsibly extracting it are starting points for securing the minerals we need now to build a renewable future.

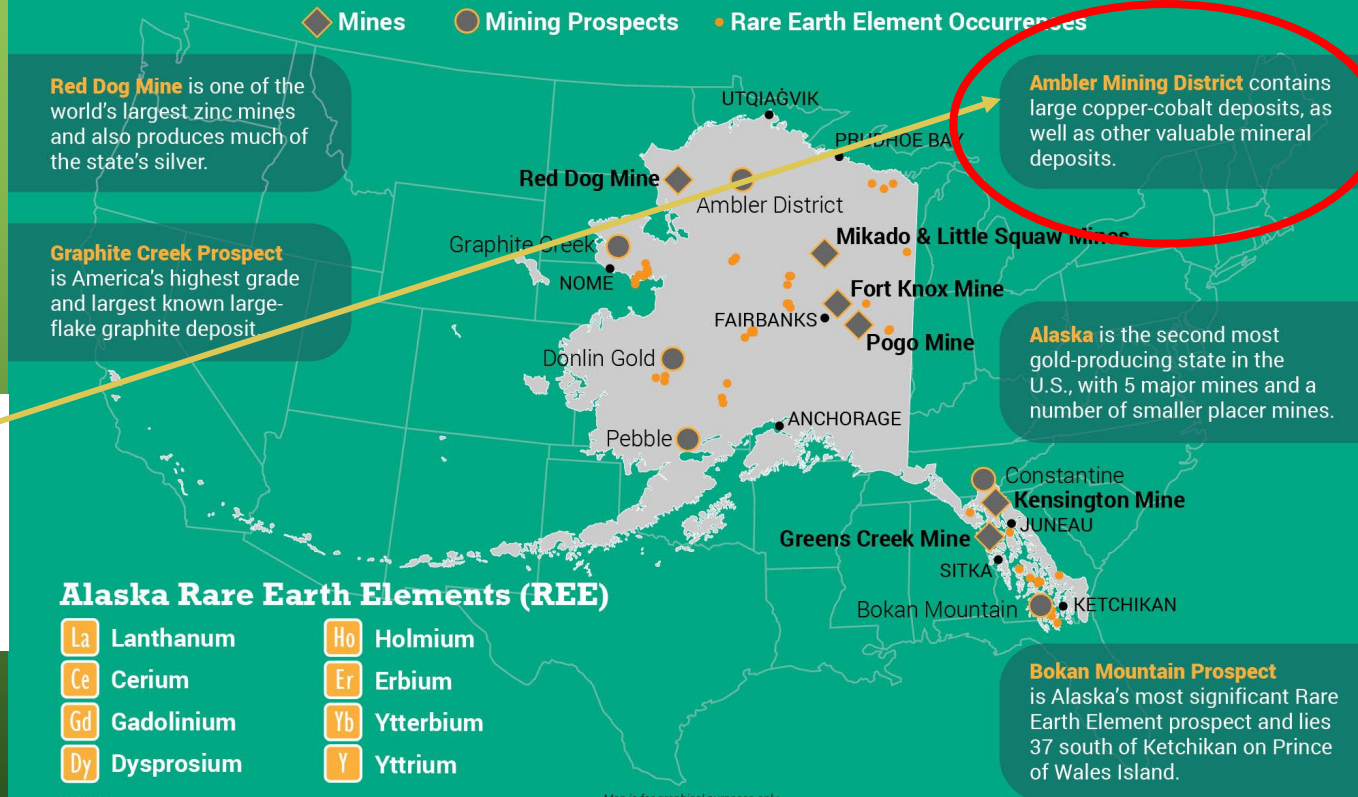
Alaska's vast mineral resources may help decrease national reliance on imports while protecting the Earth under some of the most stringent environmental laws in the world.



