INSTITUTO ATLÁNTICO DE GOBIERNO

REPSOL Fundación

CURSO EJECUTIVO
TRANSICIÓN ENERGÉTICA EN ESPAÑA 2024

"MATERIALES CRÍTICOS COMO RECURSOS ESENCIALES“

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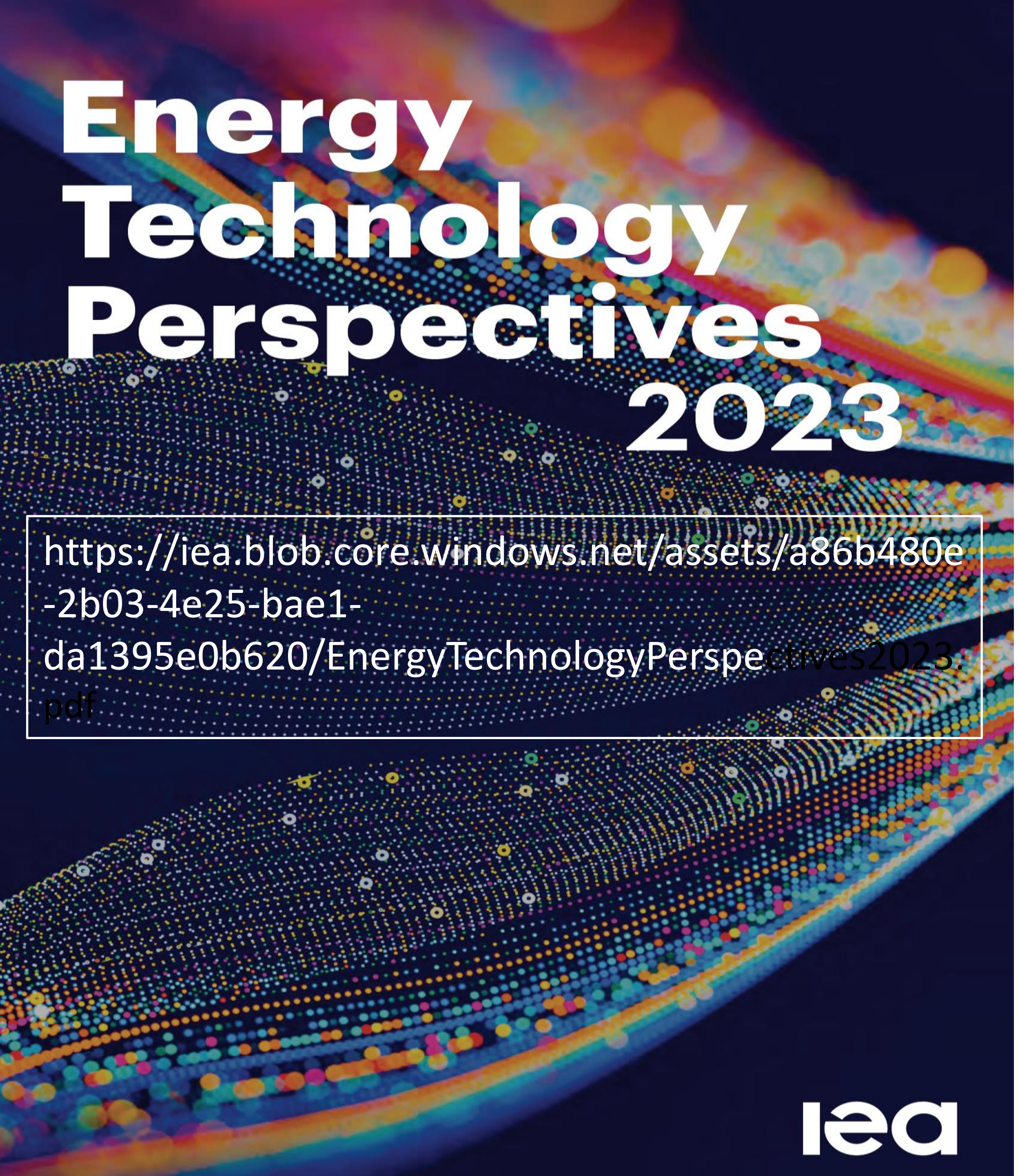
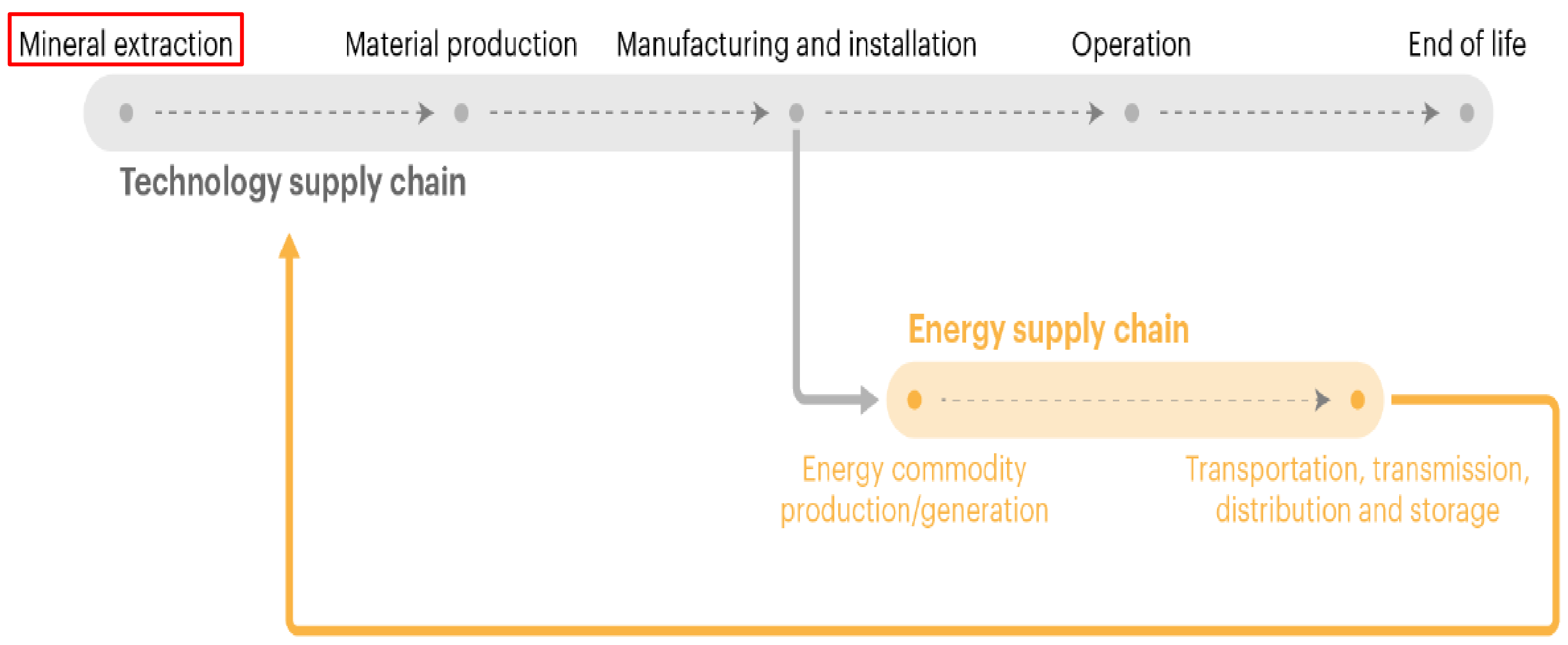


https://iea.blob.core.windows.net/assets/a86b480e-2b03-4e25-bae1-da1395e0b620/EnergyTechnologyPerspectives2023.pdf

- **En la ruta hacia las cero emisiones netas el concepto de seguridad energética cambia**

- **La flexibilidad del sistema eléctrico, la ciberseguridad y la seguridad de las cadenas de suministro de tecnología y energía son cada vez más importantes**

Cadenas de suministro de tecnología y energía: eslabones e interdependencia



(IEA, ETP 2023)

Las cadenas de suministro de tecnología y energía son interdependientes: una no puede operar sin la otra.

The Role of Critical Minerals in Clean Energy Transitions

Los minerales críticos son metales y no metales que se consideran vitales para la buena marcha de las economías del mundo, pero cuyo suministro puede estar en riesgo debido a escasez geológica, cuestiones geopolíticas, decisiones comerciales u otros factores

