7 TH APEEN ANNUAL CONFERENCE

EEIC – Energy Economics International Conference

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Geopolitics of the Energy Transition

A short introduction/A personal view …

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GEOPOLITICS OF E ENERGY TRANSITION: *MUCH MORE THAN OIL & GAS …..*

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Energy Transition and Digital Transition: NEXUS

Critical Raw Materials(CRM)

Important risk drivers for most of CRM

How to implement CRM sustainable value chains, strongly reducing supply risks from their overuse and overconfidence on Imports?

Are specific legislation and EC Directives enough?

- **European CRM Regulation (março 2023)**
- **Electricity market reform and ZERO INDUSTRY ACT**

ECRMR: 4 main goals(2030):*

10% of EU consumption covered by domestic extraction of CRMs;

40% covered by domestic processing;

15% covered by recycling;

A maximum of 65% of the EU's annual consumption of a single SRM should originate from a single third (non-EU MS) country

Technological Dynamics

Geopolitical Dynamics

Associated Risks

Political/Companies Vision, Pragmatism, Systematization in a highly volatile and complex economic-financial framework

*Noble, Philippa (2023)

LOW CARBON TECHNOLOGIES AND RAW MATERIALS

CRM/Rare Earth Elements (REE)

→

Electric cars batteries, wind/solar/H2 equipments …

High Tech equipment & innovative technologies, like alloys or its additives

IMPORTANT!

- **Green transition:** reduction of fossil fuels dependence/ increased pressure on other RM production&international trade
- IEA (2023): RES increased share on energy systems will imply, *on average, a 50% increase of minerals to get a new energy generation unit when compared to 2010.*

- **RENEWABLE TECHNOLOGIES ARE MORE INTENSIVE IN MINERAL INPUTS.**

Pressure on supply/ Price volatility/ increase of importers vulnerability

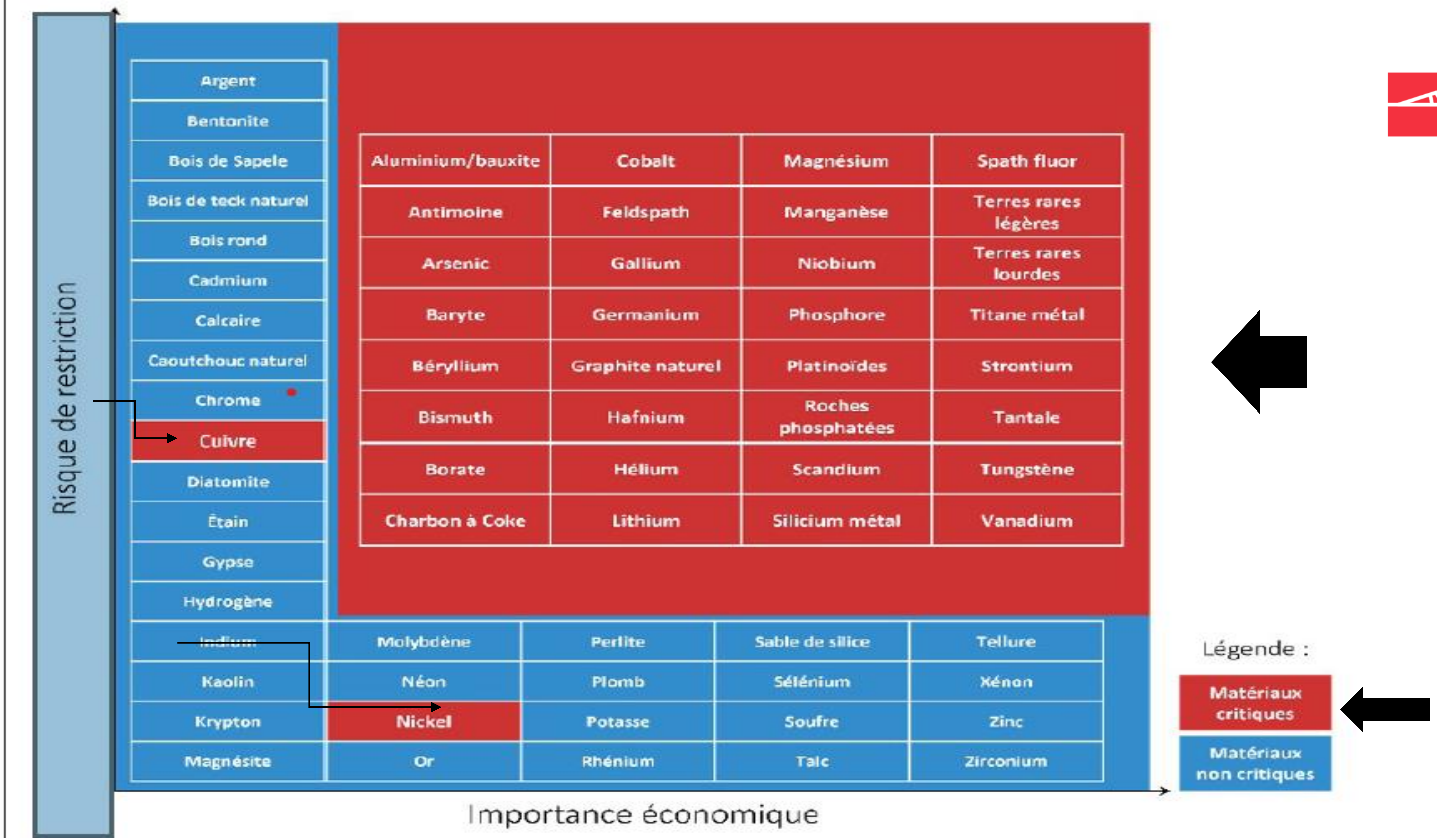
Table 2.1. List of critical raw materials for green technologies

