Mining for Net Zero

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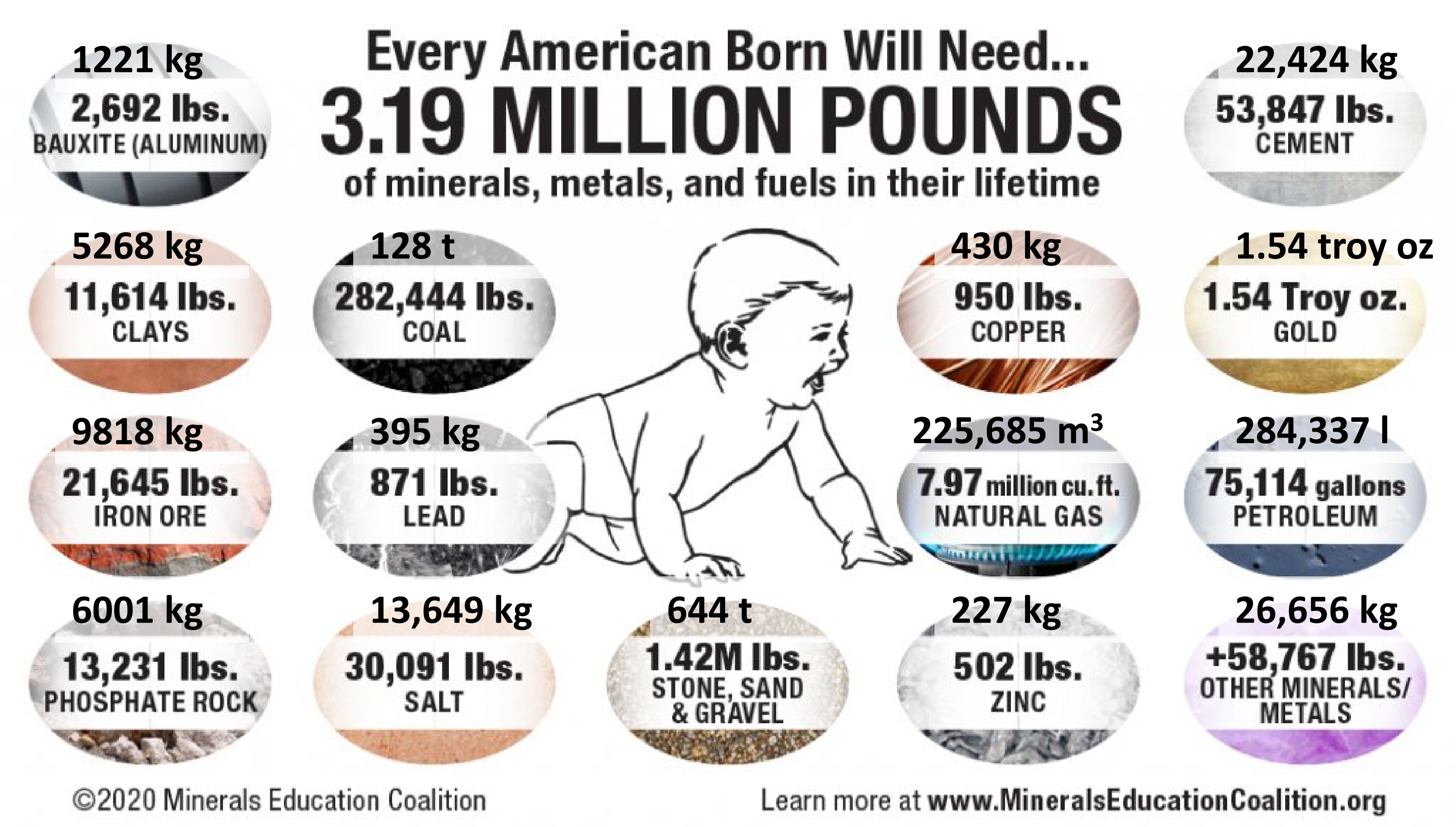
The University of Nevada, Las Vegas wishes to acknowledge and honor the Indigenous communities of this region, and recognize that the university is situated on the traditional homelands of the Nuwuvi, Southern Paiute People

Mining is old, dirty, problematic, and we don't need it, right?

Climate change and mining

- You all know the previous statement is incorrect
- Mining has been vital to modern life and society for centuries, will remain so for the foreseeable future, and is needed to meet the UN SDG and more
- However, comparatively few people acknowledge or even think about this (even in countries like Australia or states like Nevada and Colorado with significant mining; see protests at mining conferences globally and unwillingness of banks and other organizations to deal with "mining")
- "But mining is dirty and harms the environment and people"… perhaps, but mining companies do a better (not perfect) job of environmental assessment, cleanup etc. than in the past and are more socially aware – and mining can provide communities with benefits
- Meaningful climate change mitigation and limiting CO_2 emissions requires mining – I'll show data to back this claim up shortly
- But before we get into that, a brief reminder of why modern society needs mining

Mineral and metal requirements for modern life (metric version)



Modern technologies have become more mineral intensive

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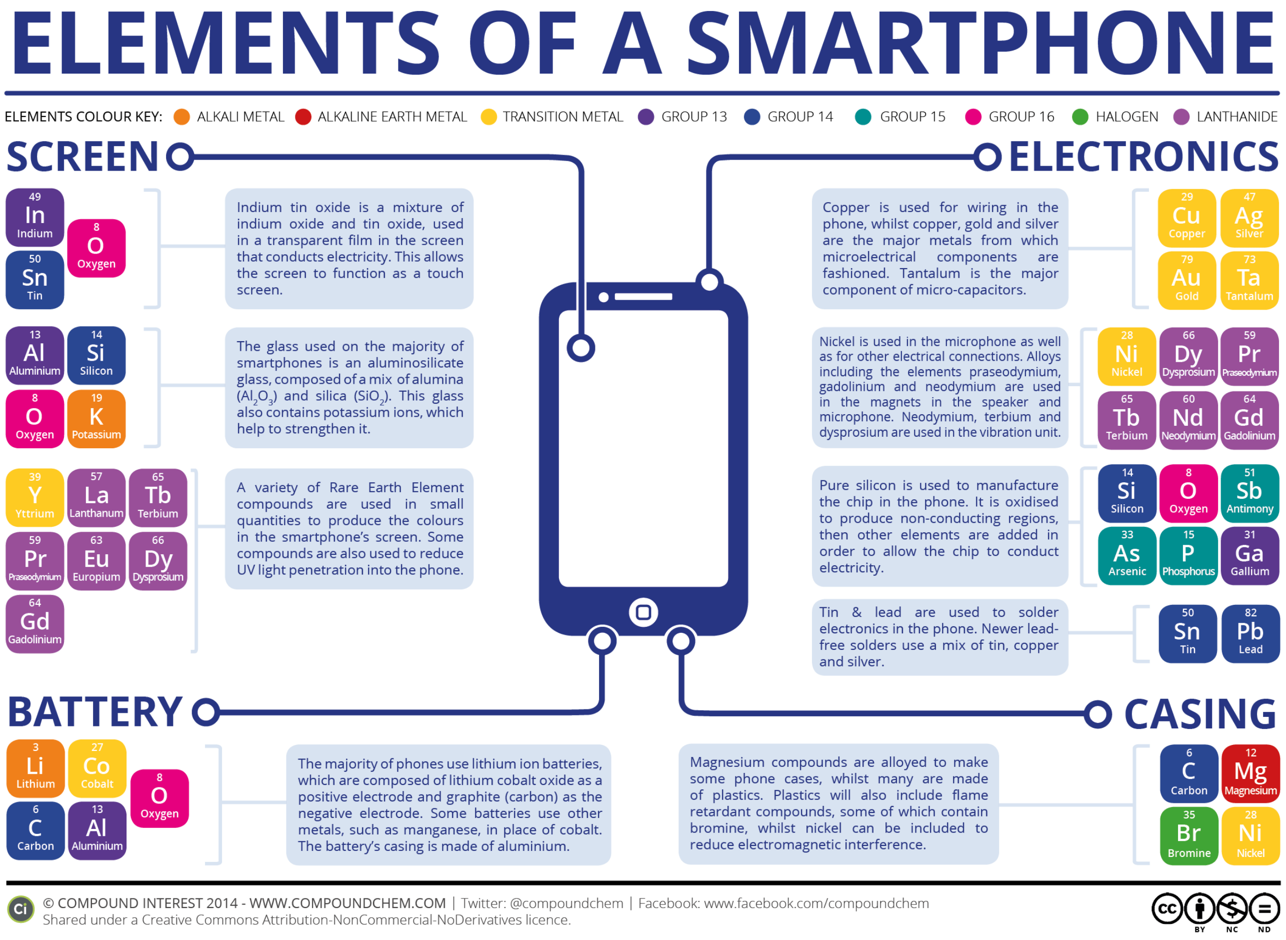
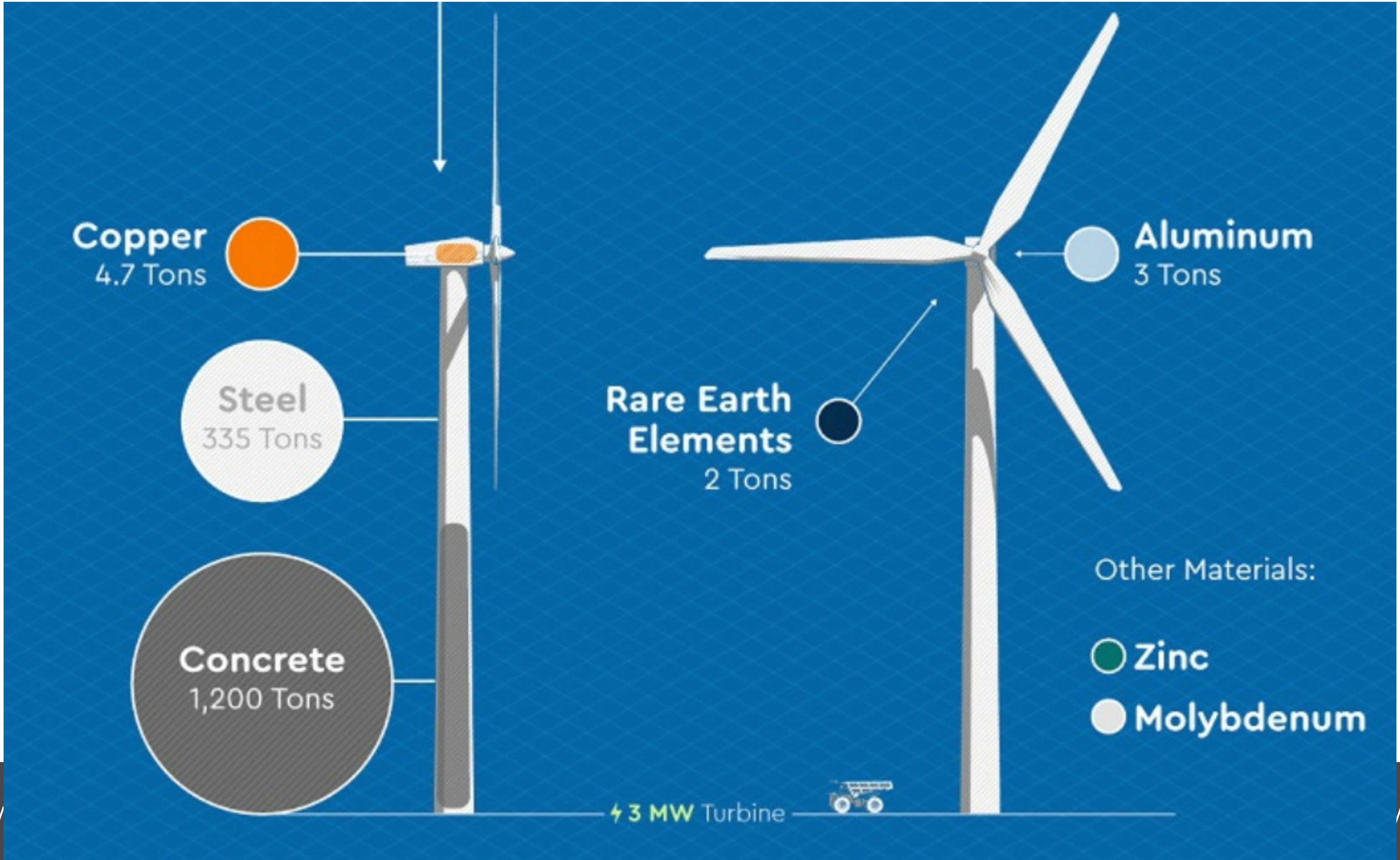
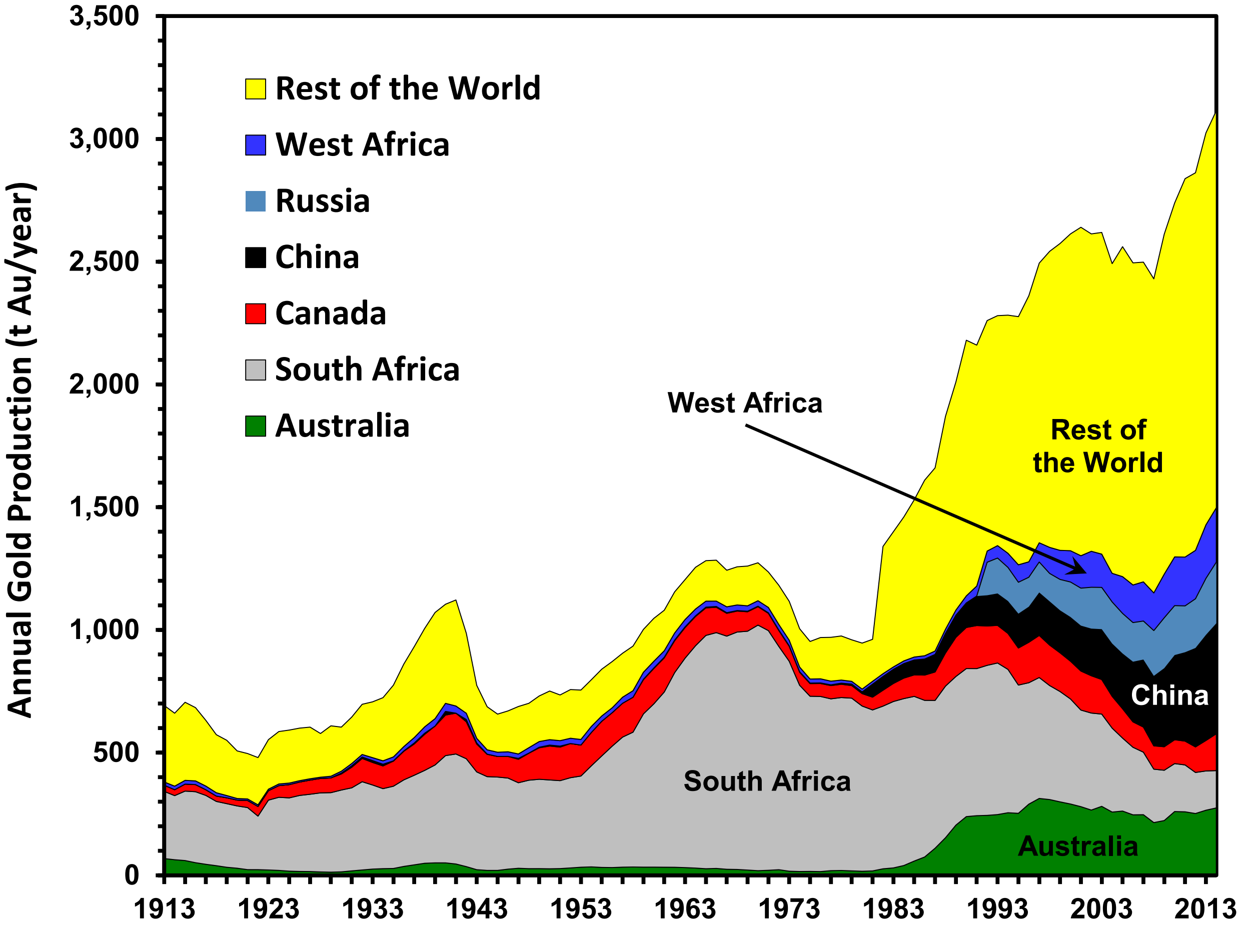


