Junho 2023

Materiais/Minerais para a Transição energética

Patrícia Fortes

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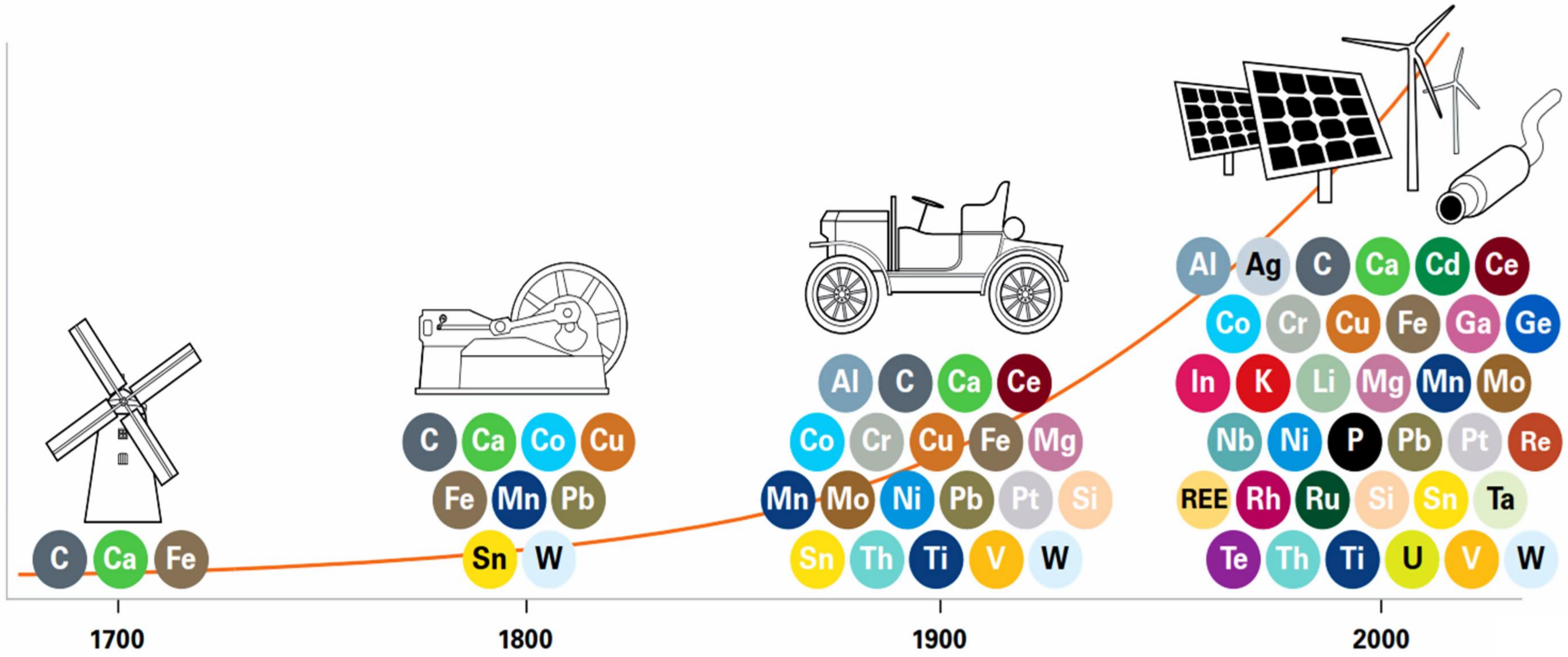

Source: [BP (2011)]

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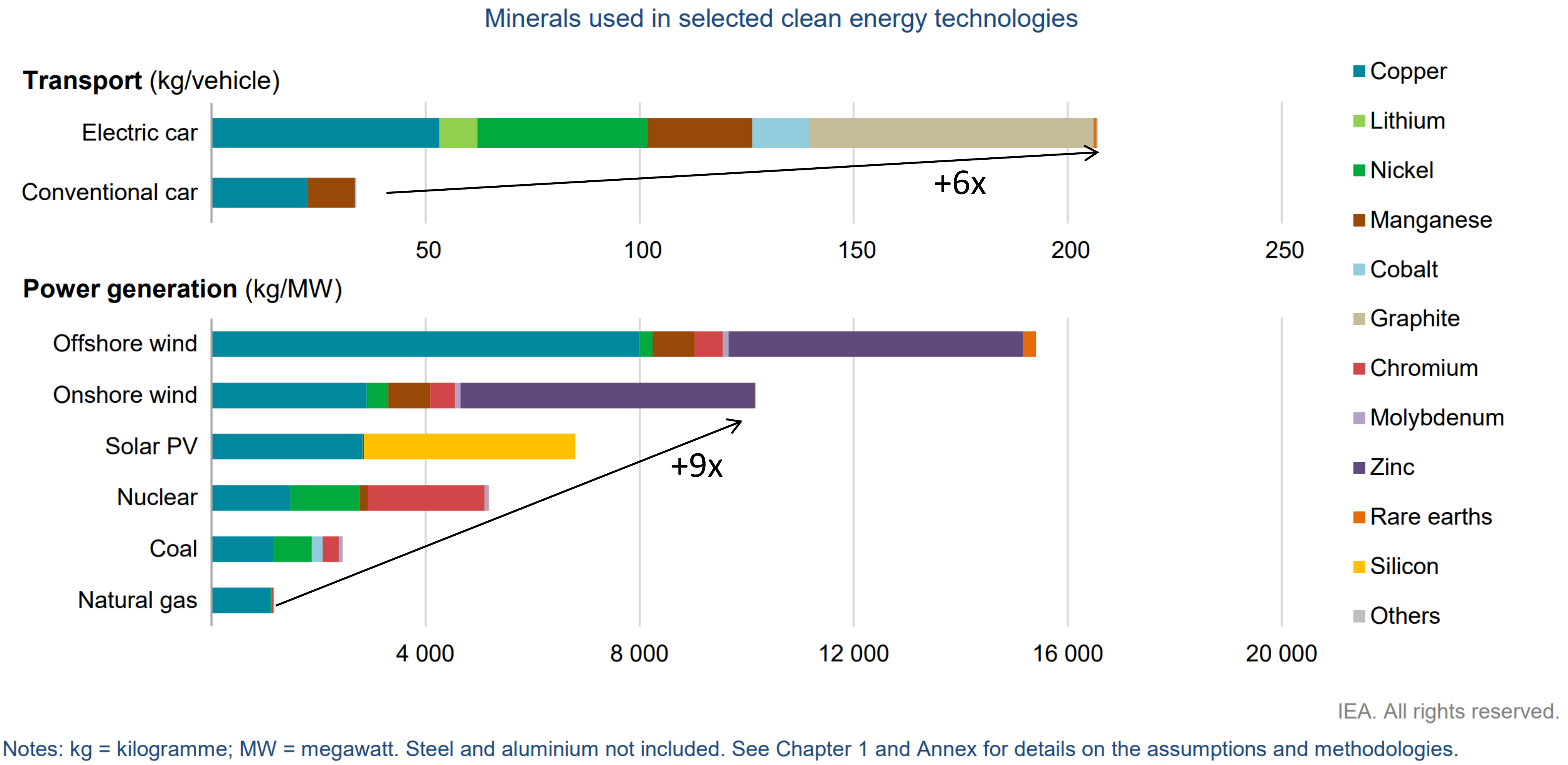
MINERAIS POR TECNOLOGIA



Source: IEA (2021). *The Role of Critical Minerals in Clean Energy Transitions* https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

MINERAIS POR TECNOLOGIA

	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.

