The European Commission's science and knowledge service

Joint Research Centre

European Commission

EMP-E 2020 –
Modelling Climate Neutrality for the European Green Deal
session: Circularity, use of raw material

2020 list of CRMs for the EU and JRC foresight study on CRMs in strategic sectors

Gian Andrea Blengini (JRC.D3)

JRC.D3 team

online, 6.10.2020

European Commission

Critical Raw Materials for a clean planet

The EU Green Deal recognizes **access to resources** as a strategic security question to fulfil EU's ambition towards 2050 climate neutrality

Critical Raw Materials for a clean planet

The role of governments and academia is key to secure a sustainable supply and drive the change

Criticality studies inform decision makers on how a secure and sustainable of supply can be achieved through:

- **diversification of supply,**
- **resource efficiency,**
- **recycling and**
- **substitution.**

European Commission methodology to define the *List of CRMs for the EU*

→2010 first release

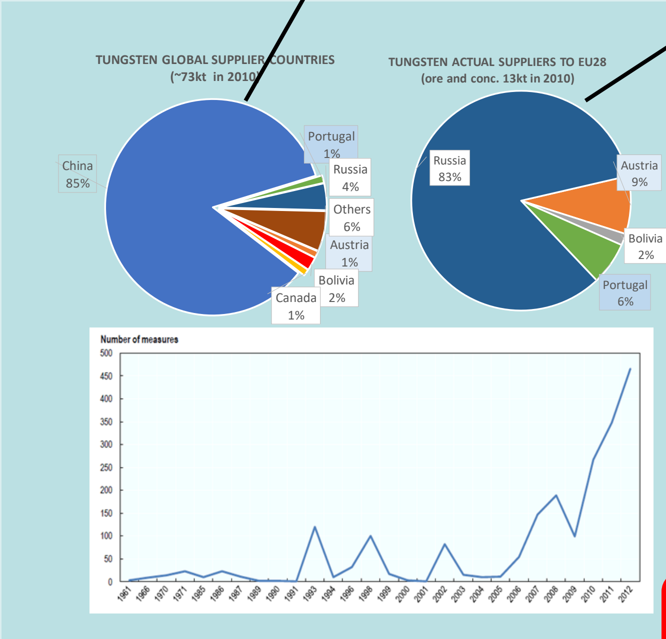
→2013 update

→2015 revision (*DG JRC*)

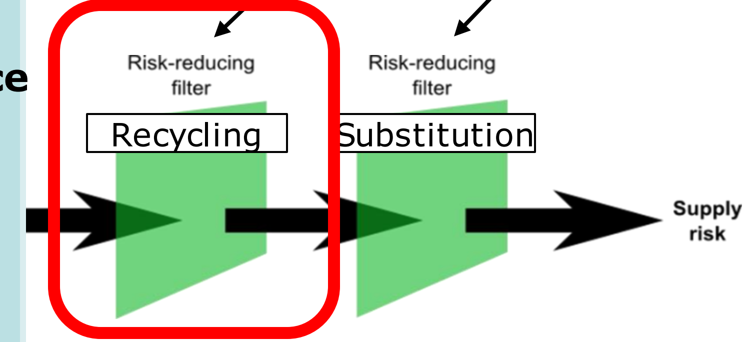
European Commission

SUPPLY RISK → role of circularity /recycling

$$SR = \left[(HHI_{WGI-t})_{GS} \cdot \frac{IR}{2} + (HHI_{WGI-t})_{EUsourcing}\left(1 - \frac{IR}{2}\right)\right](1 - EoL_{RIR})\, SI_{SR}$$



- **Supply concentr. (HHI)**
- **Poor Governance (WGI)**
- **Global vs EU**
- **Import dependency**
- **Trade**
- **Supply chain**
- **Substitution**
- **Recycling**



- **Black → already in 2014**
- **Red → JRC introduced**
- **Blue → JRC improved**

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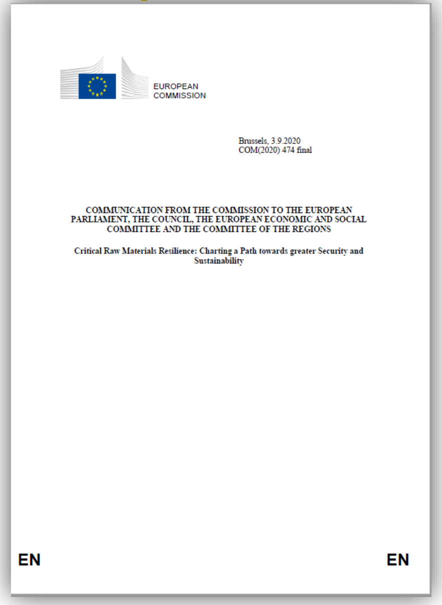
List of materials/groupings covered in the 2020 assessment

Critical Raw Materials 2020

Individual materials		
Aggregates	Germanium	Phosphate rock
Aluminium	Hafnium	Rhenium
Antimony	Helium	Scandium
Arsenic	Hydrogen	Selenium
Baryte	Indium	Sulphur
Bauxite	Iron Ore	Potash
Bentonite	Lead	Silica Sand
Beryllium	Limestone	Silicon Metal
Bismuth	Gold	Silver
Boron (Borates)	Gypsum	Strontium
Cadmium	Lithium	Talc
Chromium	Magnesite	Tantalum
Kaolin clay	Magnesium	Tellurium
Cobalt	Manganese	Tin
Coking coal	Molybdenum	Titanium
Copper	Natural Graphite	Tungsten
Diatomite	Nickel	Vanadium
Feldspar	Niobium	Zinc
Fluorspar	Perlite	Zirconium
Gallium	Phosphorus	
Platinum group metals (PGMs)		
Iridium	Platinum	Ruthenium
Palladium	Rhodium	
Rare earth elements (REEs)		
LREEs	HREEs	
Cerium	Dysprosium	Lutetium
Lanthanum	Erbium	Terbium
Neodymium	Europium	Thulium
Praseodymium	Gadolinium	Ytterbium
Samarium	Holmium	Yttrium
Biotic materials		
Natural Rubber	Natural cork	
Sapele wood	Natural Teak wood	

Legend:	
Green boxes	Materials covered in 2014 but not in the 2011 assessments
Orange boxes	Materials covered in 2017 but not in the 2014 assessments
Light blue boxes	New materials covered in the 2020 assessment

Critical Raw Materials 2020


EUROPEAN
COMMISSION

Brussels, 3.9.2020
COM(2020) 474 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability

EN EN

COM(2020) 474 final

2020 Critical Raw Materials (30)			
Antimony	Fluorspar	Magnesium	Silicon Metal
Baryte	Gallium	Natural Graphite	Tantalum
Bauxite	Germanium	Natural Rubber	Titanium
Beryllium	Hafnium	Niobium	Vanadium
Bismuth	HREEs	PGMs	Tungsten
Borates	Indium	Phosphate rock	Strontium
Cobalt	Lithium	Phosphorus	
Coking Coal	LREEs	Scandium	

Comparison with previous assessments

2020 list of CRMs compared to 2017 CRM list:

2020 CRMs vs. 2017 CRMs			
Antimony	Germanium	PGMs	Bauxite
Baryte	Hafnium	Phosphate rock	Lithium
Beryllium	HREEs	Phosphorus	Titanium
Bismuth	LREEs	Scandium	
Borate	Indium	Silicon metal	
Cobalt	Magnesium	Tantalum	Strontium
Coking Coal	Natural Graphite	Tungsten	
Fluorspar	Natural Rubber	Vanadium	
Gallium	Niobium	~~Helium~~	

Legend:

Black: CRMs in 2020 and 2017
Red: CRMs in 2020, non-CRMs in 2017
Green: CRMs assessed in 2020 that were not assessed in 2017
~~Strike:~~ Non-CRMs in 2020 that were critical in 2017

2020 list of CRMs compared to 2014 CRM list:

2020 CRMs vs. 2014 CRMs			
Antimony	Indium	Baryte	Bismuth
Beryllium	Lithium	Bauxite	Phosphorus
Borate	Magnesium	Hafnium	Strontium
Cobalt	Natural Graphite	Natural Rubber	
Coking Coal	Niobium	Scandium	
Fluorspar	PGMs	Tantalum	
Gallium	Phosphate Rock	Titanium	
Germanium	Silicon Metal	Vanadium	
HREEs	Tungsten		
LREEs			

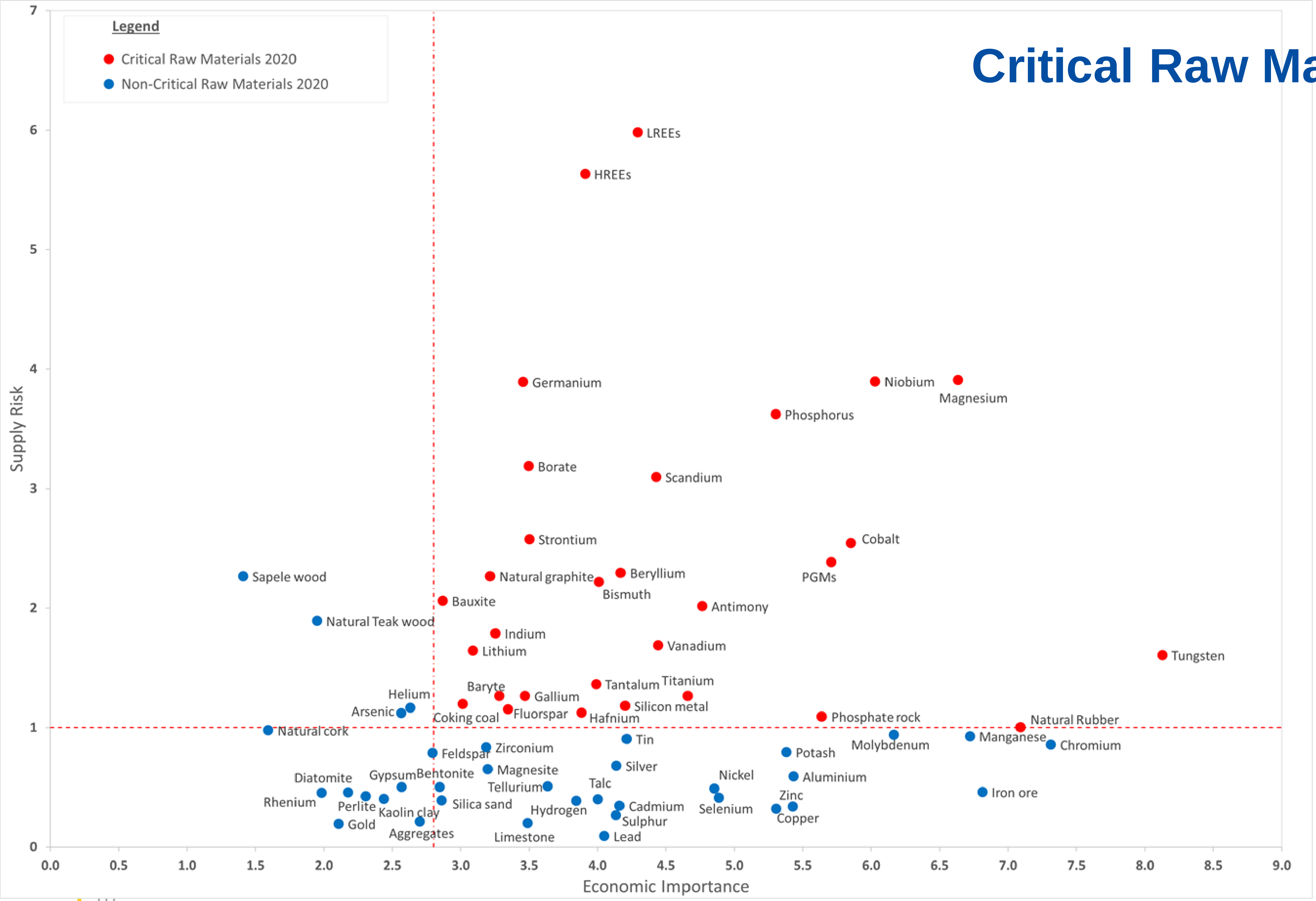
2011 assessment: 14 CRMs out of 41 raw materials

2014 assessment: 20 CRMs out of 54 raw materials

2017 assessment: 26 CRMs out of 61 raw materials (58 individual and 3 grouped materials).