Modern technologies have become more mineral intensive

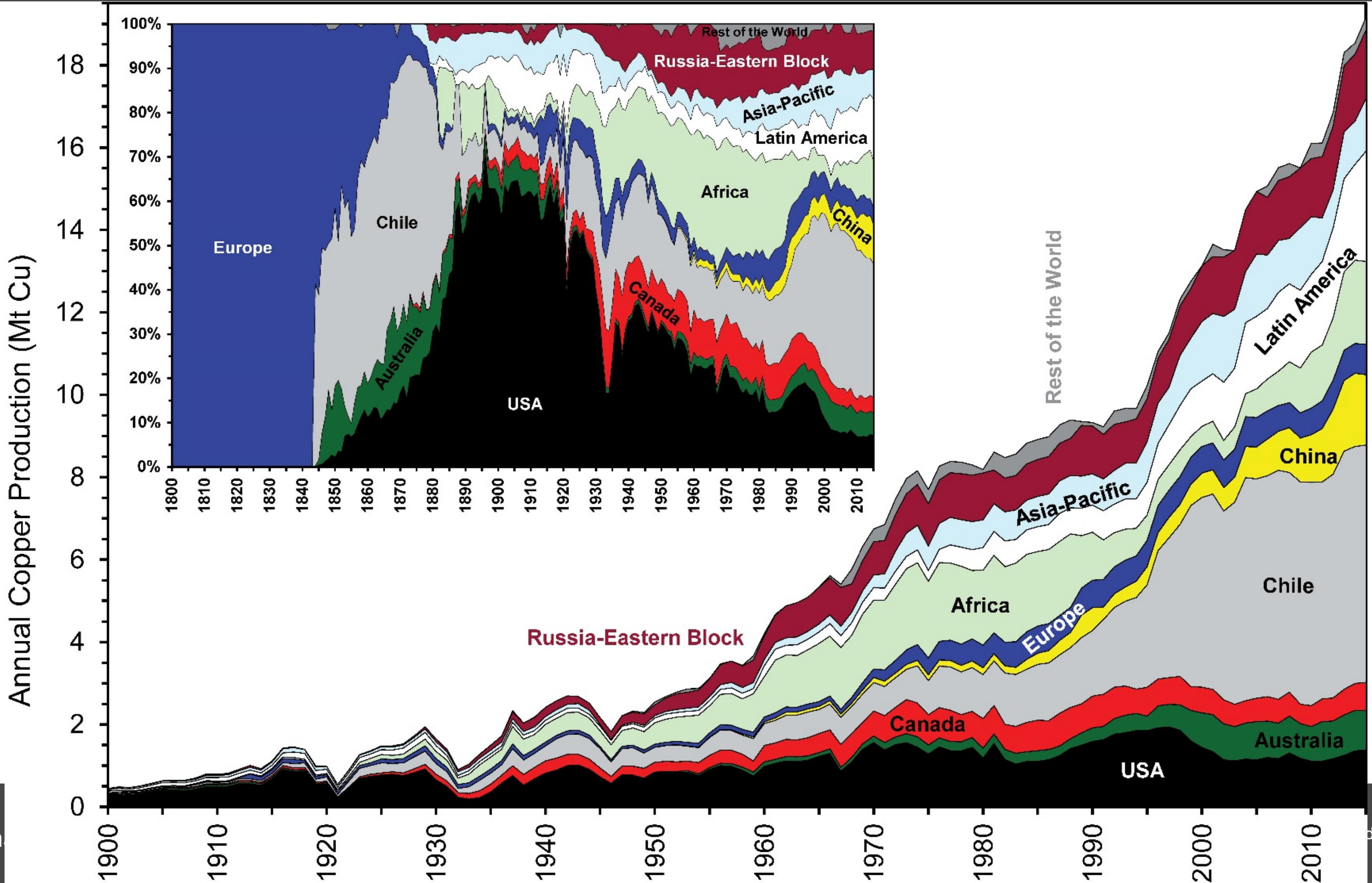


- Just a few examples of how the things we take for granted as part of modern life require metals and minerals
- Minerals and metals are the material basis for modern society – hence we need mining
- This, combined with increases in population, is the reason we currently mine more minerals and metals than at any other time in history – underlying trend for the last century plus

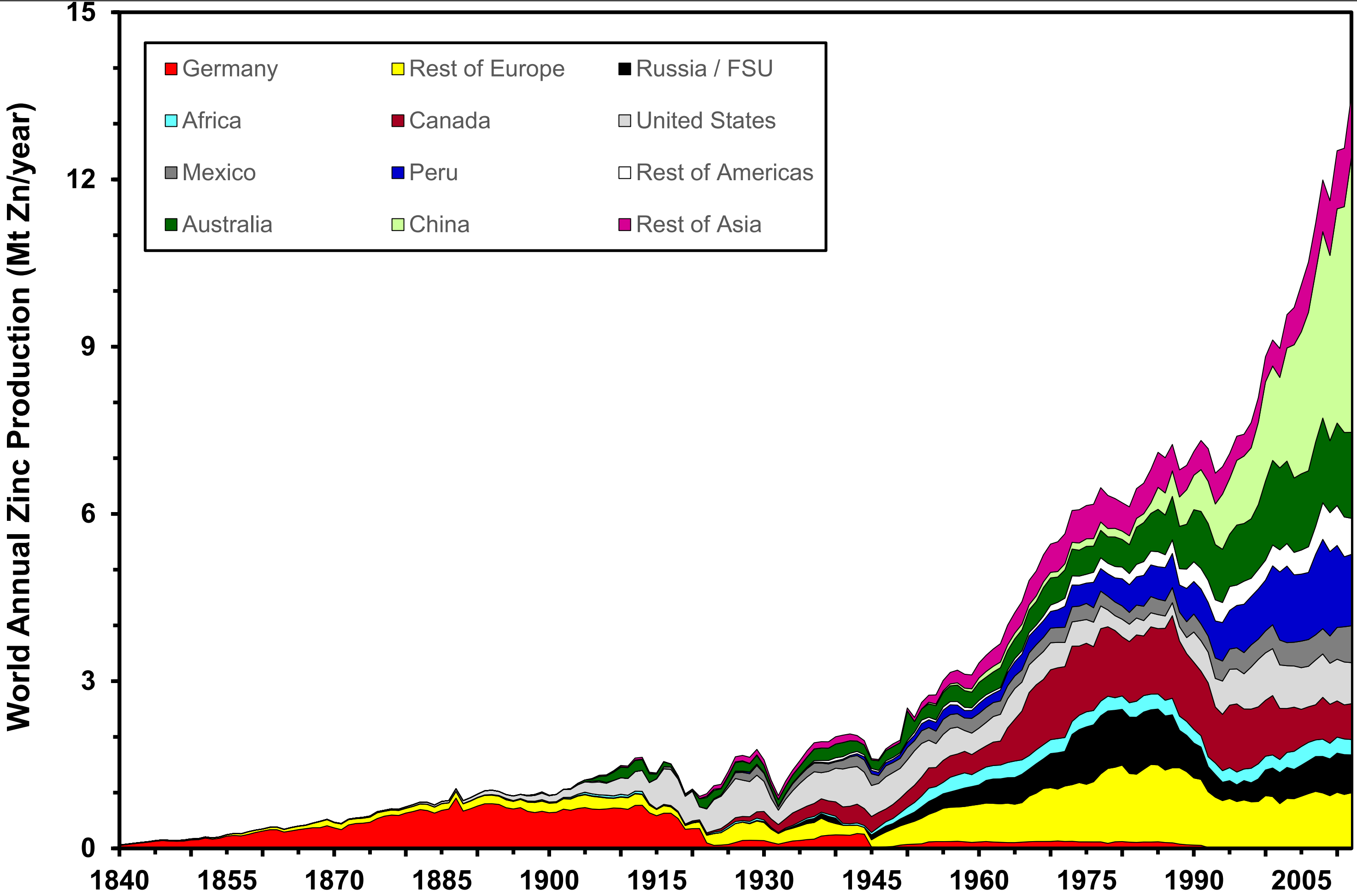
We mine more minerals and metals than ever before - Au



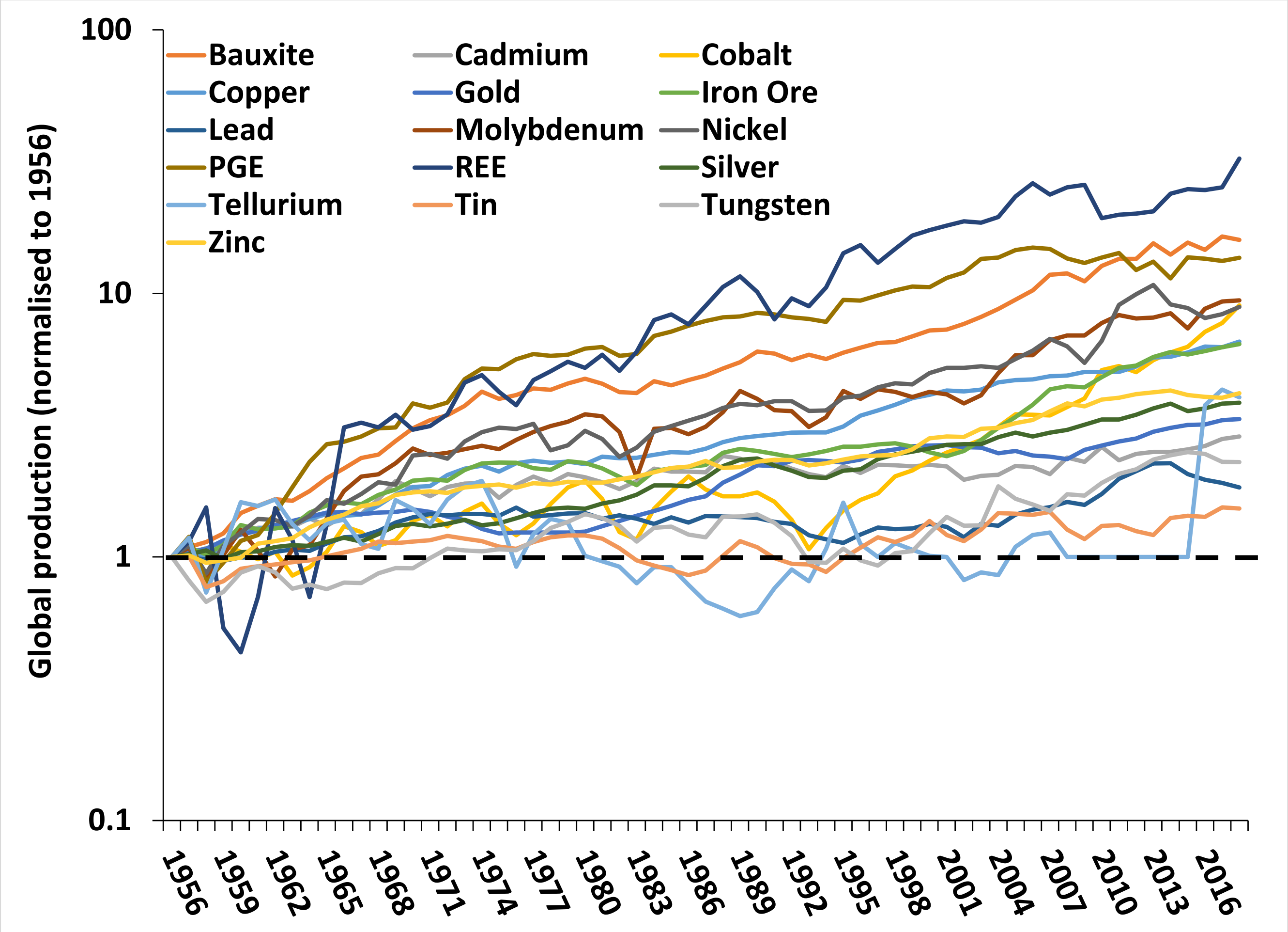
We mine more minerals and metals than ever before - Cu