Sorted by the number of green technologies in which the raw material is applied

Material	Li-ion battery	Fuels cells	Wind energy	Electric traction motors	Photo-voltaic	Number of technologies
Aluminium	x	x	x	x	x	5
Copper	x	x	x	x	x	5
Iron ore	x	x	x	x	x	5
Borates		x	x	x	x	4
Germanium and other*	x	x	x		x	4
Cobalt	x	x	x			3
Rare earth elements	x	x	x	x		3
Lead	x		x		x	3
Manganese	x	x	x			3
Molybdenum		x	x		x	3
Nickel	x	x			x	3
Chromium		x	x			2
Lithium	x	x				2
Natural graphite	x	x				2
Selenium	x	x				2
Silver		x			x	2
Tin	x				x	2
Titanium	x	x				2
Arsenic		x				1
Cadmium					x	1
Gold		x				1
Magnesium		x				1
Palladium and platinum		x				1
Phosphorus	x					1
Zinc					x	1
Zirconium		x				1
Iron ore and steel products**			x		x	

Note: * "Germanium and other" is a group of materials including germanium, niobium, vanadium, gallium, indium and hafnium. **Iron ore and steel are not on the original list of Bobba et al. but have been included in the analysis because of their intense use in some green technologies such as for example wind and solar energy.
Source: Based on Bobba et al. (2020[8]).

OCDE (2023)



Hache, E.; V. D'Herbemont; L-M. Malbec (2023). COM BASE NO RELATÓRIO DA CE (2023)

TECHNOLOGICAL DYNAMICS AND CRM

2023 CRMs vs. 2020 CRMs			
aluminium/bauxite	gallium	phosphate rock	vanadium
antimony	germanium	phosphorus	arsenic
baryte	hafnium	PGM	feldspar
beryllium	HREE	scandium	helium
bismuth	lithium	silicon metal	manganese
borate	LREE	strontium	copper
cobalt	magnesium	tantalum	nickel
coking coal	natural graphite	titanium metal	~~indium~~
fluorspar	niobium	tungsten	~~natural rubber~~

Legend:

Black: CRMs in 2023 and 2020

Red: CRMs in 2023, non-CRMs in 2020

~~Strike:~~ Non-CRMs in 2023 that were critical in 2020

CRW LARGEST SUPPLIERS

PGMS:METALS BELONGING TO PLATIIUM GROUP

HREES:HEAVY REE

LREES: LIGHT REE

	Material	Stage *	Main global supplier	Share		Material	Stage *	Main global supplier	Share
1	aluminium	E	Australia	28%	27	magnesium	P	China	91%
2	antimony	E	China	56%	28	manganese	E	S. Africa	29%
3	arsenic	P	China	44%	29	natural graphite	E	China	67%
4	baryte	E	China	32%	30	neodymium	P	China	85%
5	beryllium	E	USA	67%	31	niobium	P	Brazil	92%
6	bismuth	P	China	70%	32	nickel	P	China	33%
7	boron	E	Türkiye	48%	33	palladium	P	Russia	40%
8	cerium	P	China	85%	34	phosphate rock	E	China	48%
9	cobalt	E	DRC	63%	35	phosphorus	P	China	79%
10	coking coal	E	China	53%	36	platinum	P	S. Africa	71%
11	copper	E	Chile	28%	37	praseodymium	P	China	85%
12	dysprosium	P	China	100%	38	rhodium	P	S. Africa	81%
13	erbium	P	China	100%	39	ruthenium	P	S. Africa	94%
14	europium	P	China	100%	40	samarium	P	China	85%
15	feldspar	E	Türkiye	32%	41	scandium	P	China	67%
16	fluorspar	E	China	56%	42	silicon metal	P	China	76%
17	gadolinium	P	China	100%	43	strontium	E	Iran	37%
18	gallium	P	China	94%	44	tantalum	E	DRC	35%
19	germanium	P	China	83%	45	terbium	P	China	100%
20	hafnium	P	France	49%	46	thulium	P	China	100%
21	helium	P	USA	56%	47	titanium metal	P	China	43%
22	holmium	P	China	100%	48	tungsten	P	China	86%
23	iridium	P	S. Africa	93%	49	vanadium	E	China	62%
24	lanthanum	P	China	85%	50	ytterbium	P	China	100%
25	lithium	P	China	56%	51	yttrium	P	China	100%
26	lutetium	P	China	100%					

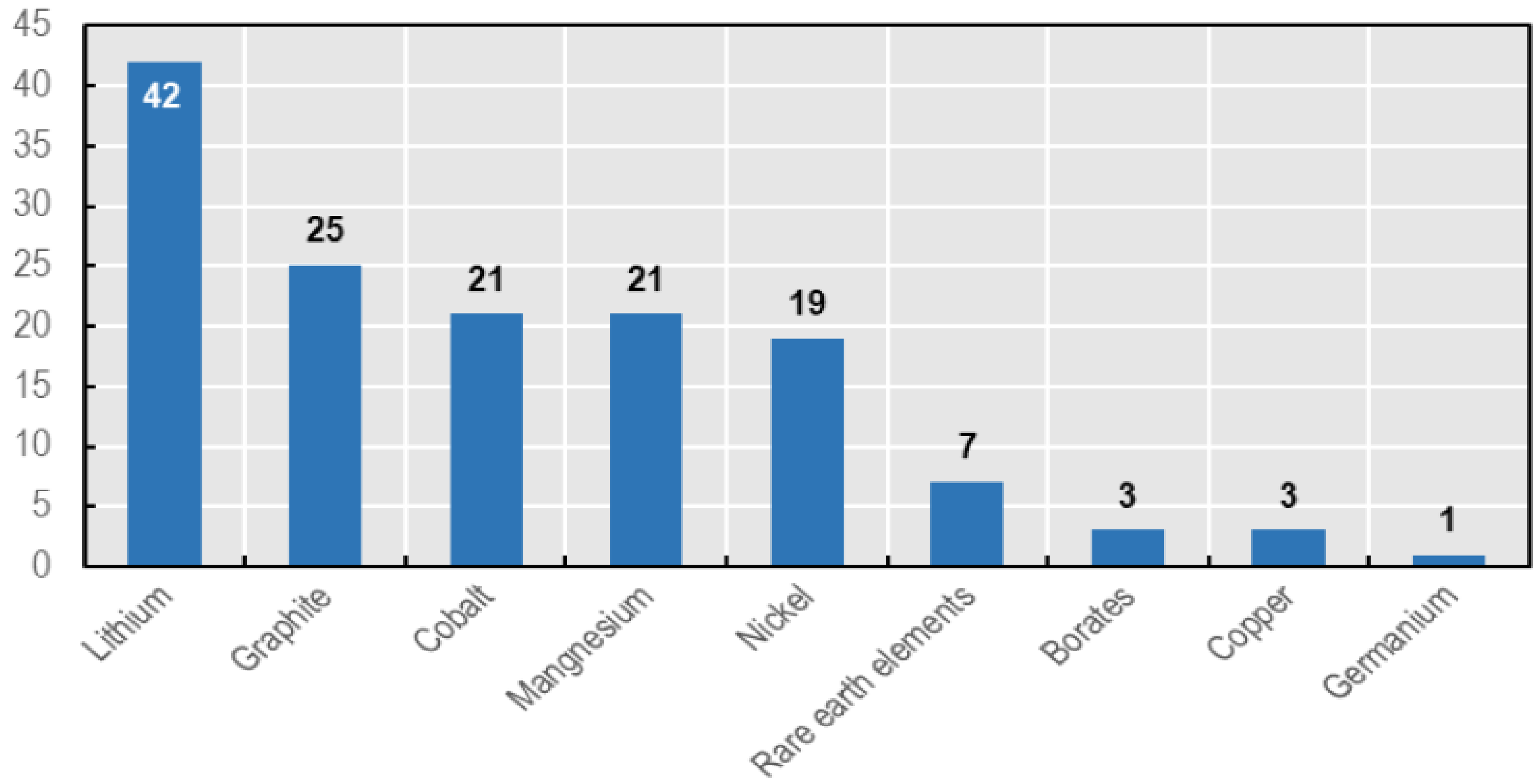
Grouped materials	Stage	Main global supplier	Share
HREEs	P	China	100%
LREEs	P	China	85%
PGMs[6] (iridium, platinum, rhodium, ruthenium)	P	South Africa	75%
PGMs (palladium)	P	Russia	40%