REEs = Rare Earth Elements

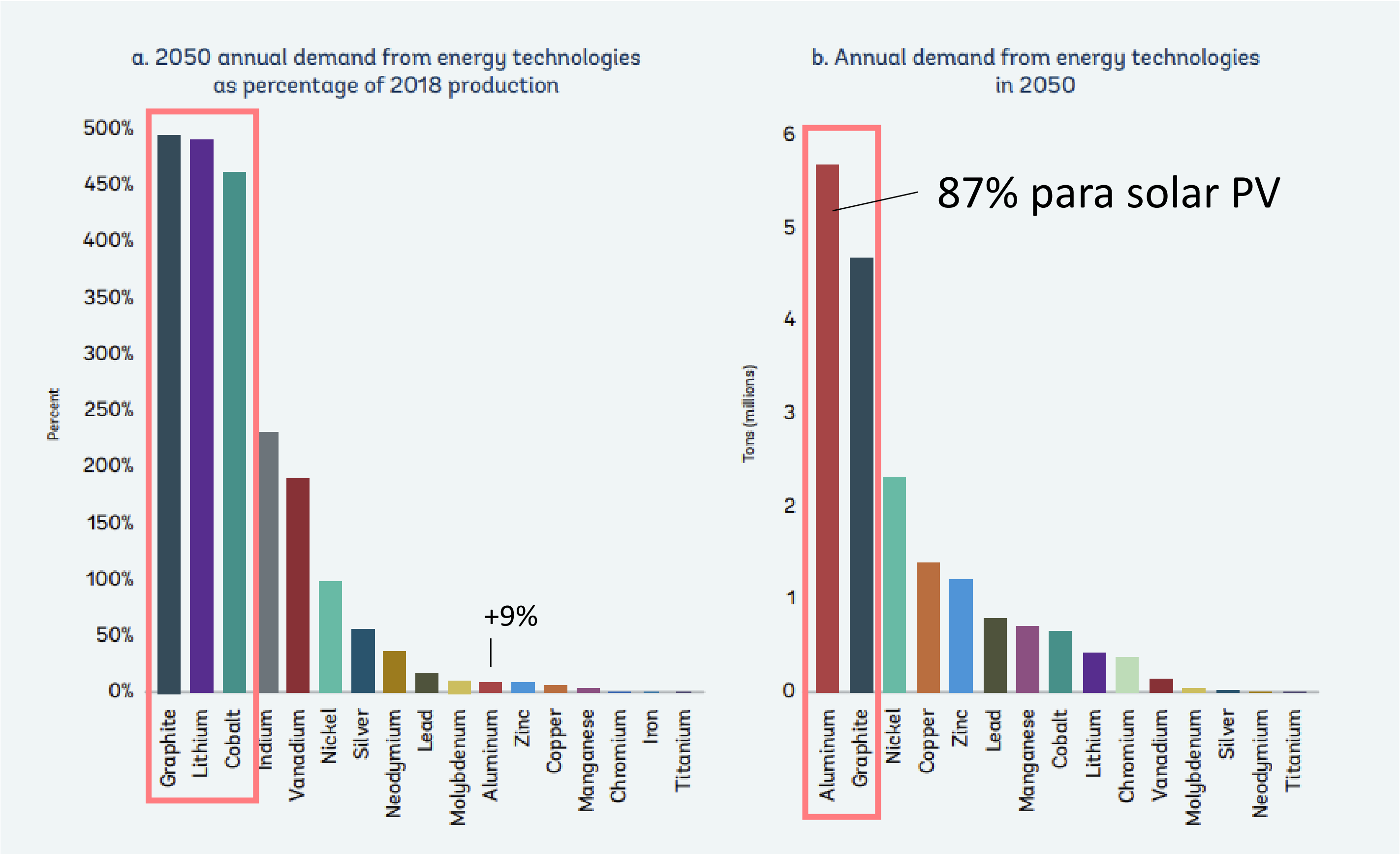
PGM = Platinum group metals

Source: IEA (2021). *The Role of Critical Minerals in Clean Energy Transitions* https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

PROCURA FUTURA DE MATERIAIS

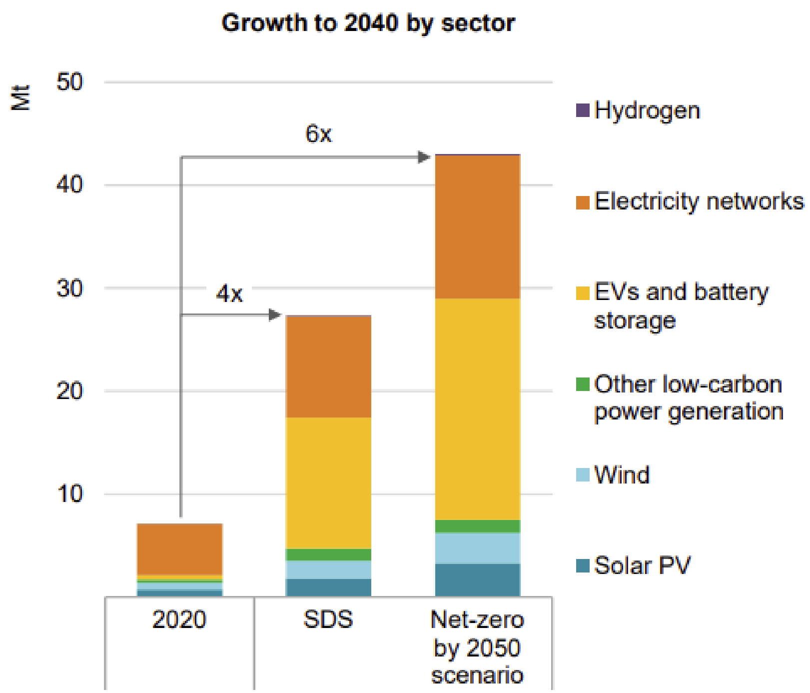
> No futuro, a procura por **grafite, lítio e cobalto** será tão elevada que a produção actual precisa crescer quase 500% até 2050 num cenário climático de 2°C

