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CiRCLETECH 101079354 Funded by the European Union - Twinning partnership to deliver enhanced networking for circular technological and socio-economic impact, raising research excellence and strengthening management capacity.

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WASTEBUILDZERO

NDSM, AMSTERDAM | 11-12 May 2023

Critical Materials - Risks and Opportunities

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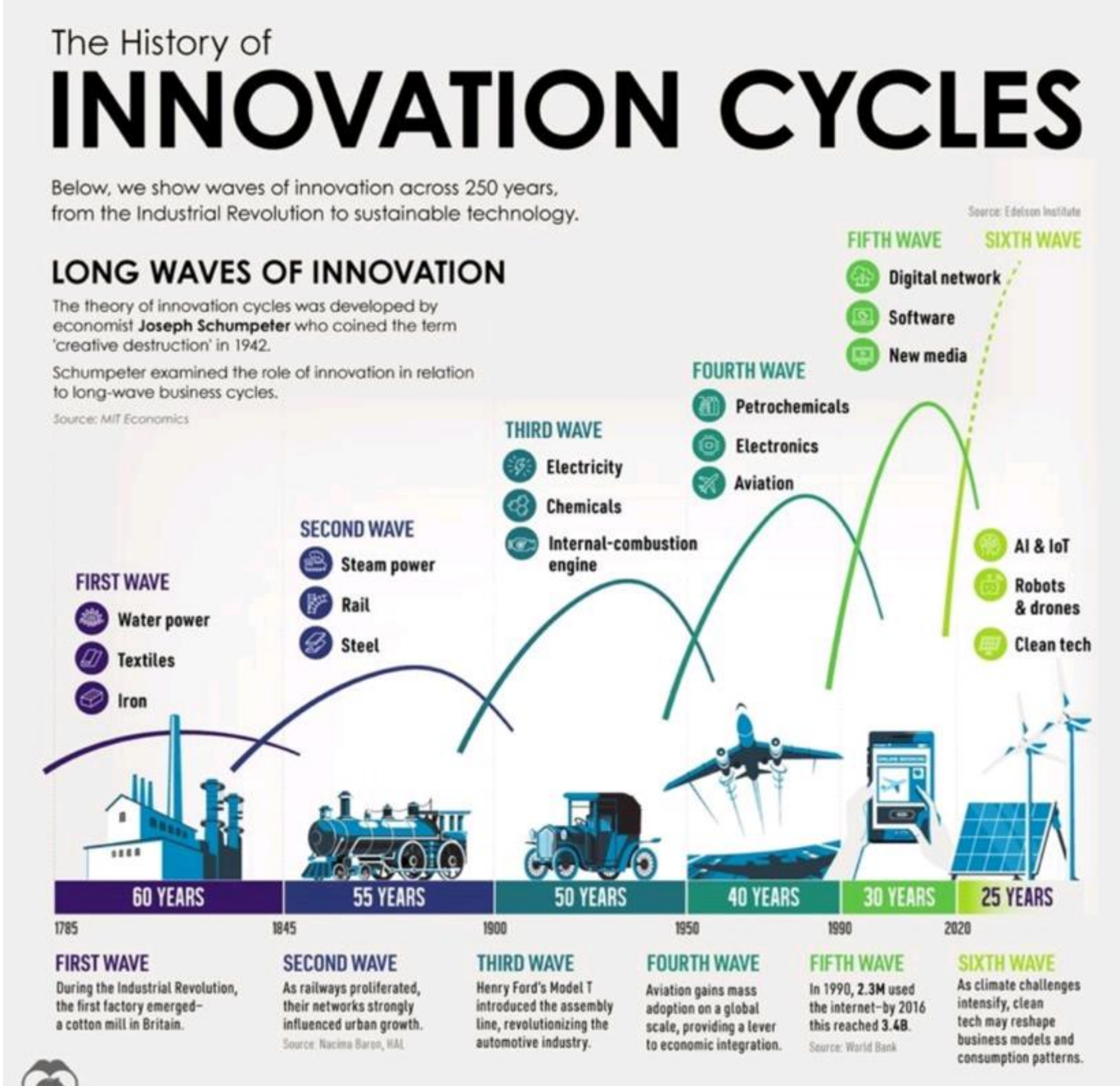