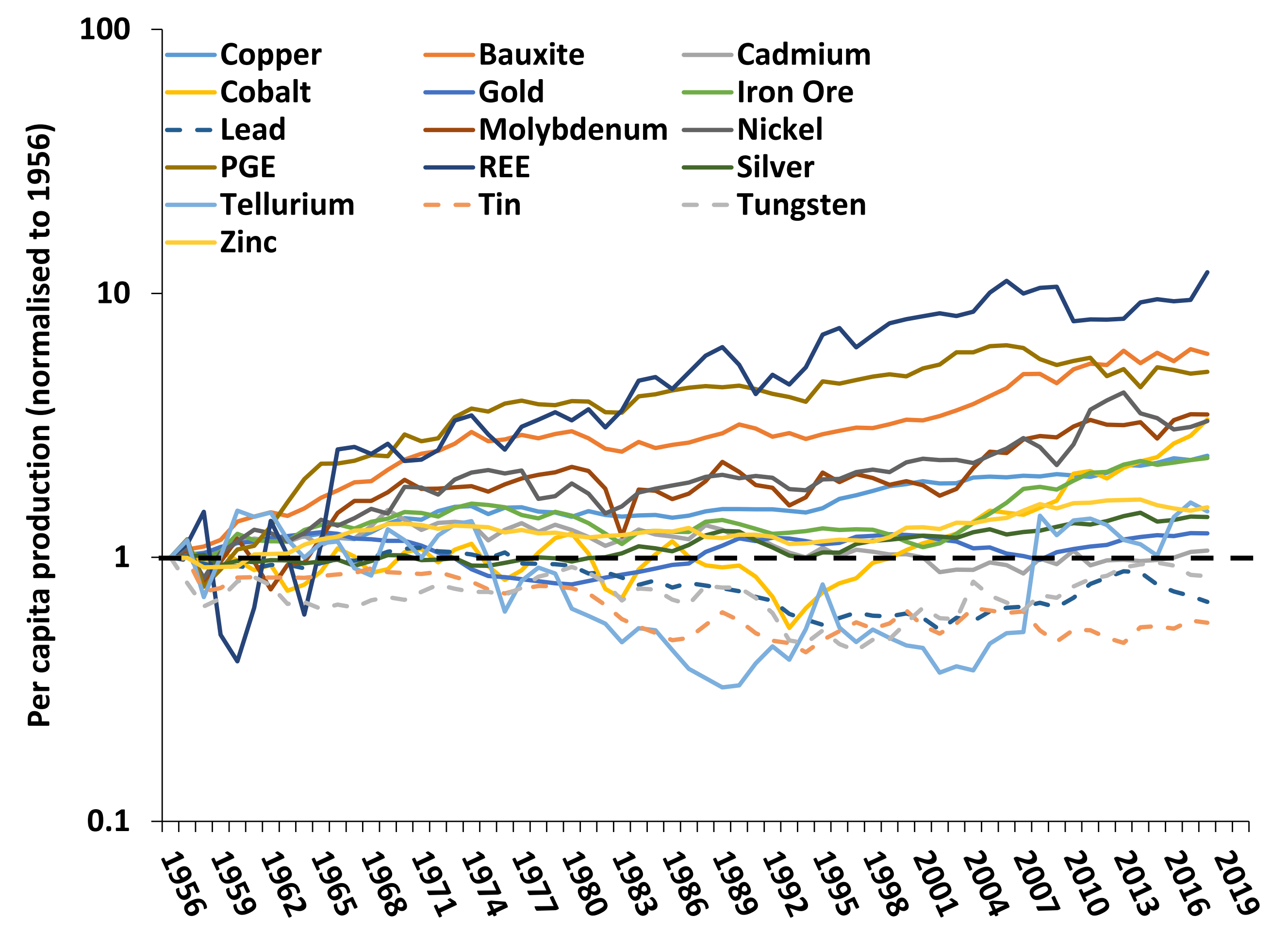
We mine more minerals and metals than ever before - Zn



Applies to almost all metals (and doesn't account for increased recycling)

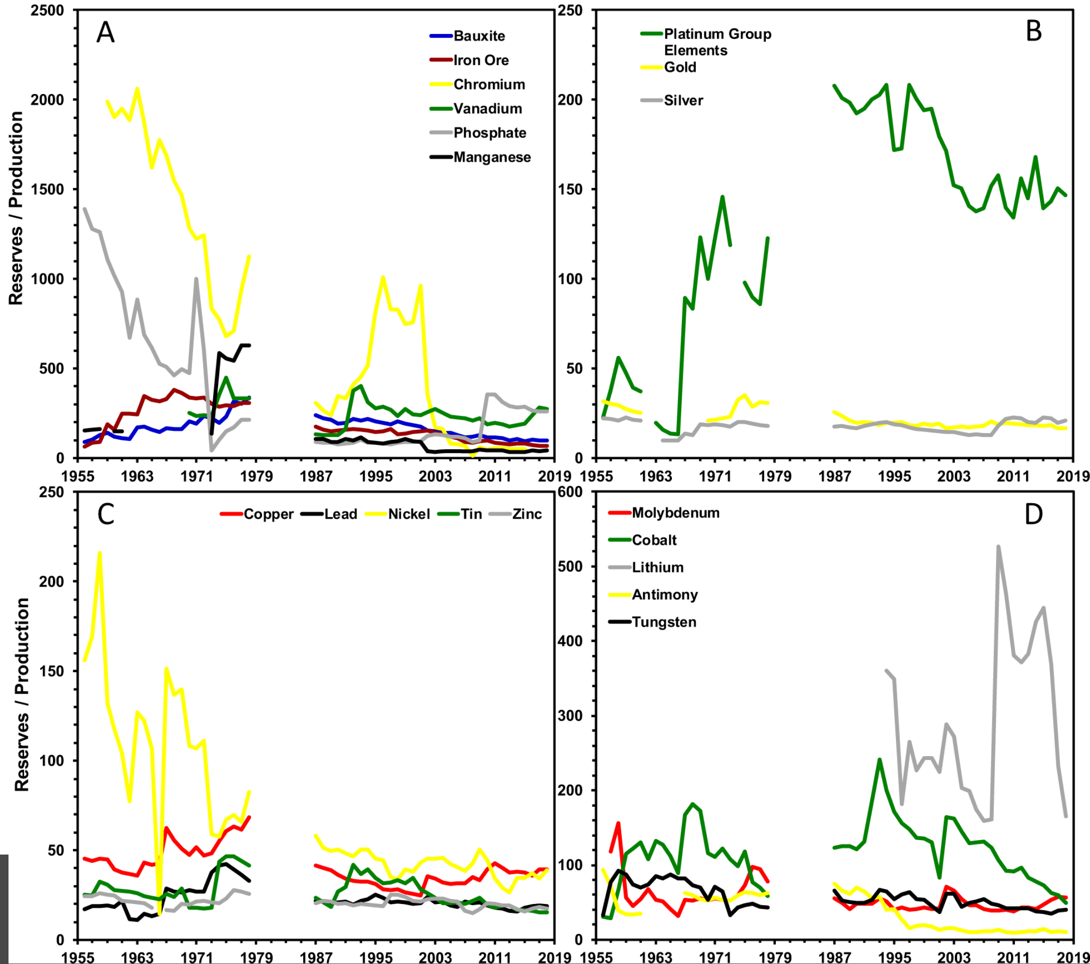


Not just totals but per capita (exceptions are Pb, Sn, W)



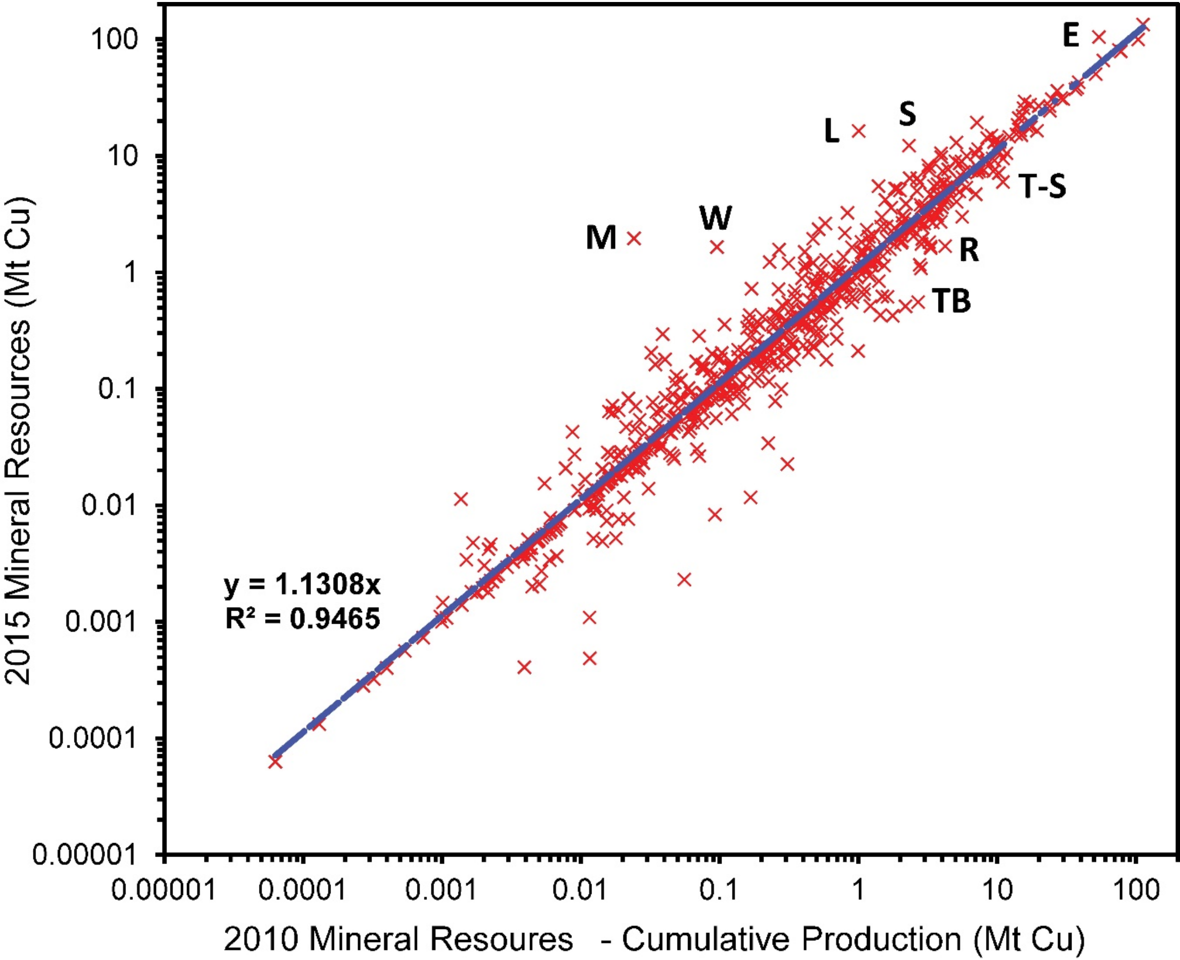
OK – so we mine more… does that mean we are running out?

- Not necessarily.
- Although the data are noisy, in general **reserve/production** ratios (= years left) have been fairly steady for the last 30+ years.
- Some volatility in minor metals; may reflect poorer data rather than actual variations
- Exhausted reserves replenished by delineation of **known but not formally quantified** mineralization



OK – so we mine more… does that mean we are running out?

- Copper data for 2010 and 2015; shows resources on average increase by 13% despite ongoing production
- Indicates that reserves generally steady, resources increase through brownfield expansion
- New discoveries add more metal to the mix
- So all good, right?



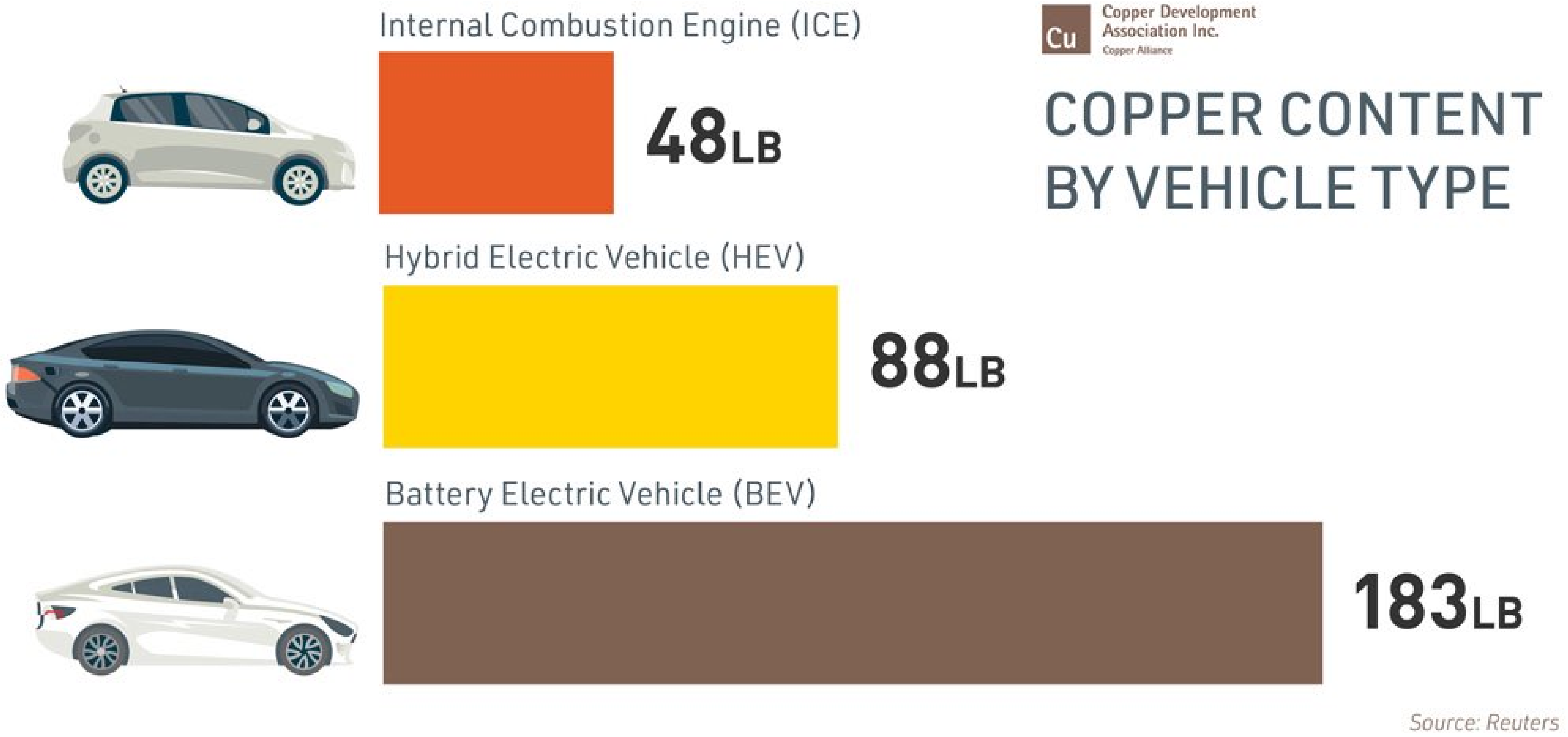
So we just mine more to mitigate against climate change, right?