2020 assessment: 30 CRMs out of 66 raw materials (63 individual and 3 grouped materials

Critical Raw Materials 2020



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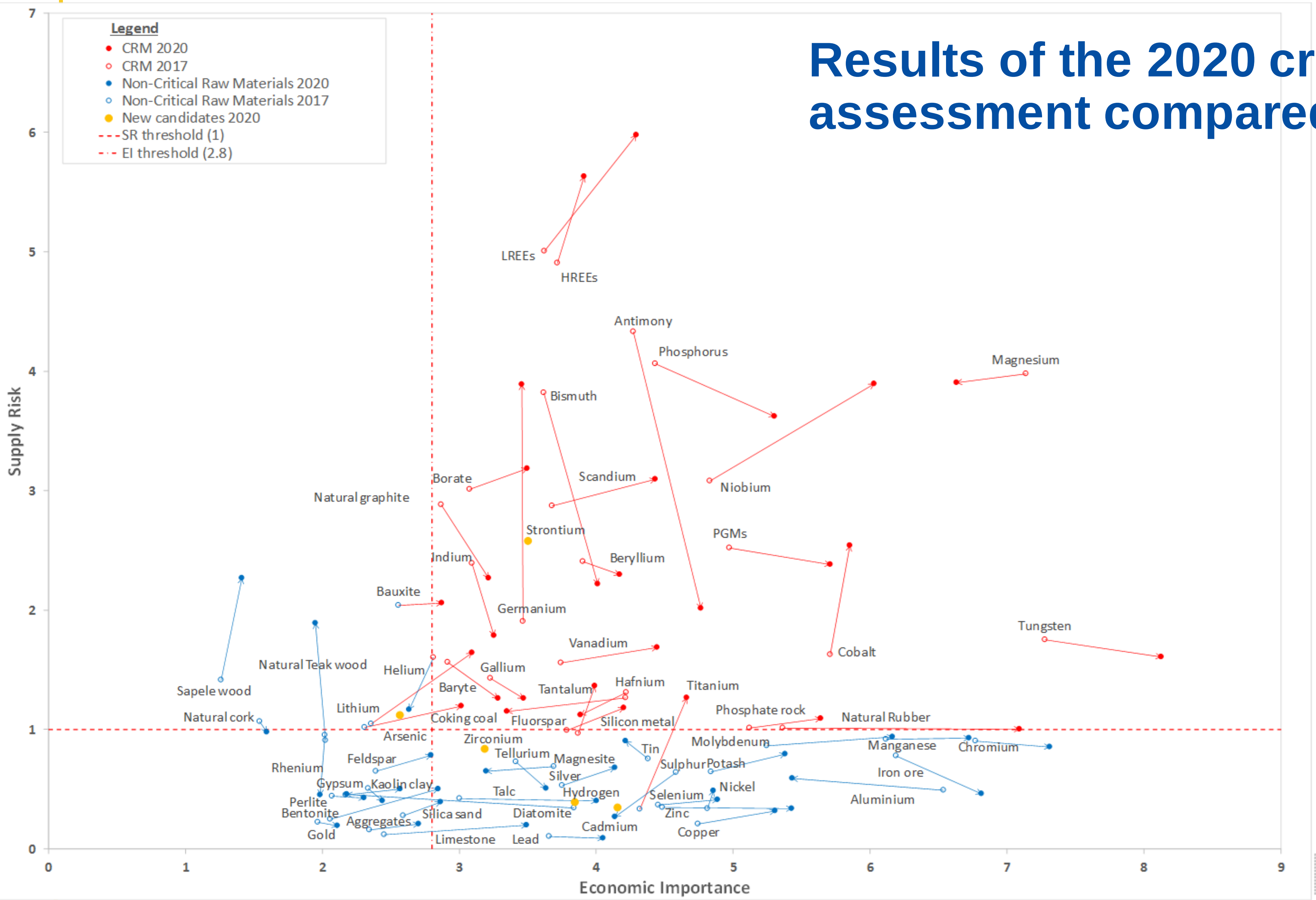
Results of the 2020 criticality assessment compared to 2017



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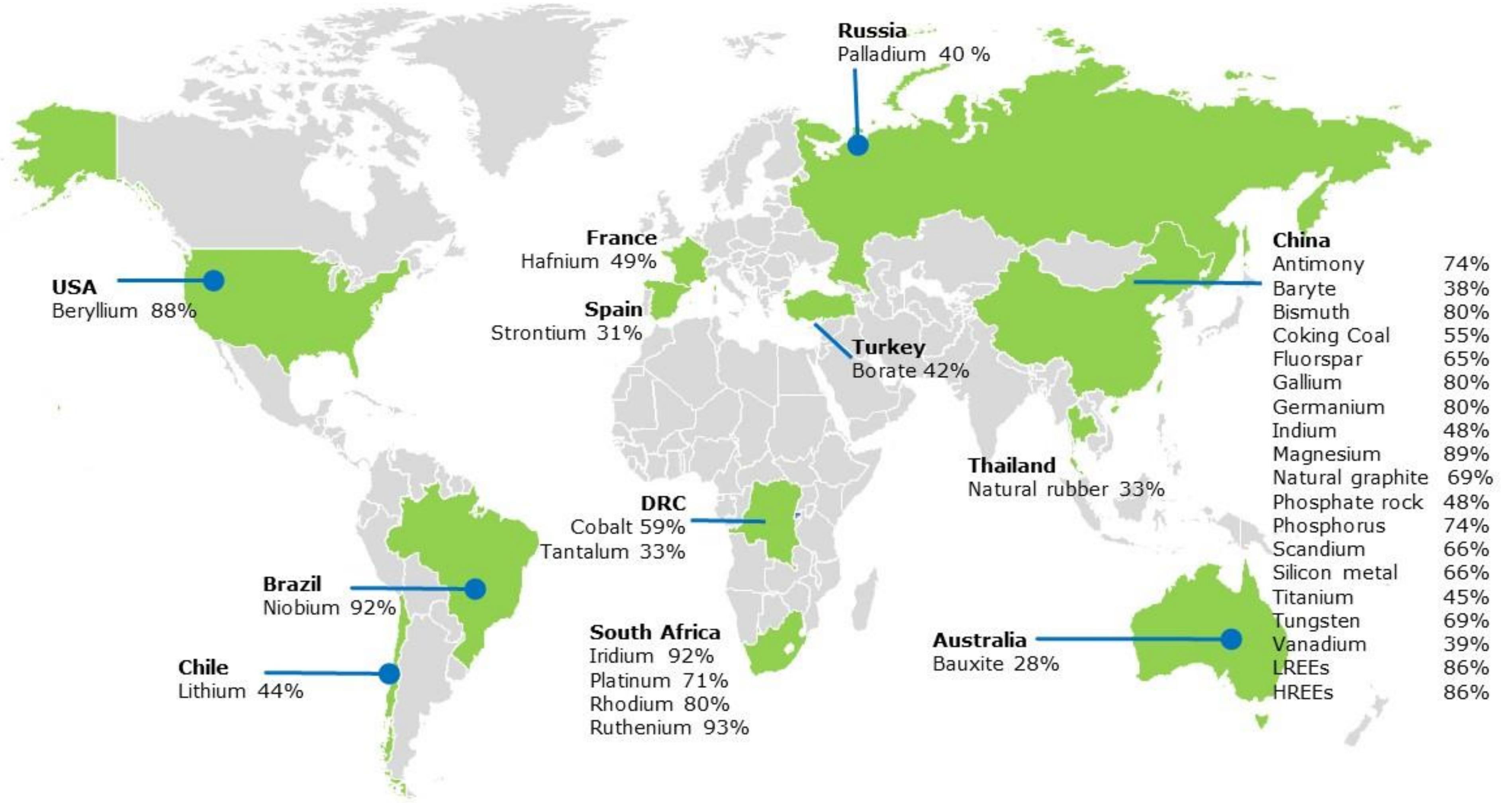
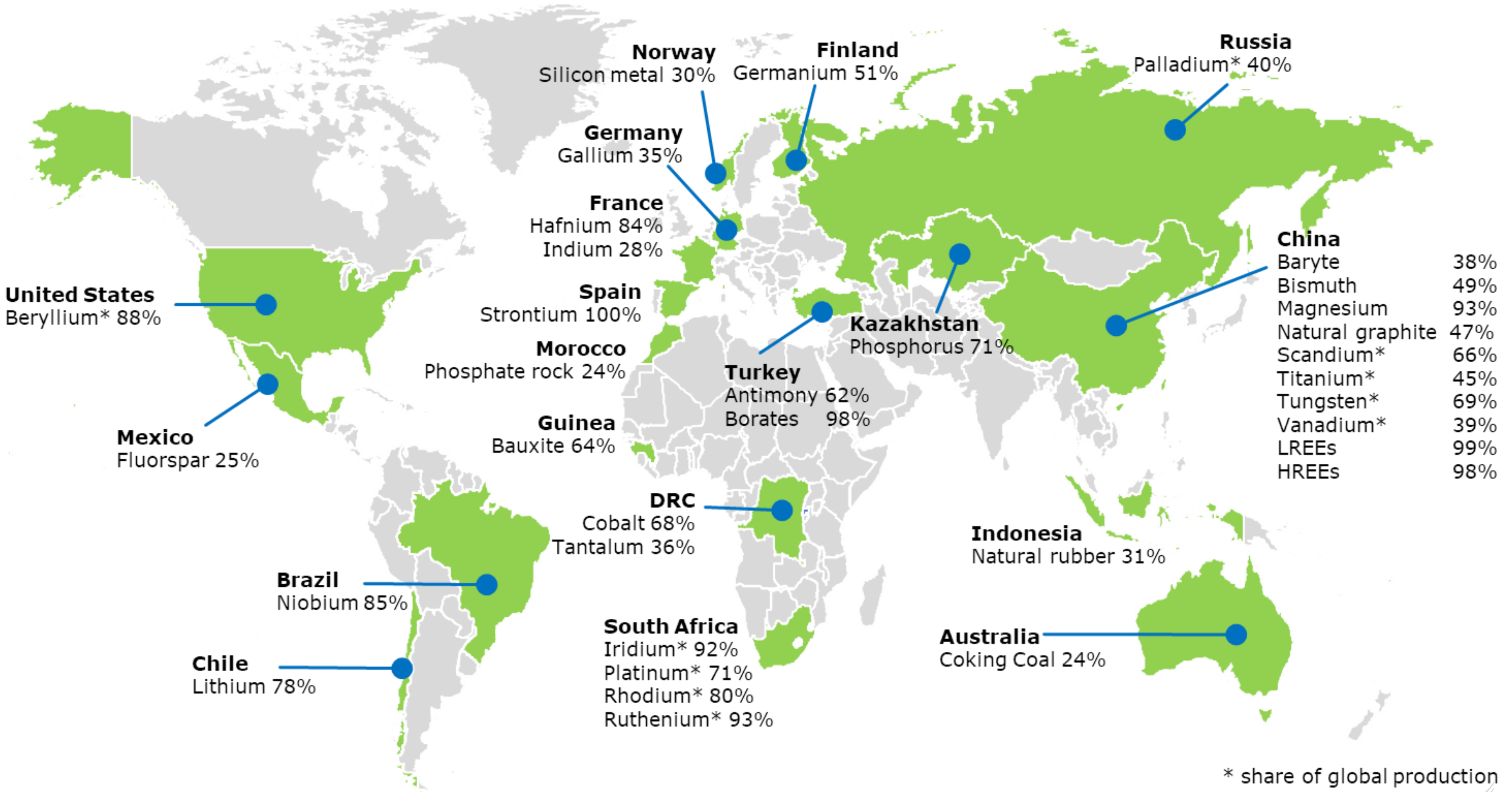
Global supply of CRMs