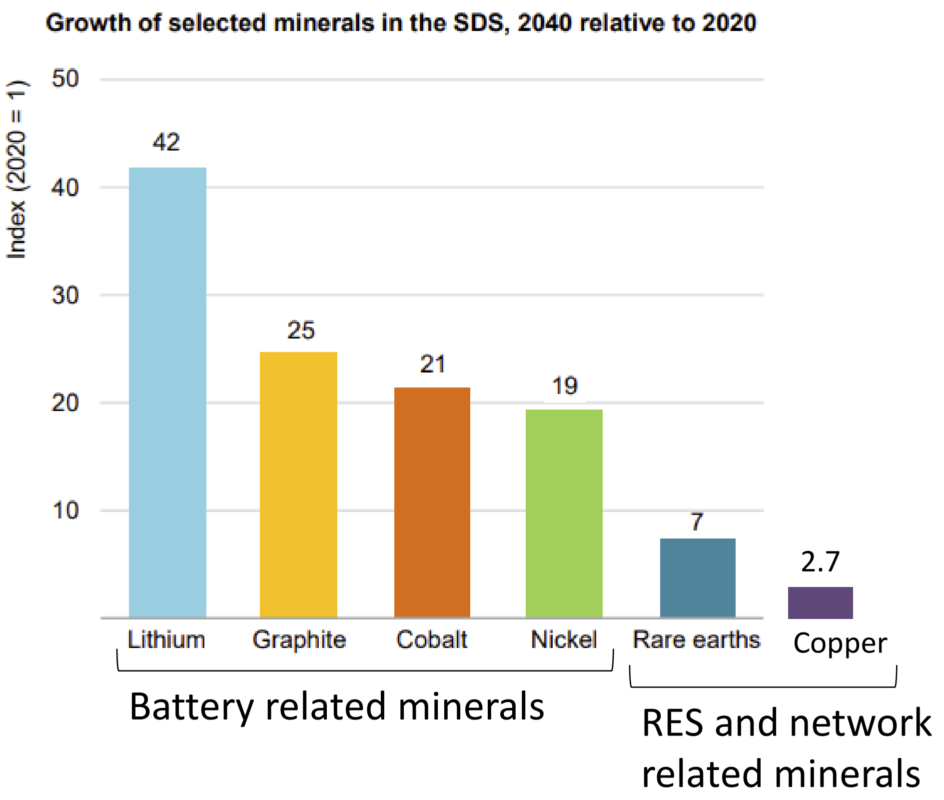
Figure 4.3 Projected Annual Mineral Demand Under 2DS Only from Energy Technologies in 2050, Compared to 2018 Production Levels



Source: World Bank (2020). Minerals for Climate Action https://www.worldbank.org/en/topic/extractiveindustries/brief/climate-smart-mining-minerals-for-climate-action

PROCURA FUTURA DE MINERAIS





SDS: Sustainable Development Scenario = net-zero CO2 emissions by 2070. 50% probability of limiting the temperature rise to less than **1.65 °C by 2100**
NZE: Net-zero by 2050 Scenario = 50% probability of limiting the temperature rise to less than **1.5°C by 2100**

Source: International Energy Agency (2021). *The Role of Critical Minerals in Clean Energy Transitions*
https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

Unidade de Economia de Recursos

USO DE MATERIAIS PARA A DESCARBONIZAÇÃO DO SISTEMA ENERGÉTICO PORTUGUÊS

Sofia G. Simões, Filipa Amorim

LNEG – Laboratório Nacional de Energia e Geologia
UER – Unidade de Economia de Recursos

LNEG
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REPÚBLICA PORTUGUESA
AMBIENTE E AÇÃO CLIMÁTICA

Patrícia Fortes

NOVA School of Science and Technology
CENSE | Center for Environmental and Sustainable Research

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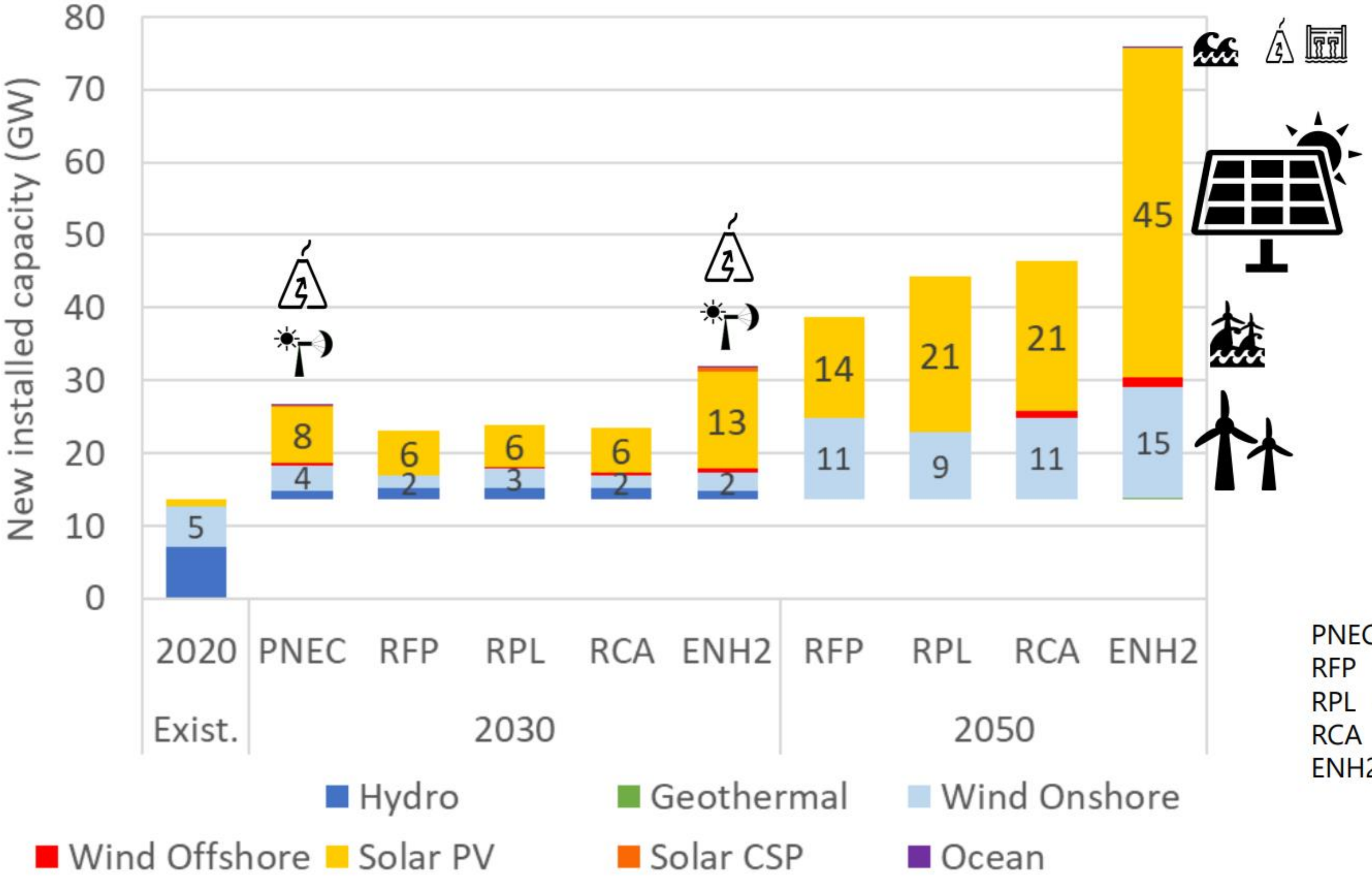
EVOLUÇÃO DA NOVA CAPACIDADE INSTALADA



PNEC – National Energy and Climate Plan 2030
RFP - RNC2050 "Fora de Pista" Scenario
RPL - RNC2050 "Pelotão" Scenario
RCA - RNC2050 "Camisola Amarela" Scenario
ENH2 – National Hydrogen Strategy

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PROCURA DE MATERIAIS/MINERAIS PARA O SECTOR ELECTROPRODUTOR NACIONAL