- If we have any hope of meeting CO_2 emissions targets, we will **need even more mining than now, and we already mine (and recycle) more than ever**
- Good target is the IEA 2 degree temperature increase; limits 2015-2100 energy-related CO_2 emissions to 1,000 Gt CO_2 equivalent (current annual production is 33 Gt/yr, equaling 2,805 Gt for 2015-2100)
- **Needs CO_2 emissions to decrease by ~60% by 2050 and to decline after towards carbon neutrality; means rapid rollout of renewables and low- and zero CO_2 transport and energy storage**
- Increased consumer demand for electric vehicles (EVs) and renewable energy makes metal and mineral demand increase also inevitable
- EVs as an example; require more metal than petrol vehicles, and no point powering an electric vehicle with electricity generated at a coal-fired power station; worse than a petrol SUV

But I don’t believe in anthropogenic climate change…

- Hopefully that doesn’t apply to this audience but it does apply to some people in our society… either way to be blunt it doesn’t matter. Why?
- **Firstly**, science doesn’t really care what you believe in
- **Secondly**, we are already shifting to low CO_2 energy generation and transport
- This is a global movement and trend that will continue and is being driven by consumer sentiment and investment funding
- **Thirdly**, metal mining, processing, green tech and energy development and more all involve the production of high value raw materials and have the potential to generate a lot of well paid jobs (as shown during the late 2000s mining boom).
- Let’s have a think about cars as a starting point…

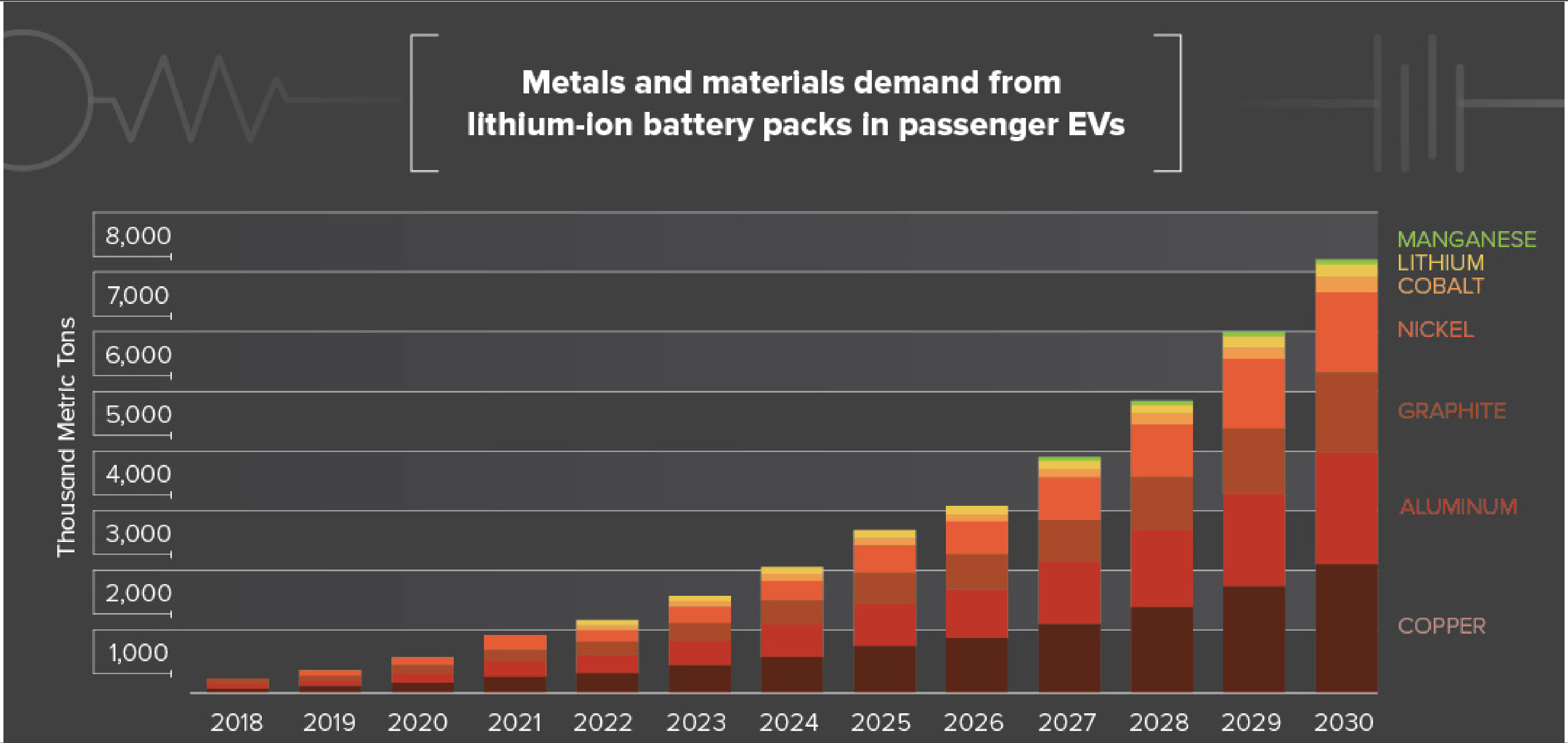
Petrol vs electric vehicle metal use (also note EVs are heavier)



Back of the envelope calculation

- Global vehicle production uses around **1 Mt of copper per year**, or 5% of global copper production; 1% of these new vehicles are electric
- Targets for various countries is to move to all electric vehicle fleets by 2035-2050 or so.
- Let’s assume the world agrees to go to all electric vehicles by 2060
- Electric vehicles need nearly **4 times as much copper as a petrol vehicle**; therefore if we go all electric the global car industry will need **~4 Mt of copper production a year assuming no growth in new vehicle demand**; 400% increase from now, **20% of global copper production**…
- Only it’s more, because you need infrastructure to charge vehicles, renewable energy sources… and this is just transport and just copper…
- What about energy generation and other sectors?

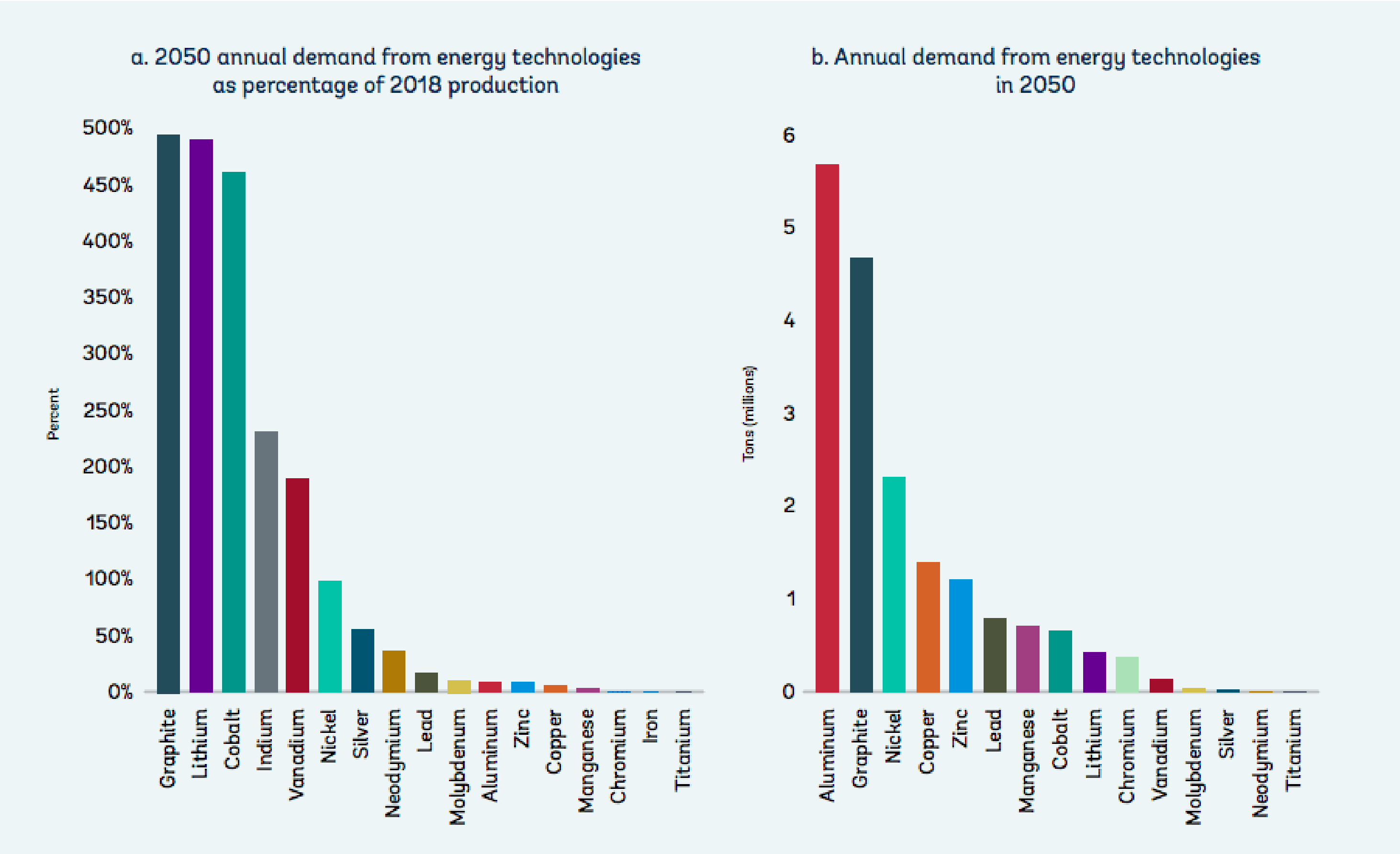
Increased demand for metals and mining as a result of green technology - EVs



Source: Electric Vehicle Outlook 2018, Bloomberg New Energy Finance

Increased demand for metals and mining as a result of green technology - energy

Figure 4.3 Projected Annual Mineral Demand Under 2DS Only from Energy Technologies in 2050, Compared to 2018 Production Levels



Demand… note that the central and right columns are from energy tech **ALONE**

Mineral	2018 annual production (Tons, thousands) [a]	2050 projected annual demand from energy technologies (Tons, thousands)	2050 projected annual demand from energy technologies as percent of 2018 annual production
Aluminum	60,000	5,583	9%
Chromium	36,000	366	1%
Cobalt	140	644	460%
Copper	21,000	1,378	7%
Graphite	930	4,590	494%
Indium	0.75	1.73	231%
Iron	1,200,000	7,584	1%
Lead	4,400	781	18%
Lithium	85	415	488%
Manganese	18,000	694	4%
Molybdenum	300	33	11%
Neodymium	23 [b]	8.4	37%
Nickel	2,300	2,268	99%
Silver	27	15	56%
Titanium	6,100	3.44	0%
Vanadium	73	138	189%

So where are we going to get this metal from?

- World Bank estimates indicate that >3 billion tons of minerals and metals will be needed to deploy wind, solar and geothermal power, the transition to EVs, and associated energy storage required for achieving a below 2°C future...
- Needs mining, lots of mining… but that's not the only thing.
- Not easy to rapidly ramp up production of any metal (e.g., Cu, Ni)
- Go back a few slides; there's a few odd metals on there like neodymium, lithium… where do we get these from?
- Whole range of metals like this that are generally called the critical metals that could be even more problematic for a low-CO_2 future

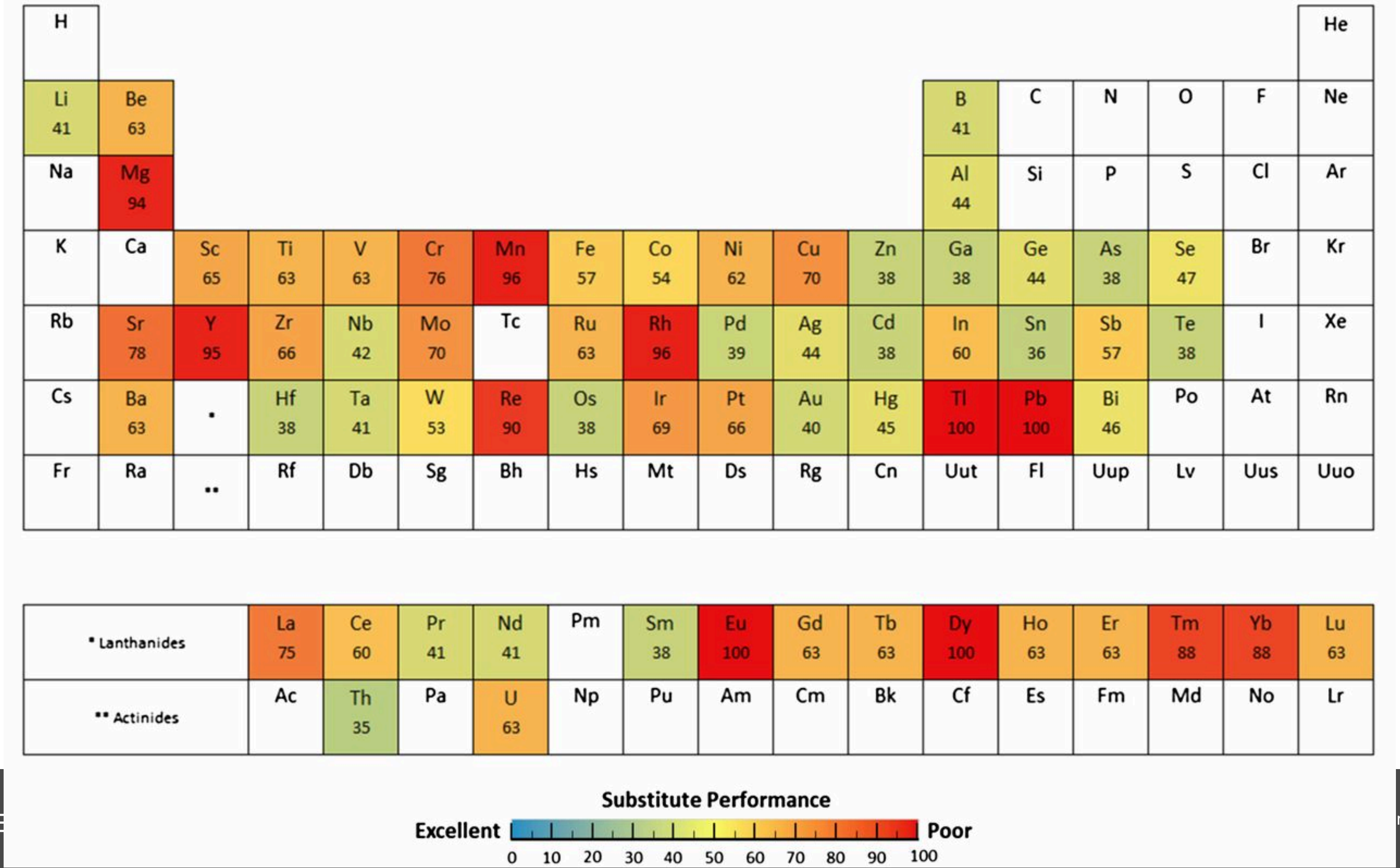
Federal Government Critical Minerals List