The History of
INNOVATION CYCLES
Below, we show waves of innovation across 250 years, from the Industrial Revolution to sustainable technology.
Source: Edelson Institute
LONG WAVES OF INNOVATION
The theory of innovation cycles was developed by economist Joseph Schumpeter who coined the term 'creative destruction' in 1942.
Schumpeter examined the role of innovation in relation to long-wave business cycles.
Source: MIT Economics
FIRST WAVE
Water power
Textiles
Iron
SECOND WAVE
Steam power
Rail
Steel
THIRD WAVE
Electricity
Chemicals
Internal-combustion engine
FOURTH WAVE
Petrochemicals
Electronics
Aviation
FIFTH WAVE
Digital network
Software
New media
SIXTH WAVE
AI & IoT
Robots & drones
Clean tech
60 YEARS
55 YEARS
50 YEARS
40 YEARS
30 YEARS
25 YEARS
1785
1845
1900
1950
1990
2020
FIRST WAVE
During the Industrial Revolution, the first factory emerged– a cotton mill in Britain.
SECOND WAVE
As railways proliferated, their networks strongly influenced urban growth.
Source: Nacima Baron, HAL
THIRD WAVE
Henry Ford's Model T introduced the assembly line, revolutionizing the automotive industry.
FOURTH WAVE
Aviation gains mass adoption on a global scale, providing a lever to economic integration.
FIFTH WAVE
In 1990, 2.3M used the internet–by 2016 this reached 3.4B.
Source: World Bank
SIXTH WAVE
As climate challenges intensify, clean tech may reshape business models and consumption patterns.

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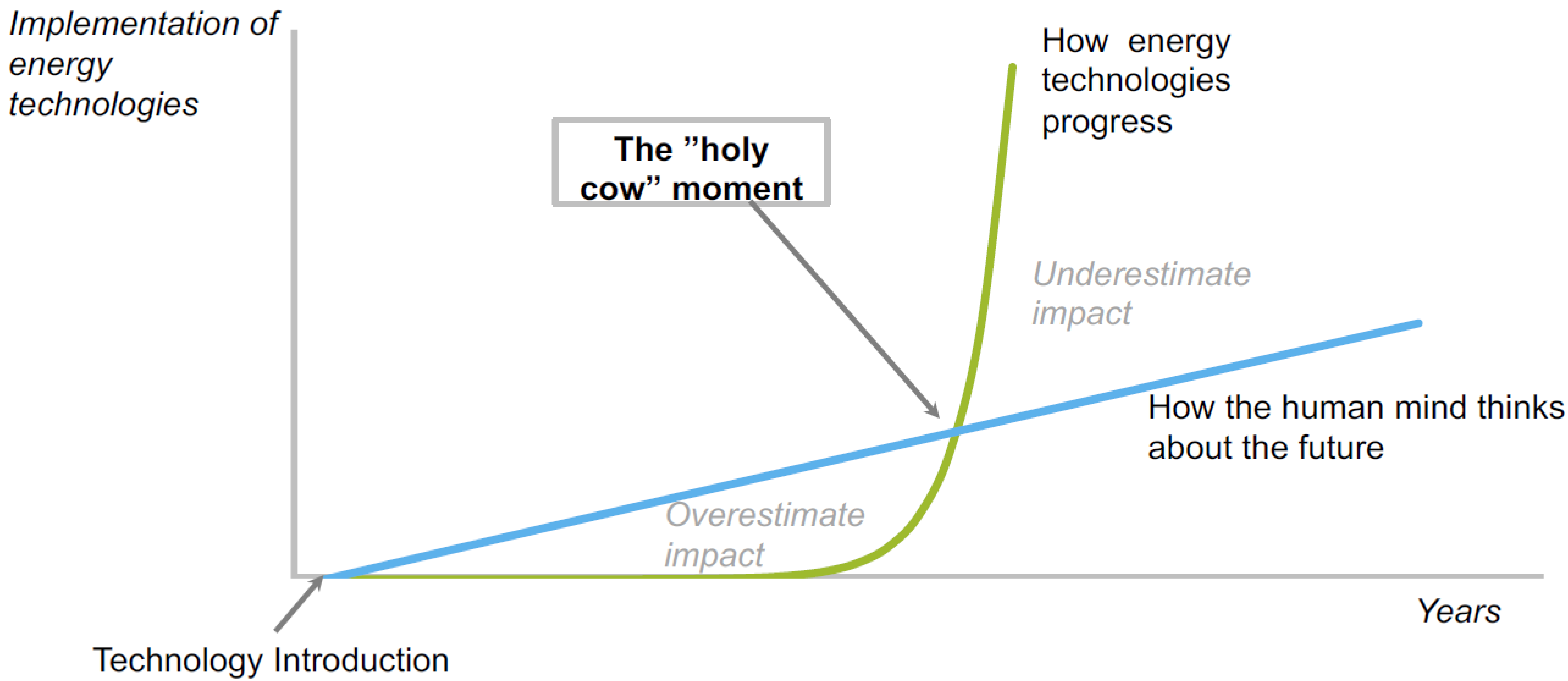
We have hit the 'holy cow' moment