	2030					2050			
(ton)	RNCFP	RNCPL	RNCCA	PNEC	ENH2	RNCFP	RNCPL	RNCCA	ENH2
Ag (silver)	93	86	93	120	210	208	208	308	687
Al (aluminium)	61,905	59,469	62,308	81,866	137,041	149,960	149,960	214,775	463,089
Cd (cadmium)	87	80	87	107	188	194	194	288	633
Cement	10,862,030	10,992,360	10,911,841	8,631,557	8,387,915	1,059,418	1,059,418	1,159,452	1,765,642
Cr (chromium)	5,669	8,992	5,923	16,088	9,675	35,403	35,403	36,040	63,102
Cu (copper)	14,294	17,208	17,200	23,127	34,163	44,909	44,909	64,029	119,968
Dy (dysprosium)	14	28	23	35	34	90	90	112	155
Fe (iron)	269,247	443,321	335,795	734,238	751,122	1,467,533	1,467,533	1,634,796	2,578,569
Ga (gallium)	6	6	6	8	13	14	14	21	45
In (indium)	25	23	25	31	54	55	55	82	181
Mg (magnesium)	269	250	269	330	581	596	596	884	1,944
Mn (manganese)	2,134	3,614	2,580	5,968	5,576	13,352	13,352	14,475	22,484
Mo (molybdenum)	333	550	384	1,163	602	2,063	2,063	2,191	4,481
Nd (neodymium)	70	155	140	194	209	437	437	614	854
Ni (nickel)	1,382	2,224	1,527	10,404	2,793	8,385	8,385	8,750	36,580
Pb (lead)	1,346	2,527	3,316	3,231	6,067	2,995	2,995	9,396	17,124
Pr (praseodymium)	36	69	56	87	82	224	224	275	378
Se (selenium)	31	29	31	38	67	69	69	103	226
Sn (tin)	2,305	2,138	2,305	2,839	5,009	5,158	5,158	7,647	16,820
Tb (terbium)	2	4	4	6	7	11	11	18	25
Te (tellurium)	50	46	50	61	108	111	111	164	362
Ti (titanium)	0	0	0	102	7	-	-	-	333
Zn (zinc)	9,372	15,910	11,528	20,359	16,980	58,066	58,066	63,649	87,598

Cement  **Fe**  **Al**  **Cu** 

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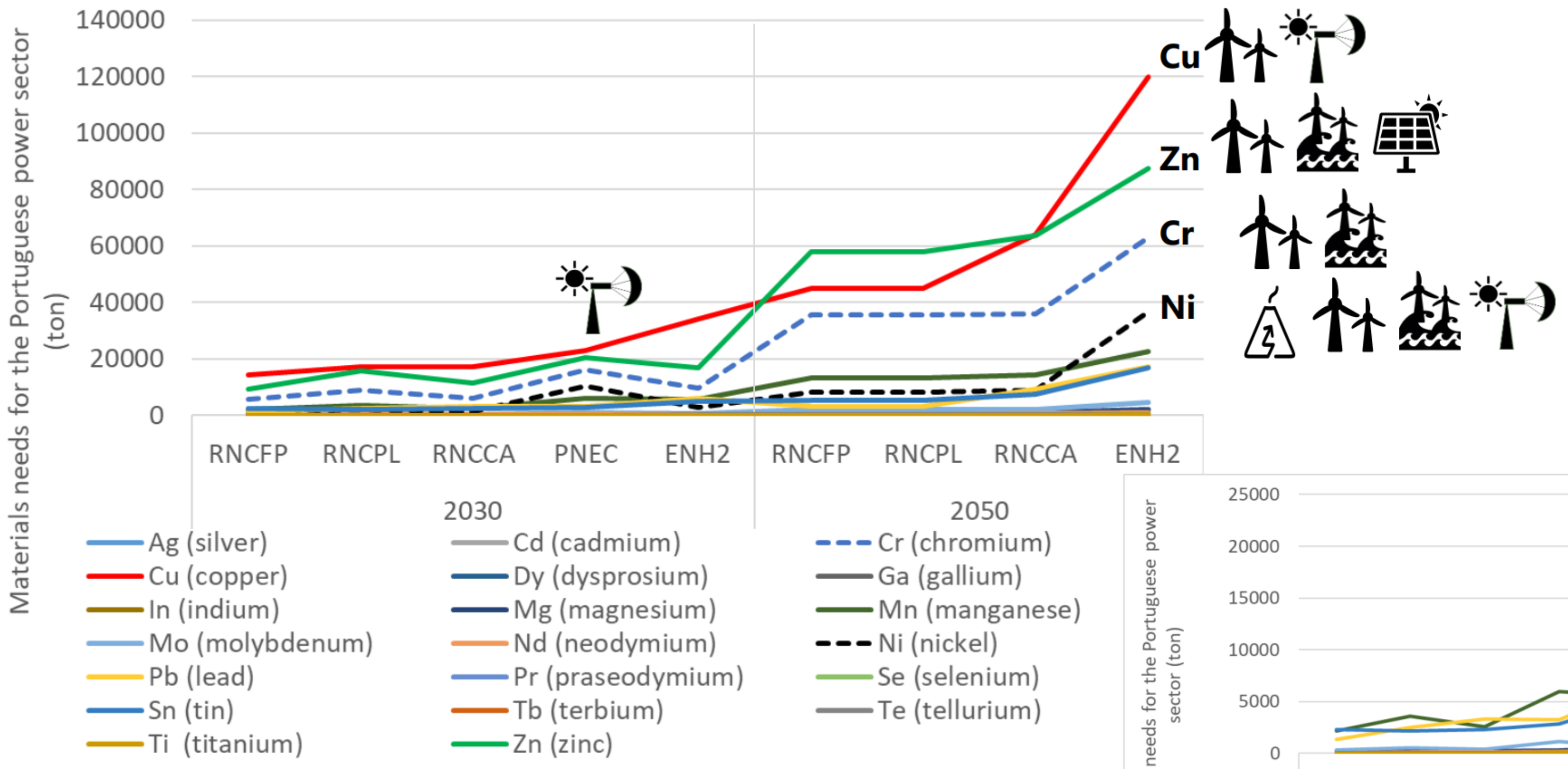
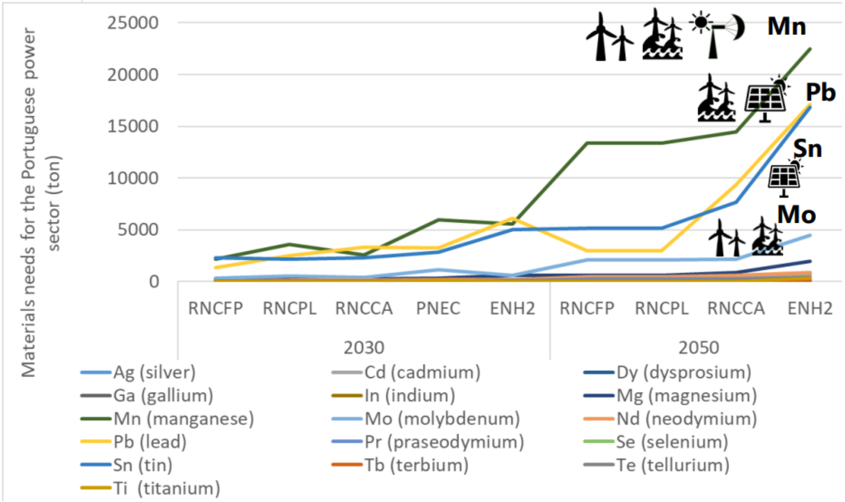
PROCURA DE MATERIAIS/MINERAIS PARA O SECTOR ELECTROPRODUTOR NACIONAL