Legend	
Stage	E = Extraction stage P = Processing stage
HREEs	Dysprosium, erbium, europium, gadolinium, holmium, lutetium, terbium, thulium, ytterbium, yttrium
LREEs	Cerium, lanthanum, neodymium, praseodymium and samarium
PGMs	Iridium, palladium, platinum, rhodium, ruthenium

Grohol, M., C. Veeh, DG GROW, EC (2023)

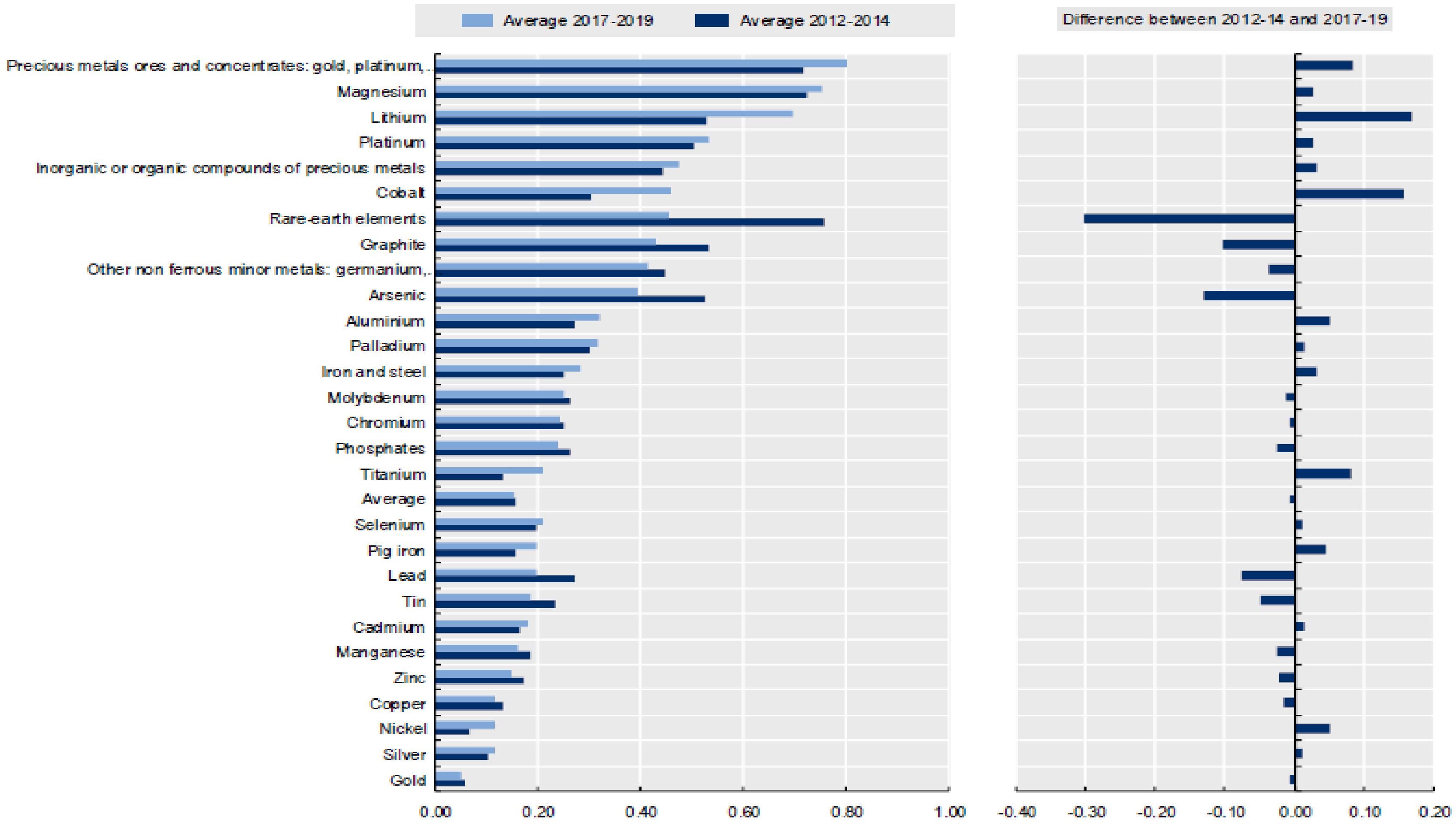
Figure 1.1. Projected global demand growth for certain raw materials by 2040