- Credit Rene Kleijn, 2022, Leiden University

Adapted from Richard Baldwin: The Globotics Upheavel, 2019

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2023 Critical Raw Materials (*new CRMs in italics*)			
aluminium/bauxite	coking coal	lithium	phosphorus
antimony	*feldspar*	LREE	scandium
arsenic	fluorspar	magnesium	silicon metal
baryte	gallium	*manganese*	strontium
beryllium	germanium	natural graphite	tantalum
bismuth	hafnium	niobium	titanium metal
boron/borate	*helium*	PGM	tungsten
cobalt	HREE	phosphate rock	vanadium
		*copper**	*nickel**

2023 Critical Raw Materials (*Strategic Raw Materials in italics*)			
aluminium/bauxite	coking coal	*lithium*	phosphorus
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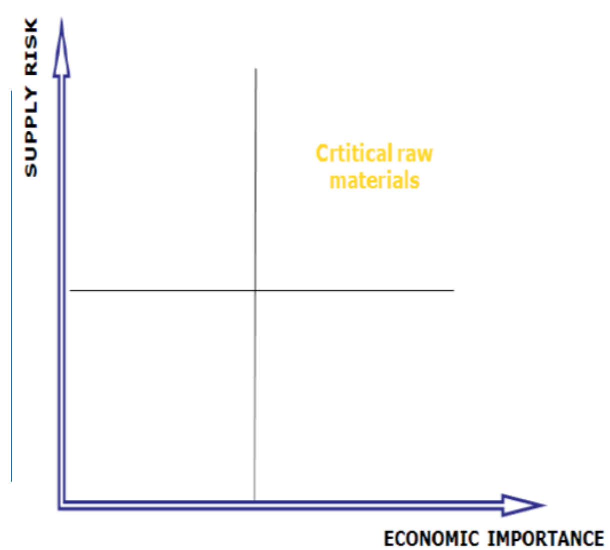
bismuth	hafnium	niobium	*titanium metal*
boron/borate	helium	*PGM*	*tungsten*
cobalt	*HREE*	phosphate rock	vanadium
		*copper**	*nickel**

* Copper and nickel do not meet the CRM thresholds, but are included as Strategic Raw Materials.



