Critical Minerals

The Economic and Public Policy Contexts

Rod Eggert

November 8, 2021

Critical Minerals Workshop
Oklahoma Geological Survey

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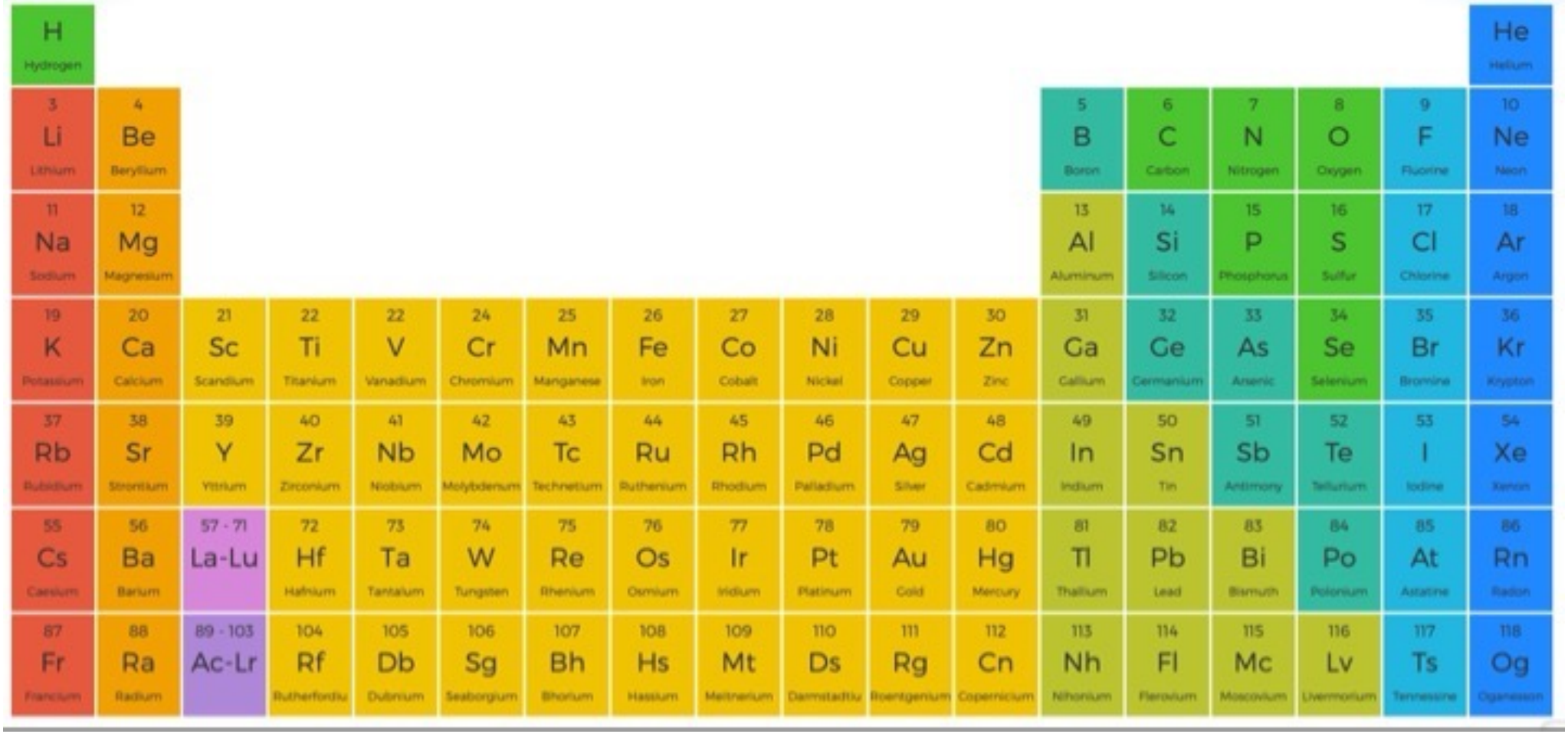
Starting Point:
What is a *Critical* Mineral?

Critical = indispensable, vital

Most of the 1st 83 elements in the periodic table are vital to someone



Source: mineralseducationcoalition.org

A narrower definition

Essential functionality (i.e., indispensable)

Difficult substitution

Supply-chain risks

Spices and vitamins of modern engineered materials

Sources:
https://www.freeimages.com/photo/spices-1-1328086
https://www.freeimages.com/photo/vitamin-s-pill1-1259285

US list - draft 2021

Not copper – US output, more-diverse production

- Gallium
- Niobium
- Cobalt
- Neodymium
- Ruthenium
- Rhodium
- Dysprosium
- Aluminum
- Fluorspar
- Platinum
- Iridium
- Praseodymium
- Cerium
- Lanthanum
- Bismuth
- Yttrium
- Antimony
- Tantalum
- Hafnium
- Tungsten
- Vanadium
- Tin
- Magnesium
- Germanium
- Palladium
- Titanium
- Zinc
- Graphite
- Chromium
- Arsenic
- Barite
- Indium
- Samarium
- Manganese
- Lithium
- Tellurium
- Nickel
- Beryllium
- Zirconium

- Cesium
- Erbium
- Europium
- Gadolinium
- Holmium
- Lutetium
- Rubidium
- Scandium
- Terbium
- Thulium
- Ytterbium

Note: In rank order from top to bottom and then left to right; elements starting with cesium were not rank ordered.