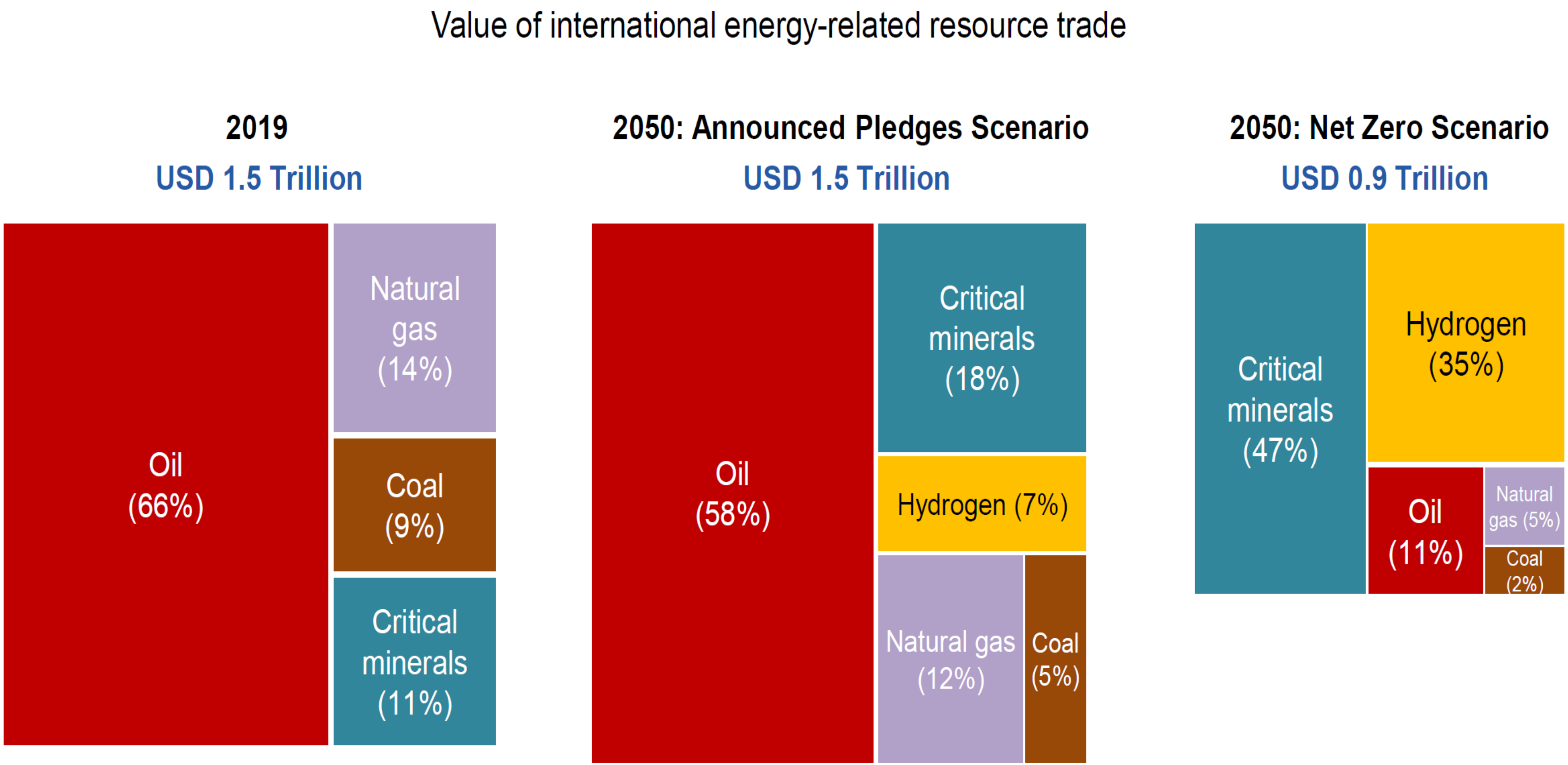
World Energy Outlook Special Report

IA, 5-5-2021

https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

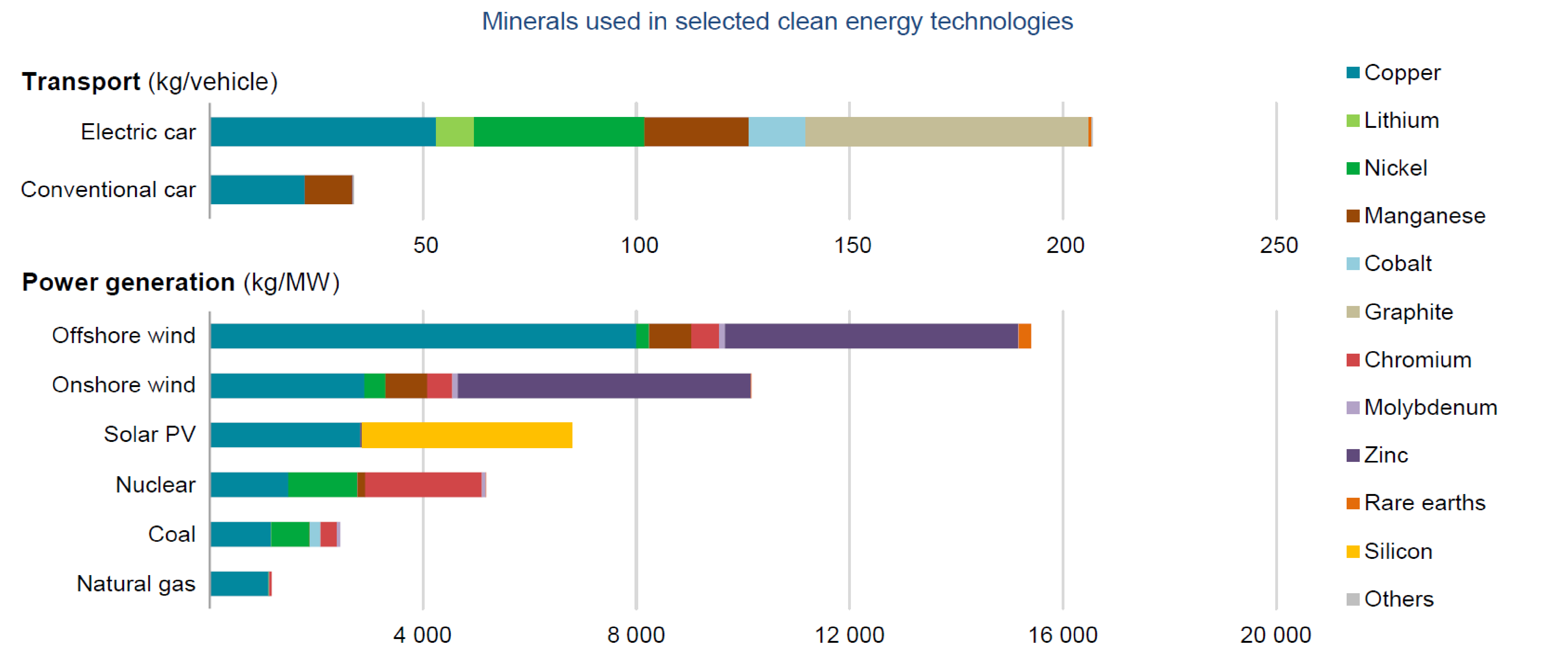
TRANSICION ENERGETICA = TRANSICION EXTRACTIVA

2019-2050: auge en el comercio internacional de minerales críticos por escenario



(IEA, WEO 2021)

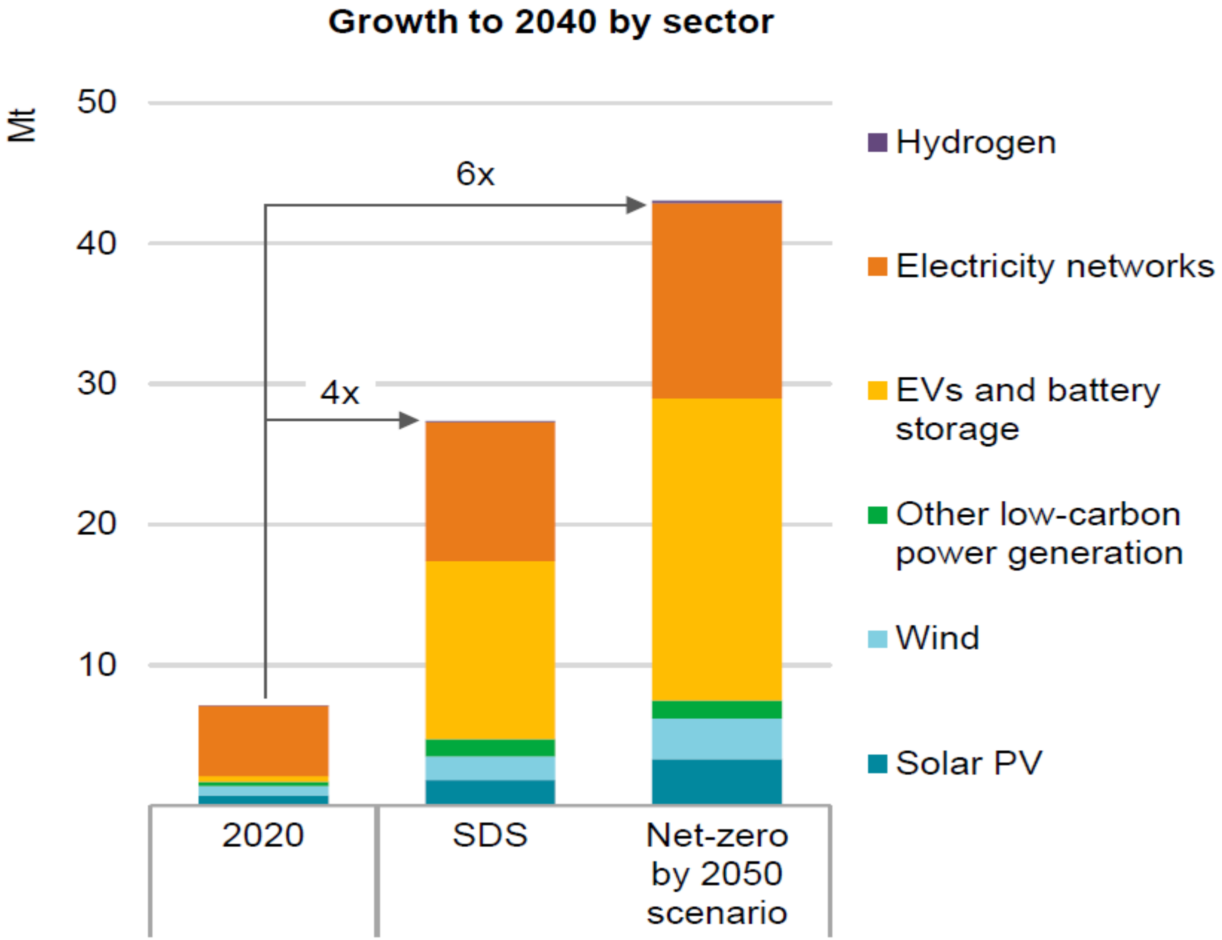
El despliegue rápido de tecnologías energéticas “limpias” requerido por la TE implica un aumento significativo de la demanda de minerales

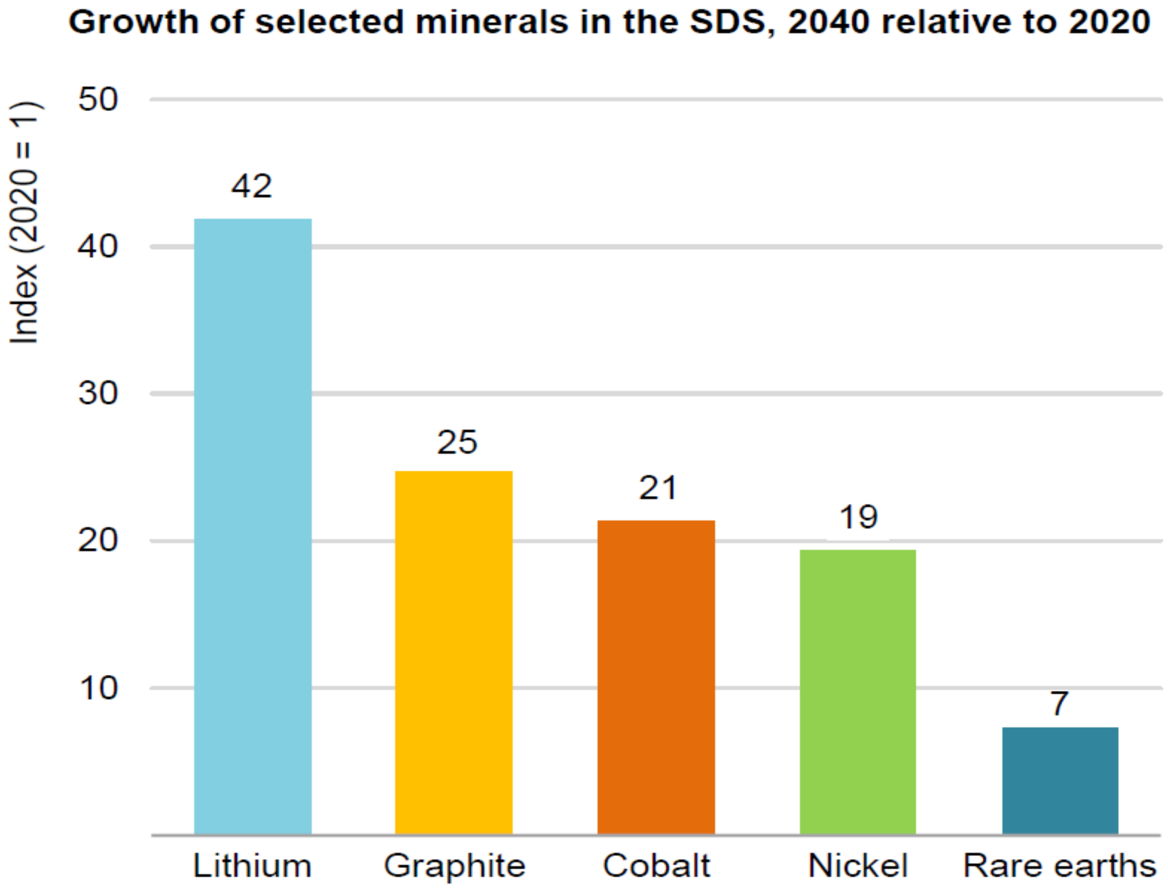


Notes: kg = kilogramme; MW = megawatt. Steel and aluminium not included. See Chapter 1 and Annex for details on the assumptions and methodologies.

La demanda de minerales para tecnologías energéticas “limpias” en 2040 se multiplicaría como mínimo por cuatro para alcanzar los objetivos climáticos, con un crecimiento particularmente alto en el caso de los vehículos eléctricos

Mineral demand for clean energy technologies by scenario





Notes: Mt = million tonnes. Includes all minerals in the scope of this report, but does not include steel and aluminium. See Annex for a full list of minerals.