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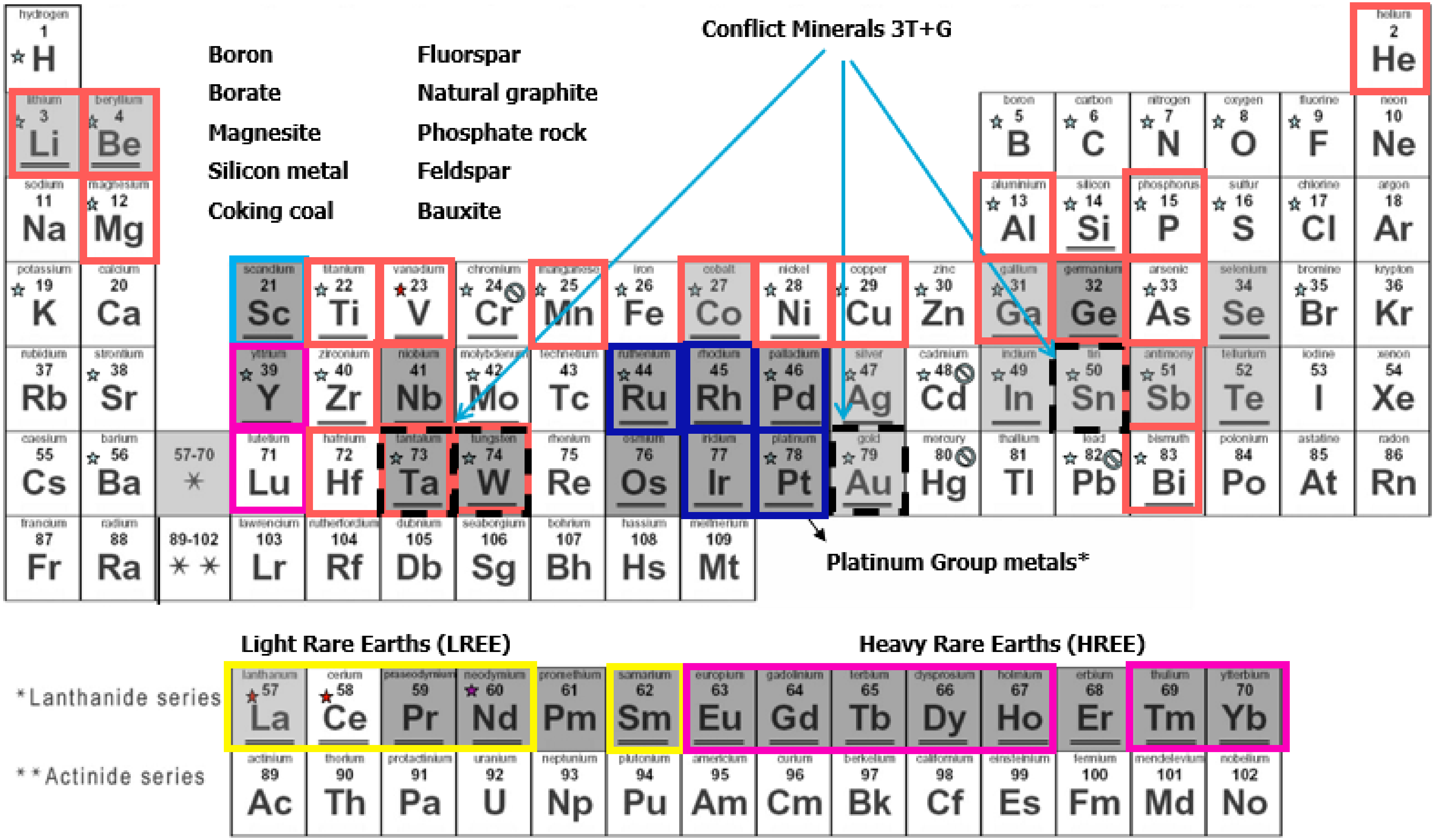
Critical materials – half of the first 83 elements



☆ Elements contained in mobile phones. Source: (Meskers at al 2009), ★ in PCs (Soneji 2009) + WEEE (Dimitrakakis 2009)

⦸ RHOS Elements (use in electronic appliances is restricted)