Source: Nassar and Fortier 2021 (USGS Open-File Report 2021-1045)

The Economic Context

Something important is at risk

Financial Times, October 22, 2020

Tesla's move into mining aimed at energising battery supply chain

March 30, 2021

"What is 'critical' depends on who you are, where you are, and when you ask"

- Alex King

World, national, company, technology

Each element has its own story

Lack of supply chain diversity
Geopolitical risks
Co-production risks and opportunities
Technology risks
Entry barriers
Opaque markets
Etc.

The time dimension often is ignored

Short-term risks v.
Long-term availability

Consider the energy transitions

Critical minerals and the energy transitions

Broad context

- Demand
  - Will increase quickly and substantially for some materials, although at what rate and by how much is uncertain
- Supply
  - Is characterized by supply chains that often are fragmented, concentrated, small, opaque
  - May not grow ‘appropriately’ to meet growing demands (sufficiently, affordably, sustainably, responsibly)
- The Fear
  - Lack of ‘appropriate availability’ will become an obstacle to clean energy transitions

Electronic materials

e.g., solar applications, power electronics

Gallium, indium, selenium, silver, tellurium, tin

Source: pexels.com

Magnets & motors

Wind turbines, EVs, other industrial and household uses

Selected rare earths

Source: pexels.com

Energy storage & batteries

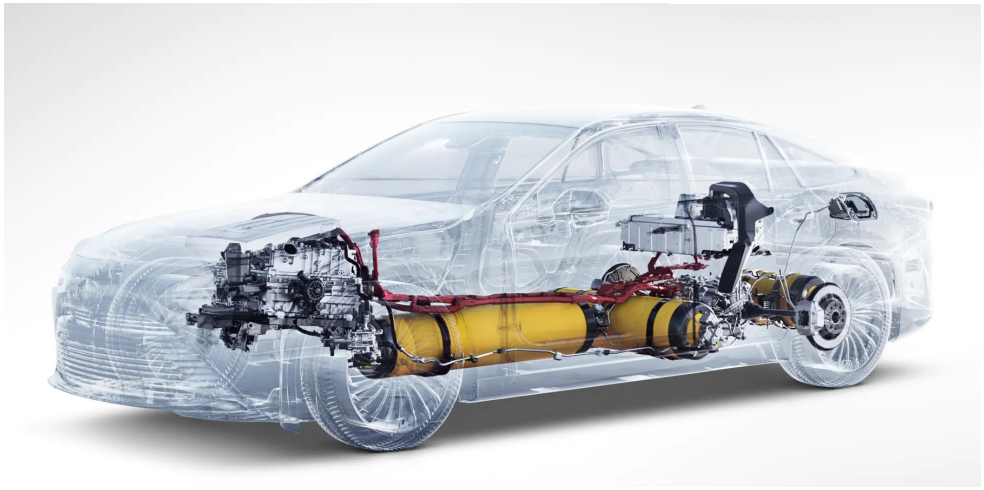
Lithium ion, solid-state lithium, sodium ion, flow, etc.

Lithium, nickel, cobalt, manganese, graphite, vanadium, sodium, lead, etc.