Las necesidades de minerales varían en función del tipo de tecnología energética

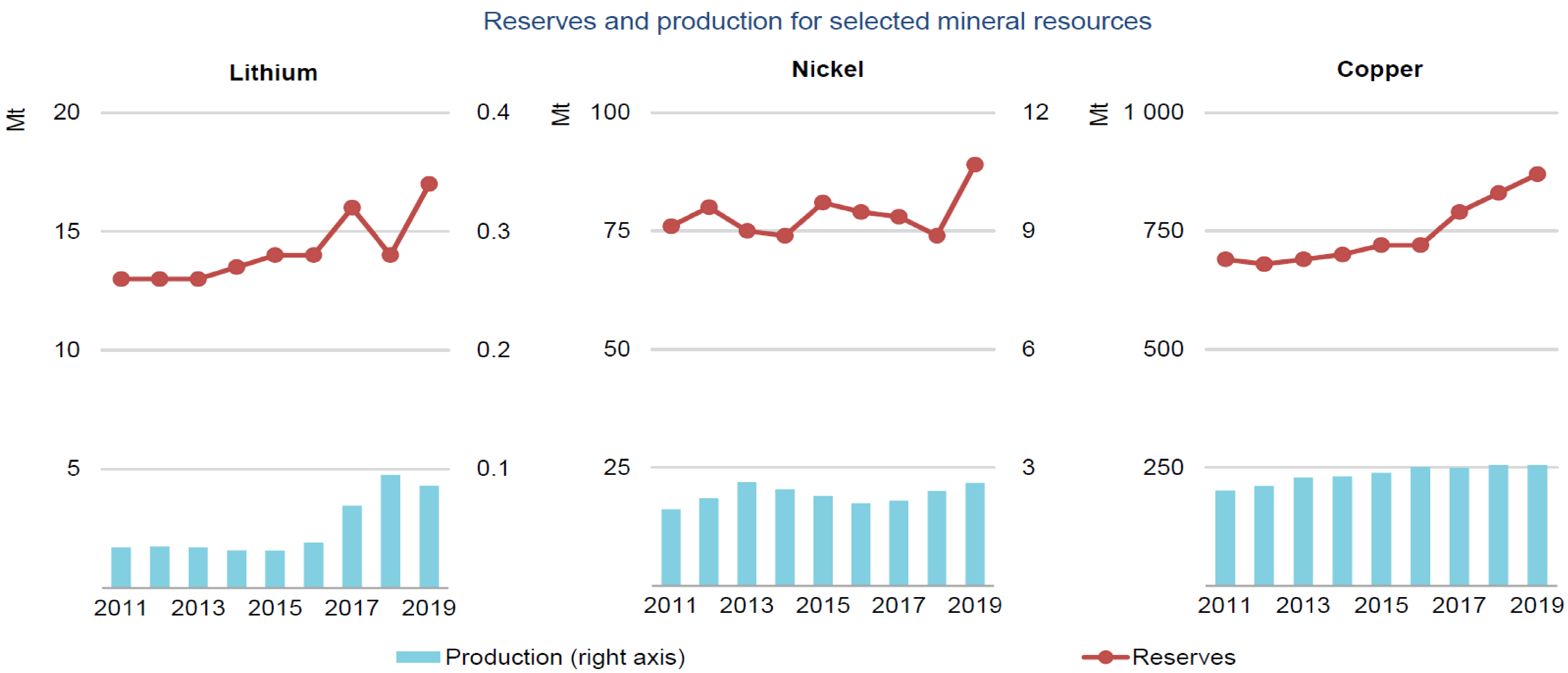
Critical mineral needs for clean energy technologies

	Copper	Cobalt	Nickel	Lithium	REEs	Chromium	Zinc	PGMs	Aluminium*
Solar PV	●	○	○	○	○	○	○	○	●
Wind	●	○	◐	○	●	◐	●	○	◐
Hydro	◐	○	○	○	○	◐	◐	○	◐
CSP	◐	○	◐	○	○	●	◐	○	●
Bioenergy	●	○	○	○	○	○	◐	○	◐
Geothermal	○	○	●	○	○	●	○	○	○
Nuclear	◐	○	◐	○	○	◐	○	○	○
Electricity networks	●	○	○	○	○	○	○	○	●
EVs and battery storage	●	●	●	●	●	○	○	○	●
Hydrogen	○	○	●	○	◐	○	○	●	◐

Notes: Shading indicates the relative importance of minerals for a particular clean energy technology (● = high; ◐ = moderate; ○ = low), which are discussed in their respective sections in this chapter. CSP = concentrating solar power; PGM = platinum group metals.

* In this report, aluminium demand is assessed for electricity networks only and is not included in the aggregate demand projections.

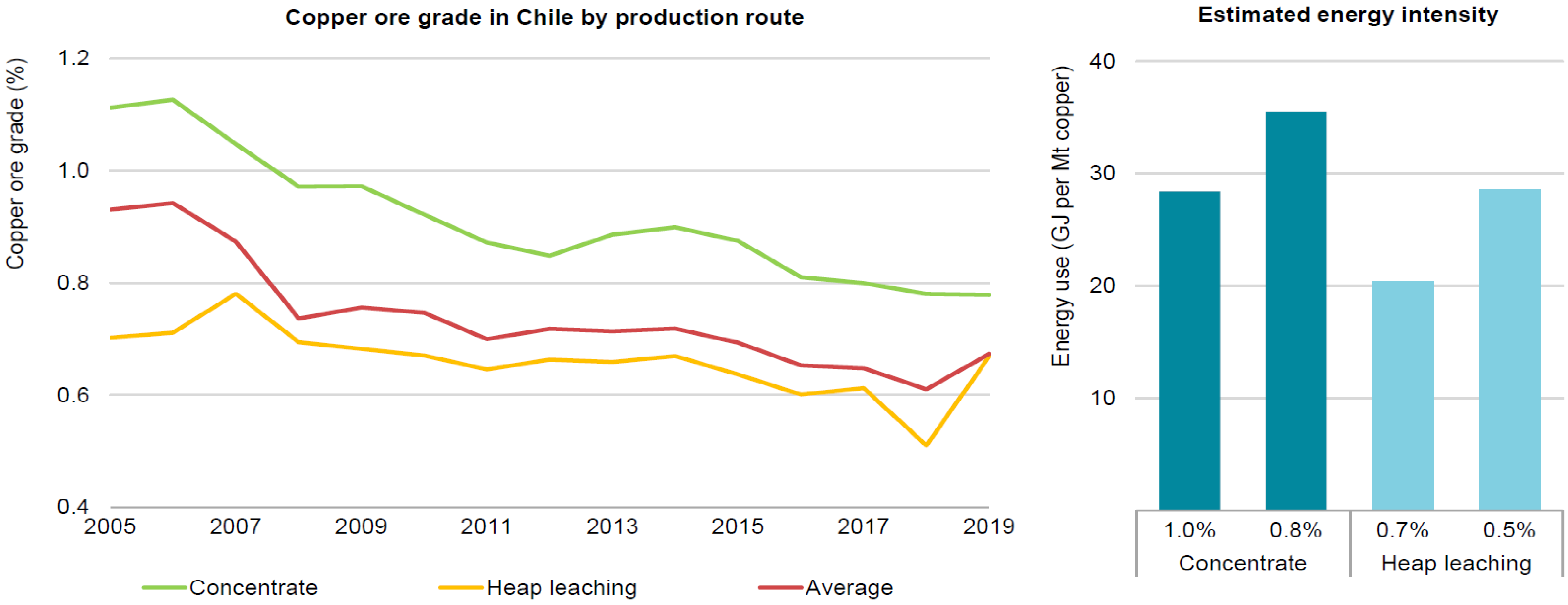
No hay carestía de recursos. Pese a un aumento continuado de la extracción las reservas económicamente viables han ido aumentando (2011-2019)



Sources: USGS (2021); USGS (2020).

Sin embargo, el declino de la calidad del mineral genera múltiples desafíos para la extracción, los costes de procesado, las emisiones y el volumen de residuos

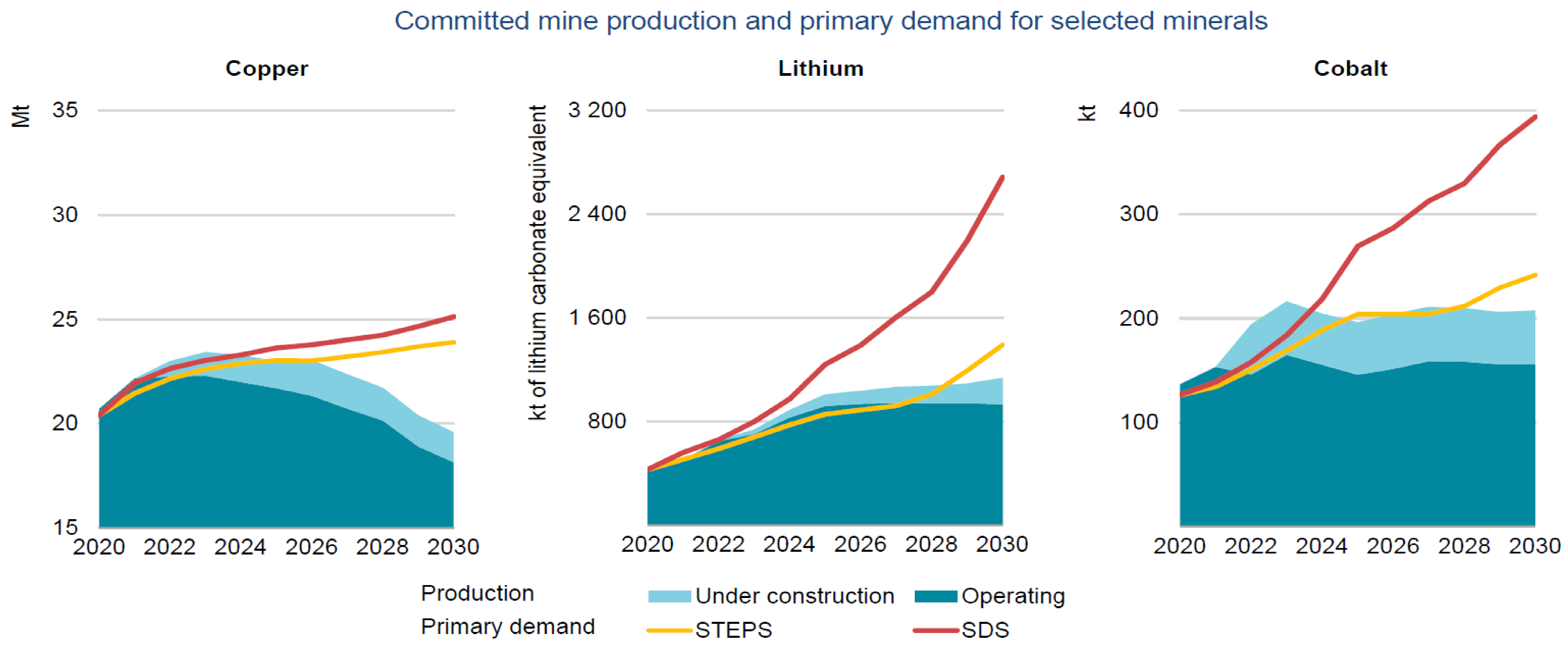
Average ore grade in Chile and estimated energy intensity by quality



Notes: Energy use for concentrate covers mine, concentrating plant, smelter, refinery and services. For heap leaching, energy use covers mine, leaching, solvent extraction, electro-winning processes and services. GJ = gigajoule.

Source: IEA analysis based on COCHILCO (2019) and Rötzer and Schmidt (2020).