Countries accounting for largest share of global supply of CRMs



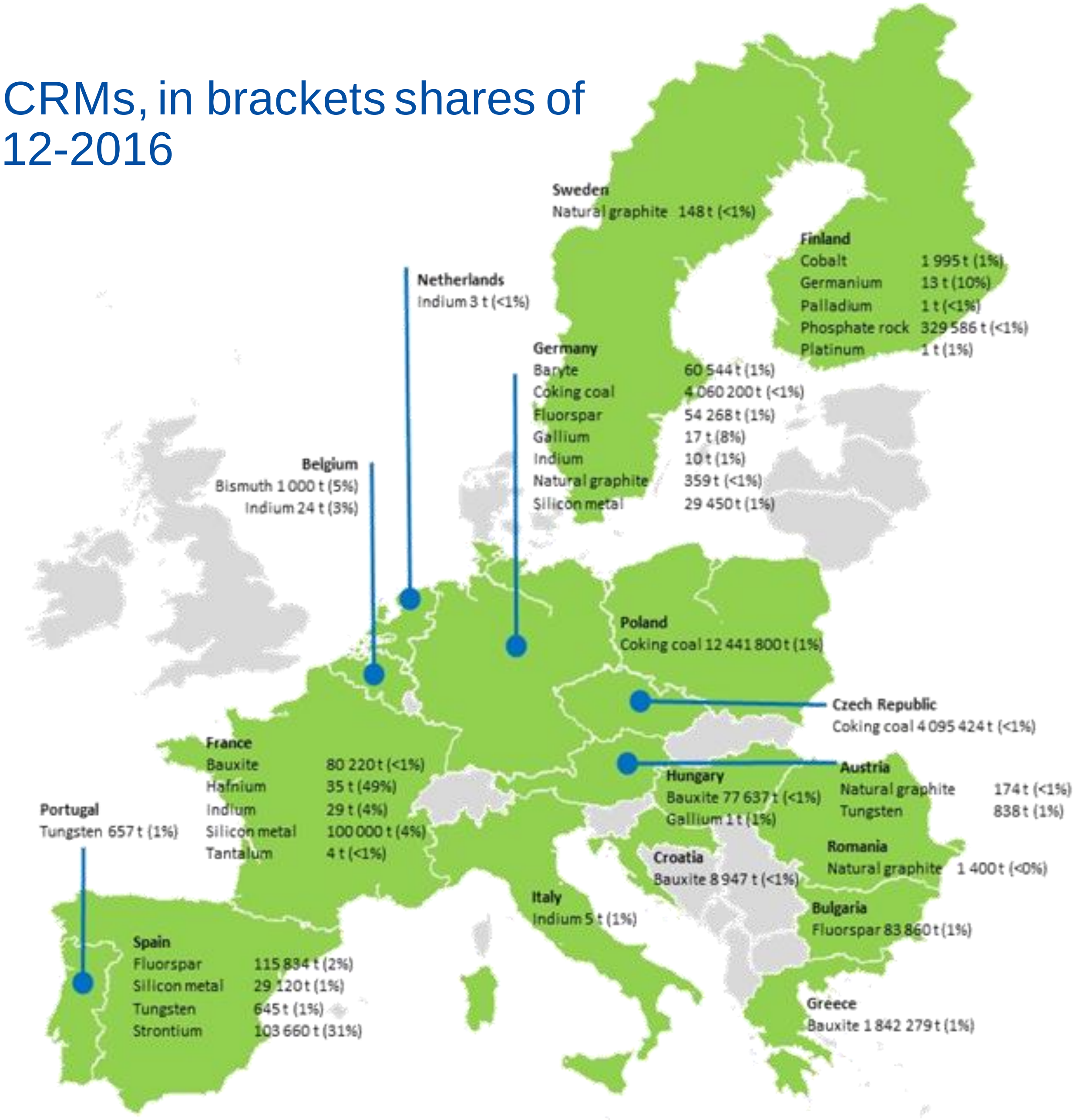
Countries accounting for largest share of EU sourcing of CRMs



* share of global production

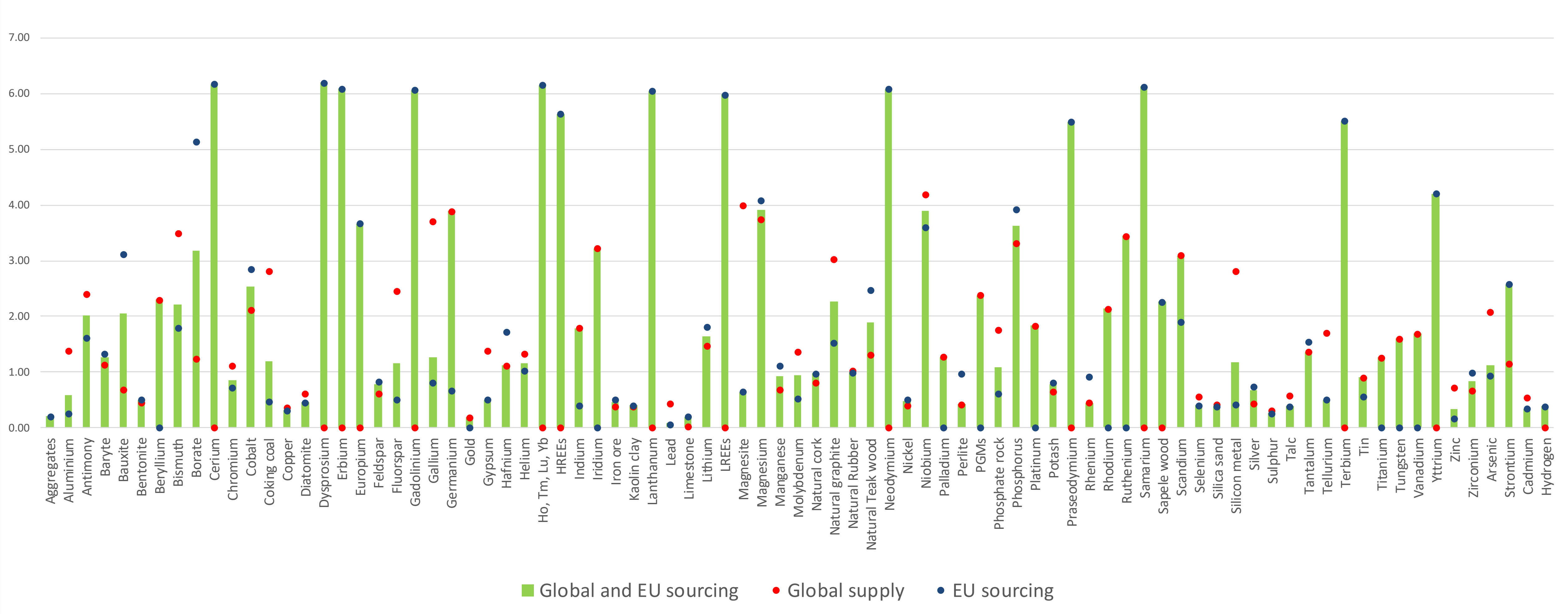
Critical Raw Materials 2020

EU producers of CRMs, in brackets shares of global supply, 2012-2016



Comparison of SR results

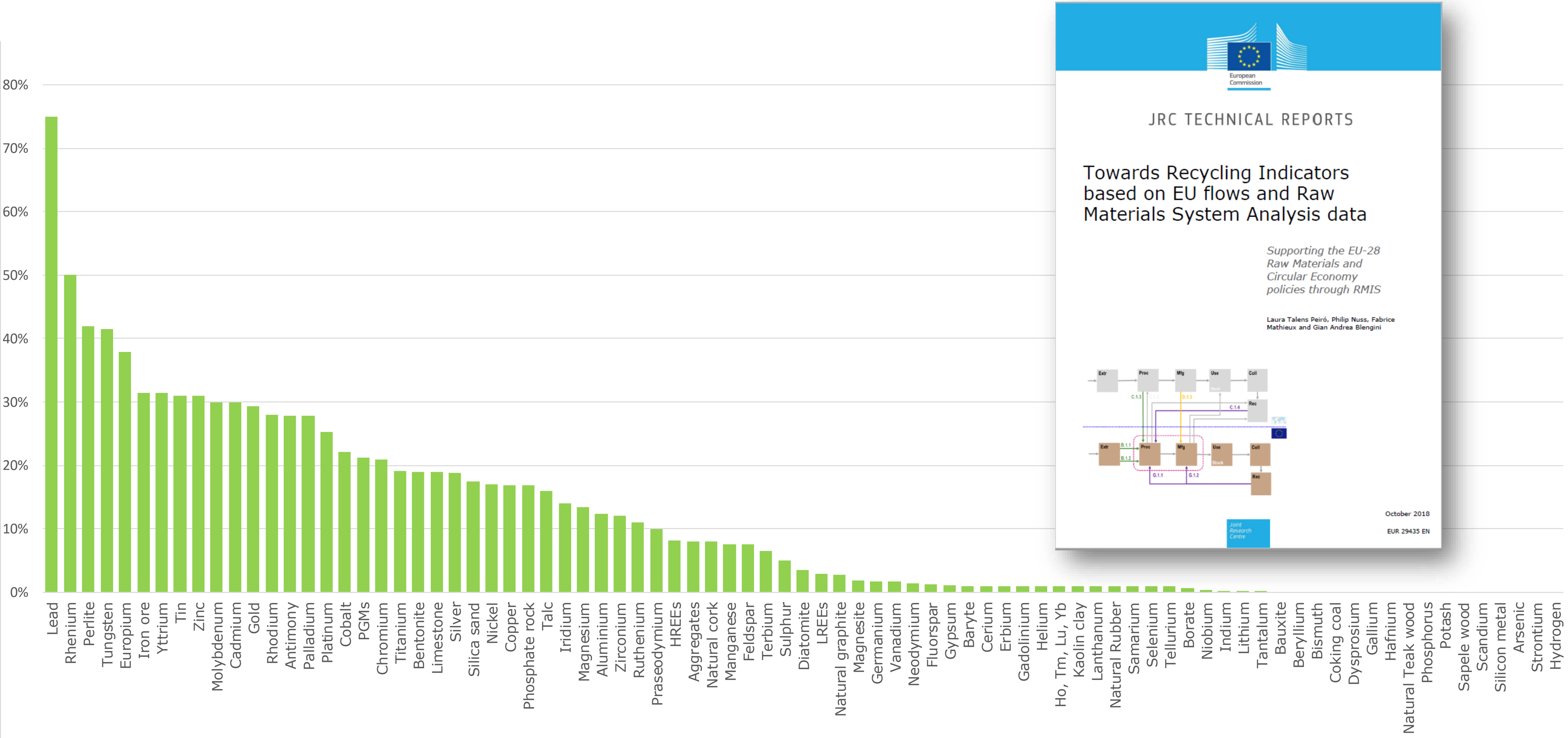
Comparison of SR results based on scope of supply data used



Global supply data and/or EU sourcing supply data i.e. refers to actual sourcing (imports) of the material into the EU