- US Department of the Interior, 22nd February 2022
- Aluminum, antimony, arsenic, barite, beryllium, bismuth, cerium, cesium, chromium, cobalt, dysprosium, erbium, europium, fluorspar, gadolinium, gallium, germanium, graphite, hafnium, holmium, indium, iridium, lanthanum, lithium, lutetium, magnesium, manganese, neodymium, nickel, niobium, palladium, platinum, praseodymium, rhodium, rubidium, ruthenium, samarium, scandium, tantalum, tellurium, terbium, thulium, tin, titanium, tungsten, vanadium, ytterbium, yttrium, zinc,and zirconium.
- "This list of critical minerals, while "final," is not a permanent list, but will be **dynamic and updated periodically** to reflect current data on supply, demand, and concentration of production, as well as current policy priorities."

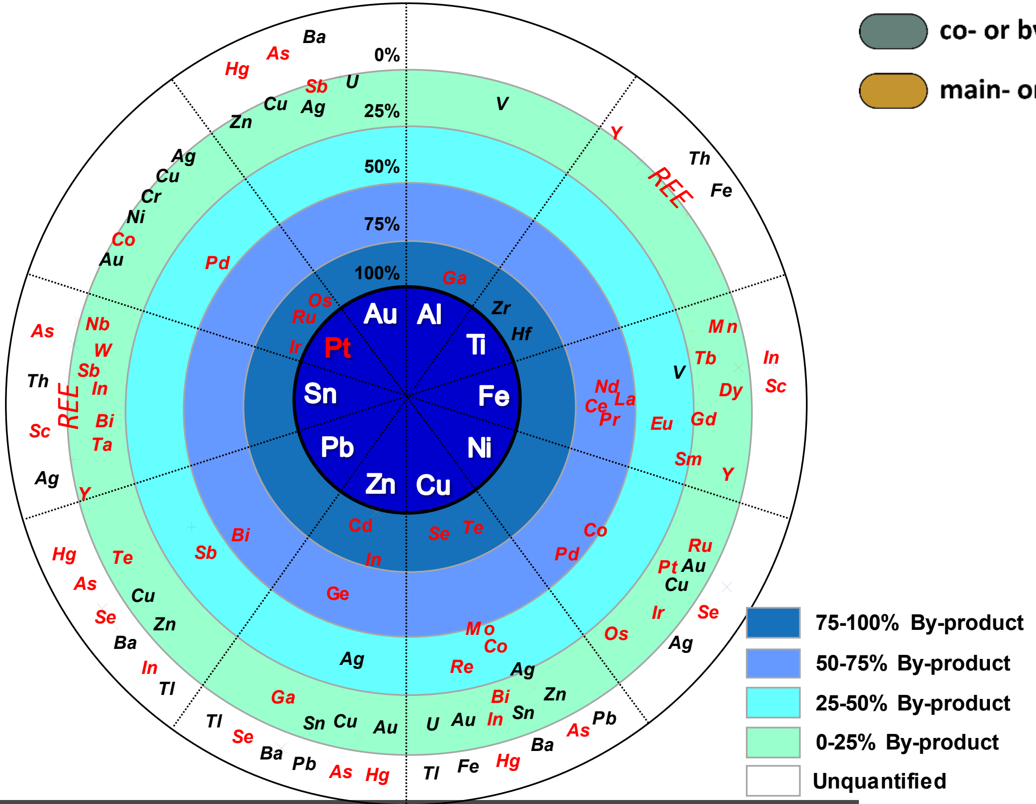
What are critical metals and why should we care?

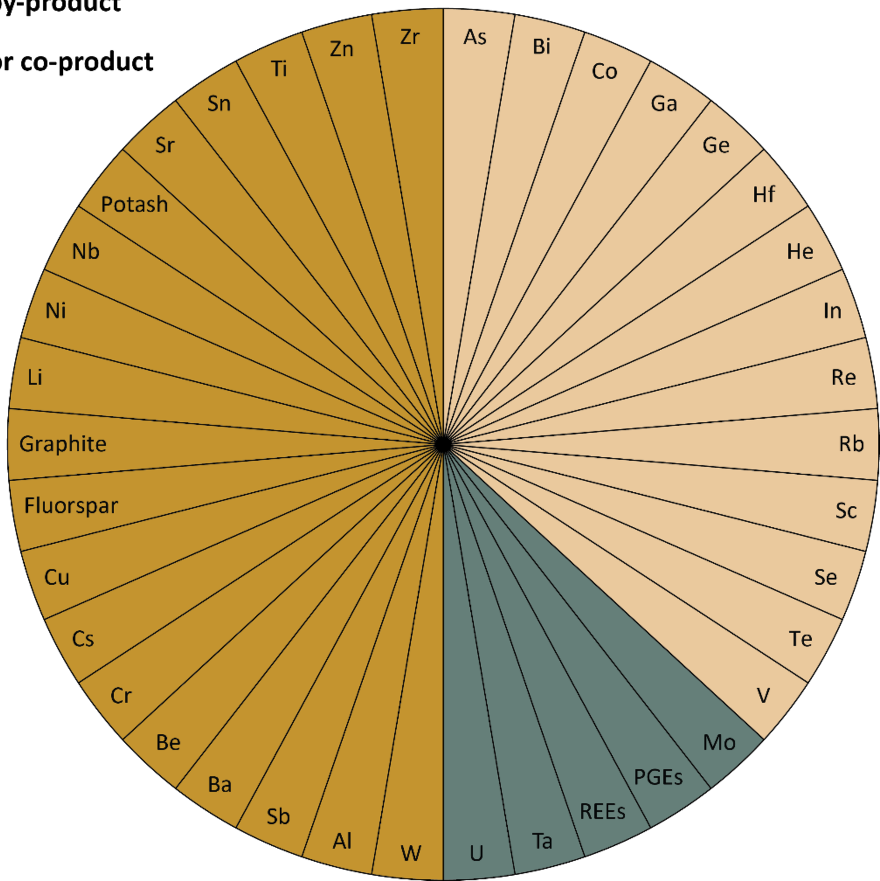
- No strict definition nor global agreement on what elements are critical
- In general, critical elements
  - Provide **essential** properties to a technology or product (**especially low-CO_2 technologies, EVs, etc; vital for climate change mitigation**)
  - Are **not easily substituted or recycled** (and recycling cannot meet increasing demand)
  - Are subject to **supply-chain risk and are often strategic** (military, energy production)
  - Few are produced as main products by mining; often dominated by extraction at smelters/refineries as by-products; uncertain what values accrues to source mine
- Importantly, we already have **significant unrealized potential** for critical metal production
  - Critical metals often deport to waste rather than being produced as a result of economics, mineral processing approaches, and insufficient knowledge of deportment
  - Resources also poorly reported, with numerous mines producing critical metals but not stating these in resource-reserve reporting

Most metals cannot easily be substituted; especially the critical metals



Critical metal companionality (left) and by- and co-products





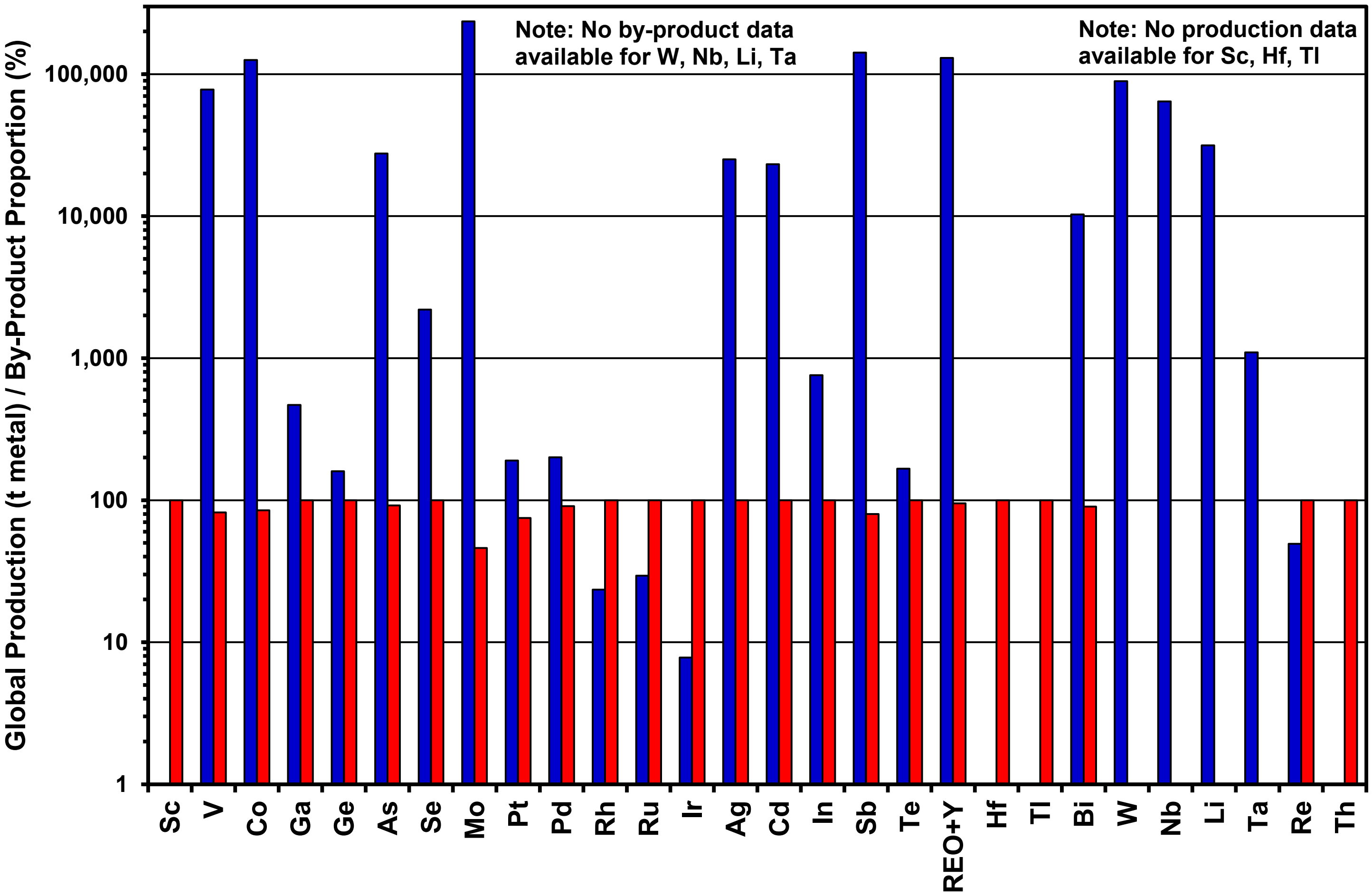
Putting it more simply

- Table below indicates which critical elements are associated with metals produced on a larger scale
- Indicates the sectors of the mining industry that the production of critical elements are reliant on
- So what? Just think about what happens if say zinc demand and production drops for some reason; we lose production of In, Ge, Cd… would limit production of touch screens, LEDs, fiber-optic cables, semiconductors, CdTe solar panels…

Copper	Zinc	Tin	Nickel	Platinum	Aluminium	Iron	Lead
Cobalt	Indium	*Niobium*	*Cobalt*	Palladium	Gallium	*REE*	*Antimony*
Molybdenum	Germanium	*Tantalum*	*PGM*	Rhodium		*Niobium*	Bismuth
PGM	Cadmium	Indium	Scandium	Ruthenium		Vanadium	Thallium
Rhenium				Osmium			
Tellurium				Iridium			
Selenium							
Arsenic							

Graedel et al., 2014

Global production of critical metals (Cu = 20.4 Mt/yr in 2018) and byproduct proportions