Sources: new.siemens.com, amazon.com, telegraph.co.uk

Fuel cells

Platinum-group elements, selected rare earths



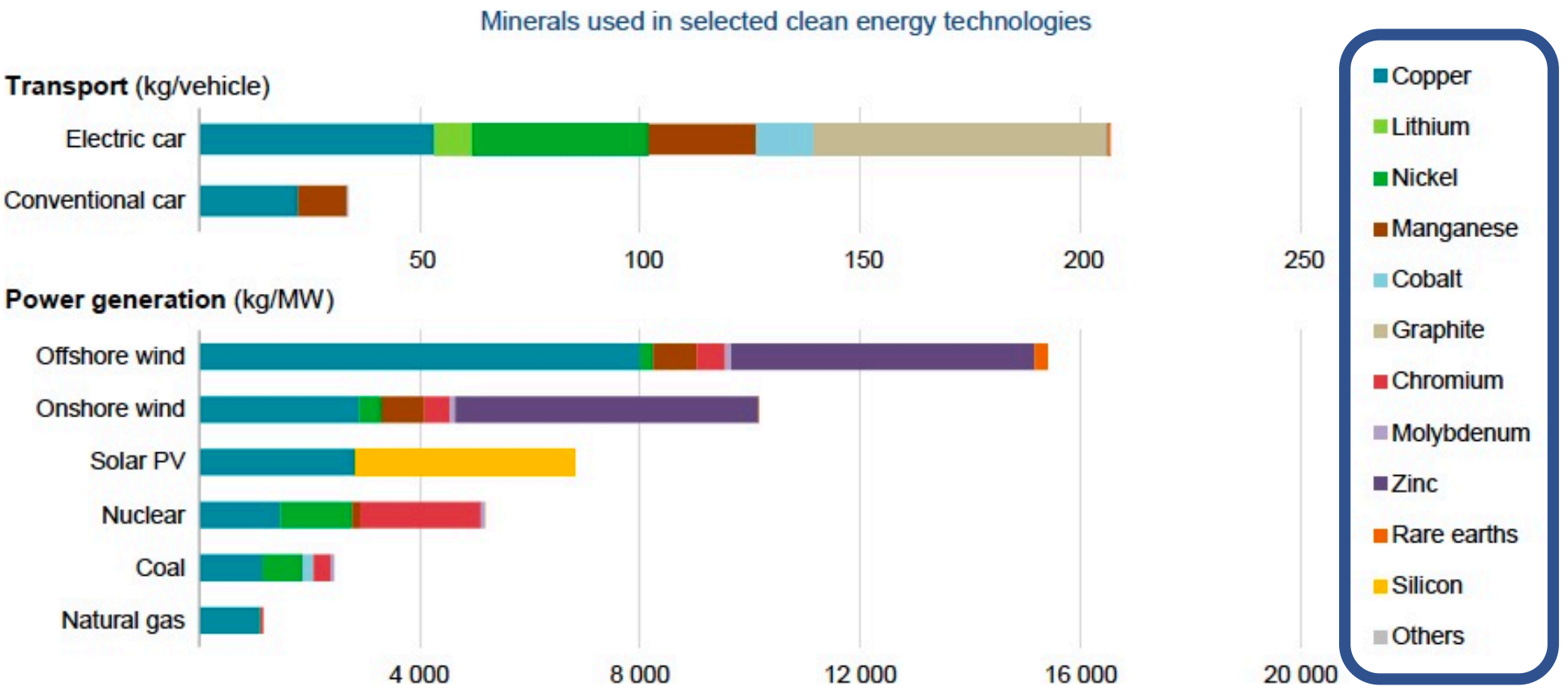
Source: Toyota.com

Nuclear

Cobalt, dysprosium, gadolinium, hafnium, indium

Source: Photo by Patrick Federi on Unsplash

Demand for some mineral-based materials will increase significantly



Notes: kg = kilogramme; MW = megawatt. Steel and aluminium not included. See Chapter 1 and Annex for details on the assumptions and methodologies.

Source: iea.org (*The Role of Critical Minerals in Clean Energy Transitions*, 2021)

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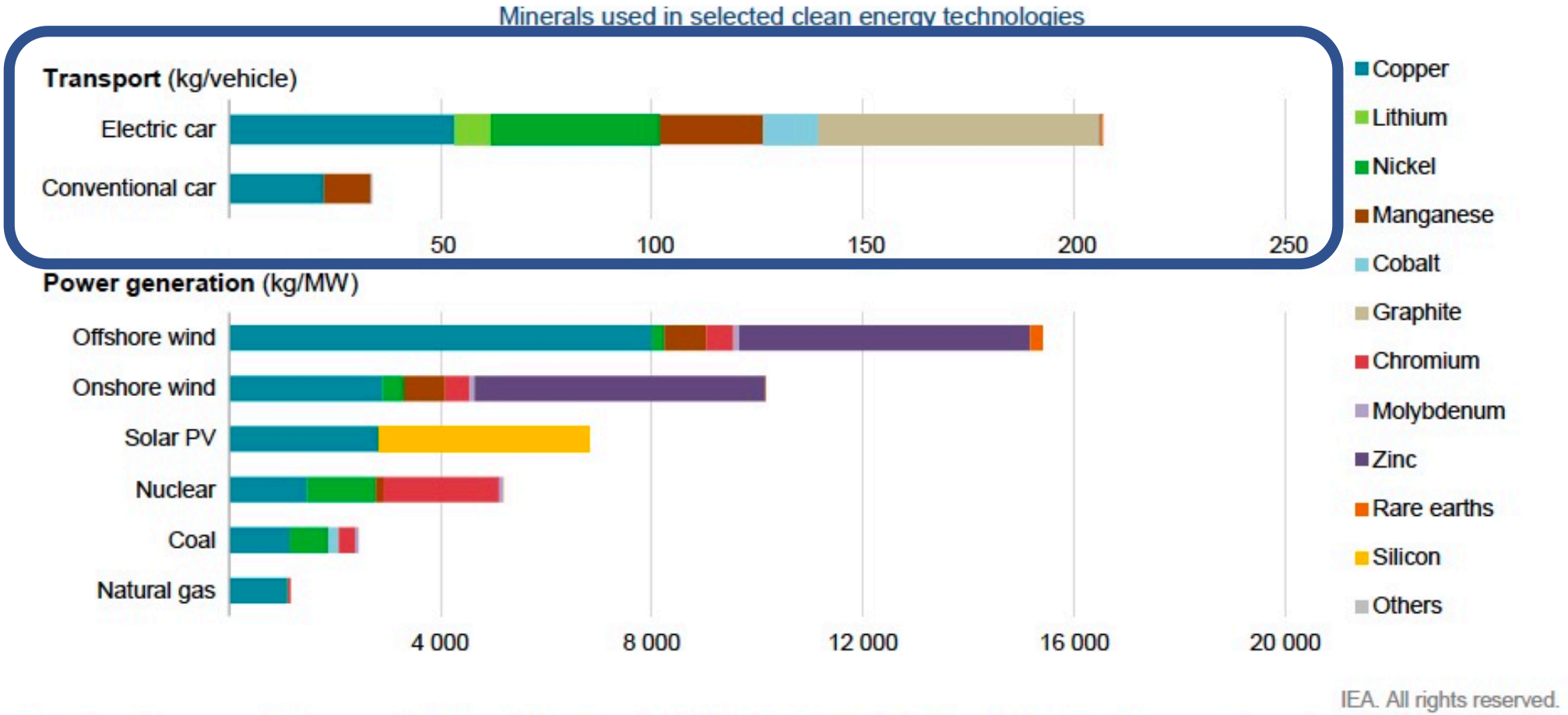