EOL-RIR 2020

Critical Raw Materials 2020



EOL-RIR 2020

Critical Raw Materials 2020

Material	EOL-RIR (%)
Aggregates	8
Aluminium	12
Antimony	28
Arsenic	0
Baryte	1
Bauxite	0
Bentonite	19
Beryllium	0
Bismuth	0
Borate	1
Cadmium	30
Cerium	1
Chromium	21
Cobalt	22
Coking coal	0
Copper	17
Diatomite	4
Dysprosium	0
Erbium	1
Europium	38
Feldspar	8
Fluorspar	1
Gadolinium	1
Gallium	0
Germanium	2
Gold	29
Gypsum	1

Material	EOL-RIR (%)
Hafnium	0
Helium	1
Ho, Tm, Lu, Yb	1
Hydrogen	0
Indium	0
Iridium	14
Iron ore	31
Kaolin clay	1
Lanthanum	1
Lead	75
Limestone	19
Lithium	0
Magnesite	2
Magnesium	13
Manganese	8
Molybdenum	30
Natural cork	8
Natural graphite	3
Natural Rubber	1
Natural Teak wood	0
Neodymium	1
Nickel	17
Niobium	0
Palladium	28
Perlite	42
Phosphate rock	17
Phosphorus	0

Material	EOL-RIR (%)
Platinum	25
Potash	0
Praseodymium	10
Rhenium	50
Rhodium	28
Ruthenium	11
Samarium	1
Sapele wood	0
Scandium	0
Selenium	1
Silica sand	18
Silicon metal	0
Silver	19
Strontium	0
Sulphur	5
Talc	16
Tantalum	0
Tellurium	1
Terbium	6
Tin	31
Titanium	19
Tungsten	42
Vanadium	2
Yttrium	31
Zinc	31
Zirconium	12

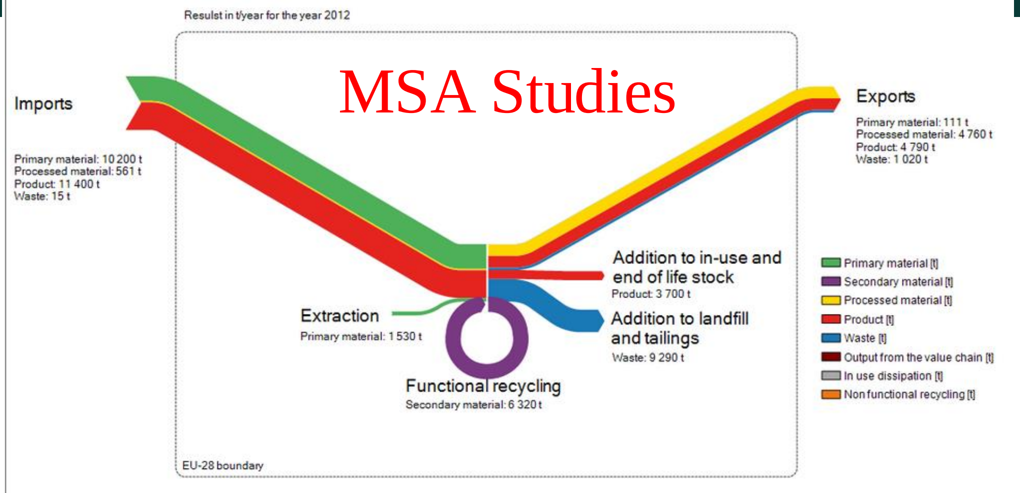
Circular Economy Monitoring Framework

Strasbourg, 16.1.2018
COM(2018) 29 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

on a monitoring framework for the circular economy

{SWD(2018) 17 final}



Example of a Sankey diagram representing the input – output flows of Cobalt in EU

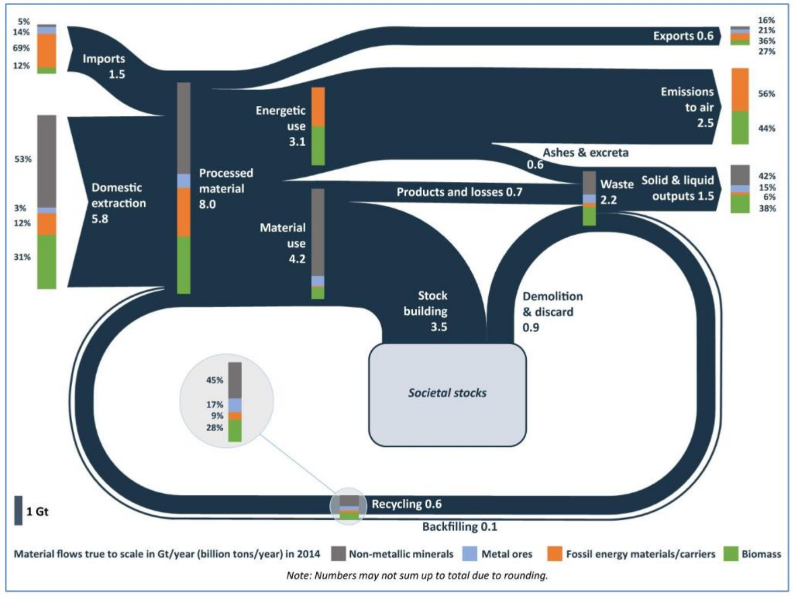


Figure 1: Material flows in the economy (EU-28, 2014)[9, 10]

Secondary raw materials

Indicator	Value	Trend
ⓘ Contribution of recycled materials to raw materials demand		
ⓘ End-of-life recycling input rates (EOL-RIR) *(percentage)*	12.4 [2016]	N/A
ⓘ Circular material use rate *(percentage)*	11.7 [2016]	

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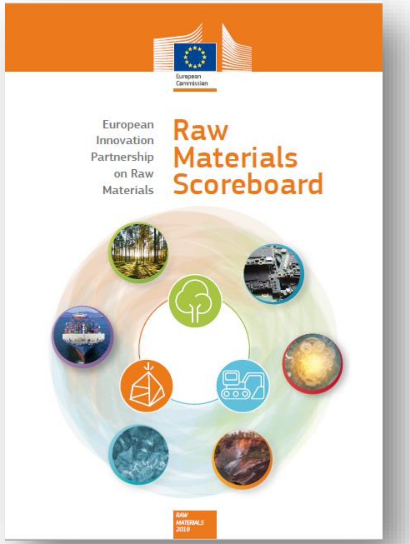
Raw Materials Scoreboard

The role of recycling to meet demand for raw materials.



End-of-life recycling input rate (EOL-RIR) [%]

Legend: > 50% (blue); > 25-50% (green); > 10-25% (yellow); 1-10% (orange); < 1% (red)

H																	He 1%
Li 0%	Be 0%											B* 0.6%	C	N	O	F* 1%	Ne
Na	Mg 13%											Al 12%	Si 0%	P* 17%	S 5%	Cl	Ar
K* 0%	Ca	Sc 0%	Ti 19%	V 44%	Cr 21%	Mn 12%	Fe 31%	Co 35%	Ni 34%	Cu 17%	Zn 31%	Ga 0%	Ge 2%	As	Se 1%	Br	Kr
Rb	Sr	Y 31%	Zr	Nb 0%	Mo 30%	Tc	Ru 11%	Rh 9%	Pd 9%	Ag 55%	Cd	In 0%	Sn 32%	Sb 28%	Te 1%	I	Xe
Cs	Ba 1%	La-Lu[1]	Hf 1%	Ta 1%	W 42%	Re 50%	Os	Ir 14%	Pt 11%	Au 20%	Hg	Tl	Pb 75%	Bi 1%	Po	At	Rn
Fr	Ra	Ac-Lr[2]	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Fl	Uup	Lv	Uus	Uuo

[1]Group of Lanthanide	La 1%	Ce 1%	Pr 10%	Nd 1%	Pm	Sm 1%	Eu 38%	Gd 1%	Tb 22%	Dy 0%	Ho 1%	Er 0%	Tm 1%	Yb 1%	Lu 1%
[2]Group of Actinide	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

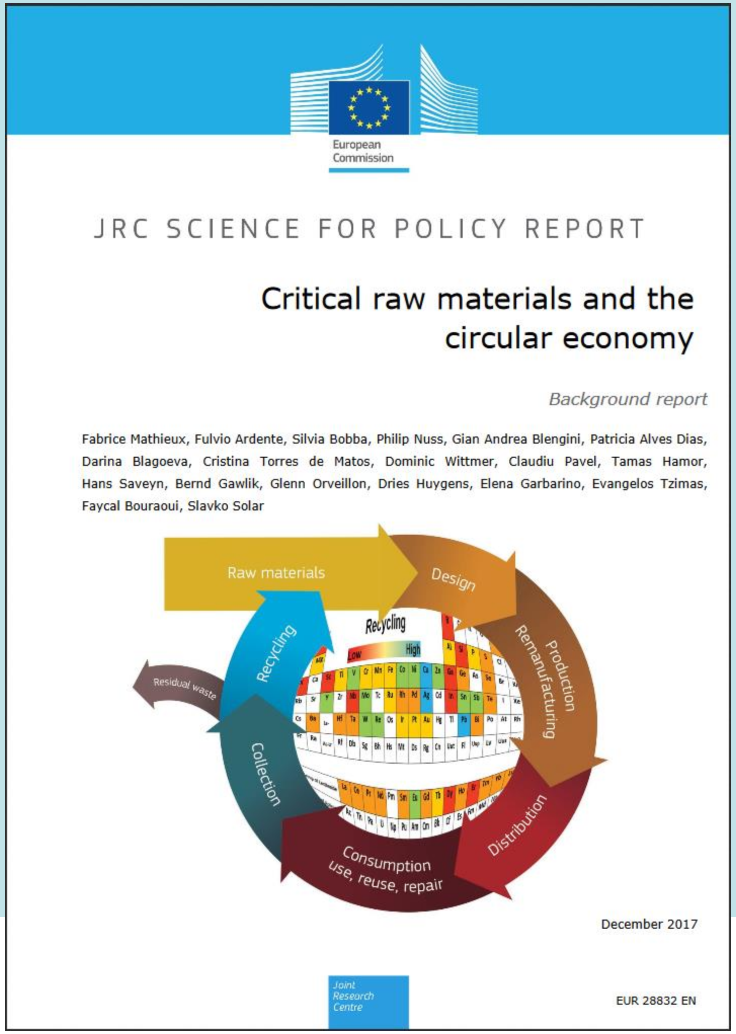
Aggregates	Bentonite	Coaking Coal	Diatomite	Feldspar	Gypsum	Kaolin Clay	Limestone	Magnesite	Natural Cork	Natural Graphite	Natural Rubber	Natural Teak Wood	Perlite	Sapele wood	Silica Sand	Talc
7%	50%	0%	0%	10%	1%	0%	58%	2%	8%	3%	1%	0%	42%	15%	0%	5%

* F = Fluorspar; P = Phosphate rock; K = Potash, Si = Silicon metal, B=Borates.