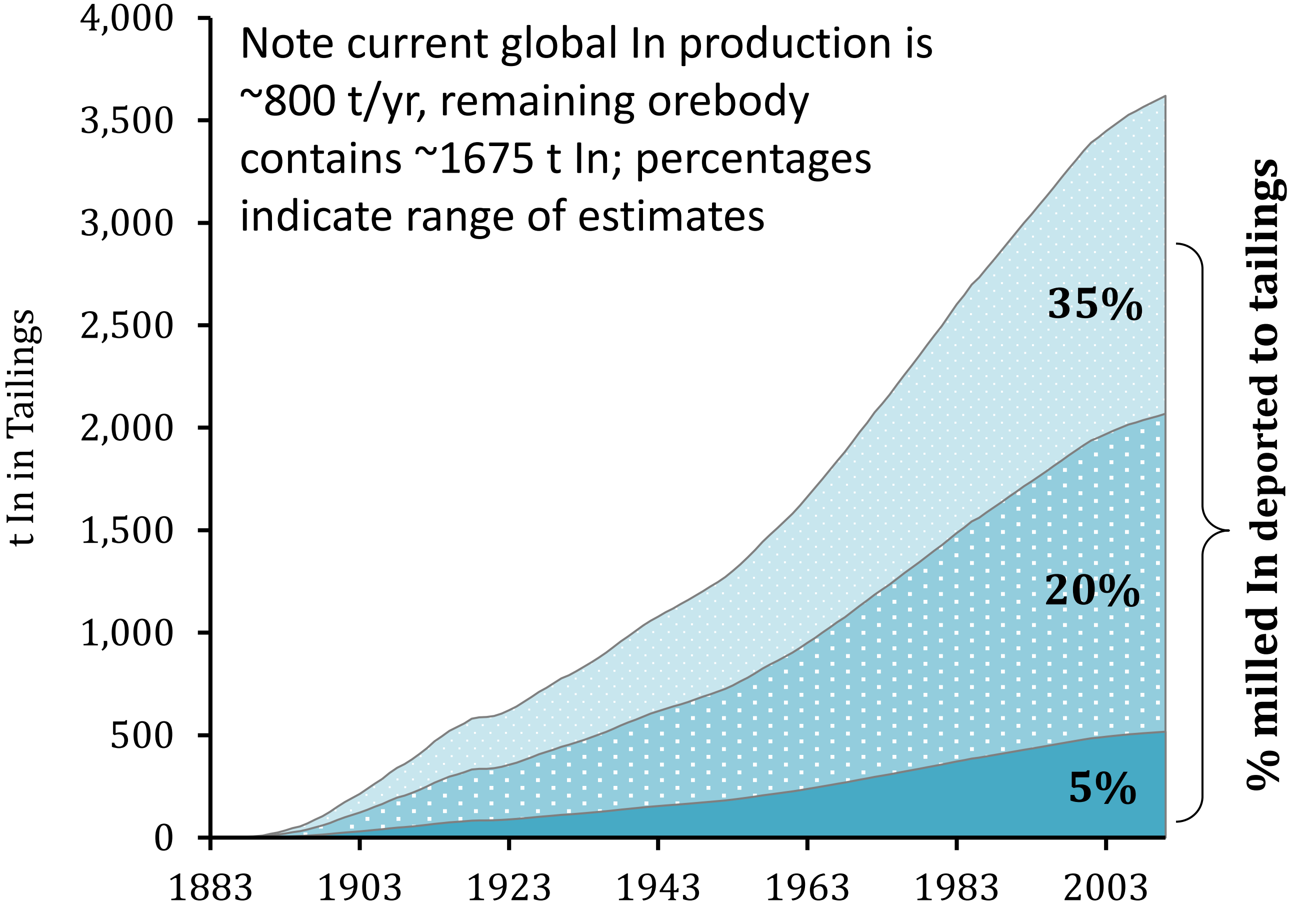
What do we know about critical metal resources?

- Few critical metal resources are well quantified
  - The PGE, REE, Indium…
- Other critical metal resources have significant uncertainties, or little to no data are available for resources/reserves and sometimes production, or contrasting data from different sources
- How can we assess the criticality of a metal or focus on security of supply without knowing where metals are coming from and how much we have already identified?
- How can we produce more of these metals and ensure their supply given their by- and co-product nature?

What do we need to know about critical metal resources?

- Global resources – baselines to predict how we can meet future demand
- Cannot also simply rely on published resource/reserve data given the lack of reporting of critical metal production
- E.g. Sierrita mine in Arizona produces rhenium but does not report this in resources/reserves
- E.g. Australian Pb-Zn deposits known to contain indium but Australian Zn refineries do not produce this critical metal; byproduct production dependent on where you ship/sell your concentrates
- Put simply, we do not know how much we have, we do not know where what we have comes from, and we do not often know how to increase production as a result

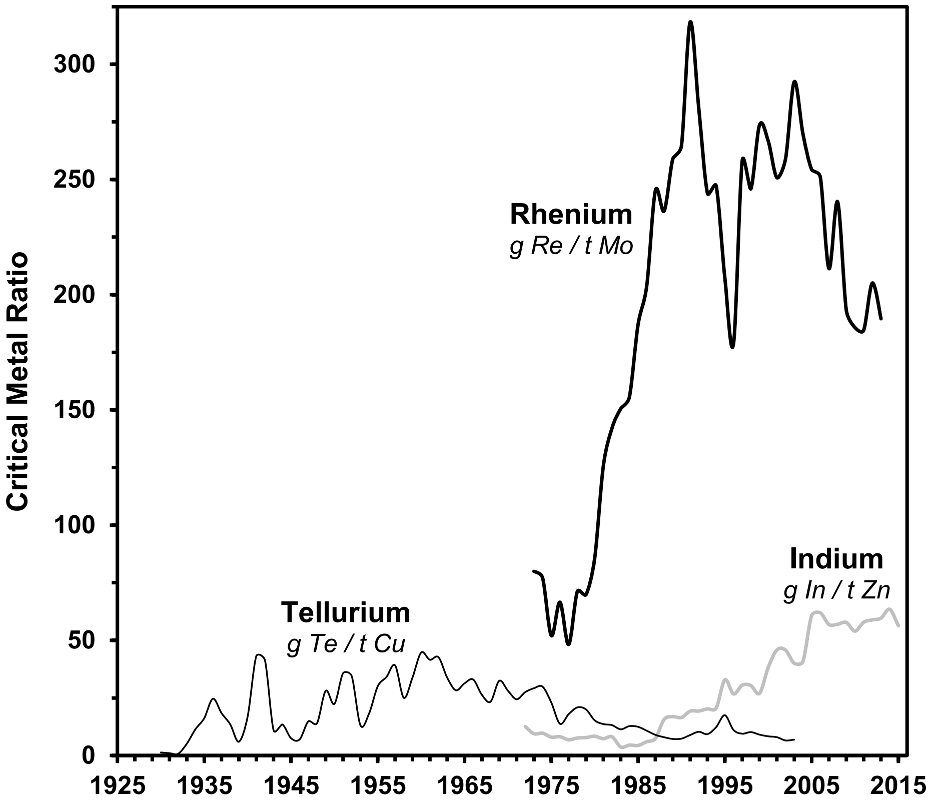
Possible secondary sources – example of indium from Broken Hill?

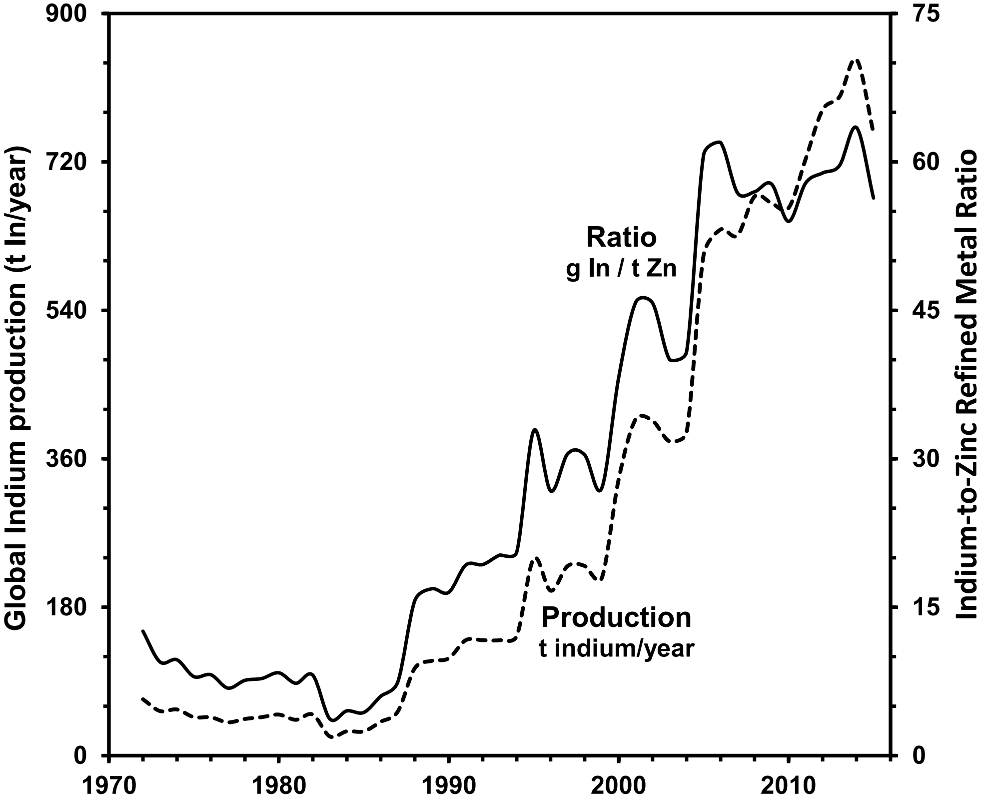


Implications for securing future supplies of the critical metals

- We are getting better at identifying and producing *some* of the critical metals
- Shown by ratios of byproducts to main products, e.g. Re to Mo, In to Zn, although Te to Cu has decreased (SXEW vs smelting?; the former does not produce Te)
- Economic decisions almost certainly control this, but probably not relating to the critical metals?
- E.g. whether concentrates containing In are sent to a Zn refinery that can produce In depends on Zn economics, not In economics
- Shows the range of challenges we need to meet (and need to undertake research in) to have a chance of meeting CO_2 targets
- All of this can add value to projects as shown by tellurium

Primary-byproduct ratios and impact on critical metal production





Examples of potential value add (based on tellurium proxies)

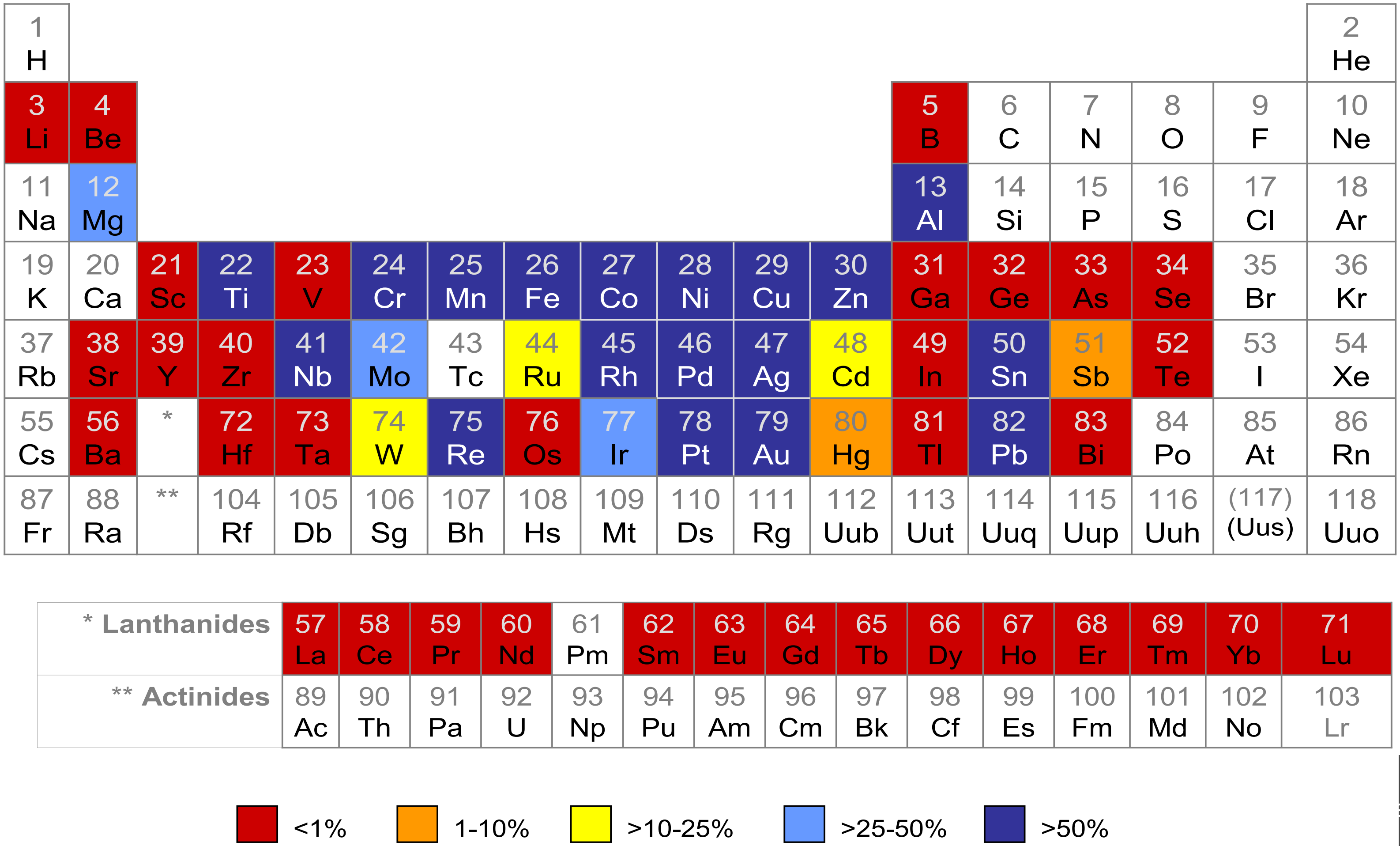
- Current UNLV project focused on Te potential of precious and base metal operations
- Small selection showing the by-product potential of selected operations
- Note this is only Te and only a handful of the 100+ operations we have developed proxies for
- Significant potential to positively affect value and perception of operations

Mine	Company	Country	Product	Te Proxy(s)	Te proxy grade (g/t)	Te proxy Content (t/yr)	Te proxy value add (mUSD)	% of AISC	Recovery Method	Gold Ore Pre-Treatment	Con Export
Chelopech	Dundee Precious Metals	Bulgaria	Cu-Au, Pyrite cons	Assay, Mineralogy	**36.9**	**81.3**	**$5.69**	**6.5%**	Flotation	none	Tsumeb, Namibia
Bingham Canyon**	Rio Tinto	USA	Cu-Au con	Assay	**0.8**	**32.3**	**$2.25**	**0.5%**	Flotation	none	Kennecott, USA
Cadia	Newcrest	Australia	Au doré (15%) Cu-Au con	Assay	**8.4**	**246.1**	**$17.2**	**20.36%**	Flotation, Free-Au	none	East Asia
Telfer	Newcrest	Australia	Au doré (25%) Cu-Au con	Assay, Mineralogy	**1.7**	**37.5**	**$2.6**	**0.7%**	Flotation, Cyanide	none	East Asia
Kensington	Coeur Mining	USA	Sulfide Au con	Assay, Mineralogy	**1.9**	**1.1**	**$0.07**	**0.07%**	Flotation	none	China

But hold on, what about recycling?