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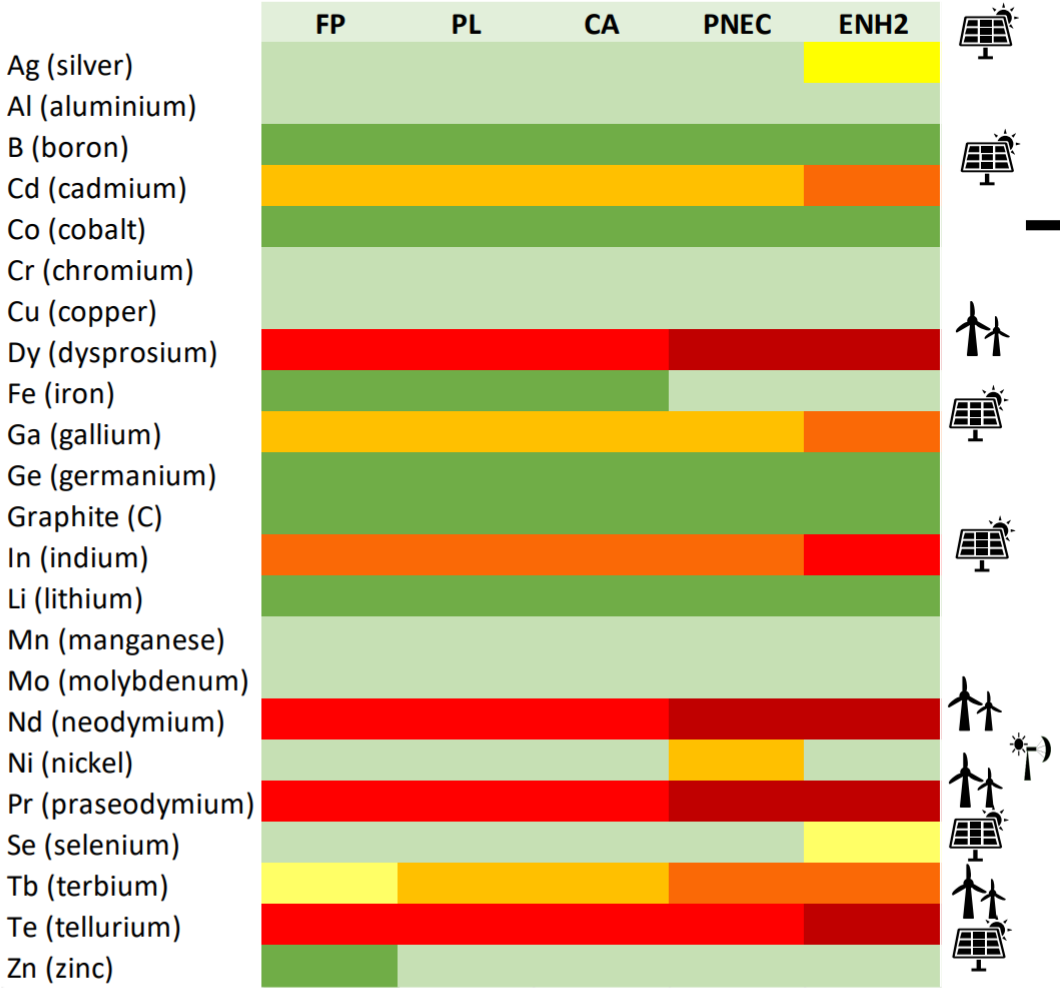
IMPORTÂNCIA RELATIVA DAS NECESSIDADES DE MATERIAIS NACIONAIS

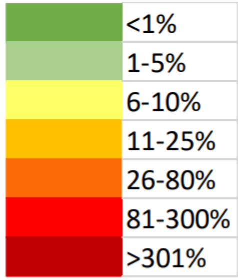


2030

this assessment

material needs for Portugal for power sector
____
current total material use in EU (2012-2017)

https://ec.europa.eu/docsroom/documents/42881



Potential higher supply risk with with #9 materials
Cd, Dy, Ga, In, Nd, Ni, Pr, Tb and Te
(>10% total current EU demand)

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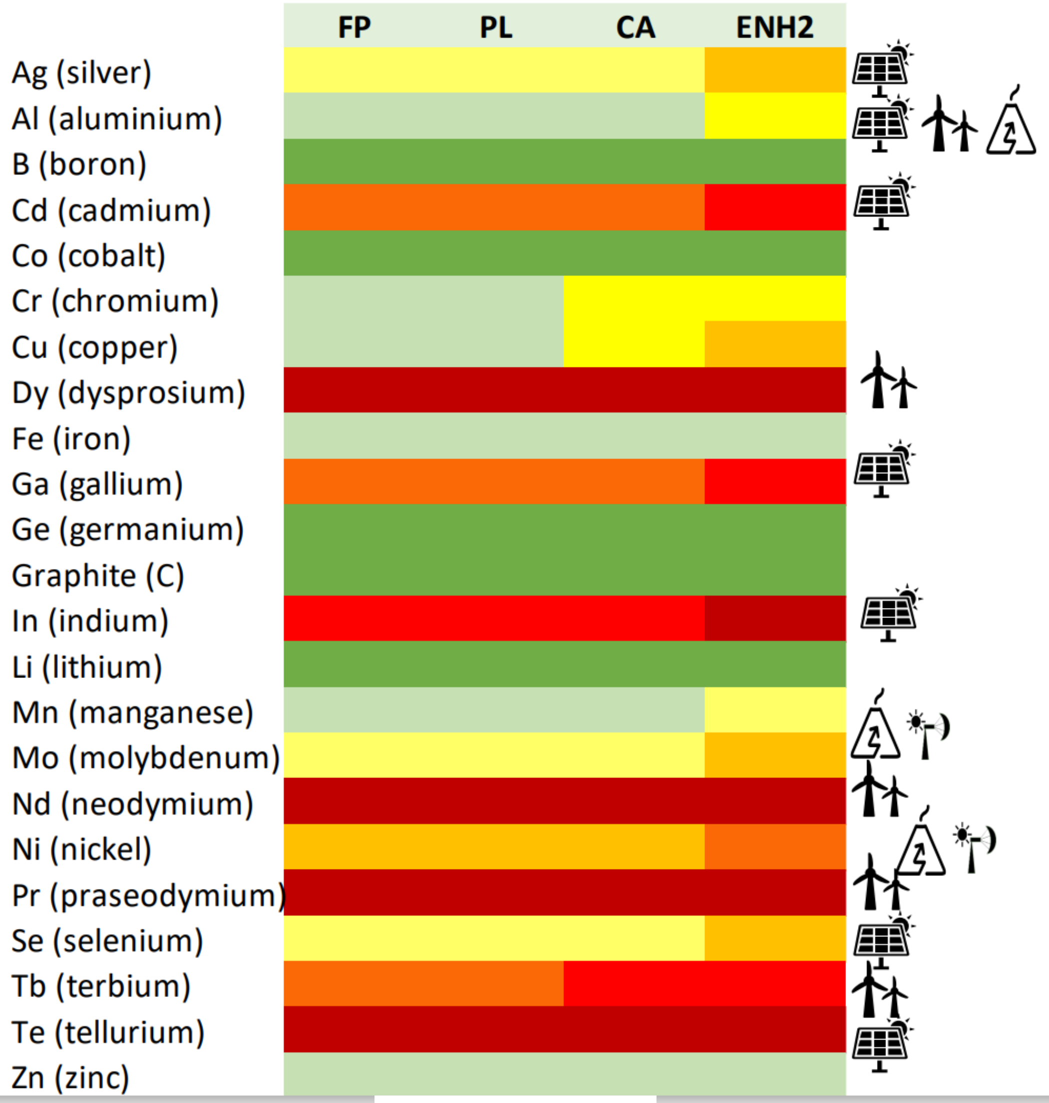
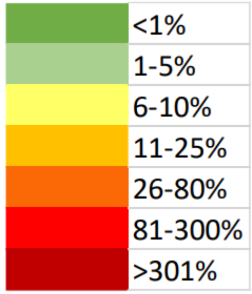
IMPORTÂNCIA RELATIVA DAS NECESSIDADES DE MATERIAIS NACIONAIS