European Commission

Report on CRMs in Circular Economy

Raw Materials Initiative Circular Economy


European Commission

JRC SCIENCE FOR POLICY REPORT

Critical raw materials and the circular economy

Background report

Fabrice Mathieux, Fulvio Ardente, Silvia Bobba, Philip Nuss, Gian Andrea Blengini, Patricia Alves Dias, Darina Blagoeva, Cristina Torres de Matos, Dominic Wittmer, Claudiu Pavel, Tamas Hamor, Hans Saveyn, Bernd Gawlik, Glenn Orveillon, Dries Huygens, Elena Garbarino, Evangelos Tzimas, Faycal Bouraoui, Slavko Solar

December 2017

Joint Research Centre

EUR 28832 EN

Objectives:

- To help EU Member States implement the new provisions on critical raw materials in the EU Waste Framework Directive
- Provide information, data sources and identify best practices and possible further actions

Issued in January 2018 (SWD(2018)36), taking into account the 2017 list of 27 critical raw materials

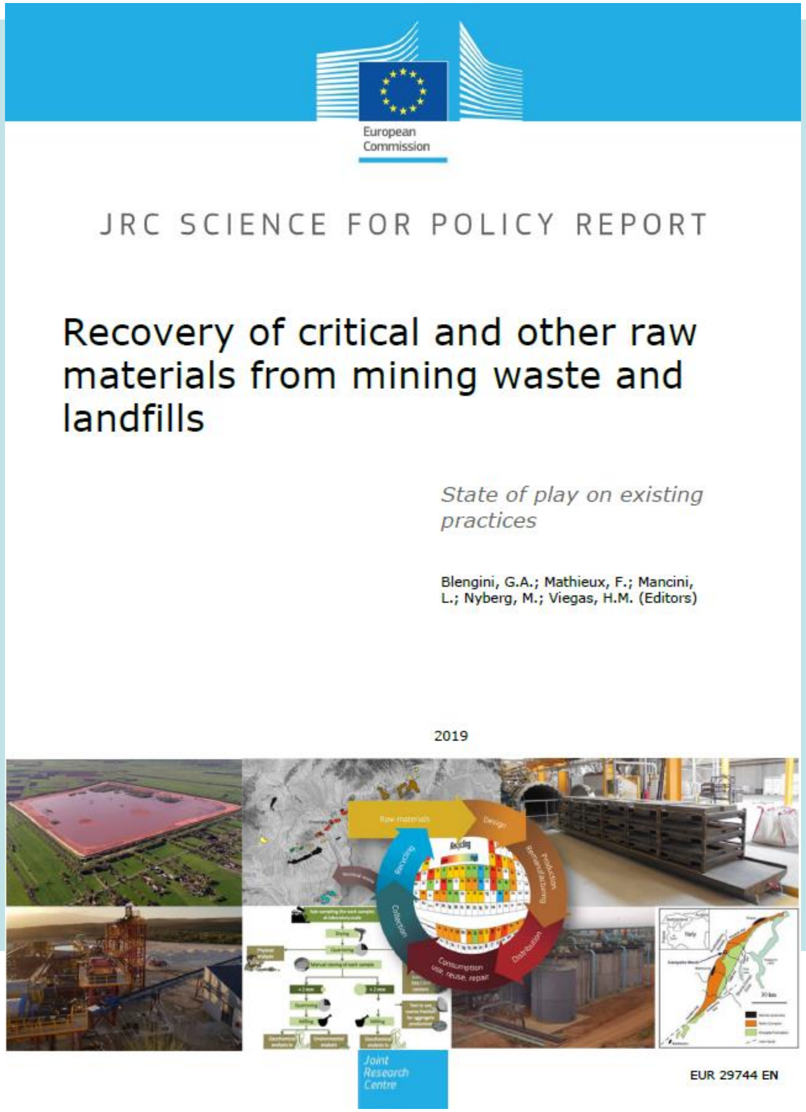
Key Sectors:

- Electric and Electronic Equipment
- Automotive
- Batteries
- Renewable Energy
- Defense equipment
- Chemicals & Fertilizers

European Commission

JRC Science for policy report: ‘Recovery of critical and other raw materials from mining waste and landfills’

Raw Materials Initiative Circular Economy



Delivers on action #39
of the Circular Economy Action Plan:
"Sharing of **best practice** for the **recovery** of critical raw materials from **mining waste** and **landfills**

- 6 examples of **existing practices** for the **recovery** of critical, and other materials from **extractive waste** and **landfills.**
- Enable **increased recycling** and **recovery** of critical and other raw materials
- **Support Member S**tates to **promote** the **recovery** of critical raw materials as stated in the **Waste framework directive** (2018/851)

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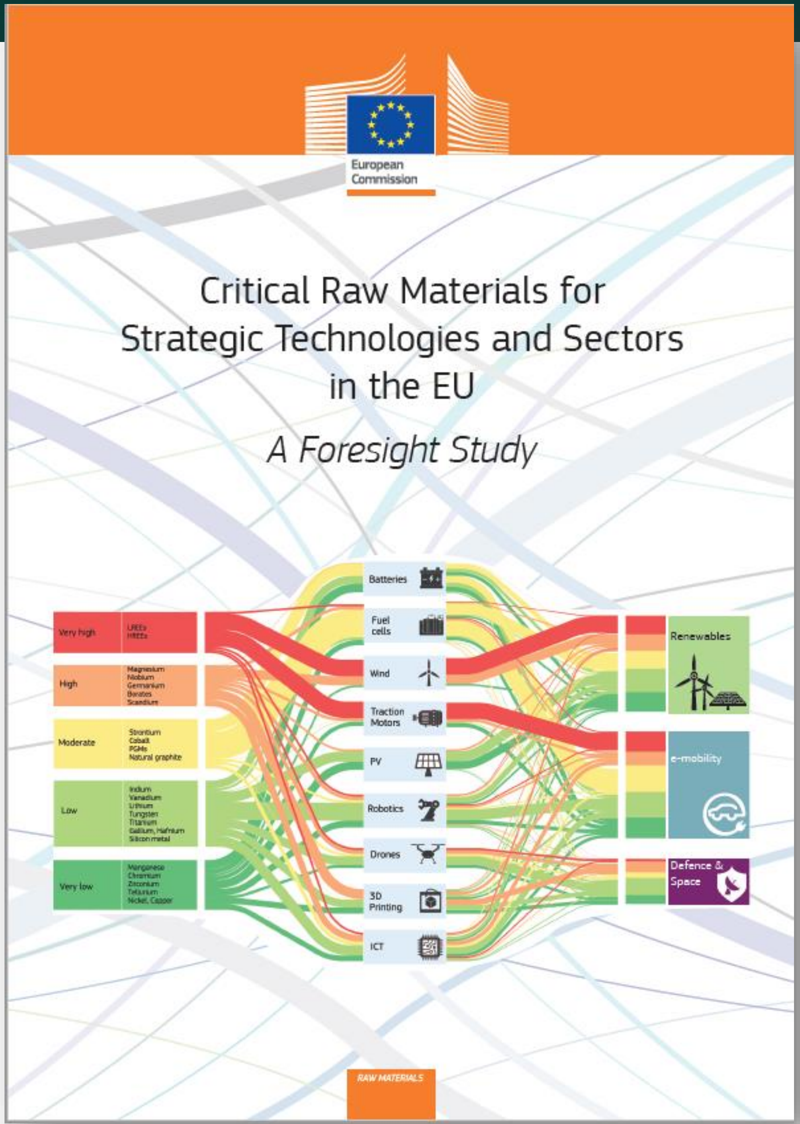
JRC foresight study on CRMs in strategic sectors



Speech | 3 September 2020 | Brussels

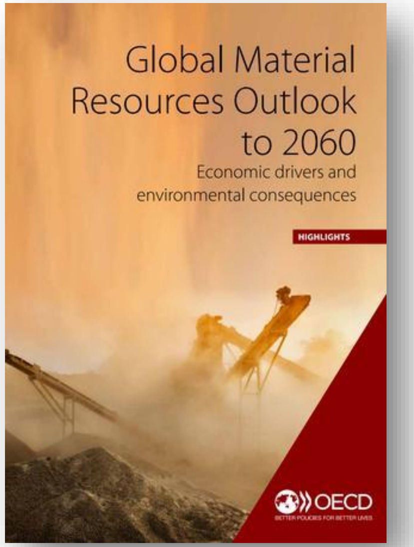
Speech by Vice-President Šefčovič at the Press Conference on critical raw materials resilience in the EU

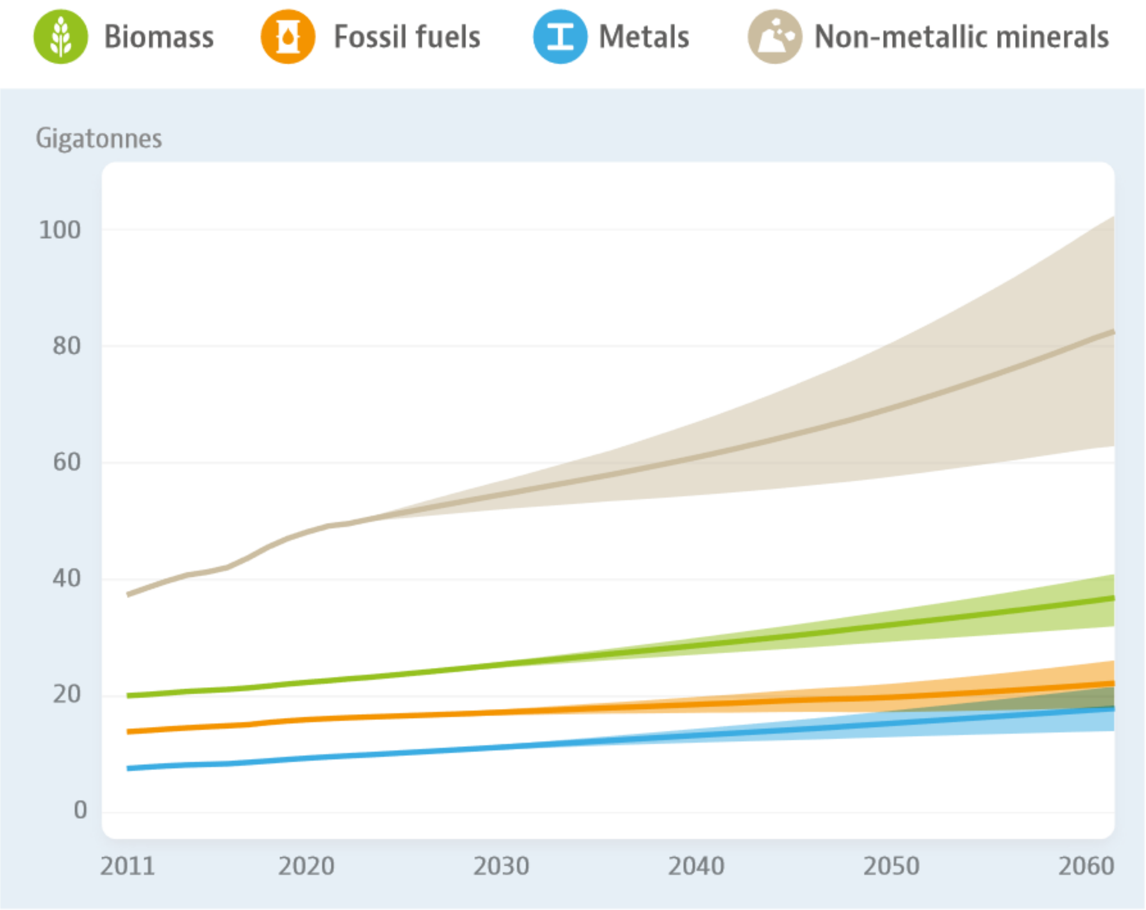
- In the world of **tomorrow,** this overreliance may become even more acute. Our **strategic foresight tells us that the demand for raw materials is only going to rise**: for example, Europe will need almost **60 times more lithium and 15 times more cobalt by 2050** for electric cars and energy storage alone. Demand for **rare earths** used in permanent magnets, critical for products like wind generators, could **increase ten-fold in the same period**.

JRC Report: → up to 60 times and up to 15 times…

European Commission

OECD forecasts that **global materials demand** will more than double from 79 billion tonnes today to 167 billion tonnes in 2060.