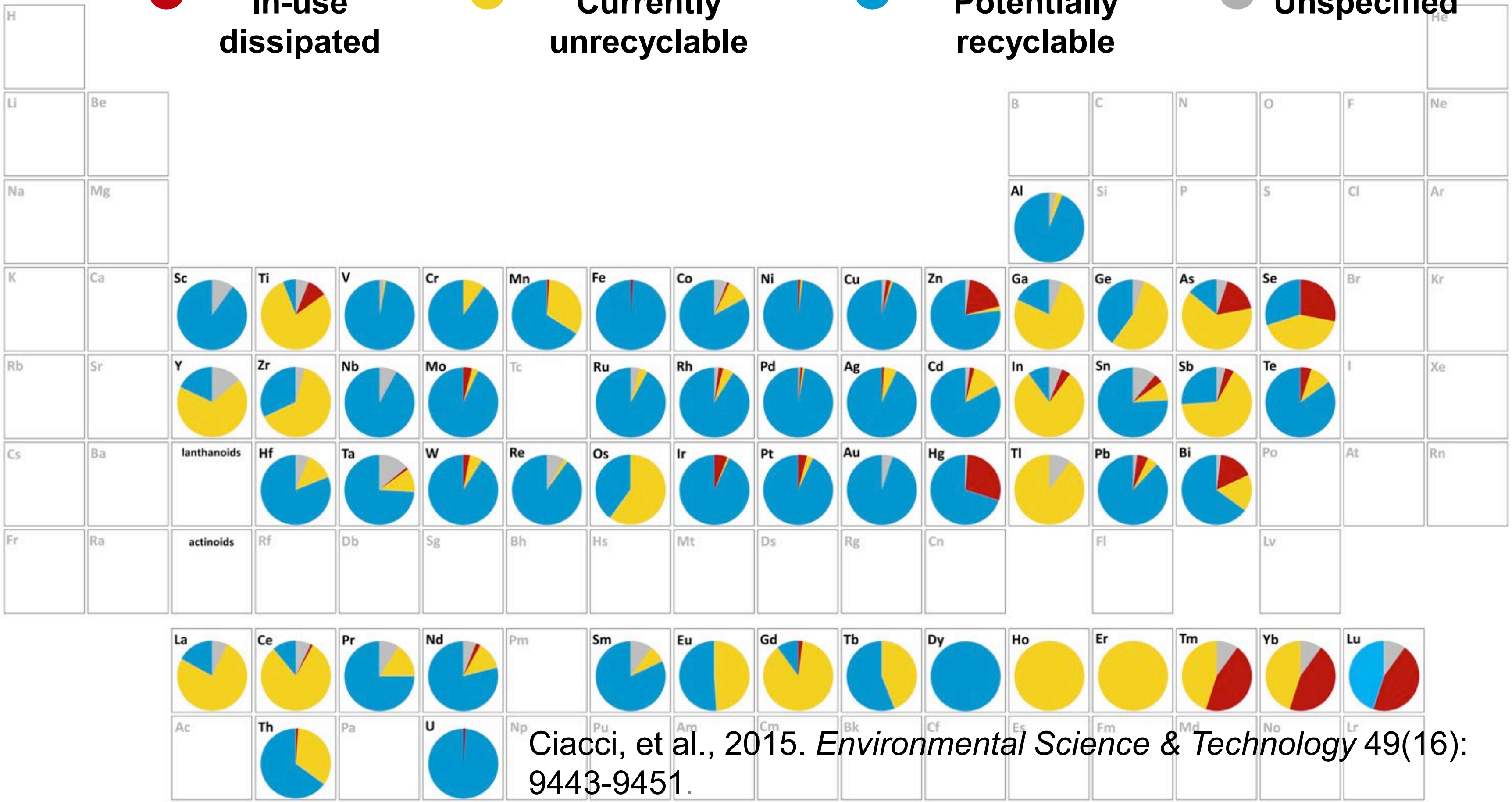
- But why can’t we recycle these metals?
- It’s a great idea, and we recycle a lot…
- …but not all metals can be recycled…
- …significant barriers to recycling of some metals (e.g., design, technological and logistical barriers)…
- and recycling cannot always meet increasing demand
- Equally product design means that a lot of the metals within waste materials simply are not designed for recycling – end up in landfills
- Metals and minerals also cannot generally be substituted for each other as mentioned before

Typical end-of-life recycling rates



Recycling potential

In-use dissipated | Currently unrecyclable | Potentially recyclable | Unspecified



Ciacci, et al., 2015. *Environmental Science & Technology* 49(16): 9443-9451.

Other challenges to think about

- It doesn't just stop there…
- **Finding the mineral deposits we need** – not easy
- **Ensuring we make the most of these deposits** – not easy again
- **Waste rock and tailings**; need to store these securely and make the most of them (e.g. CO_2 sequestration) given increased mining
- **ESG issues** – environmental, social and governmental challenges to mining and ensuring mining is as sustainable as possible
- **NIMBYs and BANANAs**… you cannot have solar power and Tesla vehicles without raw materials, so there needs to be some acceptance that mining is required and that metals need to be smelted/refined/etc. You cannot just continue to ship it to other countries for processing and then get the manufactured products back for a huge number of logistical, security of supply, cost, geological, and social justice/exploitation reasons, among many others; equally this is a big loss in value add
- **Not just mining**; concrete and cement – huge CO_2 producer, yet we don't have a solution
- **Metallurgical coal** – still needed, although some developments here too

Other challenges to think about

- Most critical metals and minerals will never be significant enough for major mining companies to target; low probability of transformational change (e.g., Sykes et al., 2016)
- This means that effective policymaking will be key, and we need to do much more than current actions (e.g. Jowitt, 2021)
- Developments between geopolitically friendly countries will also be important to secure supplies of critical metals and minerals to meed domestic demand
- Also significant potential for domestic exploration and mine development but compared to other countries and regions (e.g., Western Australia) parts of the US and indeed the world are way behind in precompetitive data, streamlining of processes, permitting, etc.

Mining and climate change

- The bottom line is if you want to do anything meaningful about climate change, you will need to **mine more minerals and metals**
- Creates other questions and problems (and opportunities)
- **Where will we find these metals and minerals?**
  - Understand the geological processes that form mineral deposits
  - Increase the efficacy of mining in terms of recovery and energy use
  - We don't just have to mine natural deposits – landfills, mining waste…
  - How long will this take (exploration, discovery, permitting….)
- **What impact will this metal extraction have?**
  - Environmental, social, governmental challenges (benefits?) and risk
- **How can we do this?**
  - Needs education, research and discussion on all sides and beyond the industry – and we need to understand the problems we face. We are already doing some of this in Geoscience at UNLV (yes, it's a plug)

Mining and climate change

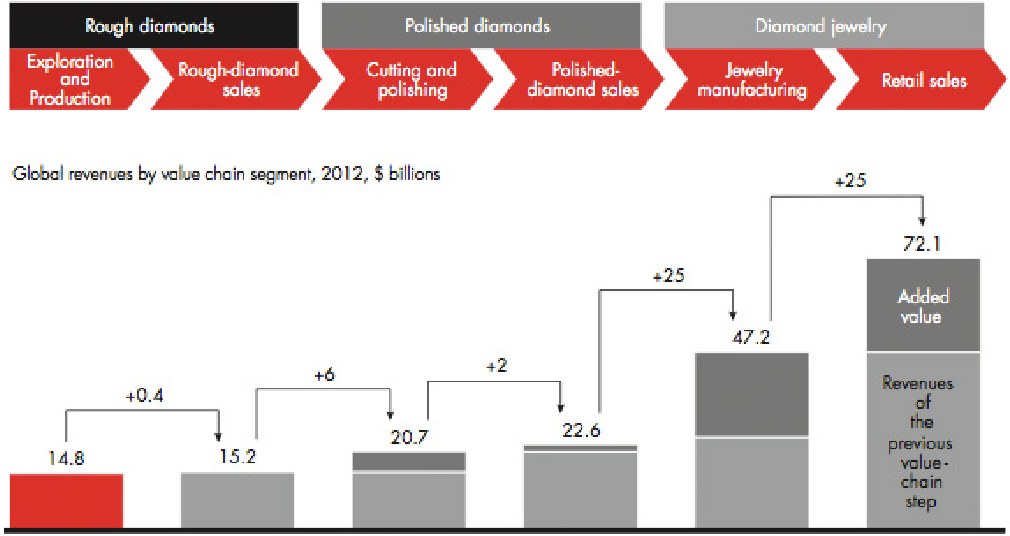
- So if you've not already been convinced, I emphasize again that every single person listening to this talk **needs mining**
- The devices you use for work and entertainment, the electricity you use, the car you drive, the house or apartment you live in, and all of the modern conveniences you use require minerals and metals
- Any sustainable future with reduced anthropogenic climate change and lower CO_2 emissions will be built on the back of the mining industry
- No point having electric vehicles fuelled by electricity generated from coal – worse impact than many petrol vehicles
- If your immediate attitude is "climate change doesn't exist", then the world is moving towards renewable energy and electric vehicles anyway; this is the chance for the US, Nevada, and Colorado to be world leaders. **Demand for these metals will increase;** does the US want to be the world's supplier of raw materials or a home of some of the high-tech manufacturing that is currently in China? If the latter, there needs to be some rethinking of where ores are processed…

So what about mining value chains?

- Where is value added along the mining chain from mining through processing and manufacturing?
- Where will critical metal concentrates be processed and refined (and value added)?
- For example, REE concentrates from Mountain Pass in CA are processed in China, concentrates from Mt Weld in Australia are processed in Malaysia…
- What implications does this have for the US economy, for Australia…?

The Mt Weld Central Lanthanide Deposit (CLD) is one of the highest grade rare earth deposits in the world. Mt Weld also hosts the undeveloped Duncan (rare earth), Crown (niobium, tantalum, titanium, rare earths, zirconium) and Swan (phosphate) deposits.

Lynas processes the CLD ore at the Mt Weld Concentration Plant to produce a rare earth concentrate that is sent for further processing at Lynas Malaysia's Advanced Material Plant near Kuantan, Malaysia.



Already seeing changes?

Australian government promises road map for processing critical minerals — but challenge is enormous

Robin Bromby

8-10 minutes

Is the Australian Government's new critical minerals plan too little, too late?

Love 'green' energy? Tellurium for solar panels will be mined in Utah

Amy Joi O'Donoghue

5-7 minutes

It is eight times rarer than gold, in high demand for its use in photovoltaic solar cells and will soon be recovered in Utah at Rio Tinto's Kennecott mine as a byproduct of copper smelting.

Tellurium is one of the least common elements on Earth, but the company later this year plans to begin recovery operations, with the capacity to produce 20 tons per year.

The recent announcement by Rio Tinto means there will be a new North American supply chain for the critical mineral, which after it is alloyed with other elements such as cadmium, forms a compound with enhanced electrical conductivity.

The thin films from the compound efficiently convert sunlight into electricity. Tellurium also can be added to steel and copper, making them easier to cut, and is used in the manufacturing of night vision goggles for the military.

Already seeing changes?

latimes.com

Rio Tinto starts making lithium in California from mining waste - Los Angeles Times

David Stringer

4-5 minutes

Rio Tinto Group is starting pilot production of lithium in California, sifting through old mining waste instead of excavating new areas, as the electric car battery revolution fuels demand for the material.

Work to reprocess waste piles from a 90-year-old mining site in the Kern County community of Boron has produced lithium carbonate — needed in rechargeable batteries for electric vehicles and consumer technology, Rio said this week. Efforts are now focused on improving quality and lifting volumes, the company said.

A pilot plant being assembled at Boron under a $10-million first phase is expected to produce about 10 metric tons a year of lithium carbonate equivalent by chemically processing material from the pile of mining waste.

The company will consider expanding to become the top domestic supplier in the United States.

Rio Tinto says it can extract strategic mineral from metal plant processing waste

Reuters Staff

2-3 minutes

FILE PHOTO: The Rio Tinto logo is displayed on a visitor's helmet at a borates mine in Boron, California, U.S., November 15, 2019. REUTERS/Patrick T. Fallon

(Reuters) - Rio Tinto Plc said on Wednesday it has developed a process to extract the rare earth scandium from its titanium dioxide production process and is studying ways to commercially produce the mineral.

The move is the latest example of Rio taking a second look at the waste from its core mining business in an effort to reprocess it and produce so-called strategic minerals and rare earths, a grouping of 17 minerals used to make electronics.

Will Thacker Pass be another Keystone? | Nevada Current

By: Jeniffer Solis - September 16, 2021 6:54 am

6-8 minutes

After tribes secured the death of the Keystone XL pipeline, Native organizers in Nevada are looking to get the same results for the planned Thacker Pass lithium mine.

Excavation on sacred native lands was allowed to proceed at the Thacker Pass project earlier this month after a federal judge denied tribal leaders' requests to temporarily halt digging.

Now, opponents of the Thacker Pass lithium mine are regrouping to plan their next steps to oppose the mine, including an appeal of the court's decision, and possible direct action, such as occupation of the site.

Will Falk, the attorney for the three tribes fighting the mine, said U.S. law is written to prioritize mining over environmental and cultural concerns, making the chance to win an appeal difficult.

"Stopping the Thacker Pass mine will require more than just legal tactics," Falk said.

Not easy being green?

Serbia may decide fate of Rio Tinto's lithium project in referendum

Cecilia Jamasmie | June 7, 2021 | 3:16 am Battery Metals Top Companies Europe Lithium

The Jadar project has an estimated production capacity of 55,000 tonnes per year.(*Image courtesy of Rio Tinto.*)

Serbia's President, Aleksandar Vucic, may seek voter approval for Rio Tinto's Jadar lithium project near the city of Loznica, in western Serbia, as community opposition grows.

Speaking on local TV on Monday, Vucic said the government fully supports the project, which could become Serbia's second largest export earner once developed. He also said his administration won't let it happen if it doesn't get the people's approval first.

Jadar has been facing local opposition due to heritage issues. Its footprint covers the area around Paulje, a Bronze Age archaeological site, as well as several classified natural monuments.