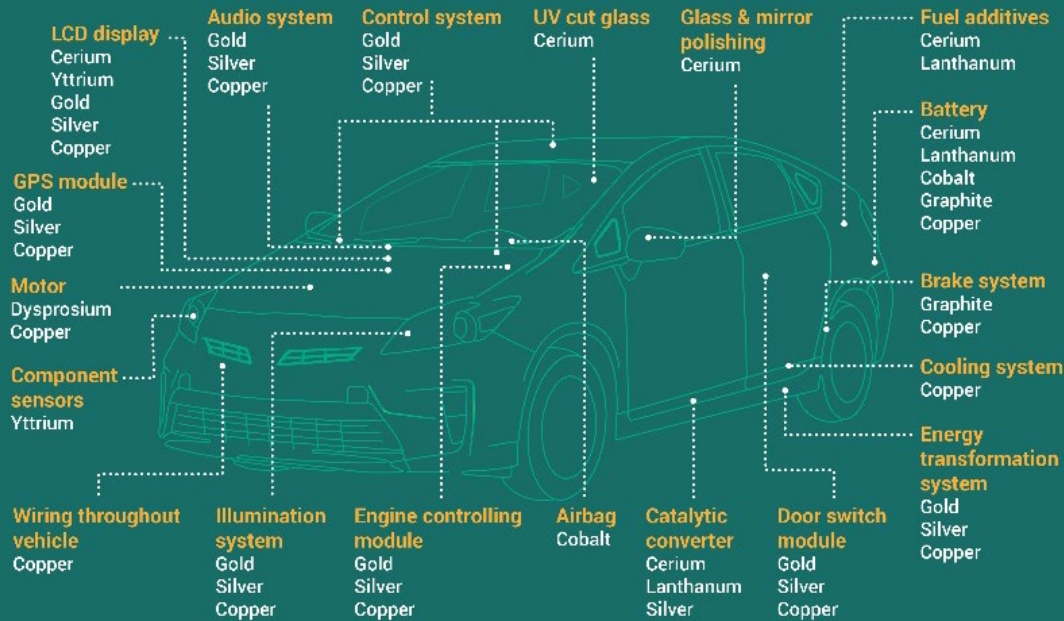
Even green tech generates waste

Considering that fewer than 5% of lithium-ion batteries were recycled worldwide in 2019, for example, we can all do better at recycling the critical minerals already mined to reduce e-waste. Thinking "Recycling before re-mining" is a good place to start.

Alaska Critical Mineral Locations



Alaska Minerals in Electric Vehicles



*Rechargeable Zinc-ion batteries, or RZIBs, are promising energy storage replacements for lithium ion batteries based on their relatively high energy density and low cost, negligible environmental impact, and increased safety.

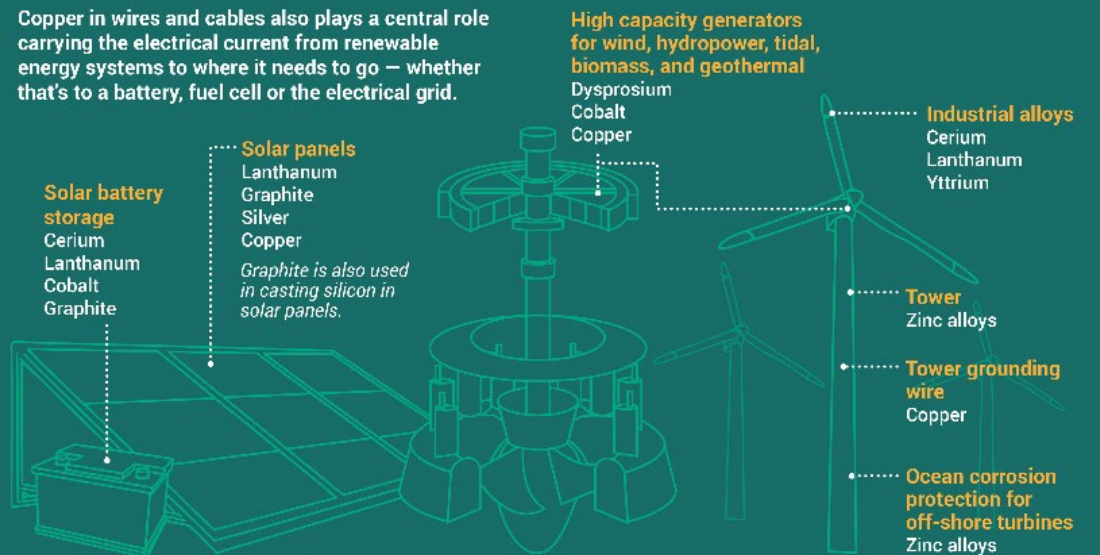
WOW!

WT...?