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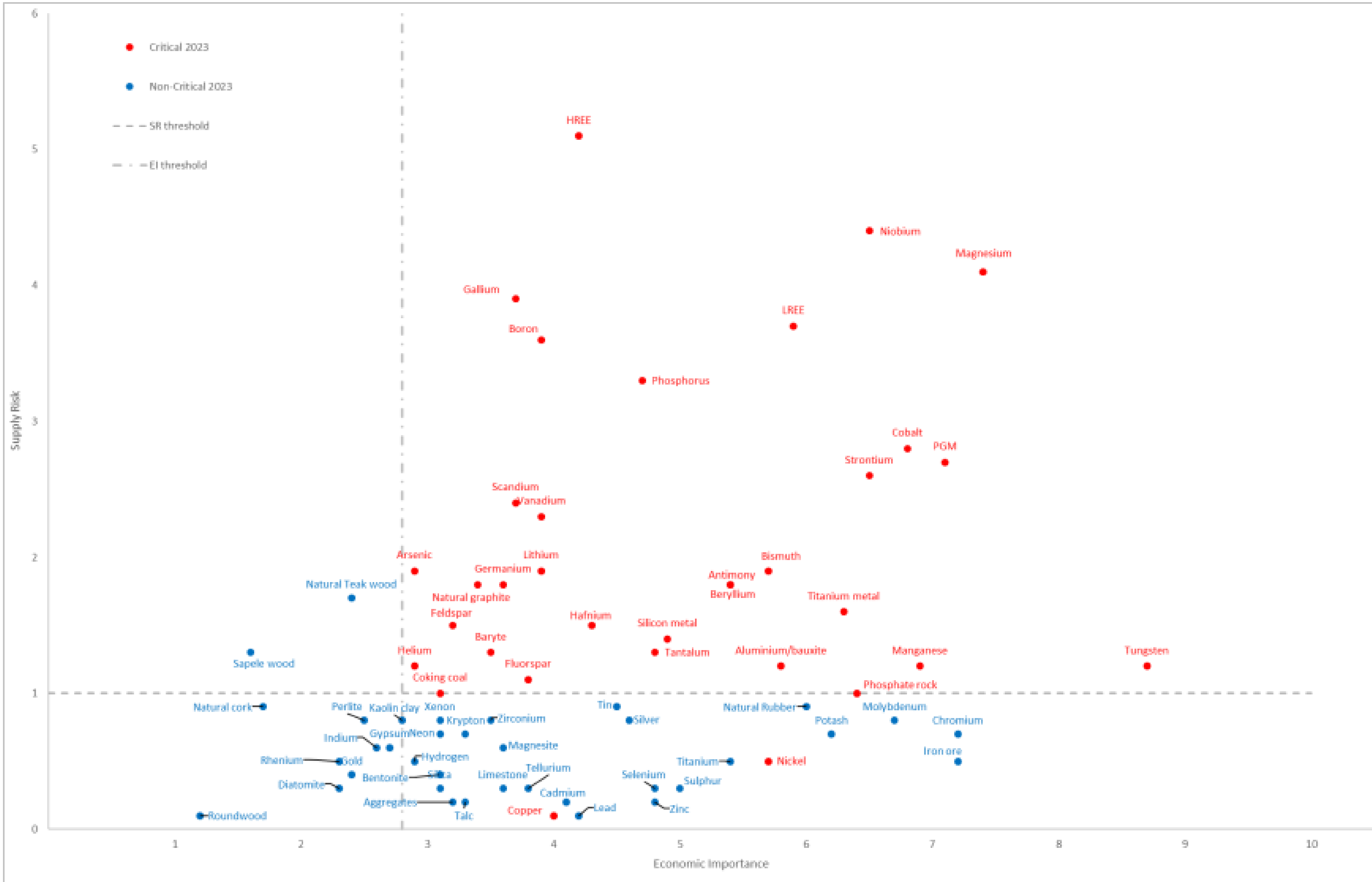