2050

Potential higher supply risk with #13 materials
Ag, Cd, Dy, Ga, In, Nd, **Ni**, Pr, Mo, Se, Tb and Te (>10% total current EU demand)
In bold new materials from 2030

Al, Cr, Mn close to 10% threshold

- From 2030 to 2050 **relative importance of Portuguese needs increases** with 3 more materials above 10% threshold and other 3 close, depending on considered scenario
- Potential risk of supply **consistently higher with ENH2** strategy scenarios

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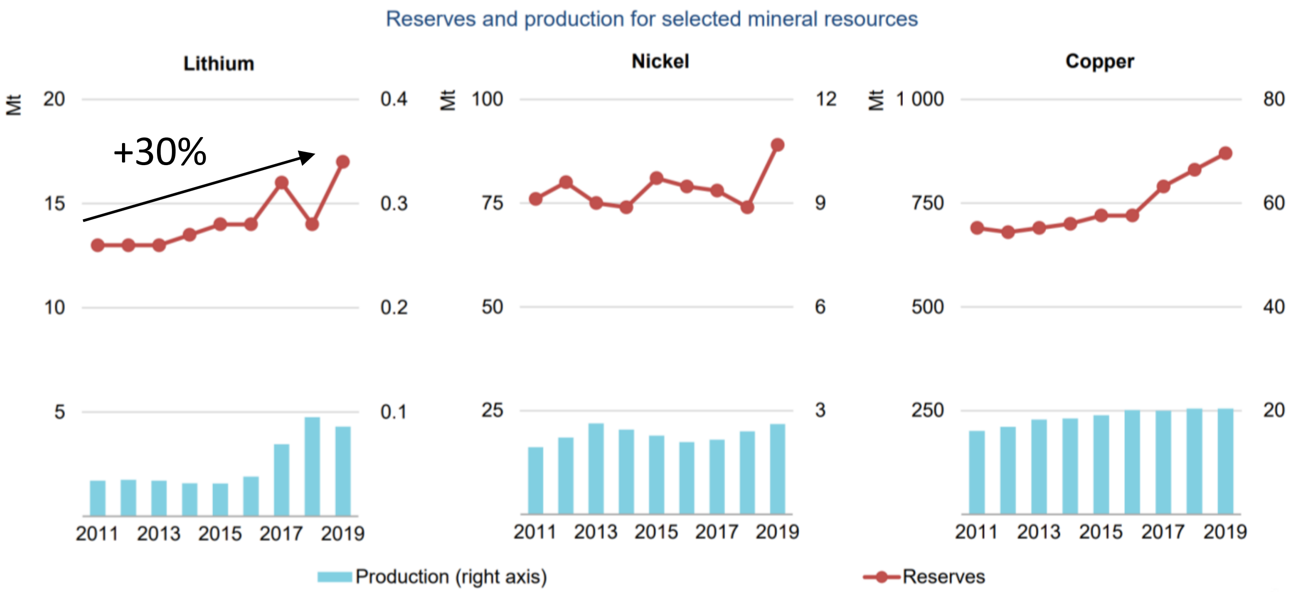
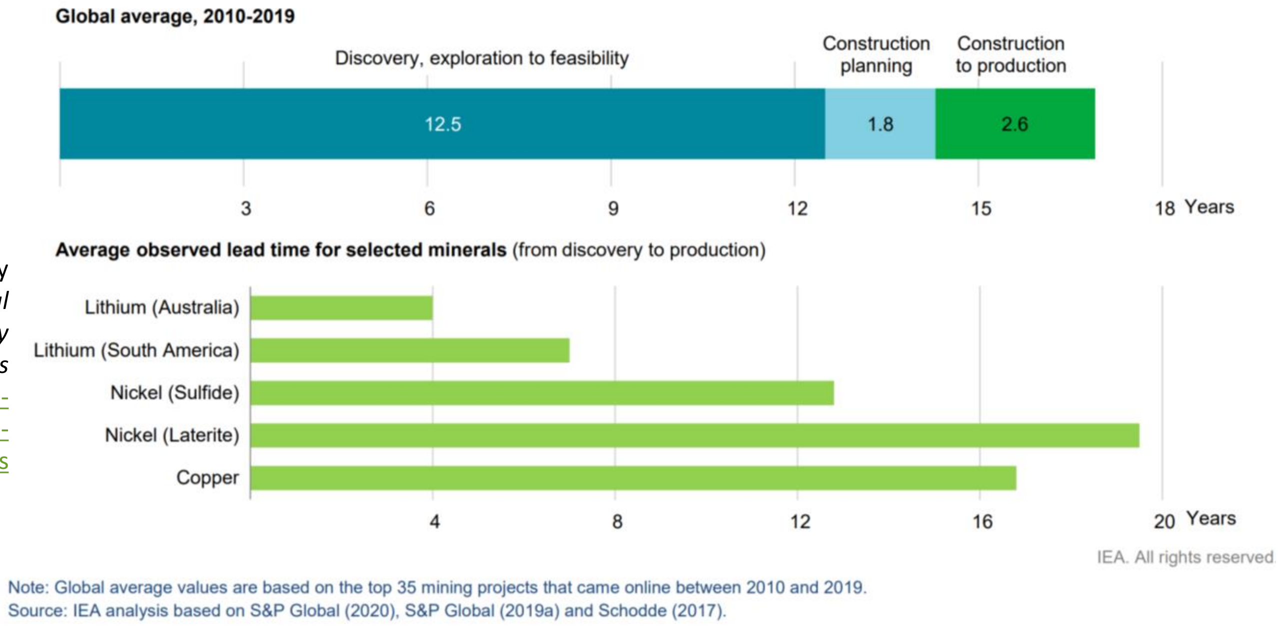
SERÃO OS RECURSOS SUFICIENTES?



Source: International Energy Agency (2021). *The Role of Critical Minerals in Clean Energy Transitions* https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

> Em principio não existe "shortage" mas a criação de novas áreas de exploração pode não conseguir acompanhar o ritmo necessário para a mitigação