Alaska Minerals in Mobile Devices

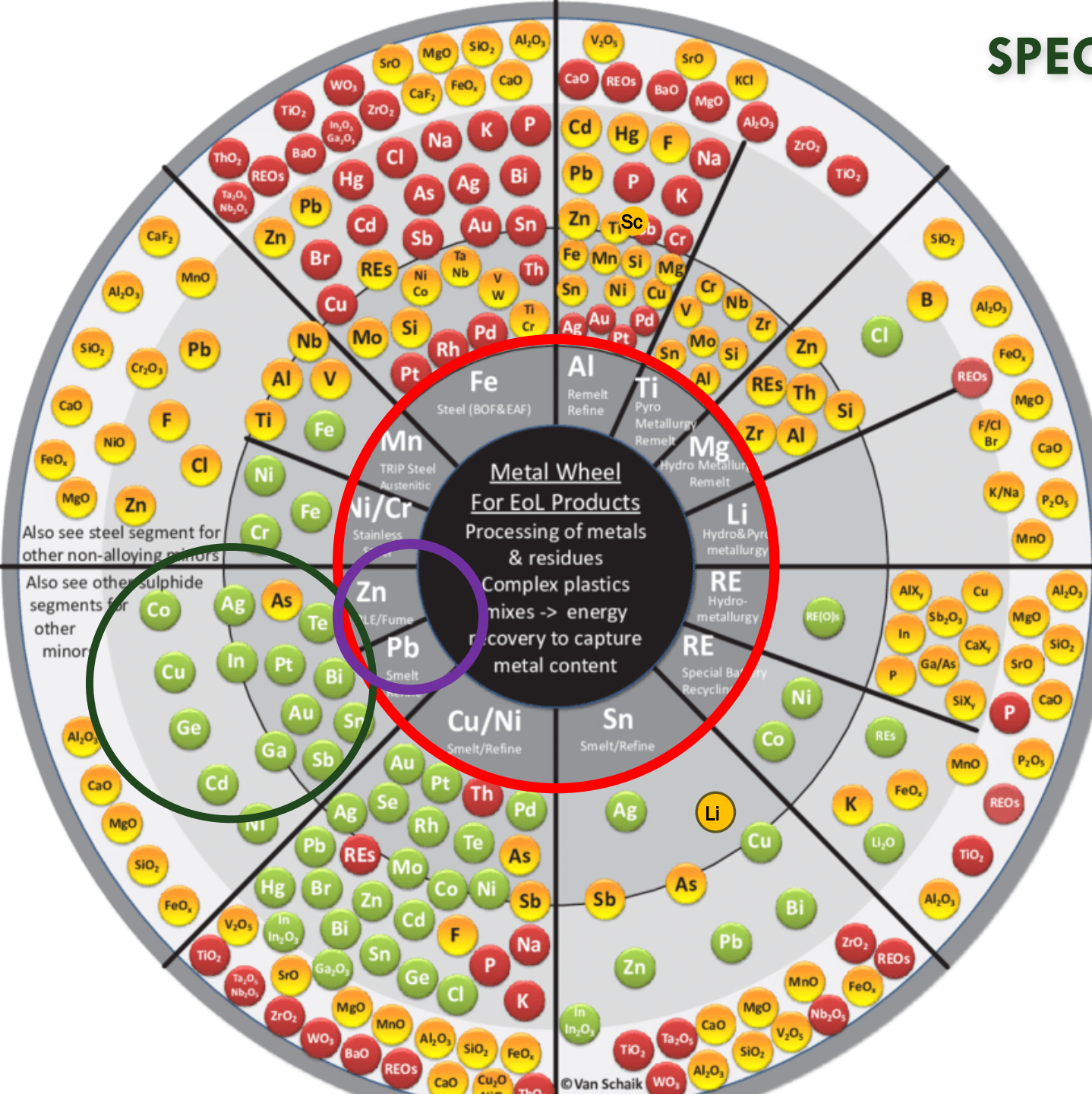


Alaska Minerals in Renewable Energy



SPECIALTY/CRITICAL = BY-PRODUCTS