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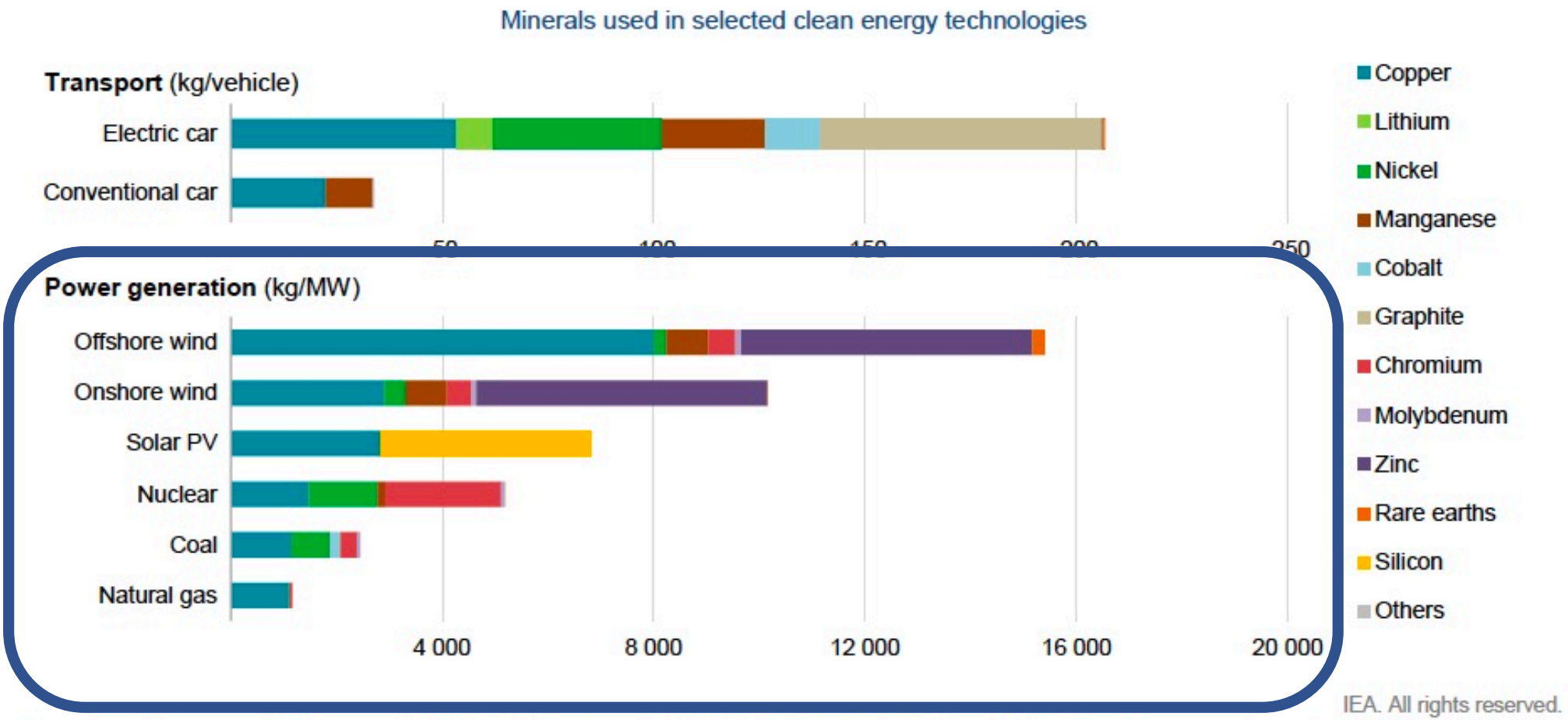