Projected increase factor (1= current demand)



OCDE (2023)

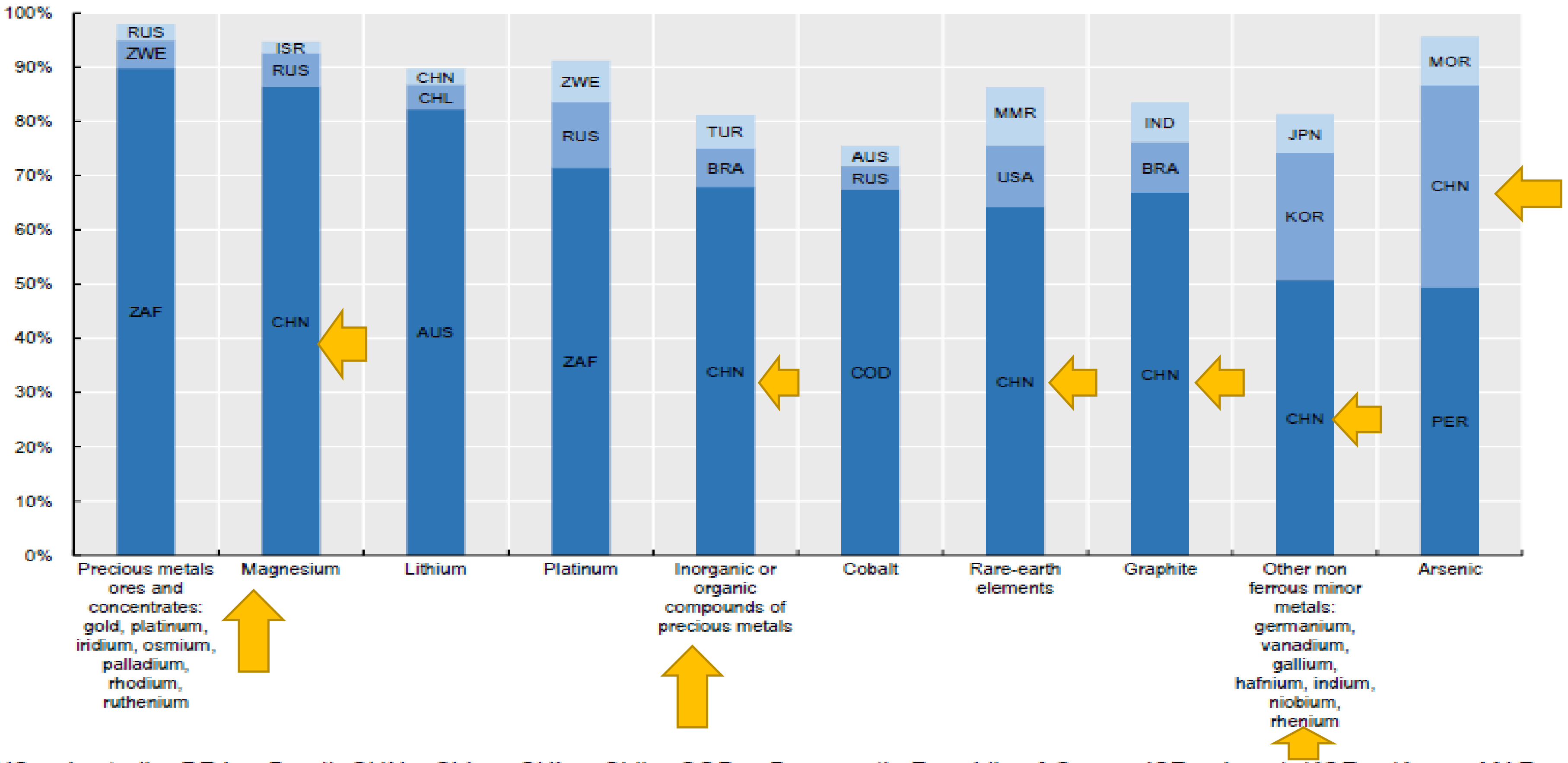
Global HHI index of production concentration across producing countries and critical raw materials