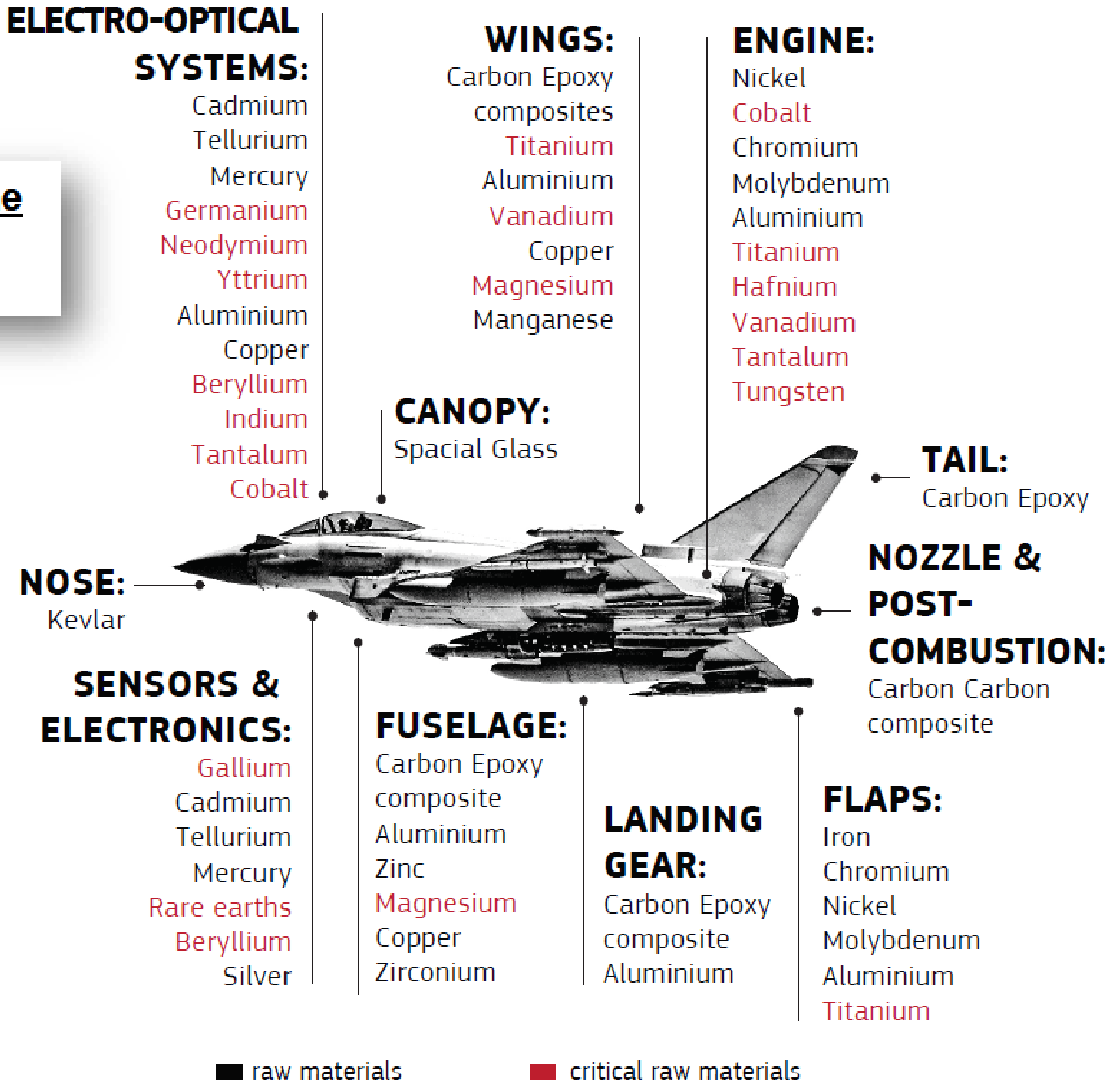
Speech | 3 September 2020 | Brussels

Speech by Vice-President Šefčovič at the Press Conference on critical raw materials resilience in the EU

- We **cannot replace our current reliance** on fossil fuels **with one on critical raw materials**.

Global **competition for resources** will become fierce in the coming decade.

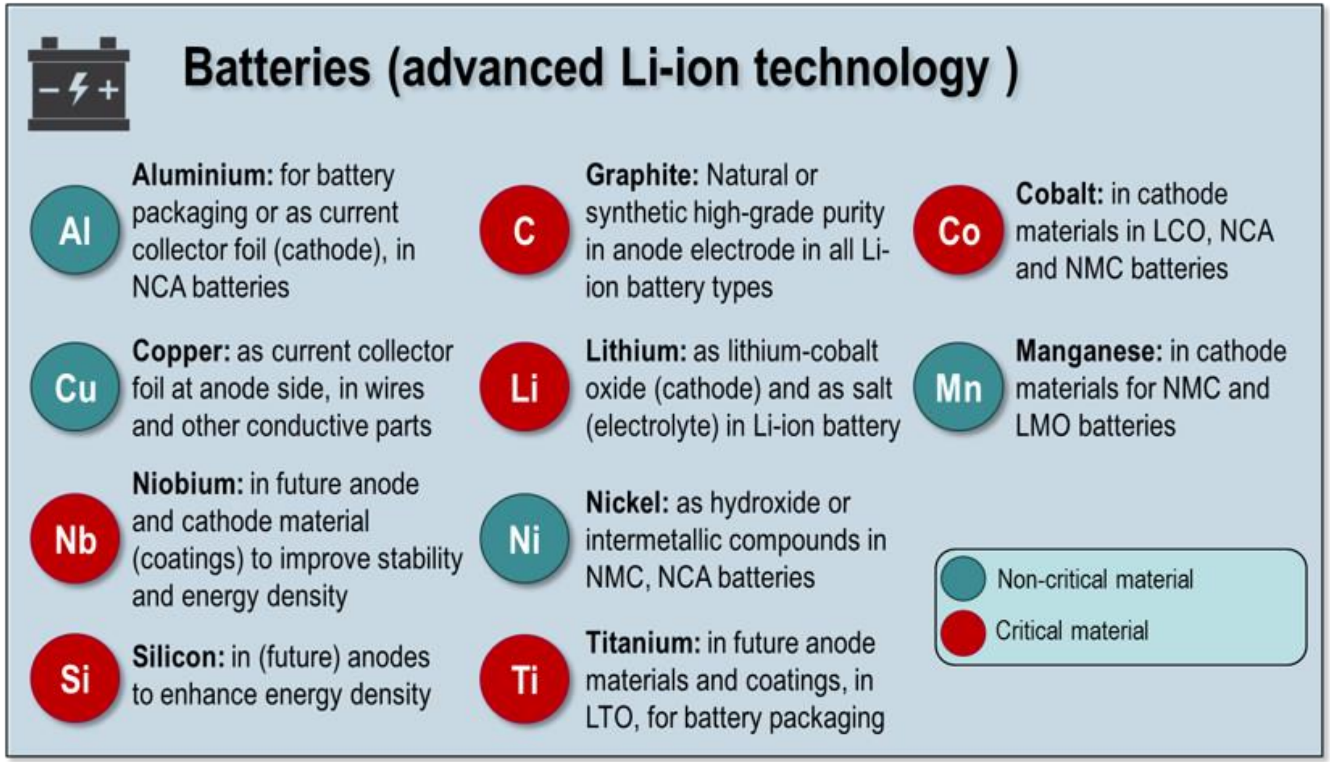
Dependence on **critical raw materials** may soon replace today's dependence on oil.



European Commission

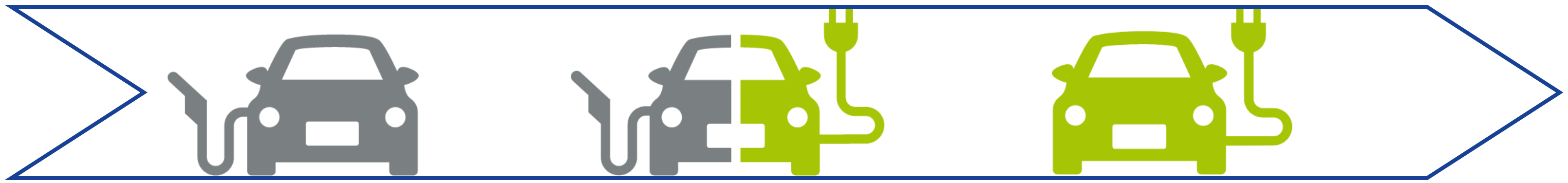
Batteries (key to low-carbon mobility)

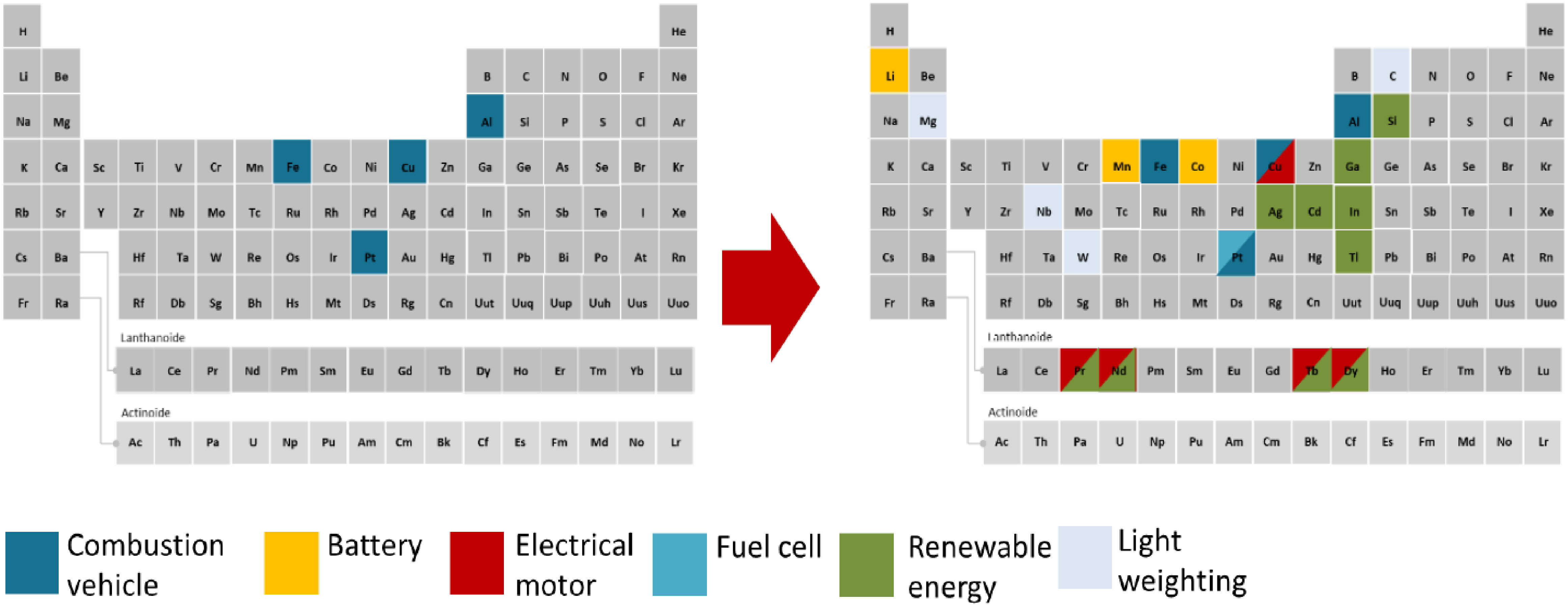
Raw materials for key technologies and strategic sectors as renewable energy, e-mobility, digital, space and defence is one of the pre-requisites to achieve climate neutrality.