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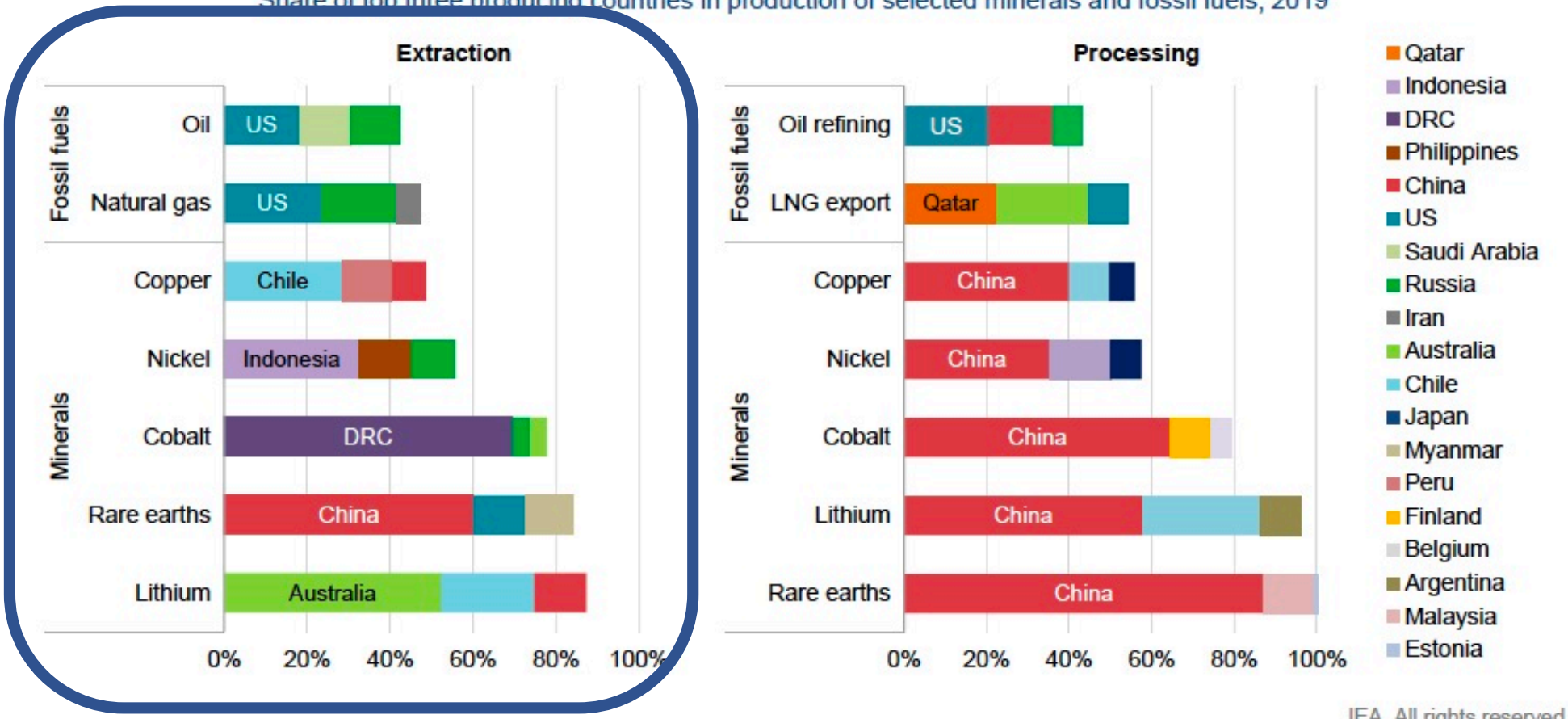
Source: iea.org

It’s about supply chains not just mining

Production of many energy transition minerals today is more geographically concentrated than that of oil or natural gas

Share of top three producing countries in production of selected minerals and fossil fuels, 2019



Notes: LNG = liquefied natural gas; US = United States. The values for copper processing are for refining operations.
Sources: IEA (2020a); USGS (2021), World Bureau of Metal Statistics (2020); Adamas Intelligence (2020).