Cubrir la demanda primaria en el SDS requiere un gran aumento de las inversiones para desarrollar nuevas fuentes de suministro en la próxima década

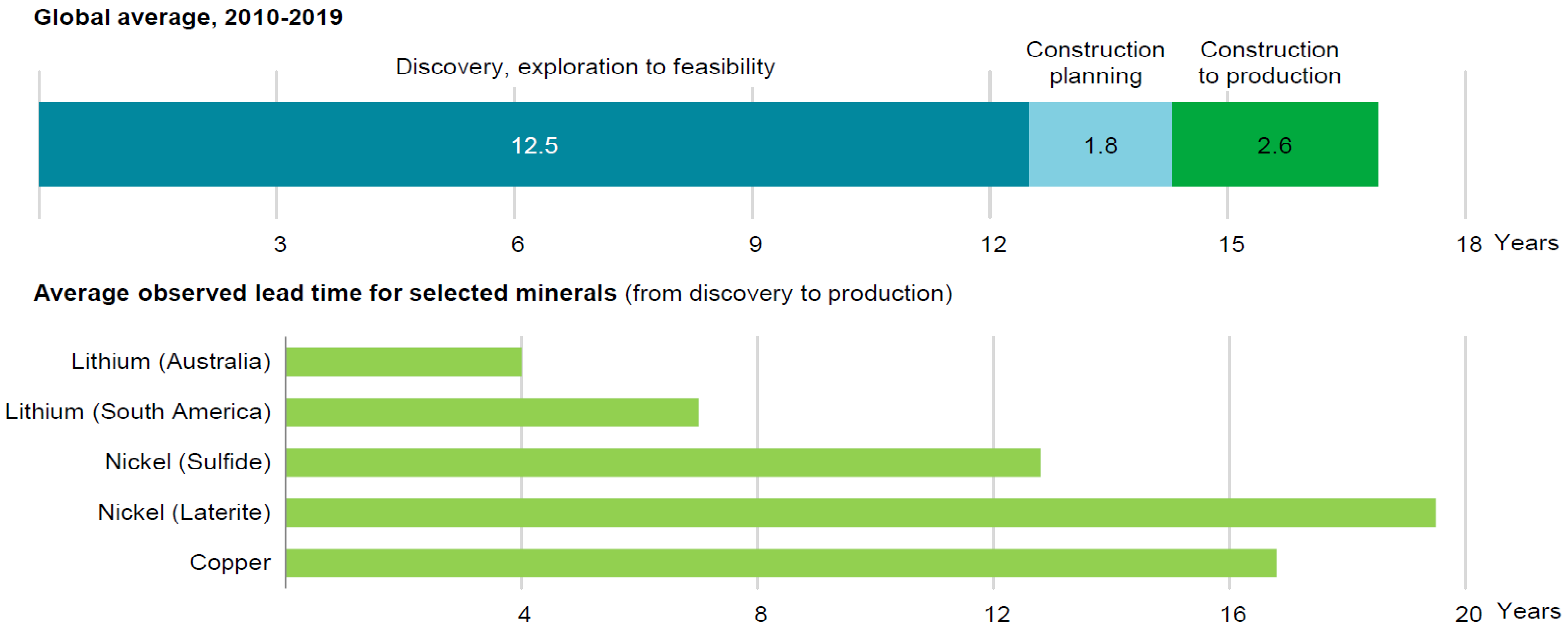


Notes: Primary demand is total demand net of recycled volume (also called primary supply requirements). Projected production profiles are sourced from the S&P Global Market Intelligence database with adjustments to unspecified volumes. Operating projects include the expansion of existing mines. Under-construction projects include those for which the development stage is indicated as commissioning, construction planned, construction started or preproduction. Mt = million tonnes.

Source: IEA analysis based on S&P Global (2021).

Los plazos de desarrollo de proyectos mineros son largos: la escasez en los mercados puede aparecer mucho más rápidamente

Global average lead times from discovery to production, 2010-2019



Note: Global average values are based on the top 35 mining projects that came online between 2010 and 2019.
Source: IEA analysis based on S&P Global (2020), S&P Global (2019a) and Schodde (2017).

La explotación de recursos minerales suscita una gran variedad de implicaciones sociales y ambientales que deben ser cuidadosamente gestionadas para asegurar un suministros fiable

Selected environmental and social challenges related to energy transition minerals

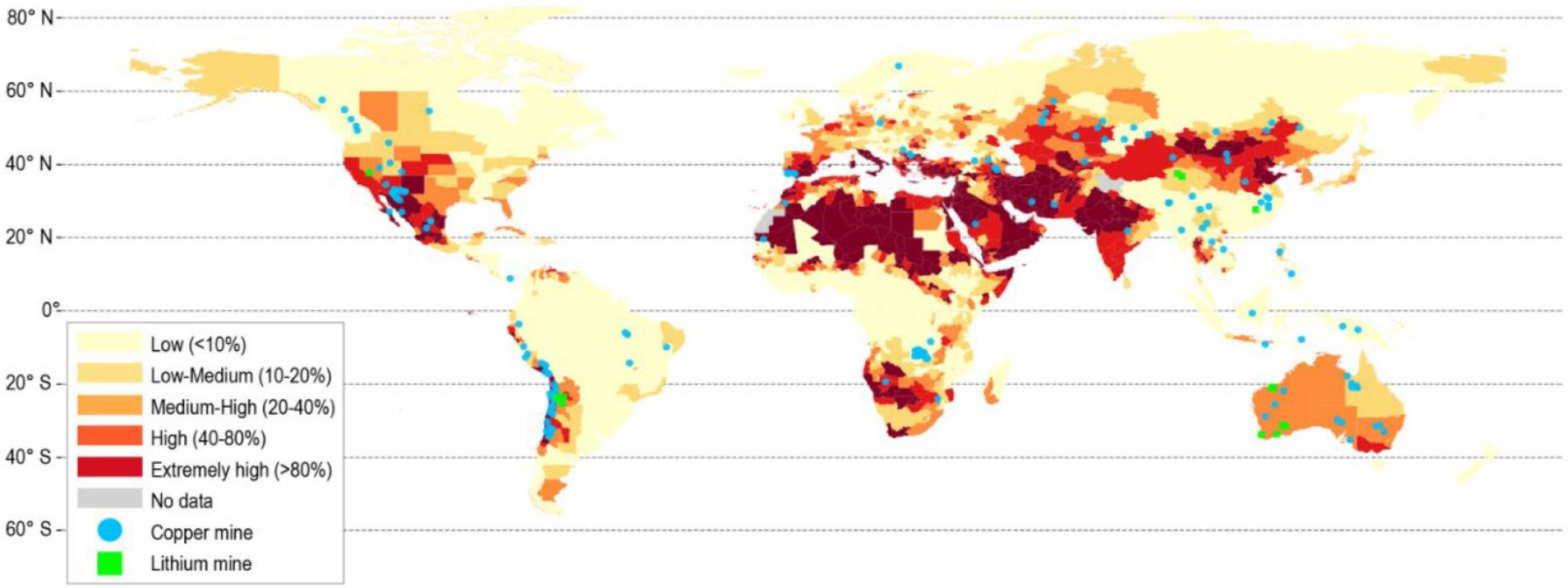
Areas of risks		Description
Environment	Climate change	• With higher greenhouse gas emission intensities than bulk metals, production of energy transition minerals can be a significant source of emissions as demand rises • Changing patterns of demand and types of resource targeted for development pose upward pressure
	Land use	• Mining brings major changes in land cover that can have adverse impacts on biodiversity • Changes in land use can result in the displacement of communities and the loss of habitats that are home to endangered species
	Water management	• Mining and mineral processing require large volumes of water for their operations and pose contamination risks through acid mine drainage, wastewater discharge and the disposal of tailings • Water scarcity is a major barrier to the development of mineral resources: around half of global lithium and copper production are concentrated in areas of high water stress
	Waste	• Declining ore quality can lead to a major increase in mining waste (e.g. tailings, waste rocks); tailings dam failure can cause large-scale environmental disasters (e.g. Brumadinho dam collapse in Brazil) • Mining and mineral processing generate hazardous waste (e.g. heavy metals, radioactive material)
Social	Governance	• Mineral revenues in resource-rich countries have not always been used to support economic and industrial growth and are often diverted to finance armed conflict or for private gain • Corruption and bribery pose major liability risks for companies
	Health and safety	• Workers face poor working conditions and workplace hazards (e.g. accidents, exposure to toxic chemicals) • Workers at artisanal and small-scale mine (ASM) sites often work in unstable underground mines without access to safety equipment
	Human rights	• Mineral exploitation may lead to adverse impacts on the local population such as child or forced labour (e.g. children have been found to be present at about 30% of cobalt ASM sites in the DRC) • Changes in the community associated with mining may also have an unequal impact on women

Para garantizar un suministro adecuado, cada mineral afronta un conjunto de desafíos especifico

Mineral	Key challenges
Copper	• Challenging to substitute due to its superior performance in electrical applications • Mines currently in operation are nearing their peak due to declining ore quality and reserves exhaustion • Declining ore quality exerts upward pressure on production costs, emissions and waste volumes • Mines in South America and Australia are exposed to high levels of climate and water stress
Lithium	• Possible bottleneck in lithium chemical production as many smaller producers are financially constrained after years of depressed prices • Lithium chemical production is highly concentrated in a small number of regions, with China accounting for 60% of global production (over 80% for lithium hydroxide) • Mines in South America and Australia are exposed to high levels of climate and water stress
Nickel	• Possible tightening of battery-grade Class 1 supply, with high reliance on the success of HPAL projects in Indonesia; HPAL projects have track records of delays and cost overruns • Alternative Class 1 supply options (e.g. conversion of NPI to nickel matte) are either cost-prohibitive or emissions-intensive • Growing environmental concerns around higher CO_2 emissions and tailings disposal
Cobalt	• High reliance on the DRC for production and China for refining (both around 70%) set to persist, as only a few projects are under development outside these countries • Significance on artisanal small-scale mining makes the supply vulnerable to social pressures • New supply is subject to developments in nickel and copper markets as some 90% of cobalt is produced as a by-product of these minerals
Rare earth elements	• Dominance of China across the value chain from mining to processing and magnet production • Negative environmental credentials of processing operations • Differences in demand outlooks for individual elements bring risk of price spikes for those in high demand (e.g. neodymium) and slumps for those in low demand (e.g. cerium)

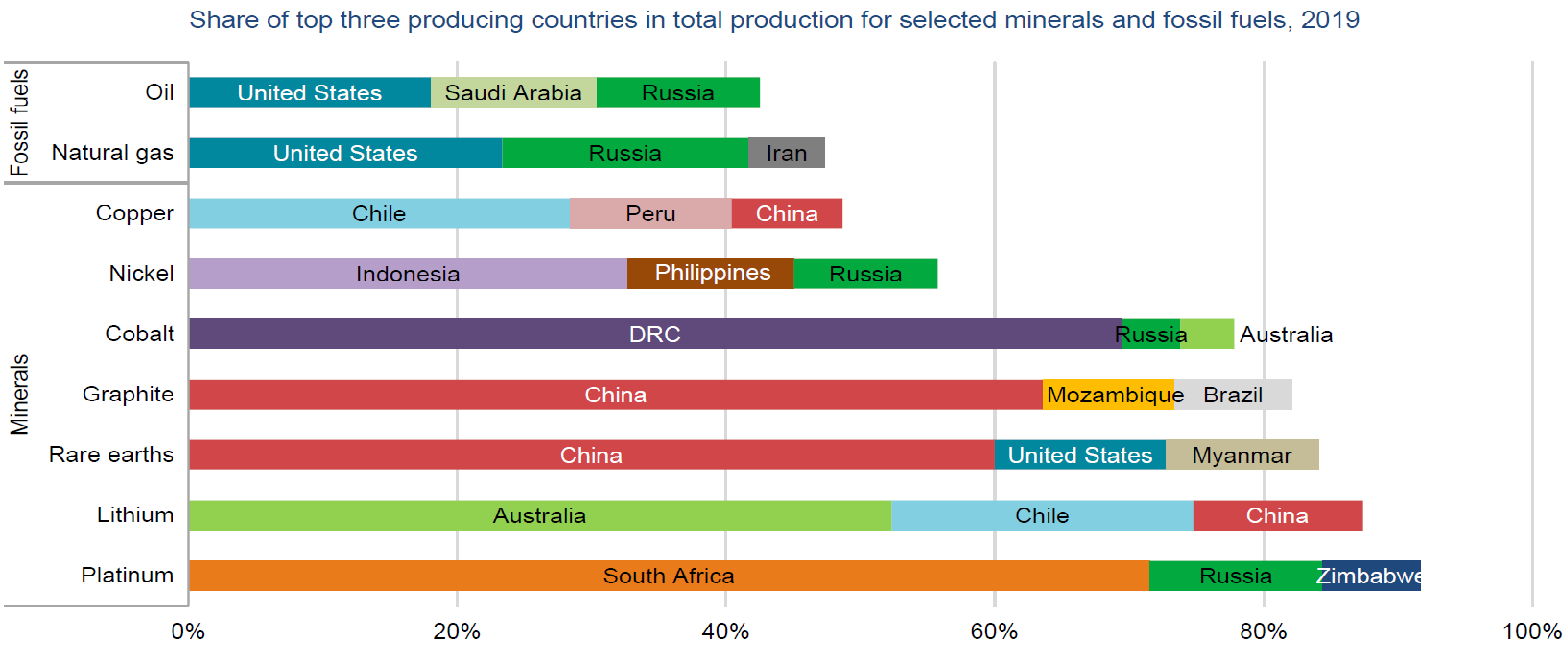
Notes: HPAL = high-pressure acid leaching; NPI = nickel pig iron.