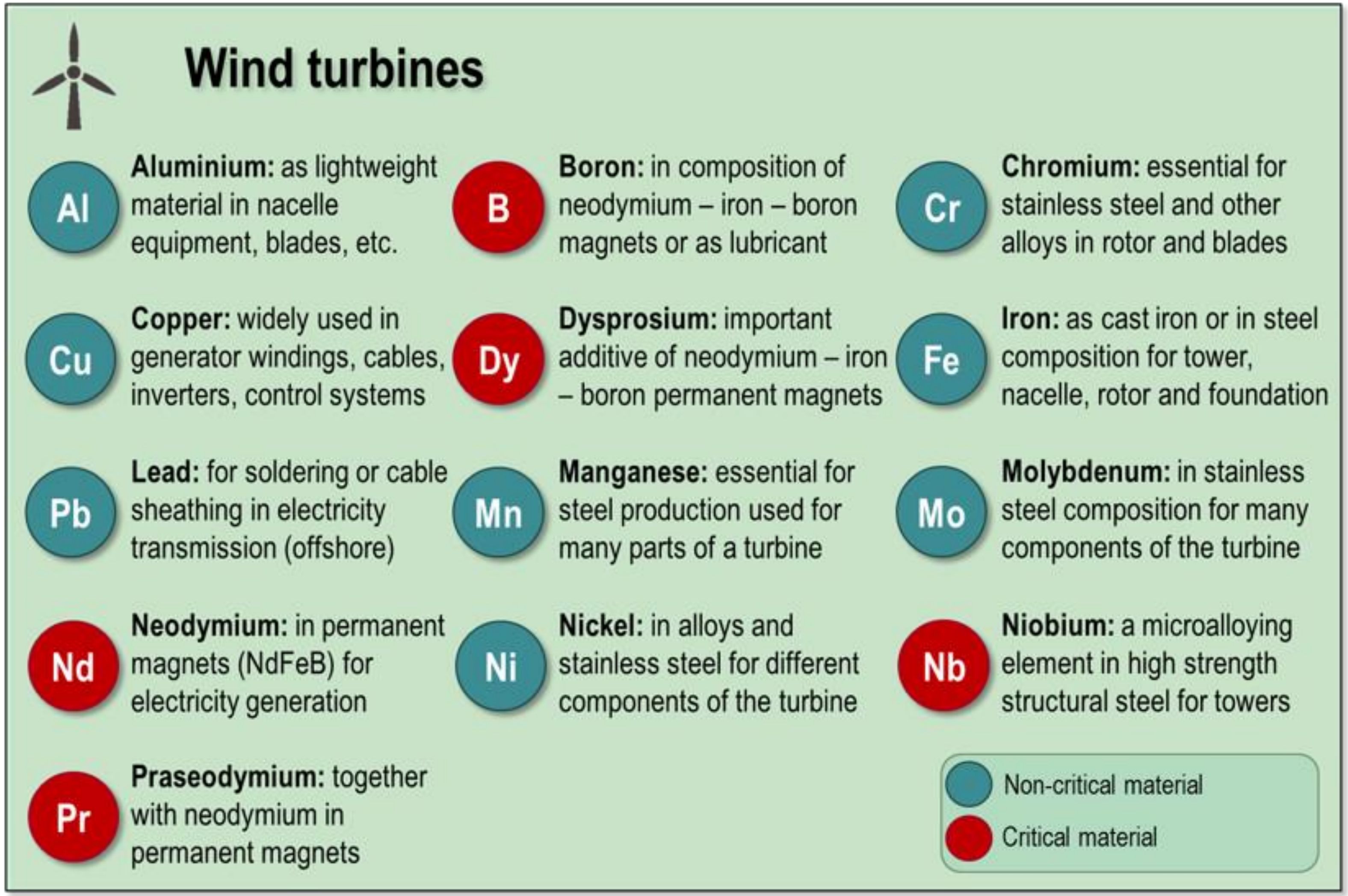
European Commission

Batteries

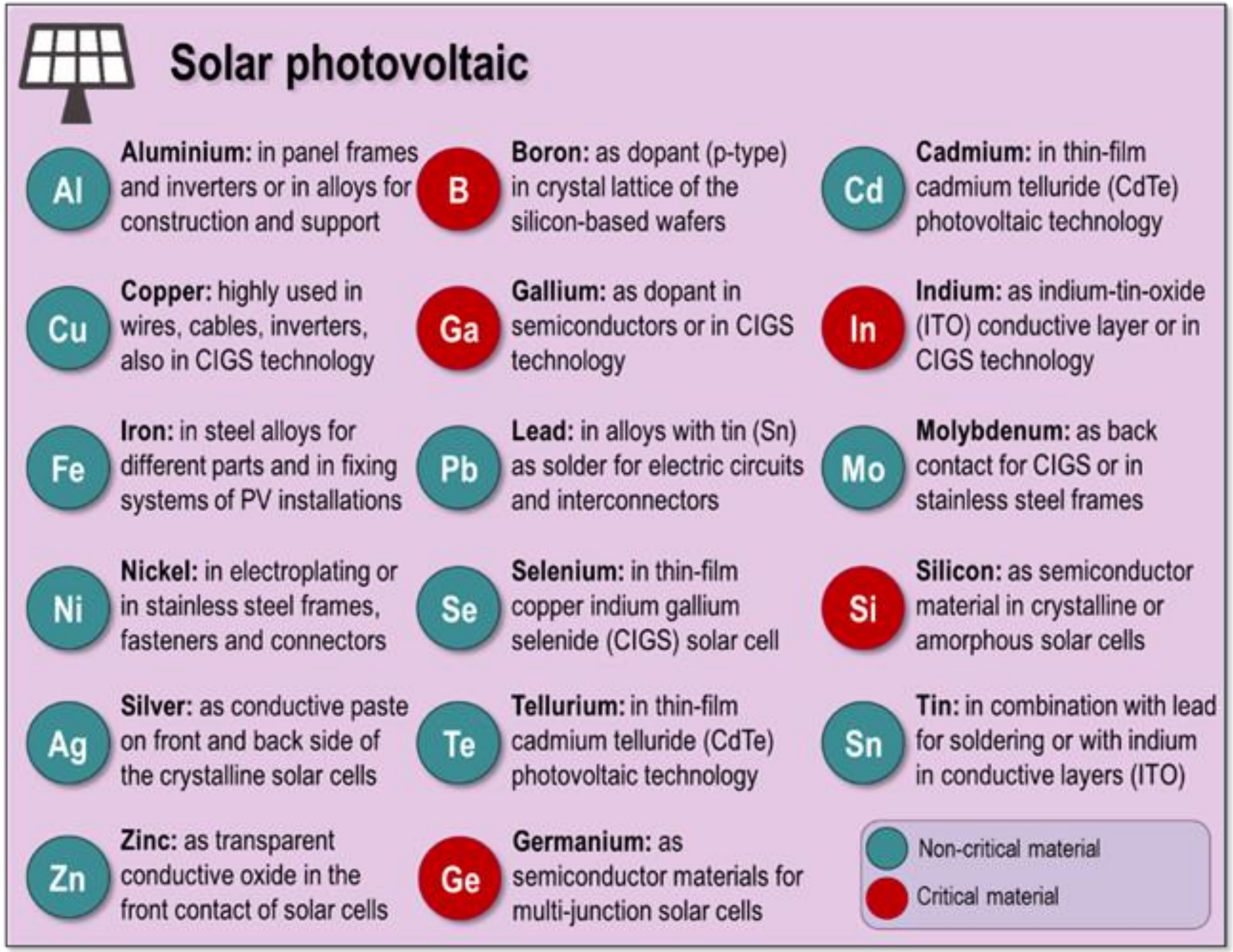



Lanthanoide
Actinoide
Lanthanoide
Actinoide
Combustion vehicle
Battery
Electrical motor
Fuel cell
Renewable energy
Light weighting