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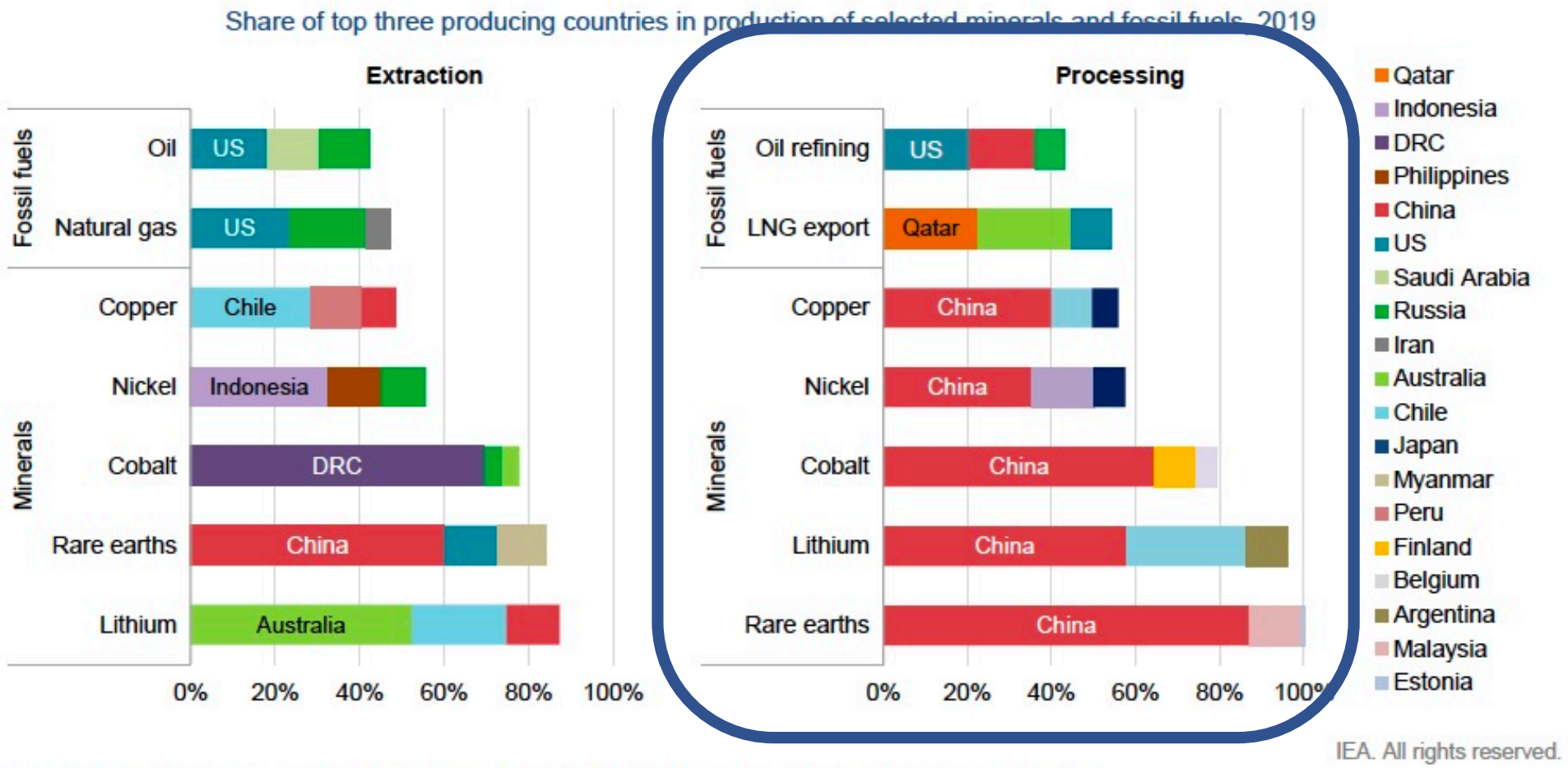

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The Public Policy Context

Or what to do?

March 28, 2021

The Economist

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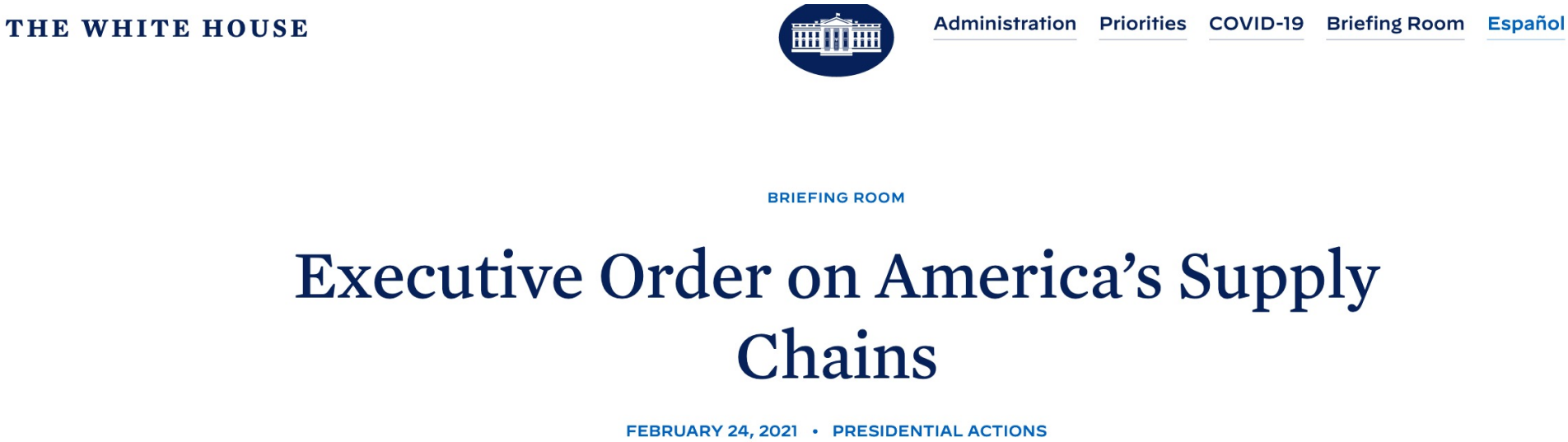
Finance & economics

Mission critical

Governments identify minerals needed for economic and national security

Obtaining them is another matter

One month into the Biden administration



But also an issue in the Trump administration

U.S. Presidential Executive Order 13953

Executive Order on Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries

ECONOMY & JOBS

Issued on: **September 30, 2020**

Financial Times, August 31, 2020

EU sounds alarm on critical raw materials shortages

Transition to a low-carbon economy and pandemic disruption exacerbate Europe's dependence on problematic partners

What needs to be accomplished?