Lead-Zinc



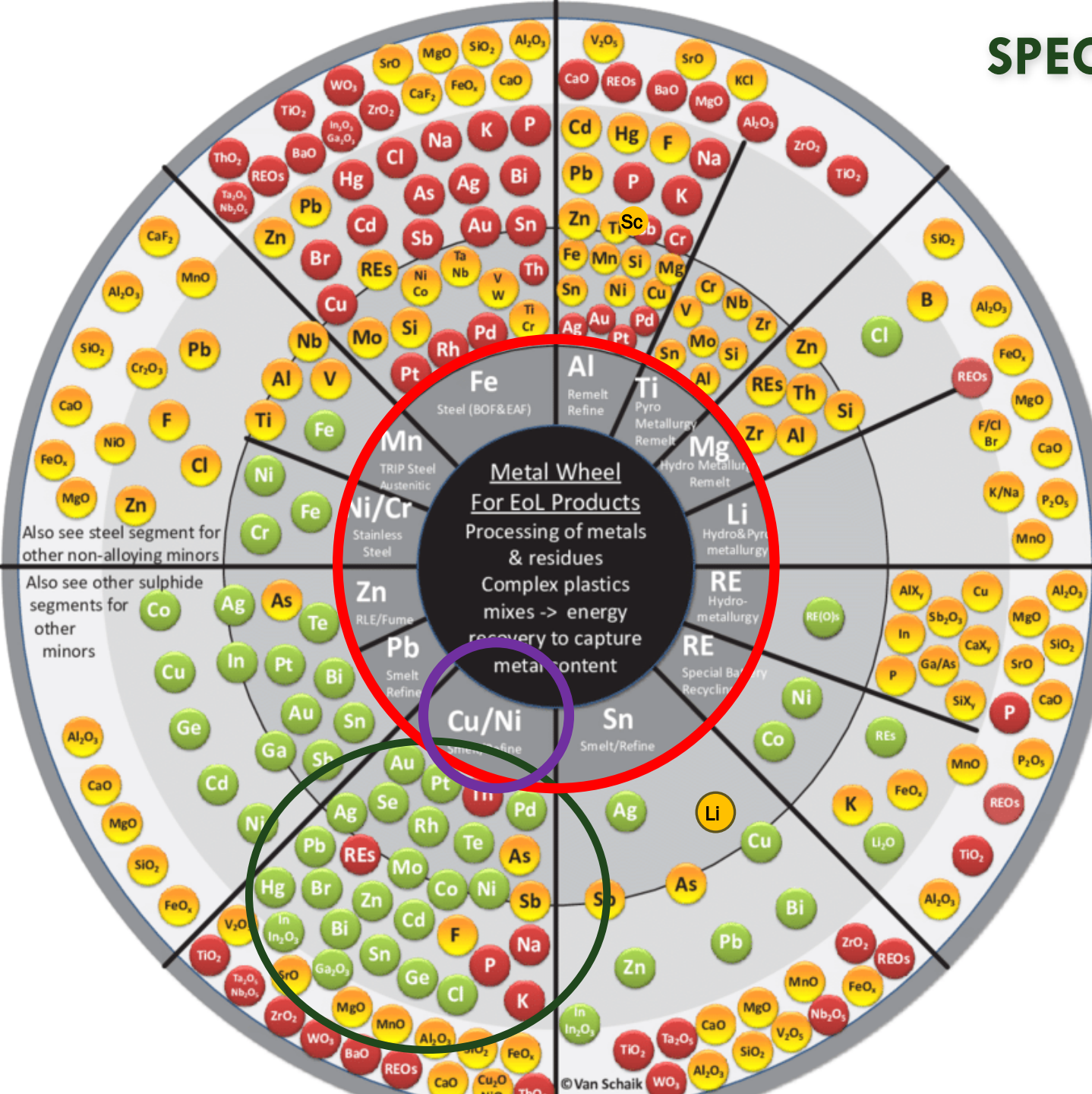
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SPECIALTY/CRITICAL = BY-PRODUCTS