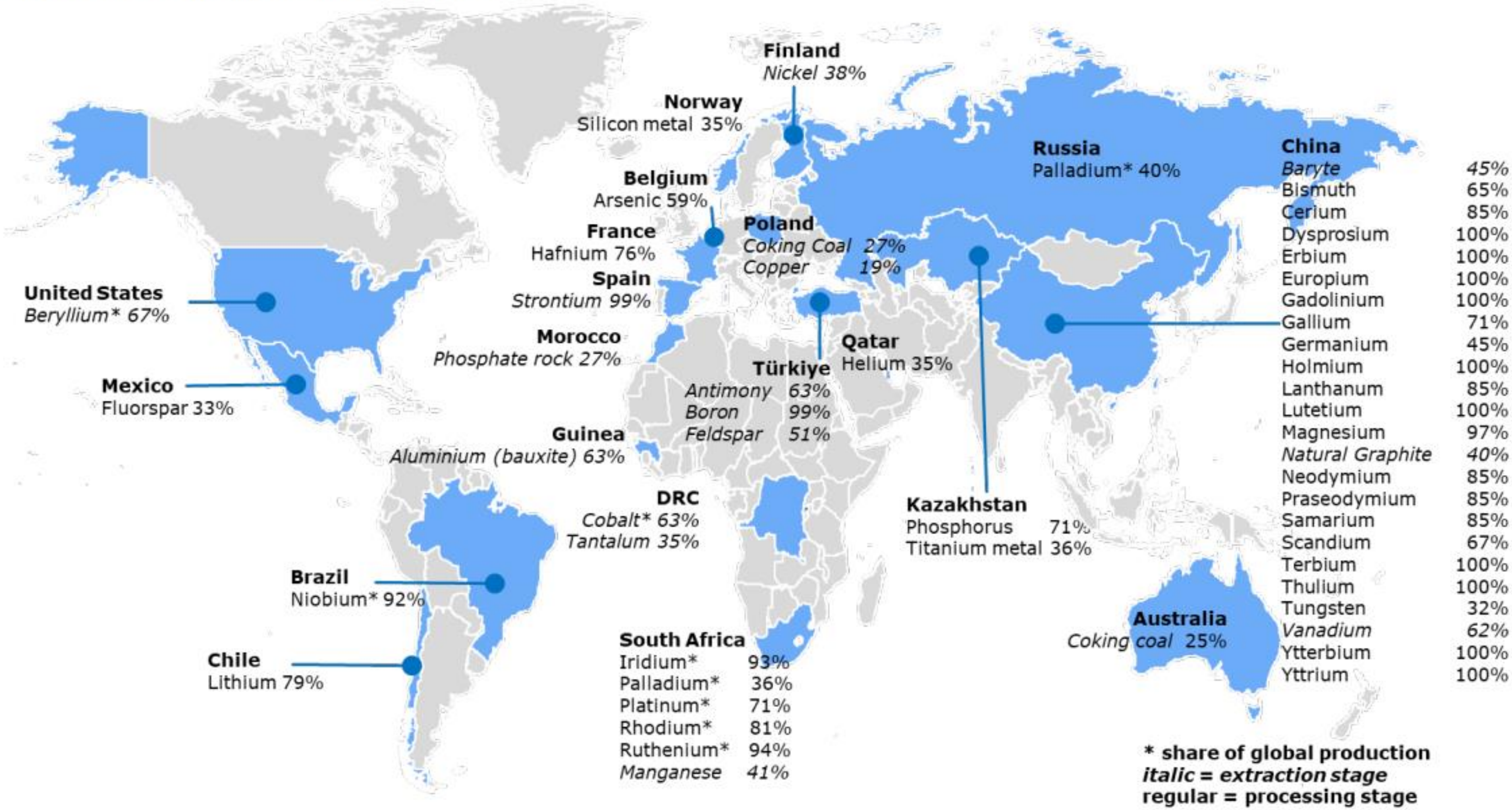
European Commission