What role for government?

- Produce more
  - Enhance and diversify primary production
- Waste less
  - Improve manufacturing efficiency
  - Enhance re-use and recycling
- Use less
  - Develop substitute materials or technologies

Possible policy approaches

- ‘Neoliberal’: rely on private initiative, focus government activities on market failures
  - Distortions to international trade
  - Education & workforce development
  - Information and strategic analysis
  - Research (science & technology policy)
- ‘Industrial policy’: achieve change sooner
  - Stockpiles
  - Government offtake agreements/domestic content requirements
  - Subsidies, tax incentives
  - Loans/loan guarantees
  - Equity co-financing

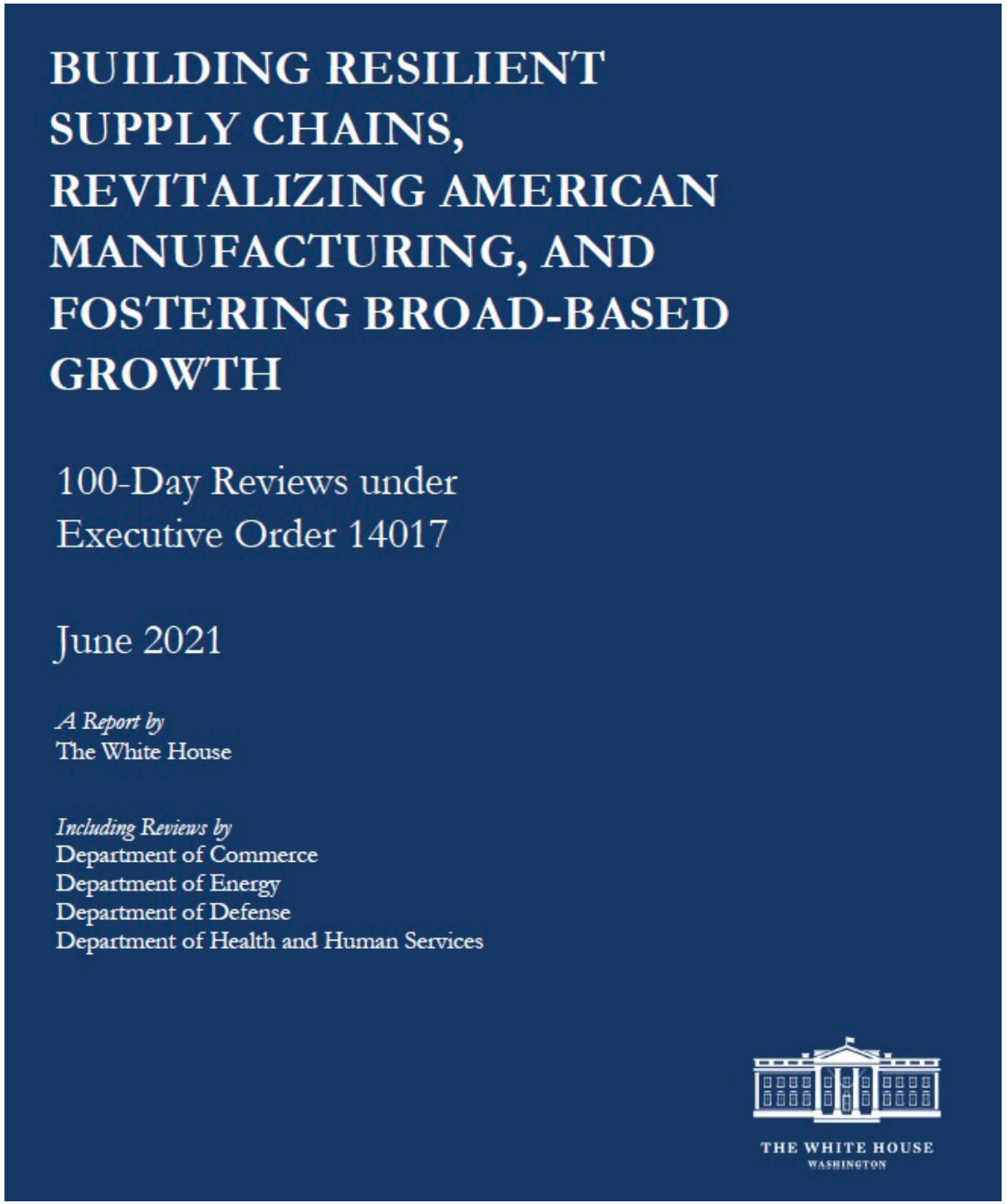
Framework for U.S. Policy, 2019
6 calls to action – mostly 'neoliberal'