Note: Ordered by the value of the HHI index in 2017-19.
Source: OECD calculations based on the United States Geological Survey data.

Figure 3.5. Top 3 producers of the top 10 most production-concentrated critical raw materials

Shares in global production (%)



Note: AUS – Australia; BRA – Brazil; CHN - China; CHL – Chile; COD – Democratic Republic of Congo; ISR – Israel; KOR – Korea; MAR – Morocco; MMR – Myanmar; MOZ – Mozambique; PER – Peru; TUR – Türkiye; RUS – Russian Federation; ZAF – South Africa; ZWE – Zimbabwe.
Shares in global production based on gross weight of production.
Source: OECD calculations based on the United States Geological Survey data.

OCDE(2023)

FEP

POLITICAL/ COMPANIES VISION, PRAGMATISM, SYSTEMATIZATION

- ✓ Geopolitical /Economic complexity: more than USA on the internationl power landscape (China, Russia…*India?)/* Restrictive financial policy/ GDP problems; High political instability/ war conflicts and regional tensions
- ✓ **EU highly dependent on CRM and SRM to achieve Energy Transition and Digital Transition**

URGENT NEED FOR

Efficiency Gains

→

Coordinated policy towards supliers diversification. EU behind USA and China! ***

→

Strong investment on targeted/coordinated I&D investment (strong link to industry, among member- states. between diferent areas

Initiatives	Pays concernés	Type d'accords
Alliance européenne des batteries (2017)	UE	Créer une chaîne de valeur compétitive en Europe sur la production de cellules de batterie
Initiative de cartographie des minéraux critiques (2019)	Australie, Canada, États-Unis	Collaboration de recherche sur les ressources minérales
Energy Resource Governance Initiative (2019)	Australie, Botswana, Canada, États-Unis, Pérou	Améliorer les pratiques de développement minier
Alliances européennes des matières premières (2020)	UE	Sécuriser l'accès aux matières premières durables et au savoir-faire en matière de transformation industrielle
Initiative sur les chaînes de valeur résilientes (2021)	Australie, Inde, Japon	Promouvoir les investissements et réduire la dépendance aux exportations de ressources naturelles de la Chine
Partenariat pour la sécurité des ressources minérales (2022)	Allemagne, Australie, Canada, Corée, États-Unis, Finlande, France, Japon, Royaume-Uni, Suède et UE	Valoriser la production, le traitement et le recyclage des ressources naturelles
Cadre économique indopacifique pour la prospérité (2022)	Australie, Brunéi Darussalam, Corée du Sud, États-Unis, Inde, Indonésie, Japon, Malaisie, Nouvelle-Zélande, Philippines, Singapour, Thaïlande et Vietnam	Décarbonation et infrastructures ; fiscalité et lutte contre la corruption ; numérique ; et résilience des chaînes d'approvisionnement

Tableau 1 : Initiatives régionales ou internationales sur les métaux.

* Hache, E. et al. (2023), página 72

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thanks