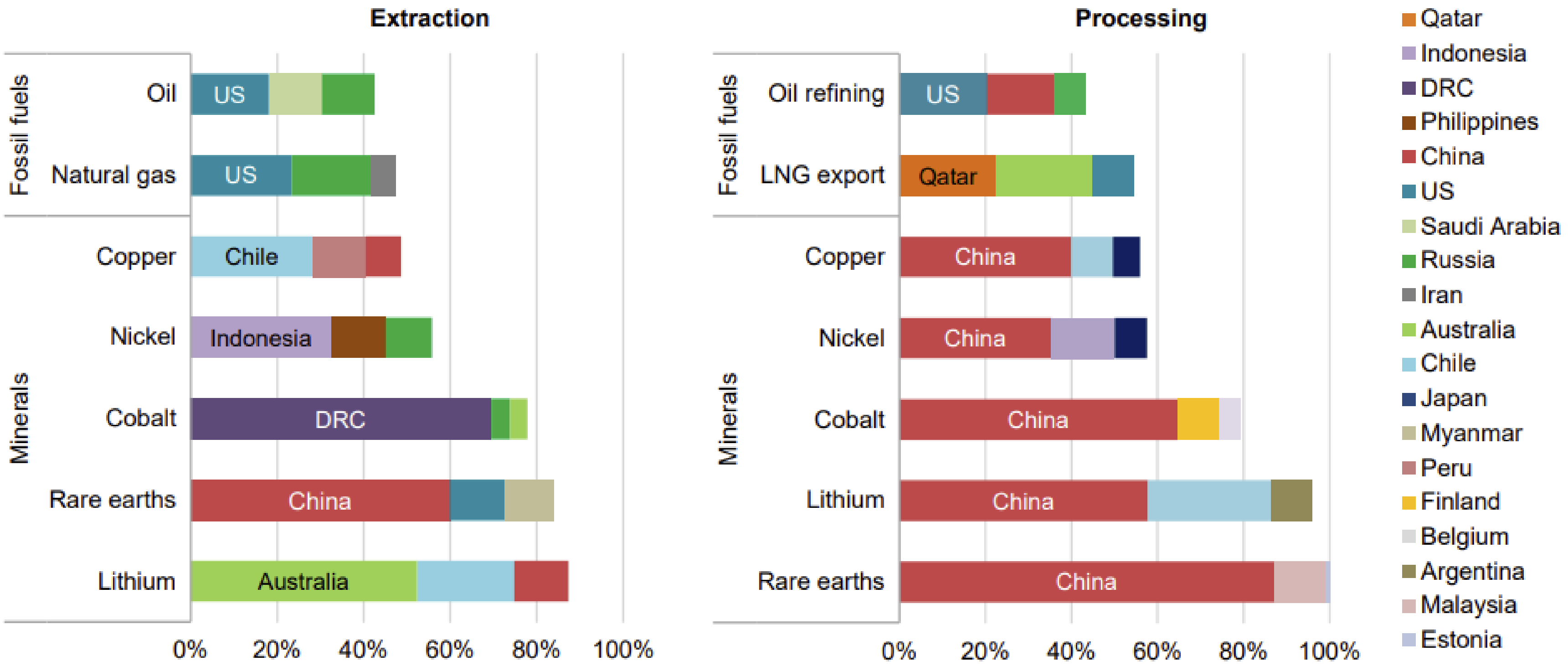
Source: International Energy Agency (2021). *The Role of Critical Minerals in Clean Energy Transitions* https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

KPMG (2021). Resourcing the Energy Transition: Making the World Go Round. https://assets.kpmg/content/dam/kpmg/cr/pdf/resourcing-the-energy-transition.pdf

RISCO NA OFERTA DE MINERAIS

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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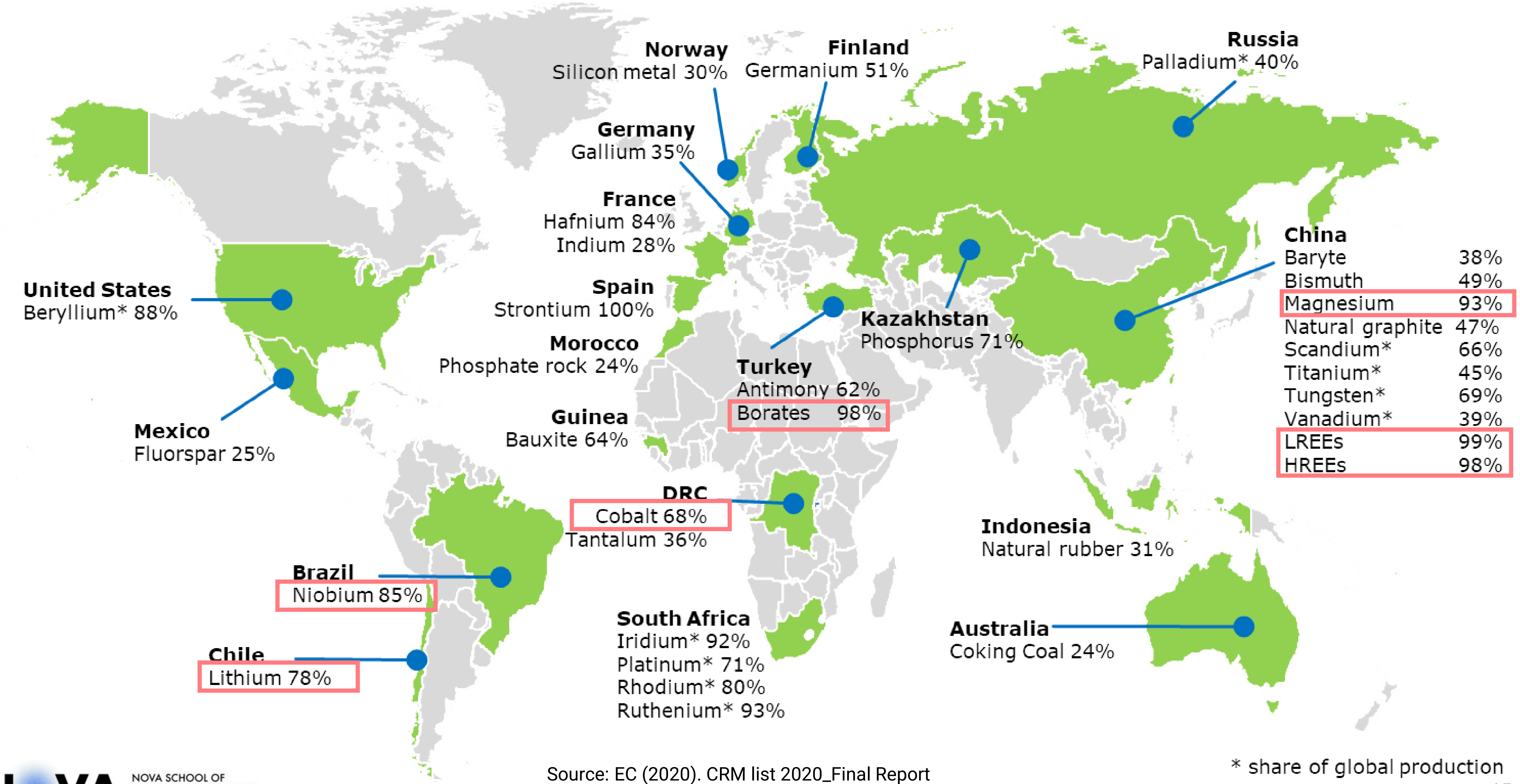
Source: International Energy Agency (2021). *The Role of Critical Minerals in Clean Energy Transitions*
https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

FONTE DE MATERIAIS CRITICOS NA EU



* share of global production

Source: EC (2020). CRM list 2020_Final Report
https://ec.europa.eu/docsroom/documents/42883/attachments/1/translations/en/renditions/native

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IMPACTES SOCIAIS E AMBIENTAIS

Children working in mines in DRC - **Mining is one of the worst forms of child labor and prohibited by international law**