Figure A: Results of the 2023 EU criticality assessment[5]



Country supply into EU concentration

Figure 5: Main EU suppliers of individual CRMs



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Part 1 The Critical Raw Materials Act

David Peck

Why - CRM for our future

March 2023

The EU is aiming to ensure a secure and sustainable supply of critical raw materials for Europe's industry.

WHY?

Critical raw materials are needed for the **green and digital transitions** as well as for defence and space

To enhance our **long-term competitiveness**

To maintain our **open strategic autonomy** in a fast-changing and increasingly challenging geopolitical environment

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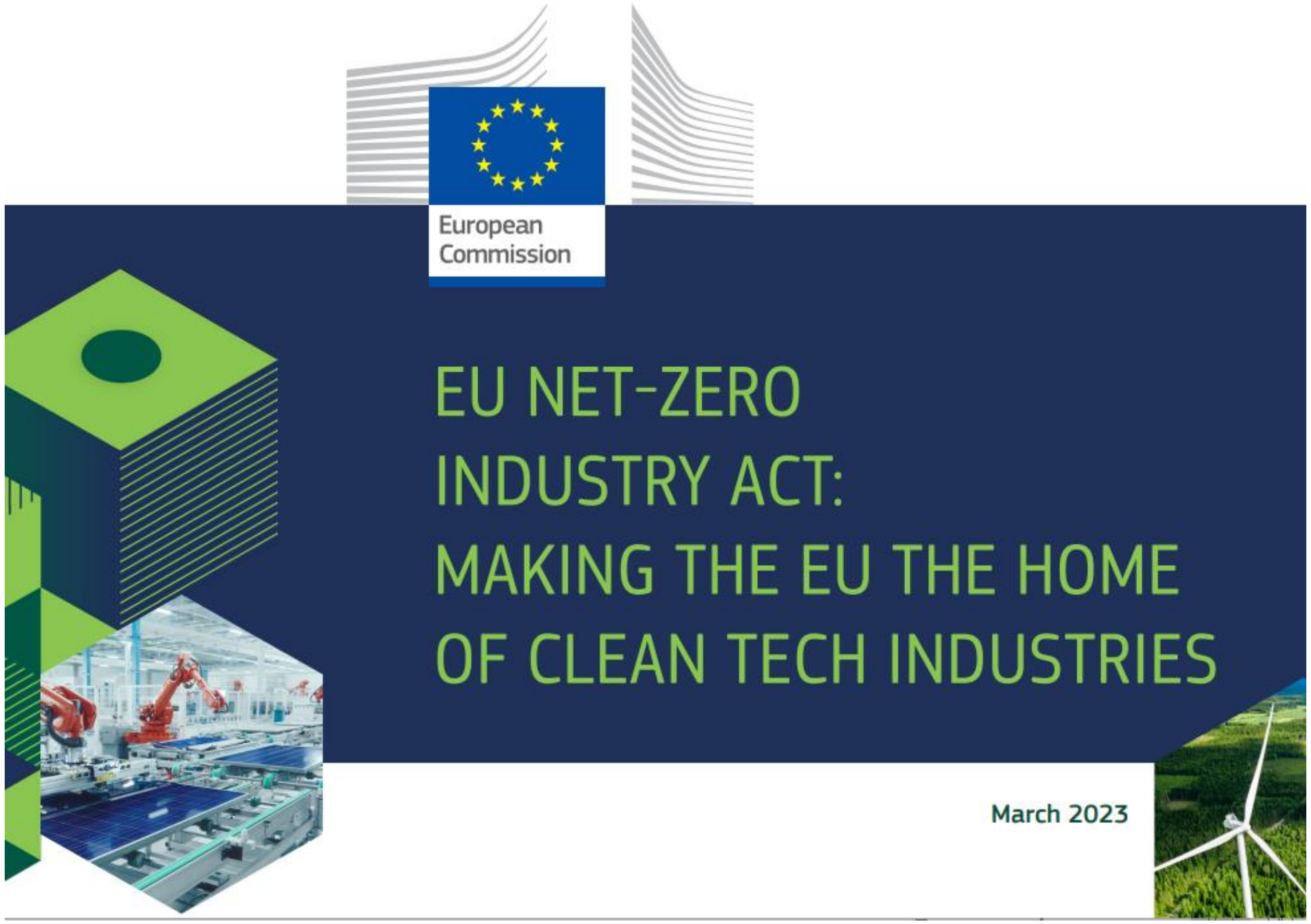
Top level targets by 2030

- Extraction (Primary Mining):
  - 10% mined in EU
- Recycling:
  - At least 15% of materials recycled in EU (currently for some CRM 0%)
- 3rd country supply:
  - No more than 65% from outside EU
- Processing:
  - At least 40% of materials processed in EU (currently for some CRM 0%)