Un buen número de activos mineros están expuestos a crecientes riesgos climáticos. Alrededor del 50% de la producción mundial de cobre y litio se concentra en áreas de alto estrés hídrico



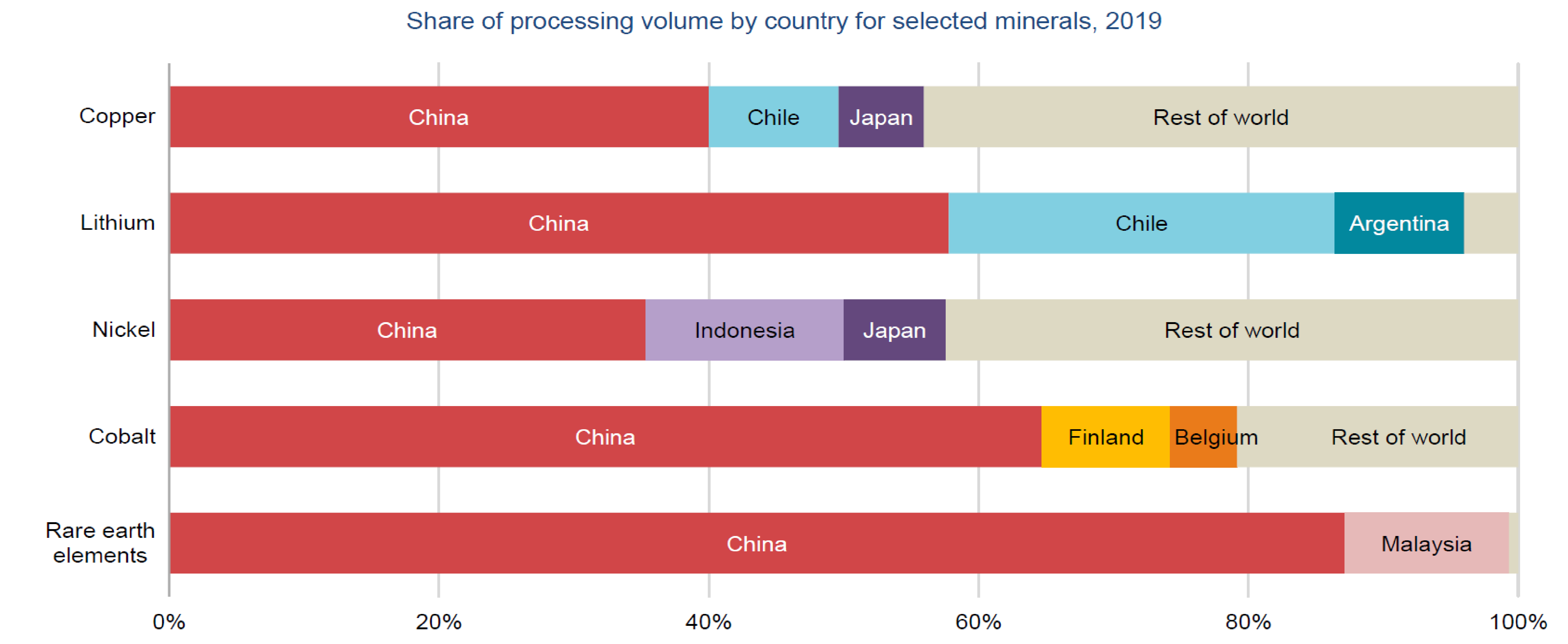
Note: The exact water stress levels vary by location. While we assessed the share of mines located in water stress areas according to granular regional representations (shown on the following page), we aggregated them at the sub-national level on the map for the sake of simplification. Water stress levels are as defined in the Aqueduct 3.0 dataset according to the ratio of total water withdrawals over the total available surface and groundwater supplies.
Source: IEA analysis based on WRI Aqueduct 3.0 dataset.

Hoy en día, la extracción de muchos minerales necesarios para la transición energética está geográficamente mas concentrada que la de petróleo y gas natural



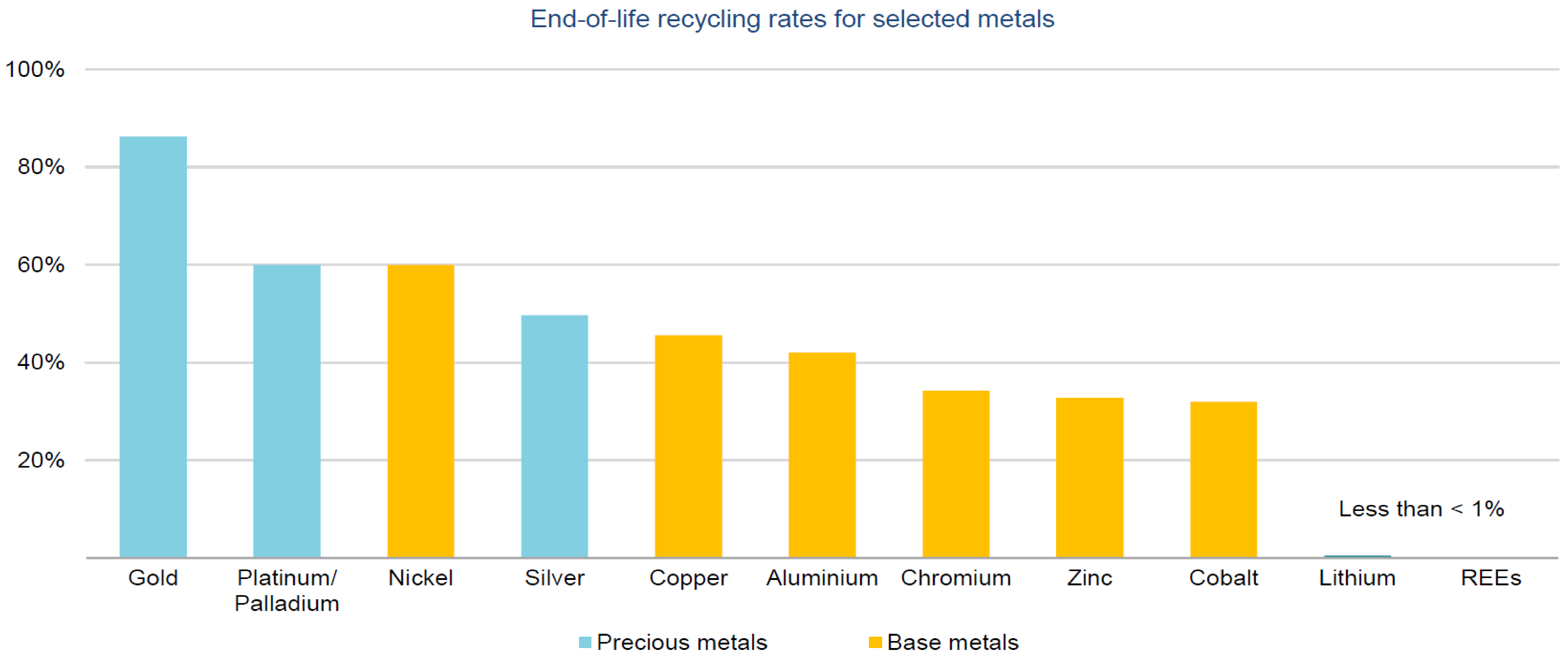
Sources: IEA (2020b); USGS (2021).

El nivel de concentración de las operaciones de procesado también es alto, con China jugando un papel relevante



Note: The values for copper are for refining operations.
Sources: World Bureau of Metal Statistics (2020); Adamas Intelligence (2020) for rare earth elements.

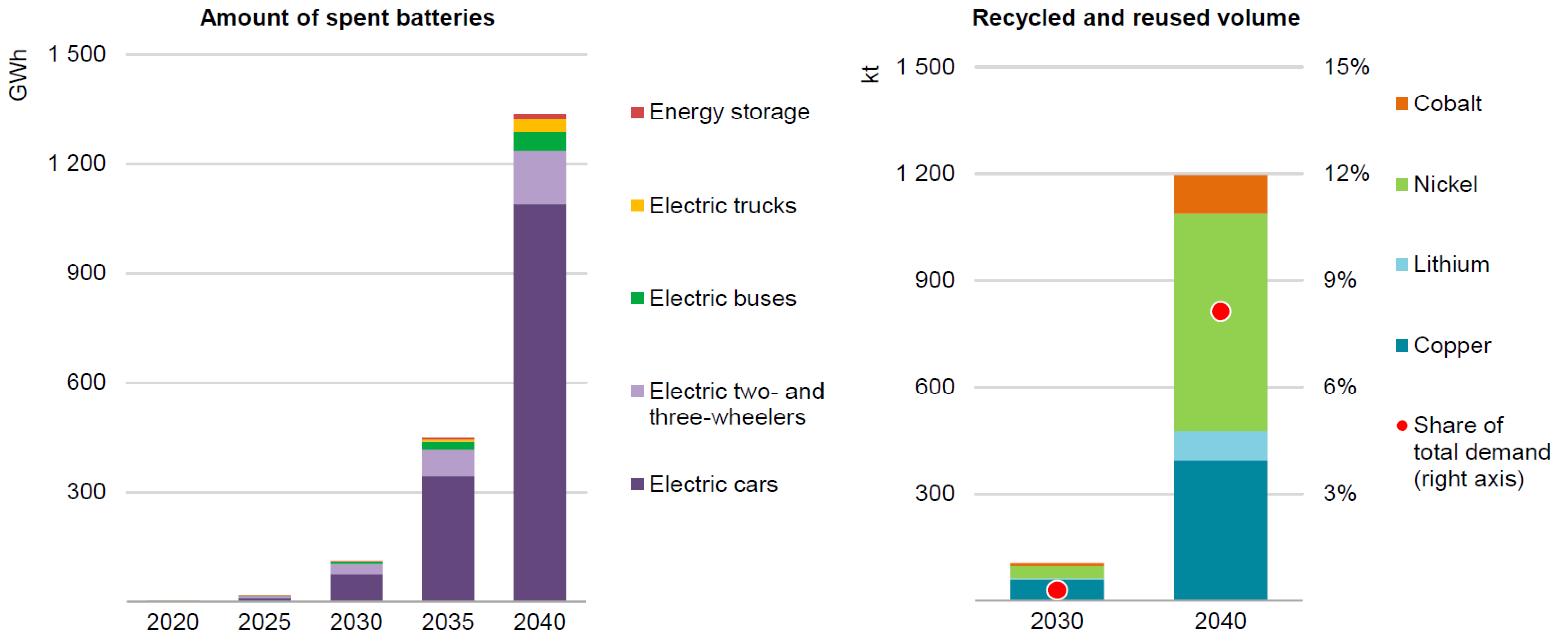
Las tasas actuales de reciclado varían según el metal dependiendo de la facilidad de recogida, los niveles de precios y la madurez del mercado



Sources: Henckens (2021); UNEP (2011) for aluminium; Sverdrup and Ragnarsdottir (2016) for platinum and palladium; OECD (2019) for nickel and cobalt.