BELGRADE, Jan 20 (Reuters) - Serbia revoked Rio Tinto's (RIO.L) lithium exploration licences on Thursday, bowing to protesters who opposed the development of the project by the Anglo-Australian mining giant on environmental grounds.

Serbian Prime Minister Ana Brnabic said the government's decision came after requests by various green groups to halt the$2.4 billion Jadar lithium project which, if completed, would help make Rio a top 10 lithium producer.

"All decisions (linked to the lithium project) and all licences have been annulled," Brnabic told reporters after a government session. "As far as project Jadar is concerned, this is an end."

Earlier this week, Rio had pushed back the timeline for first production from Jadar by one year to 2027, citing delays in key approvals. read more

Rio Tinto said it was "extremely concerned" by Serbia's decision and was reviewing the legal basis for it.

The company committed to the project just last year, as global miners pushed into the metals needed for the green energy transition, including lithium, which is used to make electric vehicle batteries.

Communities in Serbia want Rio Tinto to LEAVE

Apr 8, 2021 | Actions

Rio Tinto's plans to construct the Jadar lithium mine in Serbia have met with stiff opposition. Communities living on the land where the mine, its associated tailings storage, and power plant are due to be constructed have a simple and clear demand for Rio Tinto; LEAVE.

Below you'll find a letter from those communities. You can lend them a hand in making their voice heard by filling in the form and sending their demands straight to Rio Tinto's CEO!

CEO of Rio Tinto Group,
r and Rađevina, Serbia, Balkans and the World are sending you the following message
l read it, accept it and act on it, in line with your new host community and cultural

ttention to a number of salient facts surrounding this mining project: We would like
the valley of Jadar and Radjevina together with the surrounding areas, are a unique

23rd March 2022

Red tape vs. green minerals?

Staggering $1.5 billion lithium deposit discovered in western Maine, but excavating it may pose a challenge

Kate Cough

17-22 minutes

NEWRY — The richest known hard rock lithium deposit in the world lies a few miles northeast of the ski slopes of Sunday River and not far from Step Falls, where swimmers can wade in shallow pools formed by hundreds of feet of cascading granite ledge.

Smaller deposits have been known in Maine for decades, but this recent discovery, just north of Plumbago Mountain in Newry, is the first to have a major resource potential.

Lithium, the world's lightest metal, is a primary component of lithium-ion batteries, which are used in electric cars, most of the world's smartphones and laptops and as excess energy storage for solar and wind farms. Lithium-ion batteries are prized for being lightweight and rechargeable; they require little maintenance and can store 10 times the amount of energy stored by traditional lead-acid batteries.

And that potential is staggering: At current market prices, the deposit, thought to contain 11 million tons of ore, is valued at roughly $1.5 billion. Measuring up to 36 feet in length, some of the lithium-bearing crystals are among the largest ever found.

"We know that the Maine mining laws are such that there's not one single active mine in Maine," said Mary Freeman, who owns the land with her husband, Gary, a co-author on the paper describing the find.

"We'd have to get clarification from the state," said Freeman, when asked whether the couple planned to apply for a mining permit. "They don't have an area of the rule that explains this kind of work."

Maine's metallic mining law was designed to protect the state's natural resources and keep its water clean. But the state, and its residents, will also need lithium-ion batteries to store energy from wind and solar panels, and run electric vehicles.

Yet lithium is a metal, and state regulations passed in 2017 prohibit mining for metals in open pits of more than three acres, which would be the only way to cost-effectively extract lithium at Plumbago North.

"I don't know of any underground and manganese or lithium mines in the world," said Dr. John Slack, a geologist who co-authored a separate upcoming paper on critical minerals in Maine.

"Because those metals have a relatively low cost, in terms of their concentration per ton or per ounce, you need to excavate large volumes of rock cheaply in order to economically and profitably produce the metal you're interested in."

What's the right level of regulation?

Commercial mining has resulted in a long list of disasters, from collapses and explosions to rivers dyed a sickly shade of orange.

Some of the gravest environmental concerns revolve around mining for base metals — such as copper, lead and zinc — which often occur in bands of rock rich in iron sulfides. When exposed to air or water, iron sulfides create sulfuric acid. And once the production of sulfuric acid has begun, it can be difficult to stop, polluting waterways for decades, a phenomenon known as acid mine drainage.

Spodumene at Plumbago North. Spodumene is a mineral that contains lithium oxide, from which lithium can be extracted. Photo courtesy of William Simmons.

Indeed, Maine's most famous mines are perhaps better known for their aftermath than what they produced.

In the late 1960s, the Callahan Mining Corporation was given permission to drain a 75-acre coastal estuary in the town of Brooksville and turn the area into an open-pit mine. The company extracted roughly 800,000 tons of copper and zinc before flooding the area, turning it into Goose Pond.

The former mine is now a Superfund site, and a 2013 study by researchers at Dartmouth College found widespread evidence of toxic metals in nearby sediment, water and fish. Cleanup costs, borne by taxpayers, are estimated between $23 million and $45 million.

How realistic are policymakers' targets?

santafenewmexican.com

PNM warns of potential 'brownouts' in summer 2022 due to San Juan shutdown, solar projects not being finished

Rick Ruggles rruggles@sfnewmexican.com

4-5 minutes

Public Service Company of New Mexico executives carried a stark message Wednesday about a potential power shortage next summer because of the closure of San Juan Generating Station.

Speaking to the New Mexico Public Regulation Commission, they described a disconcerting situation for June 2022. The executives — Tom Fallgren, Ron Darnell and Mark Fenton — said they continue to work on solutions.

Commission Chairman Stephen Fischmann of Las Cruces introduced the possibility of a "brownout" next summer, or a situation in which electricity would be temporarily diminished for some customers.

"You don't want to dwell on doomsday scenarios," Fischmann said, alluding to how uncomfortable that topic is for PNM.

Fallgren said PNM practices for scenarios, such as brownouts, have detailed procedures to handle them and prioritize power for places such as hospitals.

PNM has contracts with companies to provide solar panels and other elements to replace the energy lost with the anticipated closure of the coal-fueled, polluting San Juan Generating Station.

But PNM said the coronavirus pandemic has had a profound impact on supplies, such as microchips and steel. The companies expected to build solar facilities have warned PNM that they most likely will not be ready by June 2022.

news.sky.com

Global lithium shortage could put brakes on UK electric car sales acceleration

Sky

5-6 minutes

The brakes could be put on the UK's accelerating electric vehicle sales because of a worldwide shortage of lithium needed for car batteries, experts have warned.

The importance of securing a supply of the vital metal was highlighted as carmakers pour billions of pounds into electrifying their future fleets.

It comes as the industry is already wrestling with a shortage of semiconductor chips.

Please use Chrome browser for a more accessible video player

May: The hunt for lithium in Cornwall

The UK is one of the fastest growing electric vehicle (EV) markets in Europe, with plug-in vehicles accounting for 11% of British sales.

According to the Society of Motor Manufacturers and Traders, battery electric vehicle sales rose 186% to 108,000 last year, while plug-in hybrid electric vehicles increased 91%.

Climate Change: Half US cars to be zero-emission by 2030 - Biden

6 hours ago

Climate change

GETTY IMAGES

President Biden wants half of cars sold in the US by 2030 to be zero-emission vehicles, the White House says.

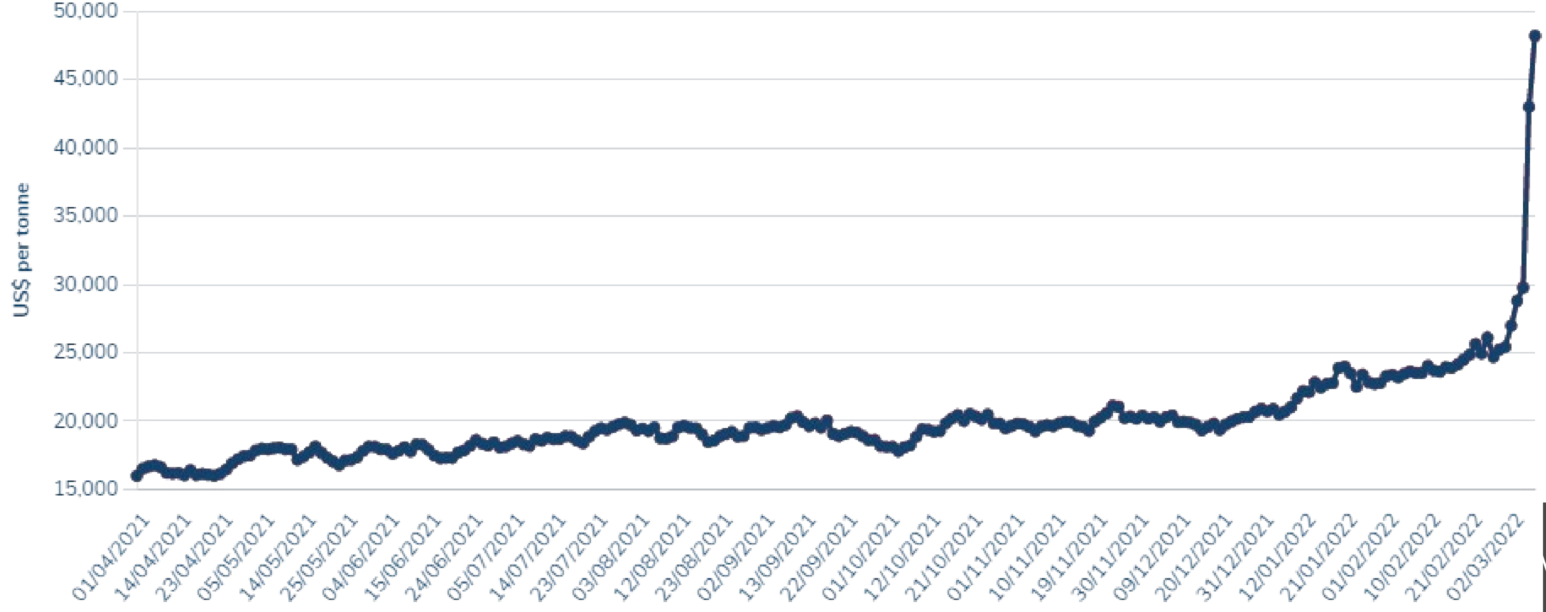
Achieving this would reduce carbon emissions and help the US compete with China, a statement said.

Transport accounted for 29% of US emissions in 2019. Sales of zero-emission vehicles in the US lag behind those in Europe and China.

The three biggest US carmakers have welcomed the target, though it is not legally binding.

Geopolitical influences – nickel considered critical by USA

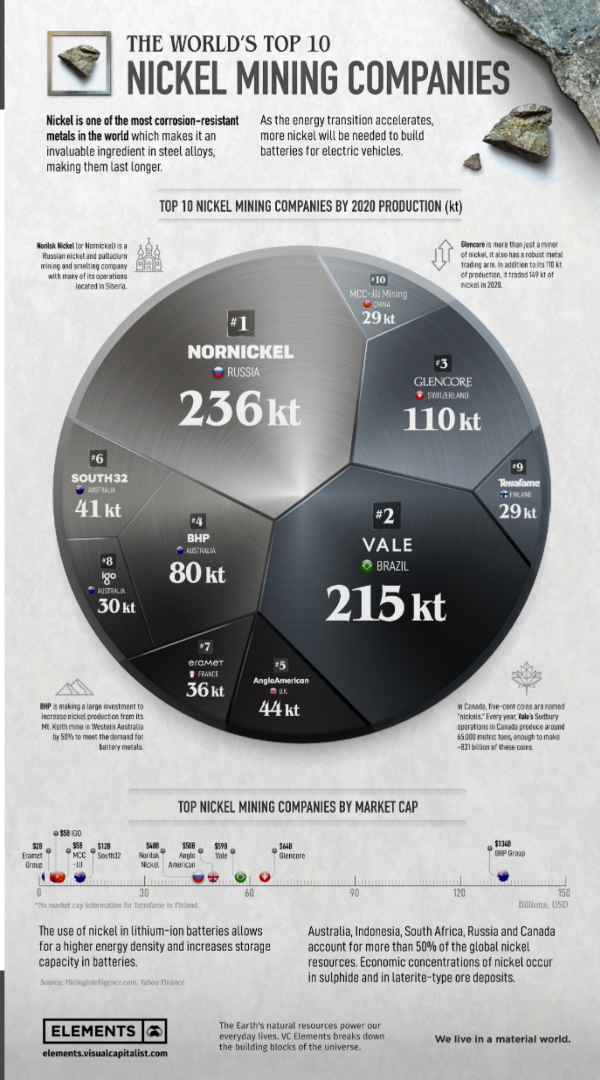
- Russia-Ukraine conflict and associated sanctions likely to have a big effect on commodity prices over at least short- to medium-term, perhaps long term
- Seeing this already with nickel (and copper, and the PGE…)



Geopolitical influences

- London Metal Exchange stopped nickel trading on 8th March after the price reached >$100,000/t; quadrupling in price
- Cancelled around $3.9 billion in nickel trades, retrospectively
- Demonstrates geopolitical influence on global commodities, and not likely to end soon
- Not just nickel, but also global supply of the PGE, diamonds, antimony, cobalt, aluminum, potash, tellurium, and more will likely be influenced by this conflict

	Mine production	
	2020	2021[e]
United States	16,700	18,000
Australia	169,000	160,000
Brazil	77,100	100,000
Canada	167,000	130,000
China	120,000	120,000
Indonesia	771,000	1,000,000
New Caledonia[8]	200,000	190,000
Philippines	334,000	370,000
Russia	283,000	250,000
Other countries	373,000	410,000
World total (rounded)	2,510,000	2,700,000



Conclusions

- So what now?
- We need more conversations and discussion of this, rather than just saying we need to reduce CO_2 emissions
- Need more research, education, outreach, and consideration of these things during policy development
- Need more open conversations from all sides about this rather than ignoring it; the public needs to know the cost of “being green” and the role of mining…
- You can talk all you want about how we need to combat climate change, and make policy to achieve this, but if you do not understand and accept the mineral and metal costs of this, you are only halfway there… my two cents anyway

Any questions?

- If not now, can always email me at simon.jowitt@unlv.edu

- Happy to pass on papers and this powerpoint and continue this discussion

- Much more information available than I can present in this time slot (I have numerous hidden slides that I had to cut!). If you want any more on any of the material I've talked about, let me know.