Copper-Nickel



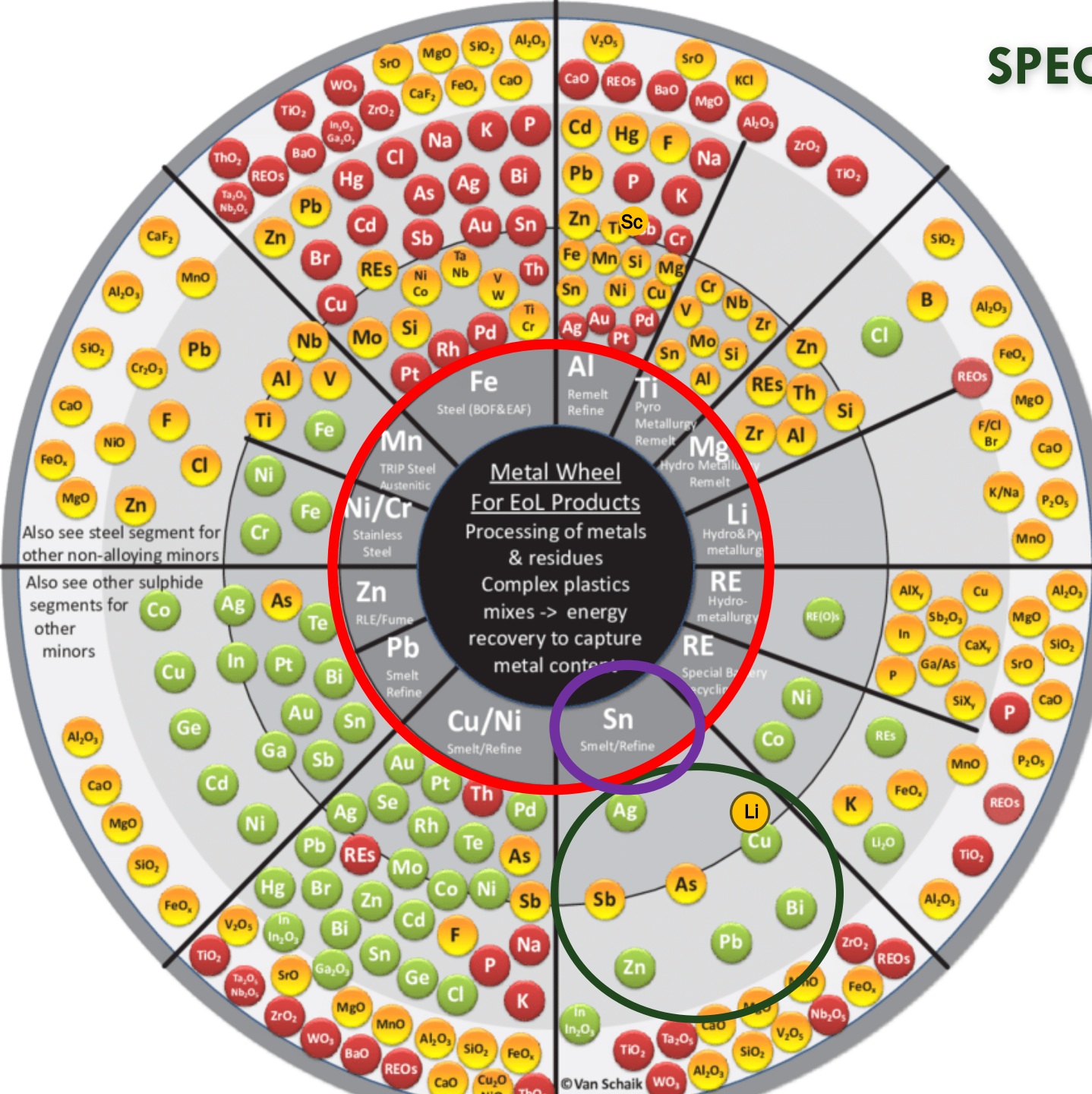
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SPECIALTY/CRITICAL = BY-PRODUCTS