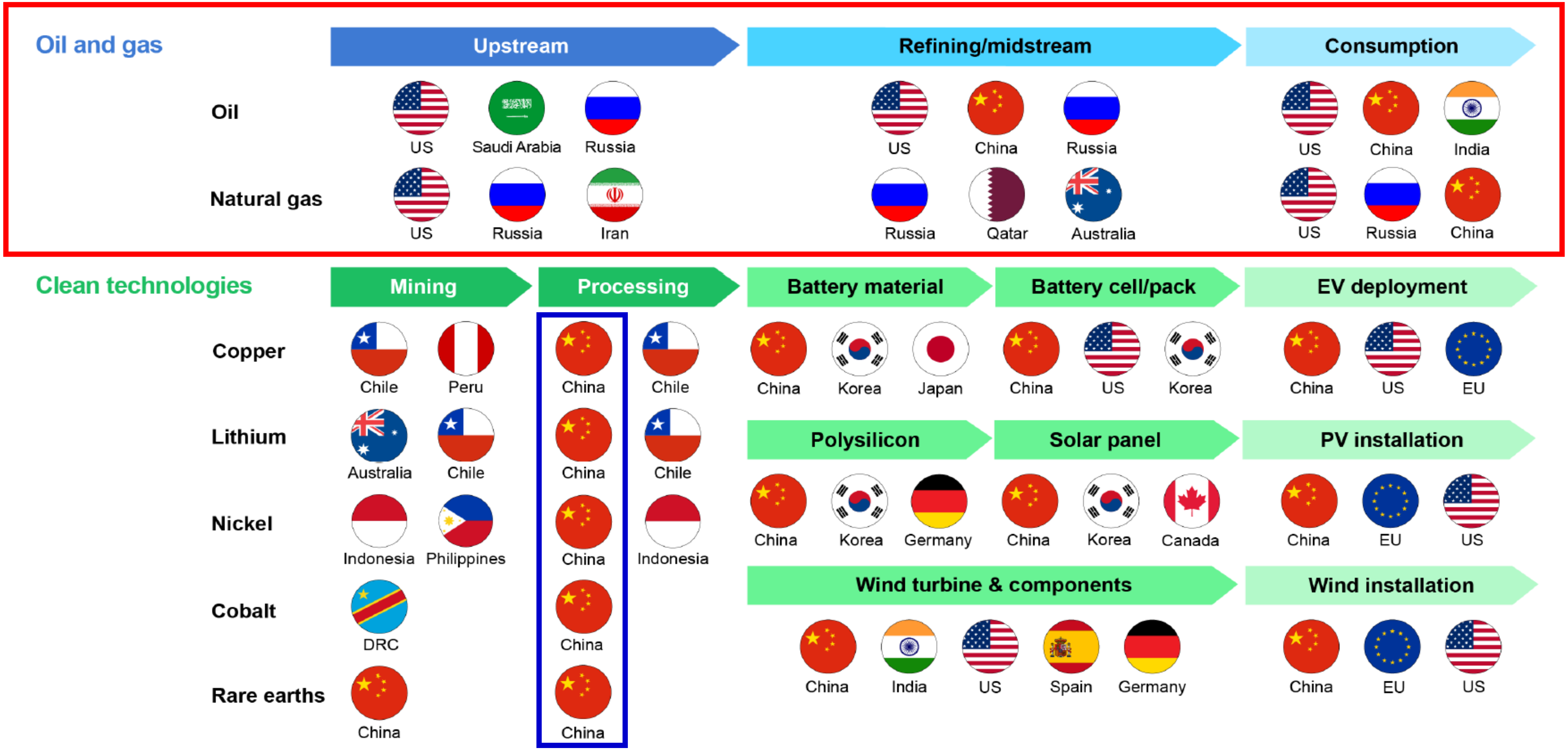
El aumento previsto en los volúmenes de baterías usadas confiere altas expectativas al reciclado

Amount of spent lithium-ion batteries from EVs and storage and recycled and reused minerals from batteries in the SDS



Note: GWh = gigawatt hour.

La TE comporta cambios significativos en el comercio energético, en los países que controlan las cadenas de suministro y, en definitiva, en la geopolítica energética



Seis recomendaciones clave para un nuevo enfoque integral de la seguridad de suministro de minerales críticos

- Garantizar una inversión adecuada en nuevas fuentes de suministro y diversificar estas
- Promover la innovación tecnológica a lo largo de toda la cadena de valor
- Multiplicar el reciclaje
- Mejorar la resiliencia de la cadena de suministro y la transparencia del mercado.
- Incorporar normas ambientales, sociales y de gobernanza más estrictas
- Fortalecer la colaboración internacional (productores y consumidores)

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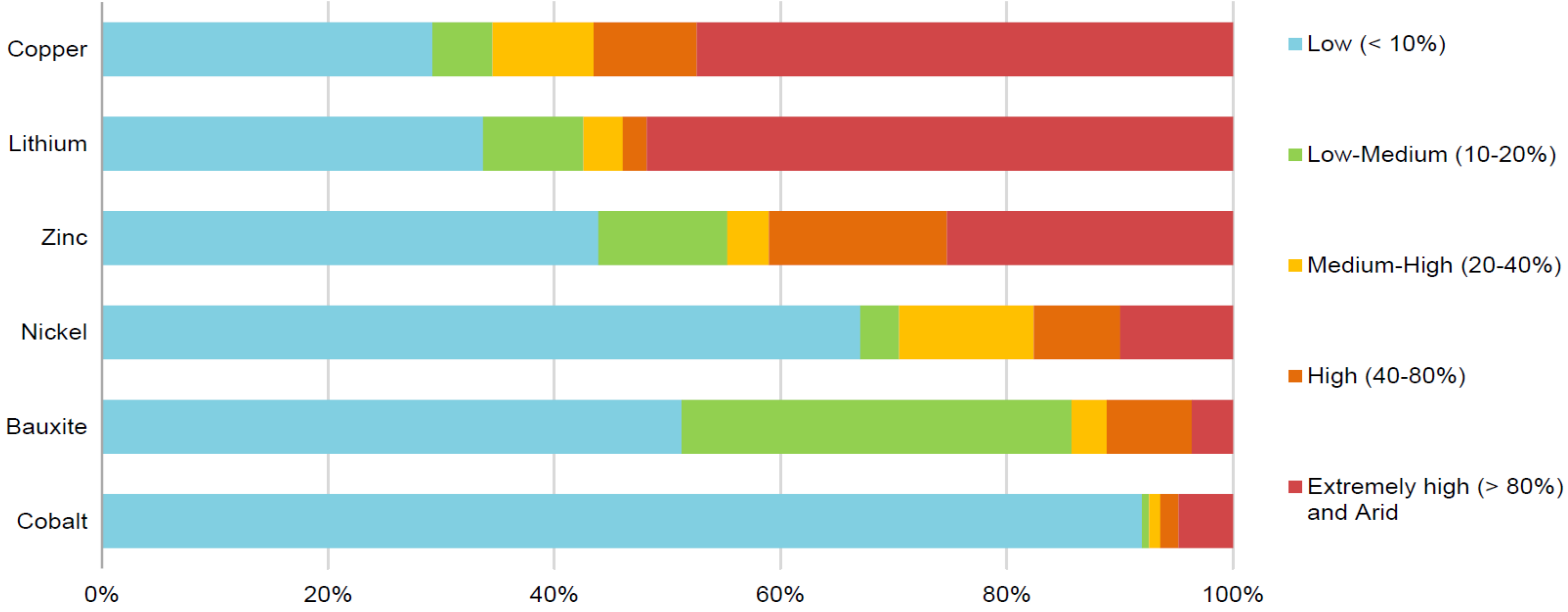
¡MUCHAS GRACIAS!

Alrededor de la mitad de la producción mundial de cobre y litio se concentra en áreas de alto estrés hídrico

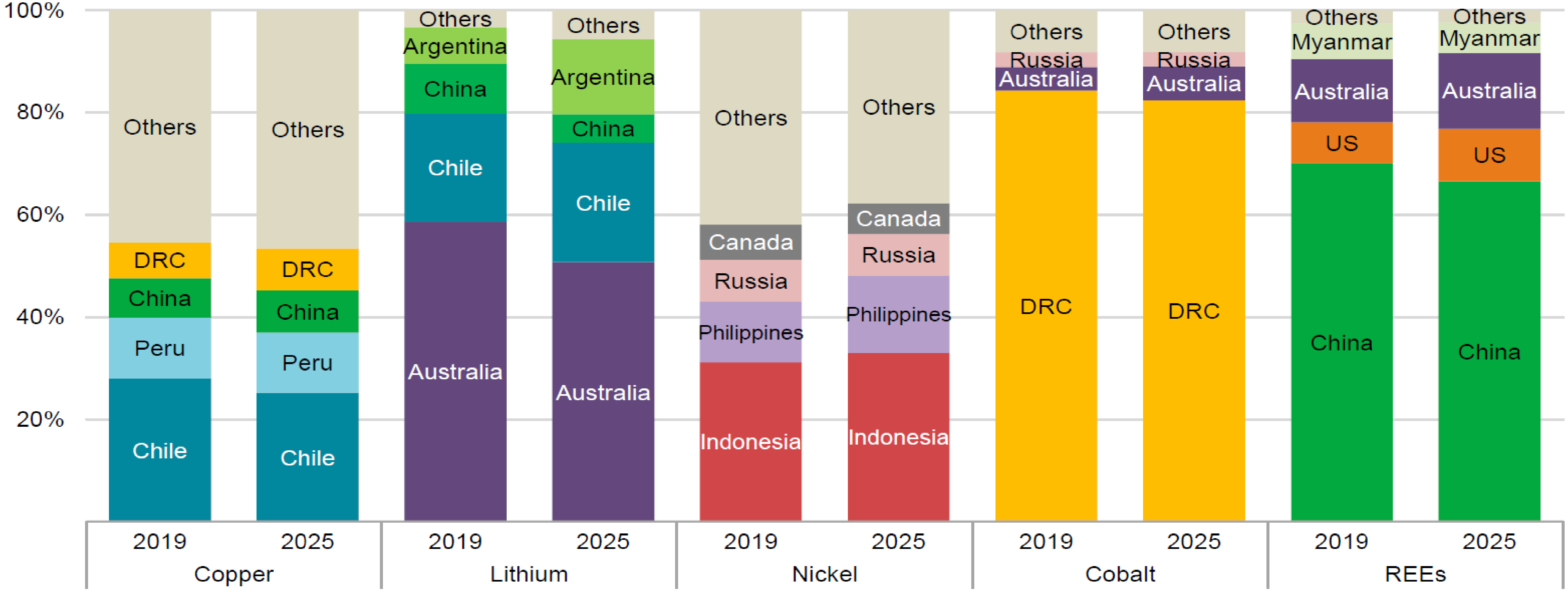
Share of production volume by water stress level for selected minerals, 2020



Note: Water stress levels are as defined in the Aqueduct 3.0 dataset according to the ratio of total water withdrawals over the total available surface and groundwater supplies.
Source: IEA analysis based on WRI Aqueduct 3.0 dataset.

El análisis de los proyectos en curso indica que, en la mayoría de casos, es improbable que la concentración geográfica de la extracción cambie en un futuro cercano

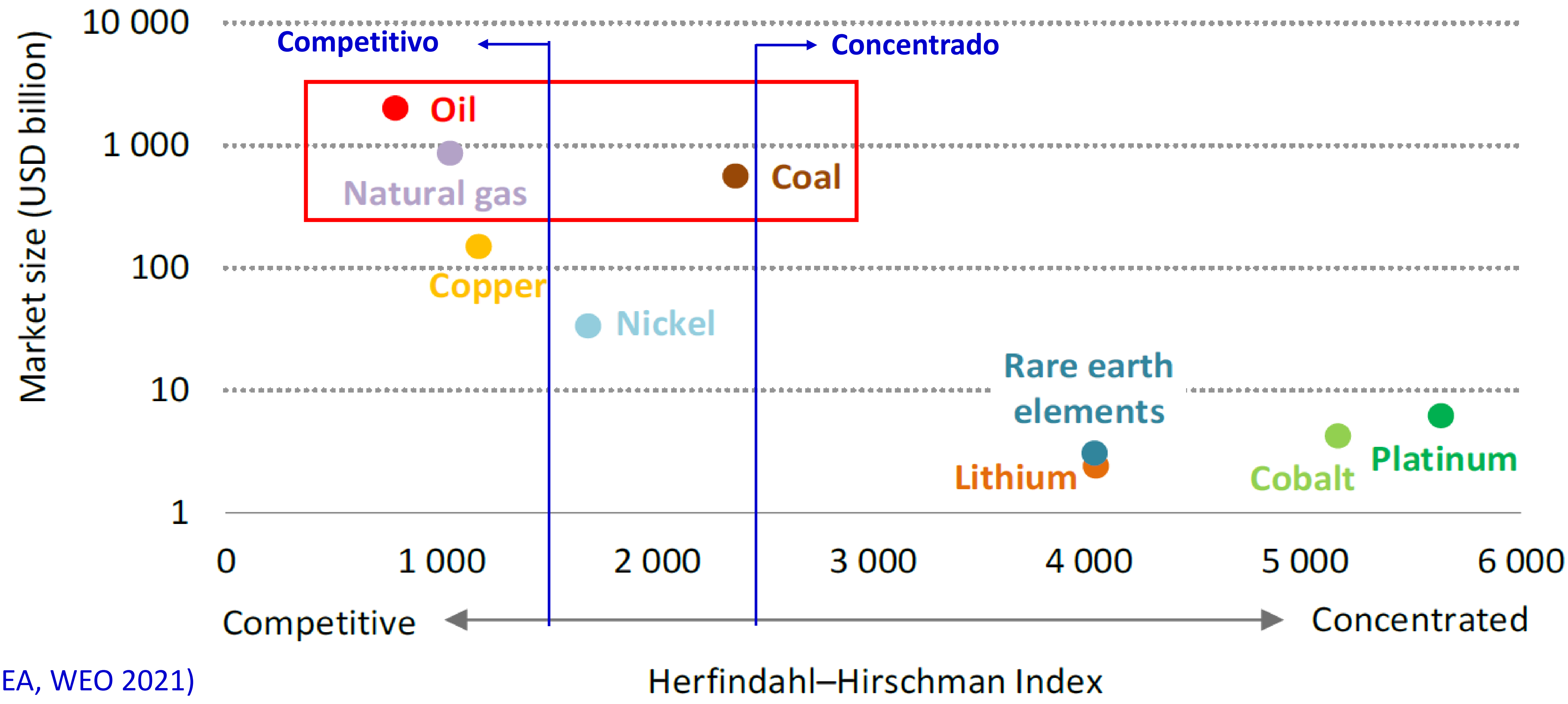
Major producing countries of selected minerals, 2019 and 2025



Note: Due to the availability of data on projections for future production, REEs here comprise neodymium, praseodymium, terbium and dysprosium only. DRC = Democratic Republic of the Congo; US = United States; Russia = Russian Federation.