- Advance transformational research, development and deployment across critical mineral chains
- Strengthen America's critical mineral supply chains and defense industrial base
- Enhance international trade and cooperation related to critical minerals
- Improve understanding of domestic critical resources
- Improve access to domestic critical mineral resources on federal lands and reduce federal permitting timeframes
- Grow the American critical minerals workforce

Source: *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, 2019 (https://2017-2021.commerce.gov/sites/default/files/2020-01/Critical_Minerals_Strategy_Final.pdf)

More industrial policy -

Gaining momentum since Great Financial Crisis, accelerated by pandemic



Summing up

- Critical minerals
  - Essential functionality, difficult substitution, supply chain risks
- Economic context
  - Something important is at risk, situational
  - The time dimension often is ignored
- Public policy context
  - How to produce more, waste less, use less
  - What is the appropriate mix of private and public activities?
  - What are the social goals not being met by market activities?

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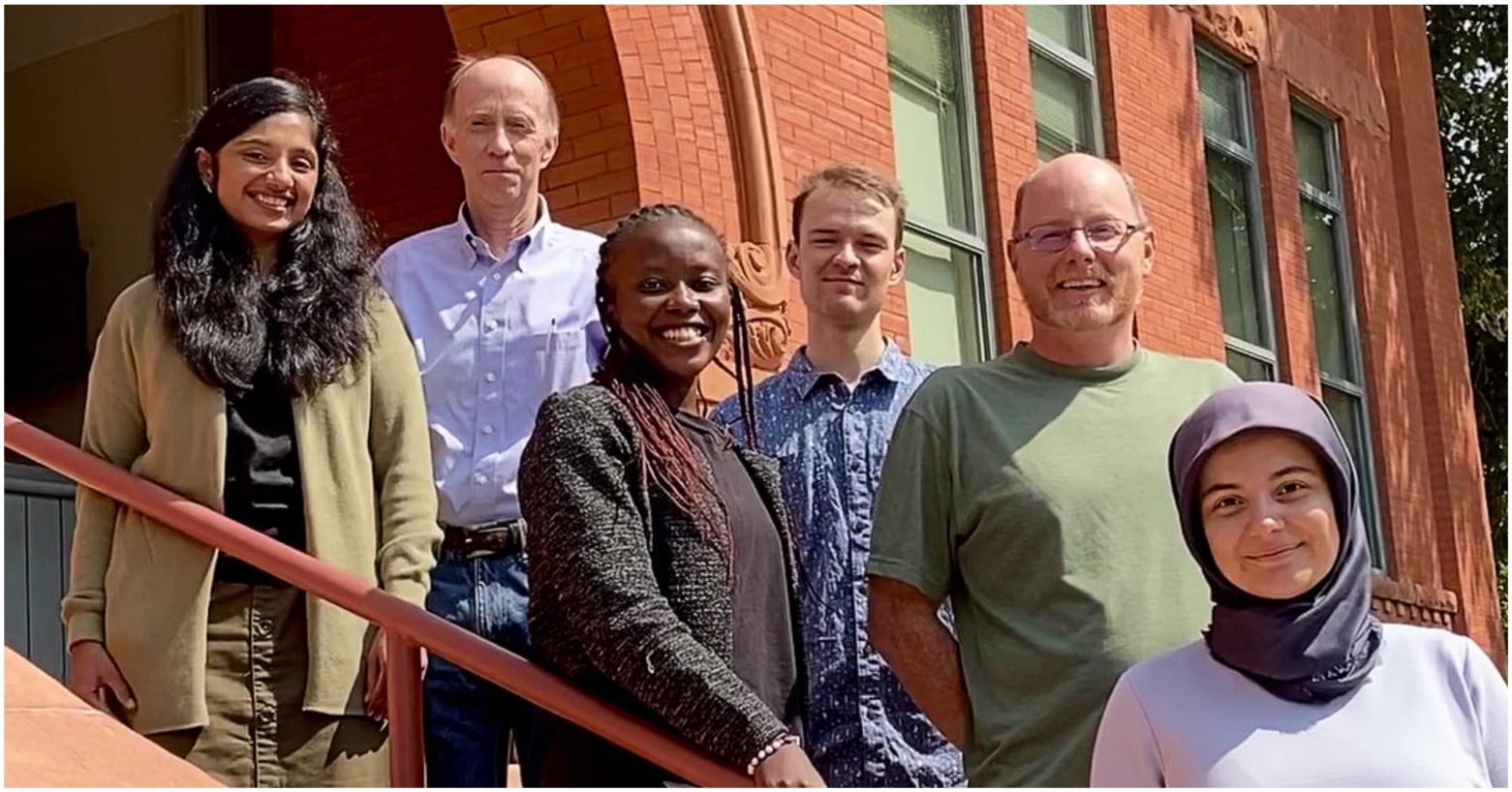

Fall 2021, Eggert Research Group

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