Tin-Tungsten



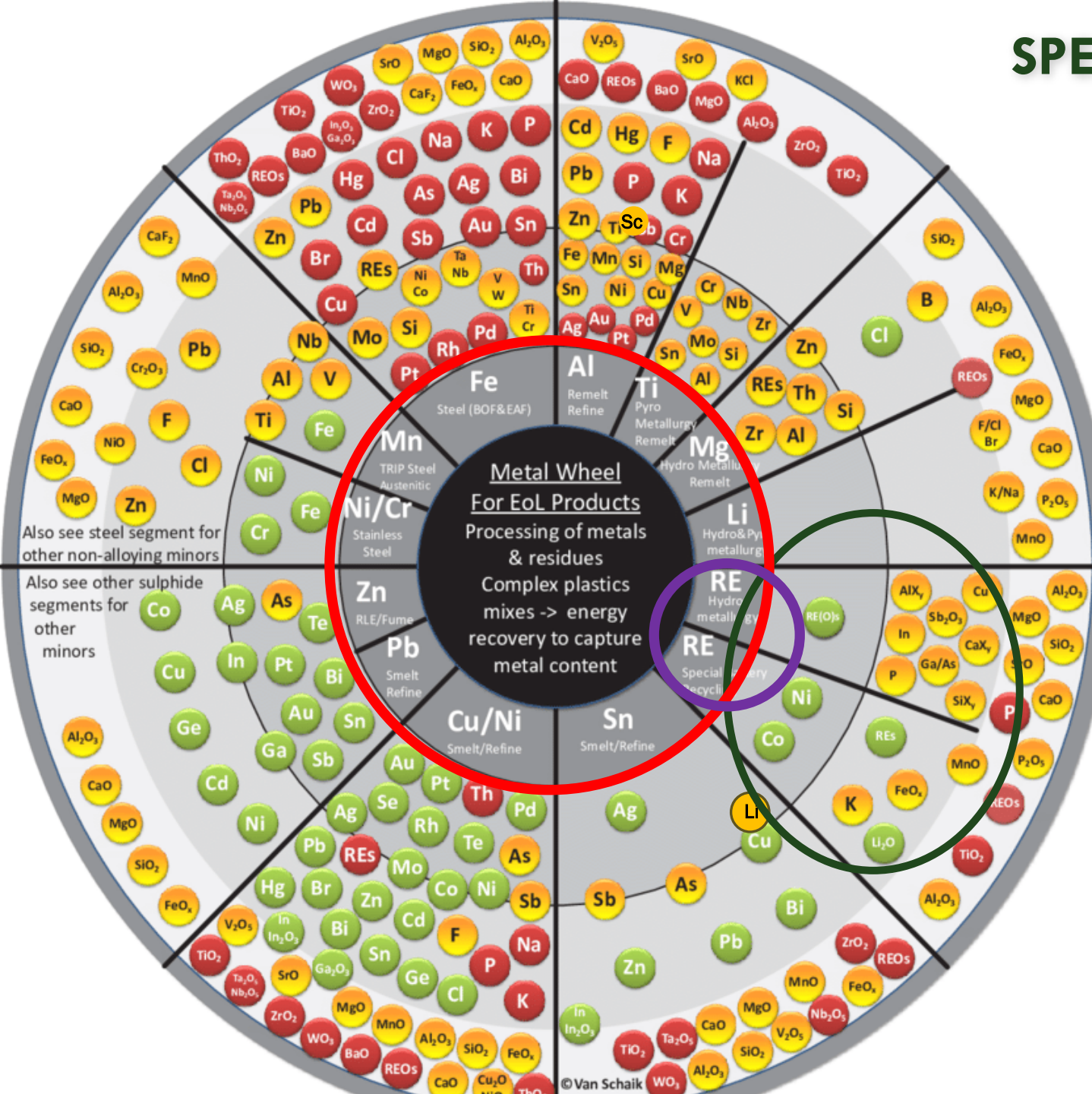
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Uranium-REE



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CRITICAL METALS: HOW CAN ALASKA MAKE A DIFFERENCE?

- Be like Iceland!
 - Iceland is one of the highest ESG-rated countries in the world
 - Iceland is a major producer of Aluminum and yet they possess no Aluminum ore (Bauxite) – sourced from South America and Africa
 - How? → Low-cost Power – Hydro/Geothermal
- Be part of the **Solution!!!**
- Build a Hydro/Geothermal or Coal with Carbon Capture technology to power hydrometallurgical facility in the Aleutians or elsewhere in Alaska!
 - Clean Cheap Power
 - Cheap Power is key to be competitive processing raw materials
 - Results in good quality jobs
 - Cheap Power could also result in better quality food sourced locally
 - Yields a better quality of life
- Alaska could mine the raw materials and add value by producing/processing metals in Alaska – especially Critical Metals!



Fjarðaál Aluminum Smelter



WOULDN'T GOOD JOBS, CHEAP POWER, AND A BETTER FUTURE BE WHAT WE WANT FOR OUR FUTURE GENERATIONS?

A photograph of the Aurora Borealis (Northern Lights) over a snowy landscape. The aurora displays vibrant green and red curtains of light against a dark, starry night sky. The foreground shows snow-covered ground with some dark, low-lying vegetation.

QUESTIONS?

THANK YOU

The background is a dark green gradient. In the four corners, there are decorative white line-art patterns resembling circuit traces or neural network connections. These patterns consist of straight lines of varying lengths and angles, ending in small white circles.