Source: IEA analysis based on the project pipeline in S&P Global (2021) complemented by World Bureau of Metal Statistics (2020) and Adamas Intelligence (2020) (for REEs).

2019: tamaño y nivel de concentración del mercado de diversas materias primas



(IEA, WEO 2021)

Hoy en día, los mercados de minerales críticos son mucho más pequeños, geográficamente más concentrados y, por lo general, menos competitivos que los de hidrocarburos

BRIEFING

EU Strategic Autonomy Monitor
July 2022

European Parliament

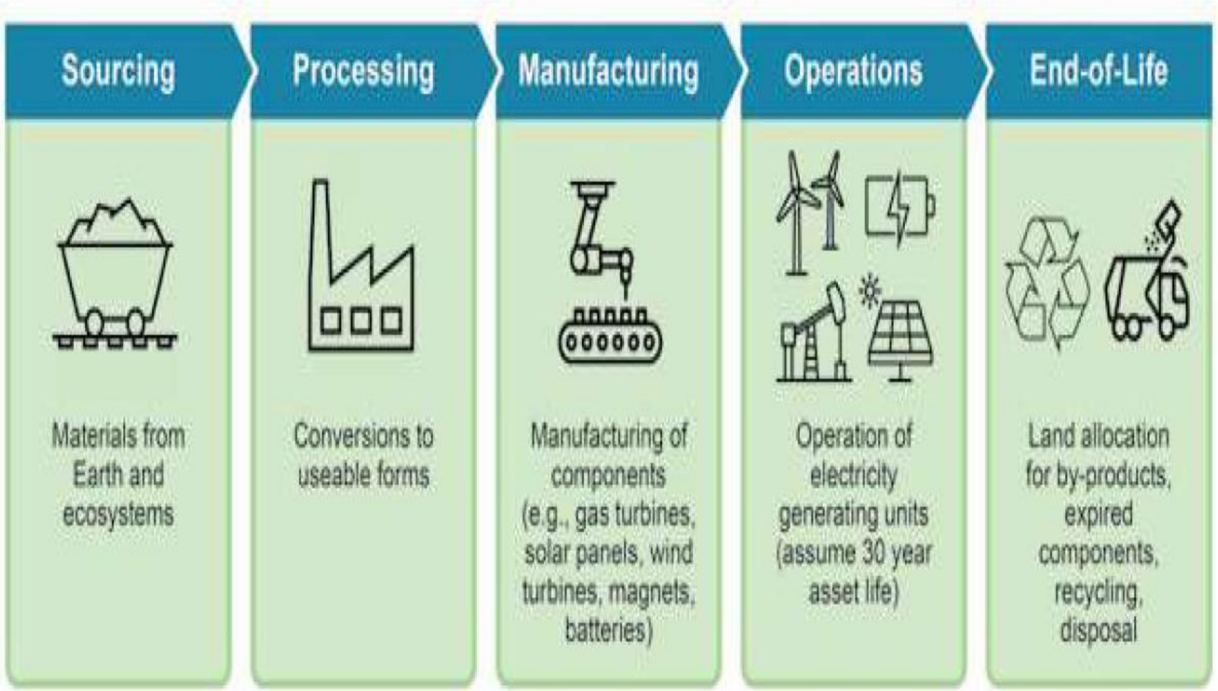
EU strategic autonomy 2013-2023

From concept to capacity

EU strategic autonomy (EU-SA) refers to the capacity of the EU to act autonomously – that is, without being dependent on other countries – in strategically important policy areas. These can range from defence policy to the economy, and the capacity to uphold democratic values…

[EU strategic autonomy 2013-2023: From concept to capacity | Think Tank | European Parliament (europa.eu)]

¡Atención a todos los eslabones de las cadenas de suministro!



https://elements.visualcapitalist.com/chinas-dominance-solar-panel-supply-chain/
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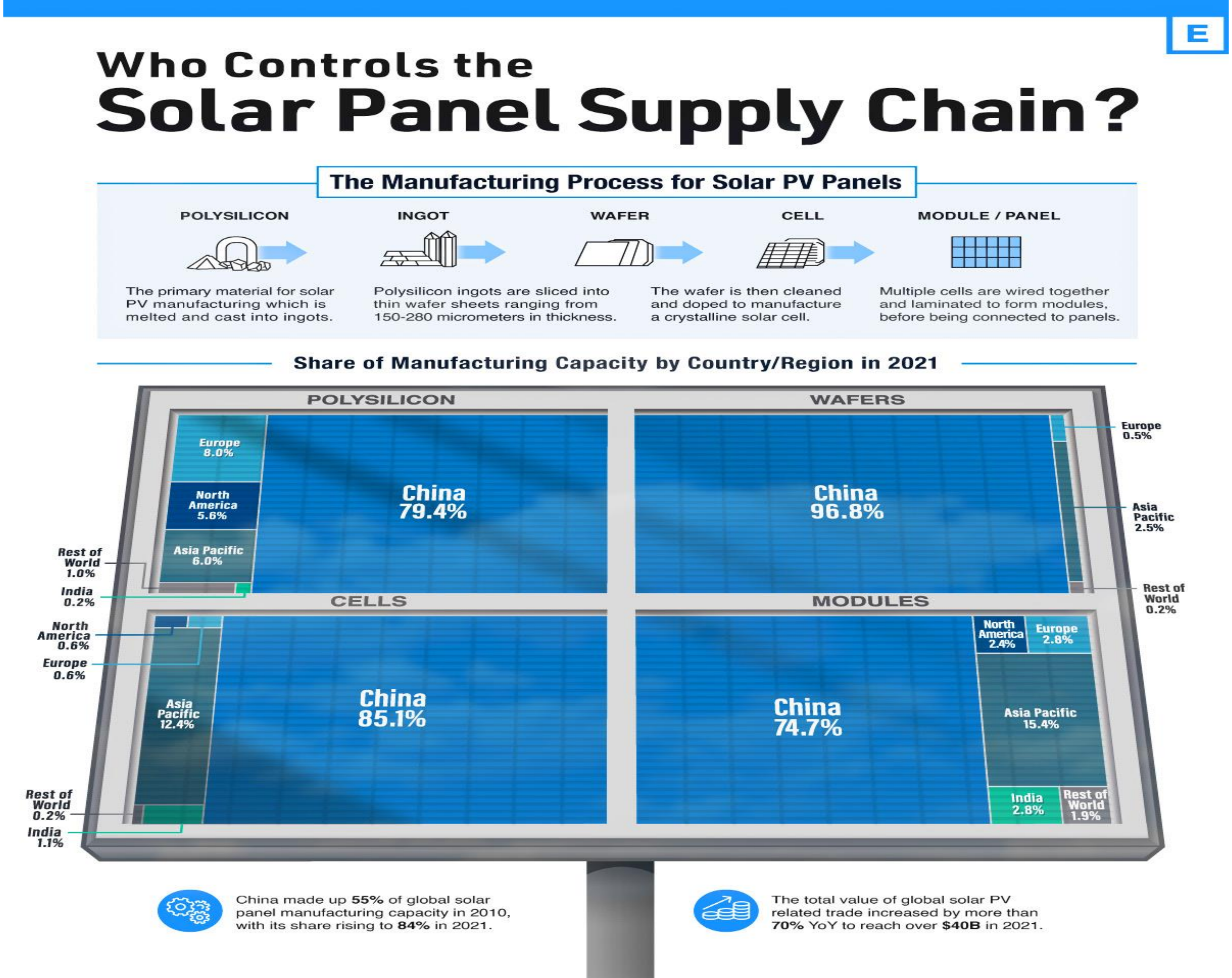
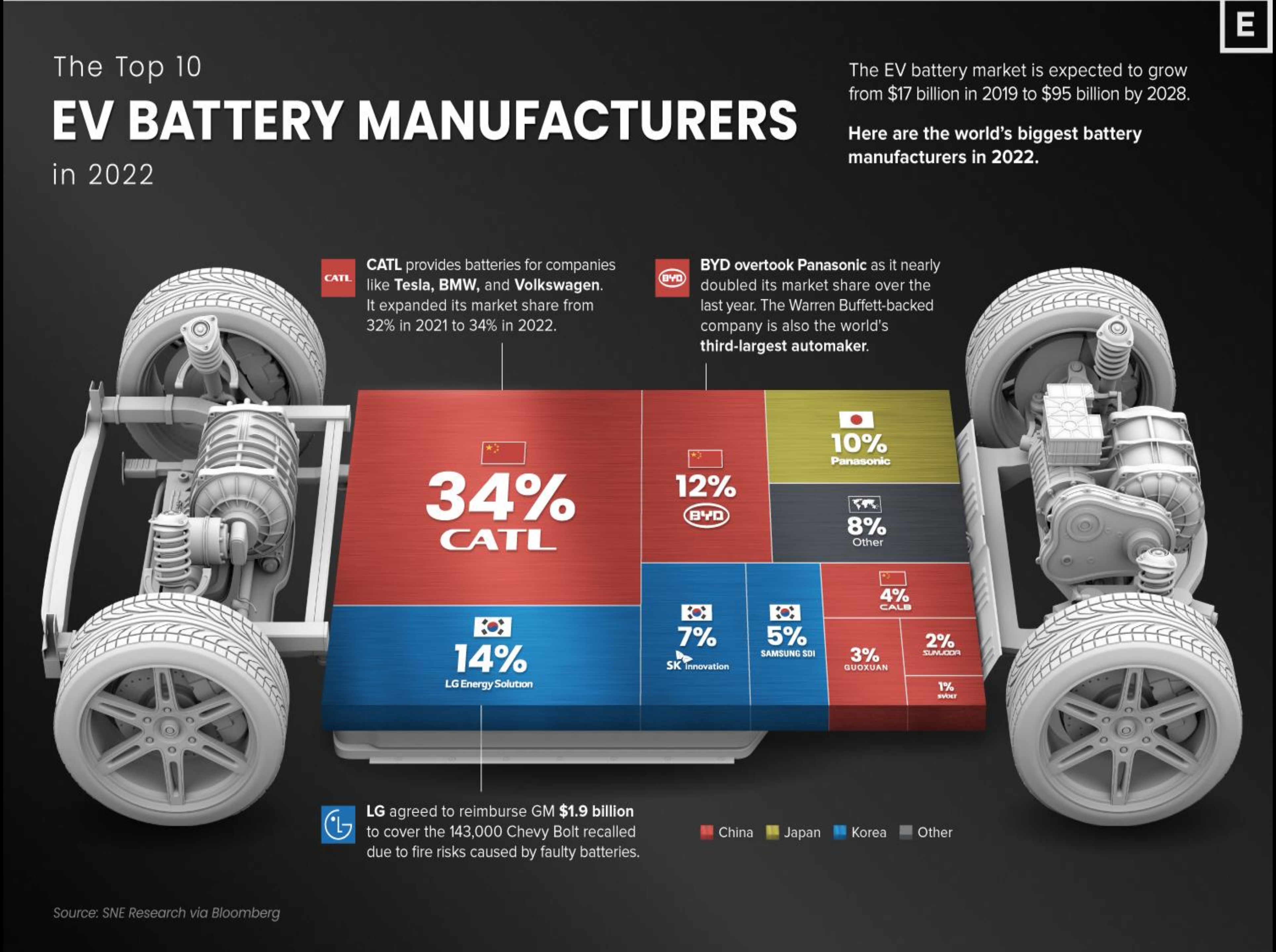
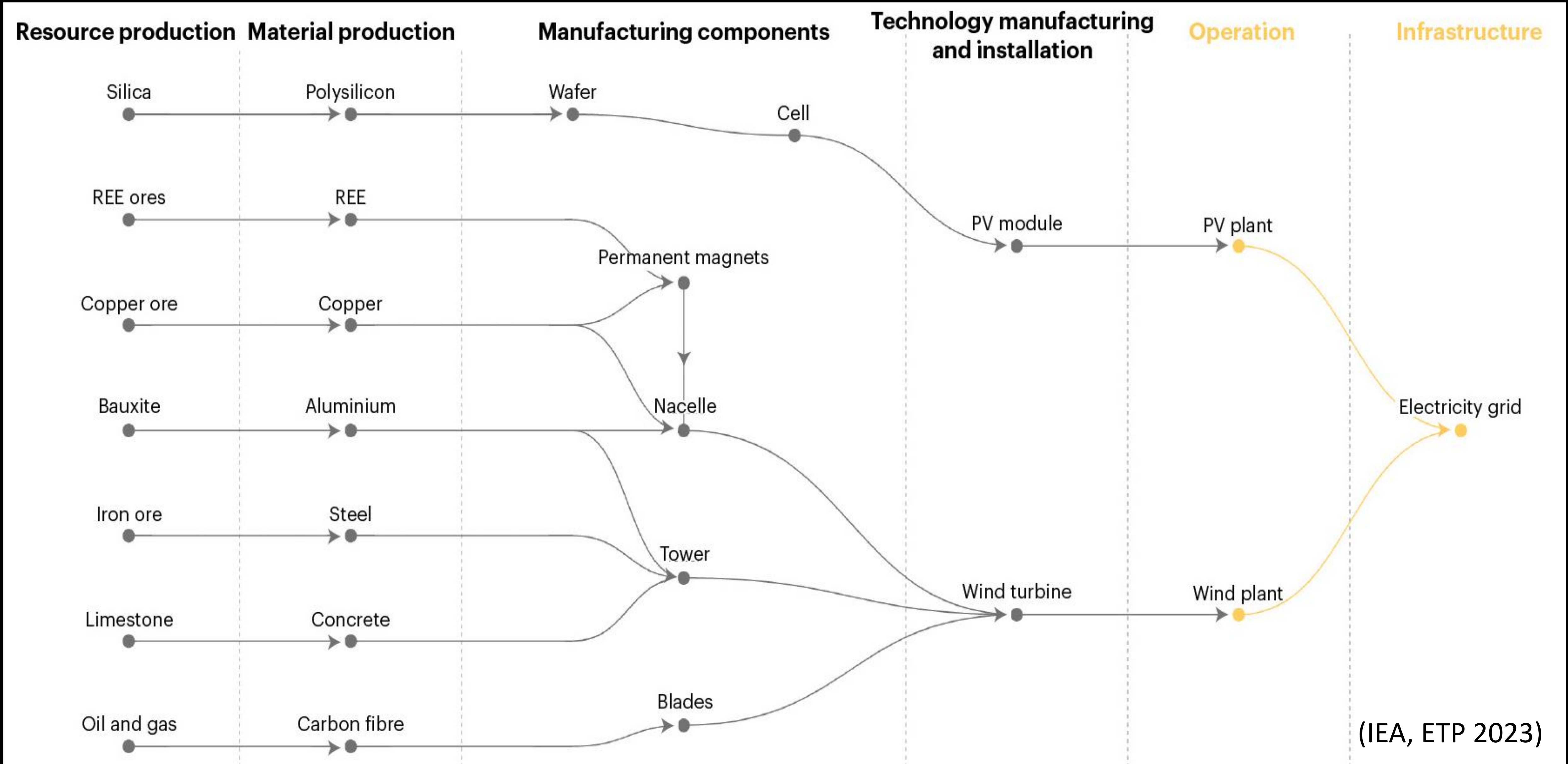