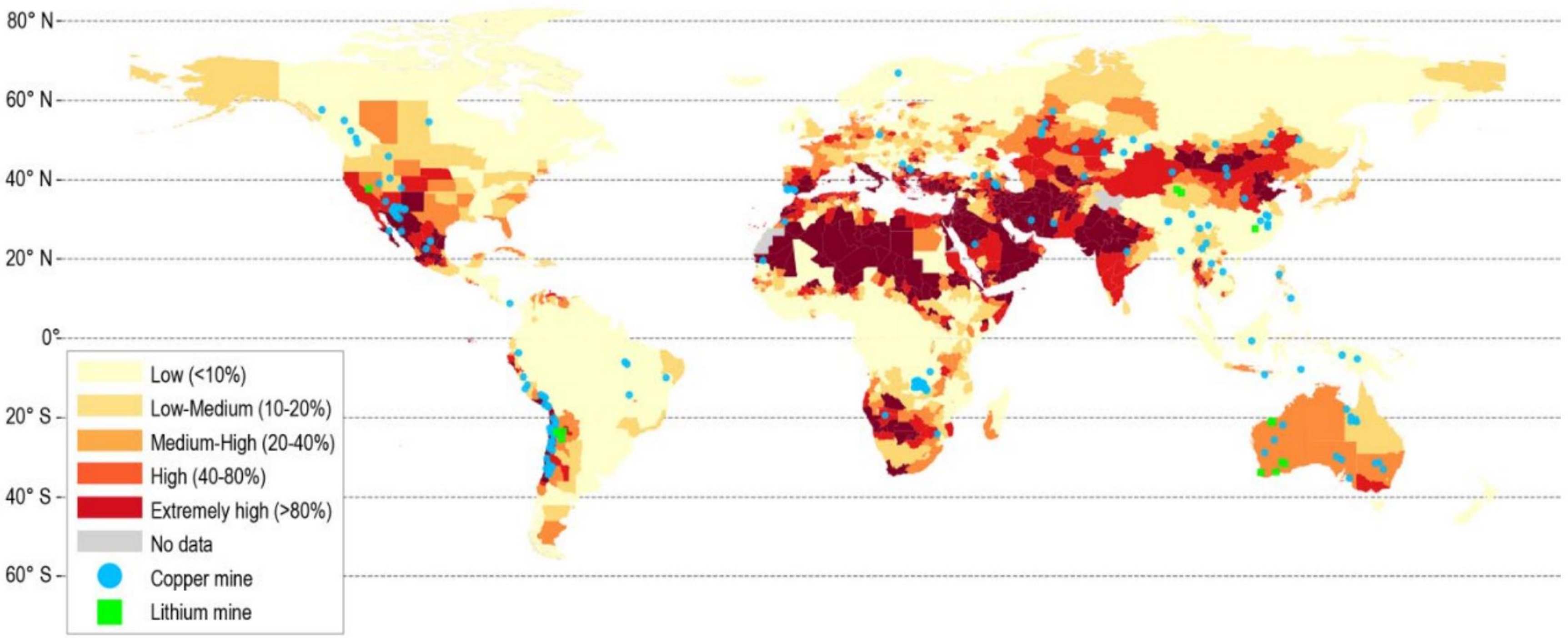
Source: https://www.humanium.org/en/child-labor-in-the-mines-of-the-democratic-republic-of-congo/

The Bayan Obo mine in Inner Mongolia, China is the world's biggest rare earth mine.

RISCOS E IMPACTES NO FORNECIMENTO DE MINERAIS

Climate risk: Mining assets are exposed to growing climate risks and water stress

Location of copper and lithium mines and water stress levels, 2020



> Cerca de 50% da produção global de lítio e cobre (com elevado consumo de água) está concentrada em áreas de elevado stress hídrico

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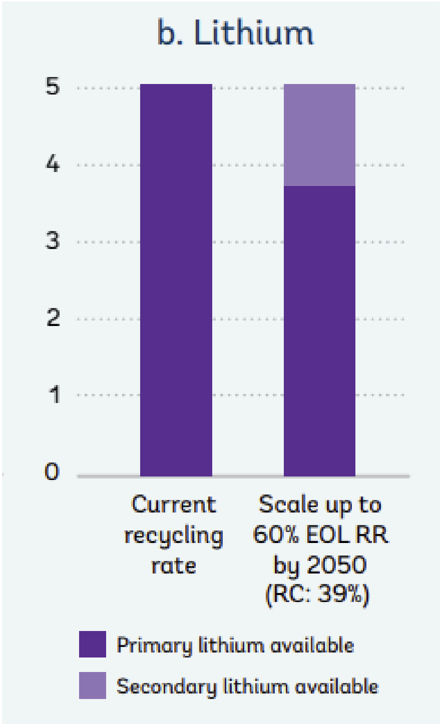
Source: International Energy Agency (2021). *The Role of Critical Minerals in Clean Energy Transitions*
https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

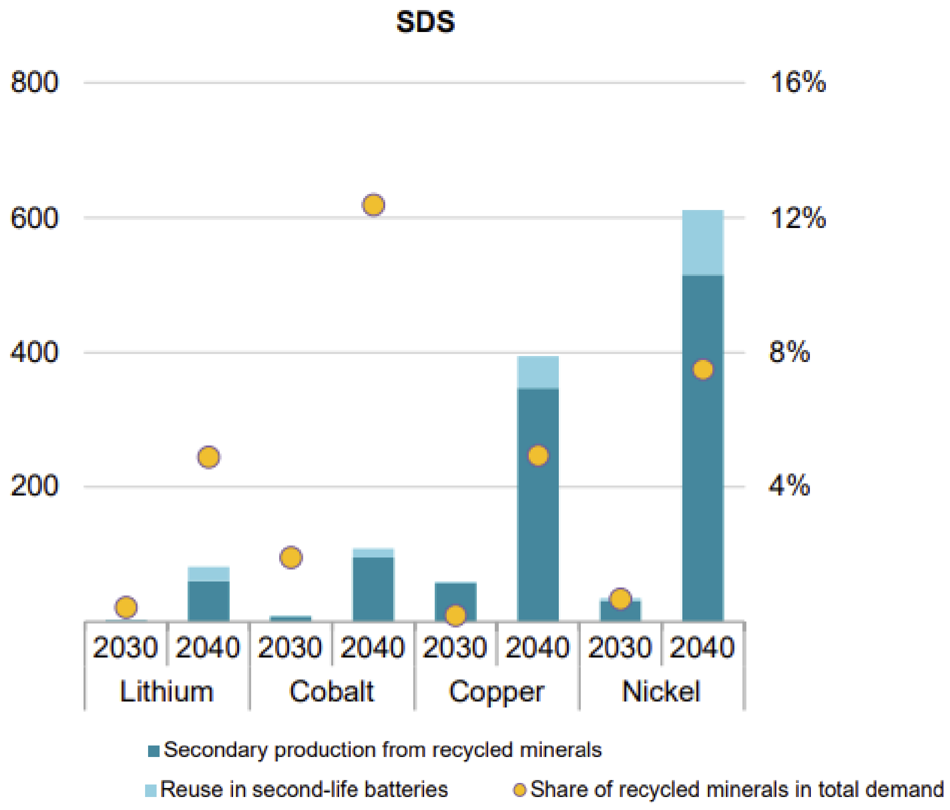
ECONOMIA CIRCULAR

- Reciclagem e a reutilização de materiais pode mitigar parte do aumento da procura
- Facilitar essa reciclagem e reutilização será vital para a transição energética
- Todavia, este não é um processo fácil, muitos productos têm mais de 50 materiais na sua composição com diferentes características termodinâmicas e metalúrgicas



De acordo com o Banco Mundial a reciclagem de litio pode diminuir a procura de litio em 26%

Source: World Bank (2020). Minerals for Climate Action



Source: International Energy Agency (2021). *The Role of Critical Minerals in Clean Energy Transitions*

Obrigada!

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