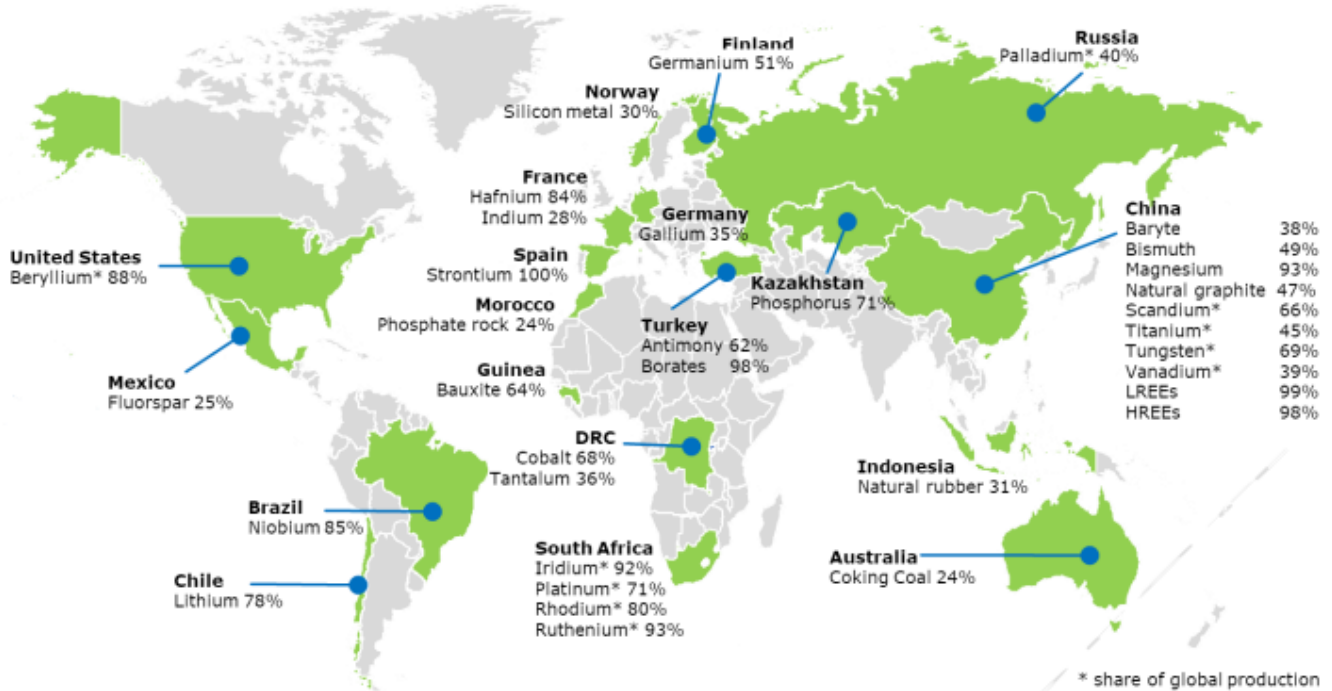
APPENDIX SLIDES - HIDE

EUROPEAN UNION LIST OF CRITICAL RAW MATERIALS (CRMS)

List of EU Critical Minerals
 Why isn't Copper on this list....since none of the other metals work without Copper!?

Poland has huge copper reserves.....right next to Russia

2020 Critical Raw Materials (new as compared to 2017 in bold)		
Antimony	Hafnium	Phosphorus
Baryte	Heavy Rare Earth Elements	Scandium
Beryllium	Light Rare Earth Elements	Silicon metal
Bismuth	Indium	Tantalum
Borate	Magnesium	Tungsten
Cobalt	Natural Graphite	Vanadium
Coking Coal	Natural Rubber	Bauxite
Fluorspar	Niobium	Lithium
Gallium	Platinum Group Metals	Titanium
Germanium	Phosphate rock	Strontium



EU Formula for Determining Criticality

Economic importance (EI) $EI = \sum (As s * Qs) * SIE$

Substitution index (SIEI) $SIEI = \sum \sum SCPI,a a * Subsharei,a * Share$

Supply risk (SR)
 $SR = [(HHIWGI,t) GS \cdot IR^2 + (HHIWGI,t) EU_{sourcing} (1 - IR^2)] \cdot (1 - EoLRIR) \cdot SIS$

Importance Reliance
 $Import\ Reliance\ (IR) = \frac{Import - Export}{Domestic\ production + Import - Export}$