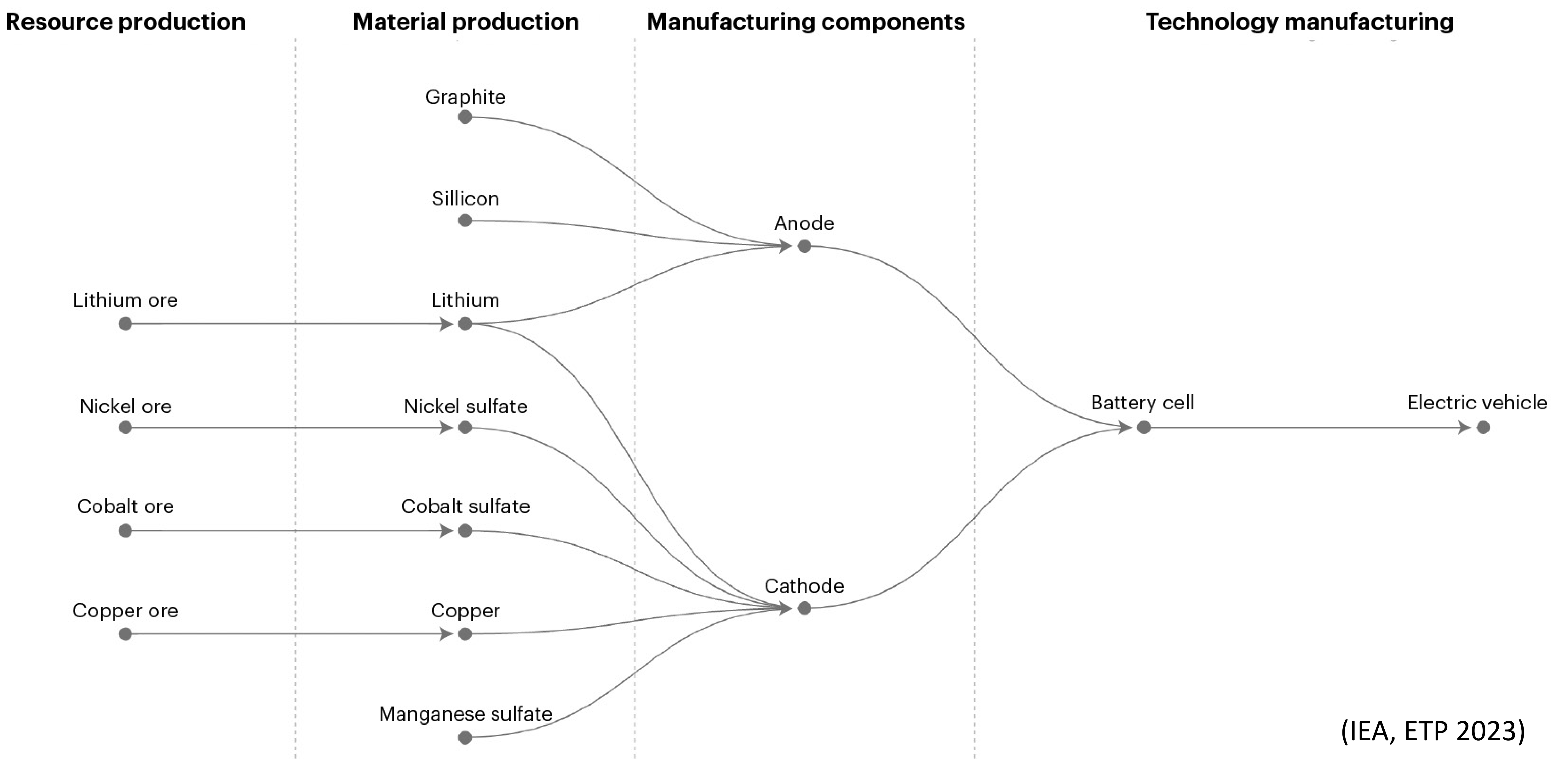
https://www.visualcapitalist.com/the-top-10-ev-battery-manufacturers-in-2022/

Electricidad baja en emisiones

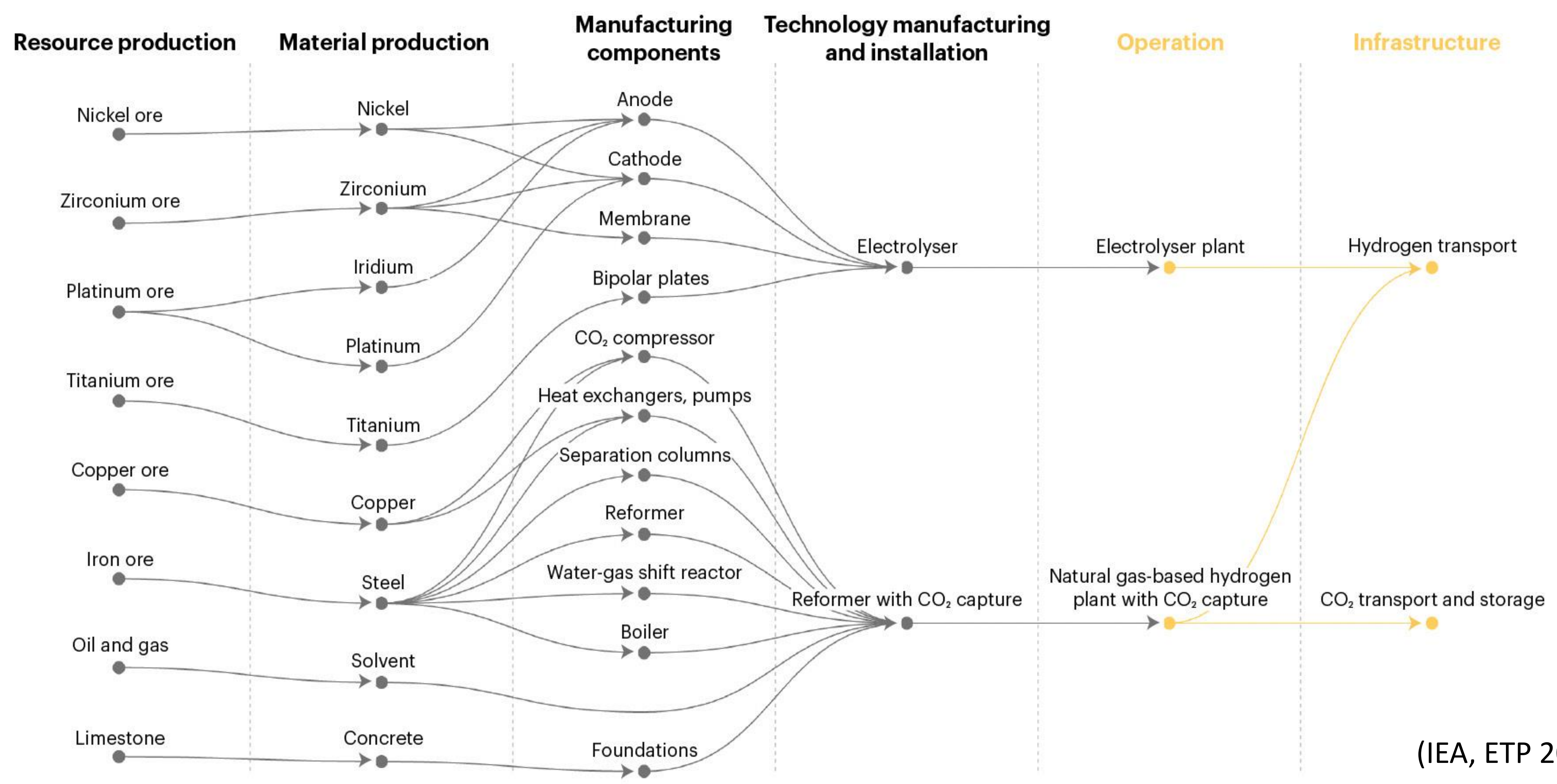


(IEA, ETP 2023)

Vehículos eléctricos de batería



Hidrógeno bajo en emisiones



(IEA, ETP 2023)