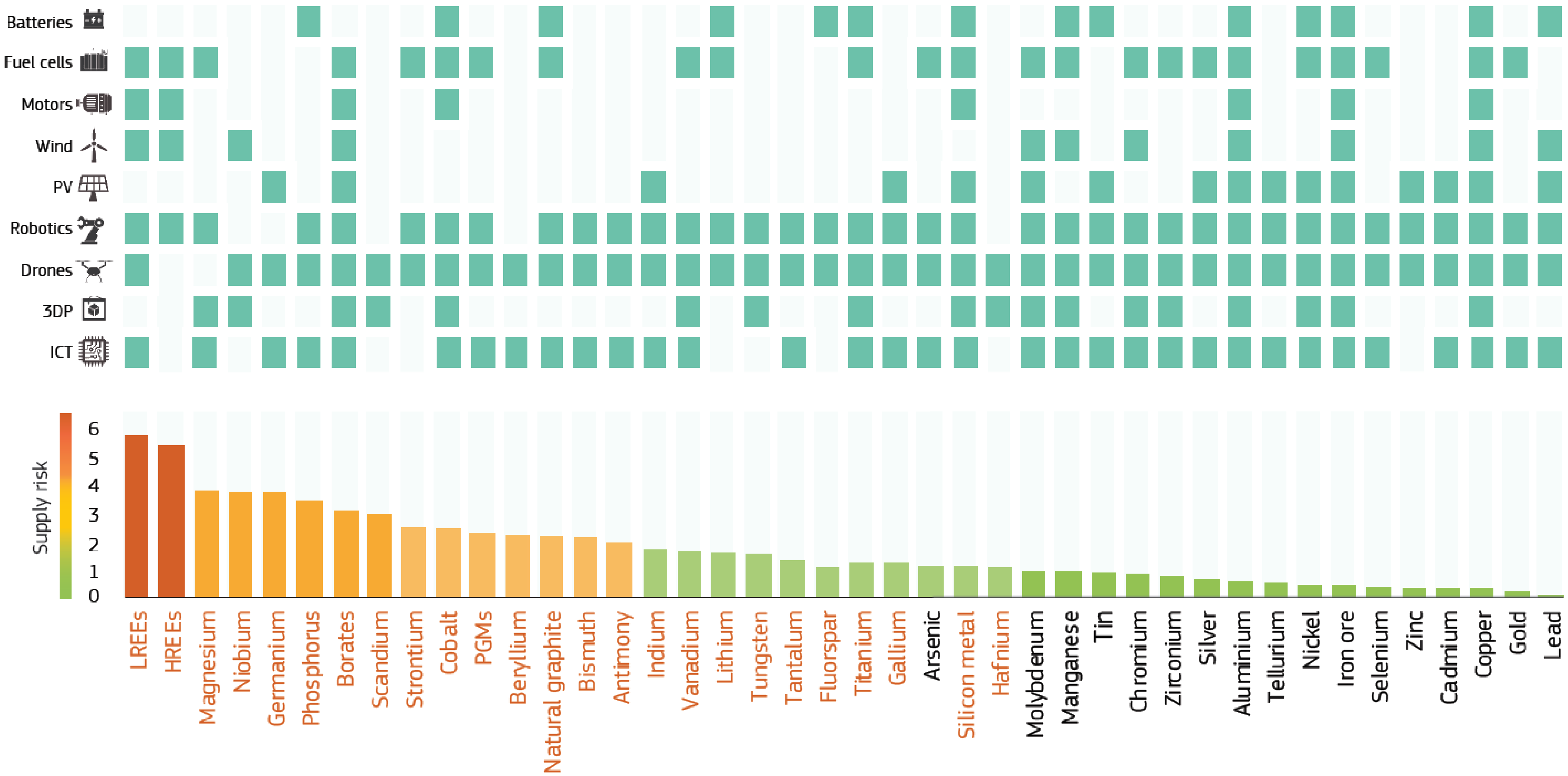
Magnets

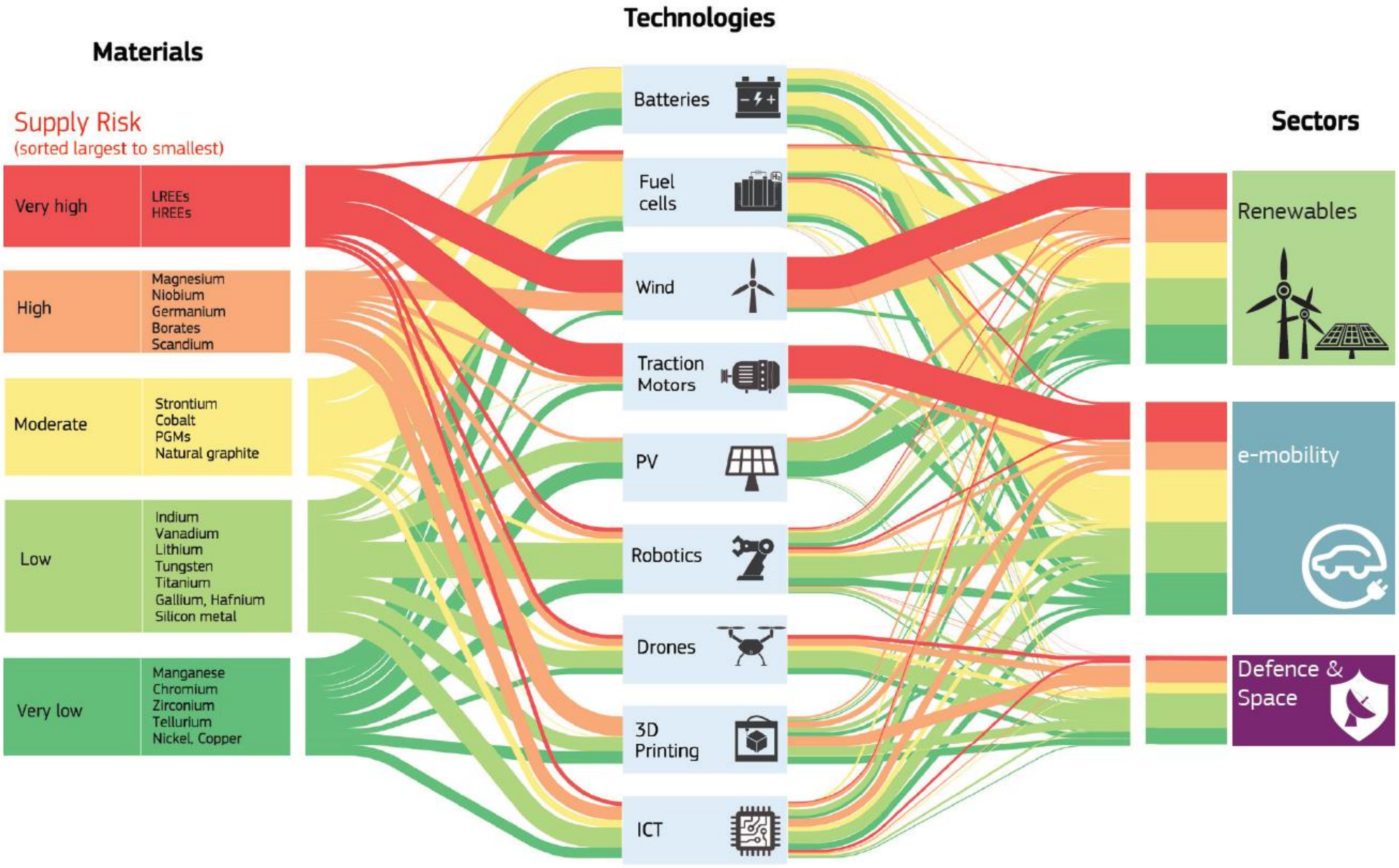

Wind turbines
Aluminium: as lightweight material in nacelle equipment, blades, etc.
Boron: in composition of neodymium – iron – boron magnets or as lubricant
Chromium: essential for stainless steel and other alloys in rotor and blades
Copper: widely used in generator windings, cables, inverters, control systems
Dysprosium: important additive of neodymium – iron – boron permanent magnets
Iron: as cast iron or in steel composition for tower, nacelle, rotor and foundation
Lead: for soldering or cable sheathing in electricity transmission (offshore)
Manganese: essential for steel production used for many parts of a turbine
Molybdenum: in stainless steel composition for many components of the turbine
Neodymium: in permanent magnets (NdFeB) for electricity generation
Nickel: in alloys and stainless steel for different components of the turbine
Niobium: a microalloying element in high strength structural steel for towers
Praseodymium: together with neodymium in permanent magnets
Al
B
Cr
Cu
Dy
Fe
Pb
Mn
Mo
Nd
Ni
Nb
Pr
Non-critical material
Critical material

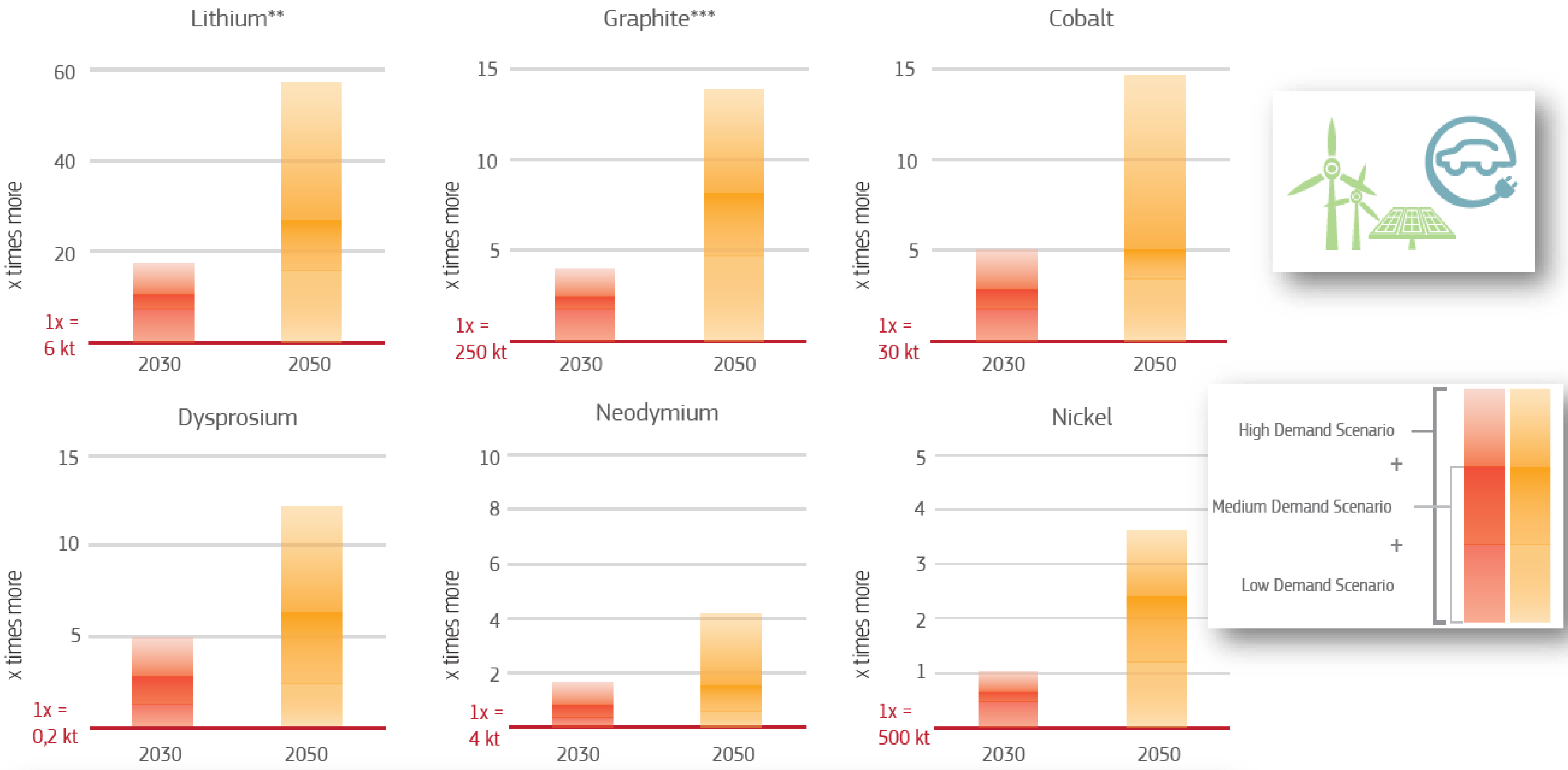
Solar


Solar photovoltaic
Al
Aluminium: in panel frames and inverters or in alloys for construction and support
B
Boron: as dopant (p-type) in crystal lattice of the silicon-based wafers
Cd
Cadmium: in thin-film cadmium telluride (CdTe) photovoltaic technology
Cu
Copper: highly used in wires, cables, inverters, also in CIGS technology
Ga
Gallium: as dopant in semiconductors or in CIGS technology
In
Indium: as indium-tin-oxide (ITO) conductive layer or in CIGS technology
Fe
Iron: in steel alloys for different parts and in fixing systems of PV installations
Pb
Lead: in alloys with tin (Sn) as solder for electric circuits and interconnectors
Mo
Molybdenum: as back contact for CIGS or in stainless steel frames
Ni
Nickel: in electroplating or in stainless steel frames, fasteners and connectors
Se
Selenium: in thin-film copper indium gallium selenide (CIGS) solar cell
Si
Silicon: as semiconductor material in crystalline or amorphous solar cells
Ag
Silver: as conductive paste on front and back side of the crystalline solar cells
Te
Tellurium: in thin-film cadmium telluride (CdTe) photovoltaic technology
Sn
Tin: in combination with lead for soldering or with indium in conductive layers (ITO)
Zn
Zinc: as transparent conductive oxide in the front contact of solar cells
Ge
Germanium: as semiconductor materials for multi-junction solar cells
Non-critical material
Critical material

SUPPLY RISK OF RAW MATERIALS FOR KEY TECHNOLOGIES




Technologies
Materials
Supply Risk
(sorted largest to smallest)
Very high
LREEs
HREEs
High
Magnesium
Niobium
Germanium
Borates
Scandium
Moderate
Strontium
Cobalt
PGMs
Natural graphite
Low
Indium
Vanadium
Lithium
Tungsten
Titanium
Gallium, Hafnium
Silicon metal
Very low
Manganese
Chromium
Zirconium
Tellurium
Nickel, Copper
Batteries
Fuel cells
Wind
Traction Motors
PV
Robotics
Drones
3D Printing
ICT
Sectors
Renewables
e-mobility
Defence & Space



Combined critical raw materials use in different technologies in the EU in 2030 and 2050

European Commission

Speech | 3 September 2020 | Brussels

Speech by Vice-President Šefčovič at the Press Conference on critical raw materials resilience in the EU

- Raw materials will **play a hugely important part** in our future, especially **given the ongoing transition towards a green and digital economy** – a trend not only accelerated, but one, which lies at the heart of our recovery.

- We **need to ensure a secure and sustainable supply of raw materials** to meet the needs of the clean and digital technologi... including in the health sector and the space and defence ...

- In order to succeed, **we must acknowledge some hard truths**.

- The simple truth also is that we ar... **unsustainable raw materi... ...n lower environmental and ...** ...ms or unstable economies.

  - **we also need** to **scale up reuse, repair and recycling** of products;
  - We must support **innovation for alternatives and resource efficiency**;

- Today's **Action Plan outlines concrete steps we are taking in response** – altogether, they will help **make Europe more resilient**

European Commission

Thank you

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