Part 2; The Net Zero Industry Act



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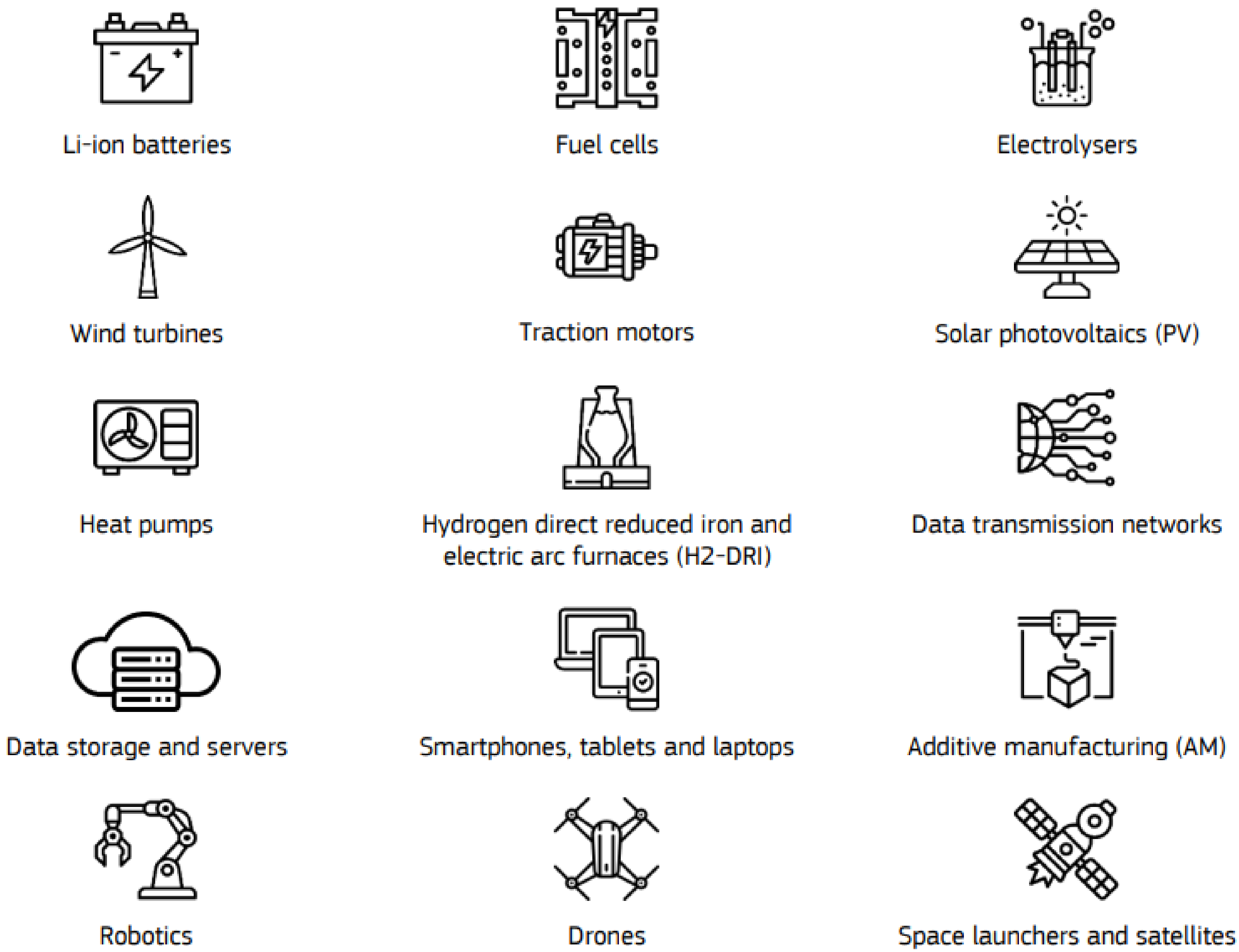
The act: Made in EU by 2030



Source: JRC elaboration based on flaticon.com

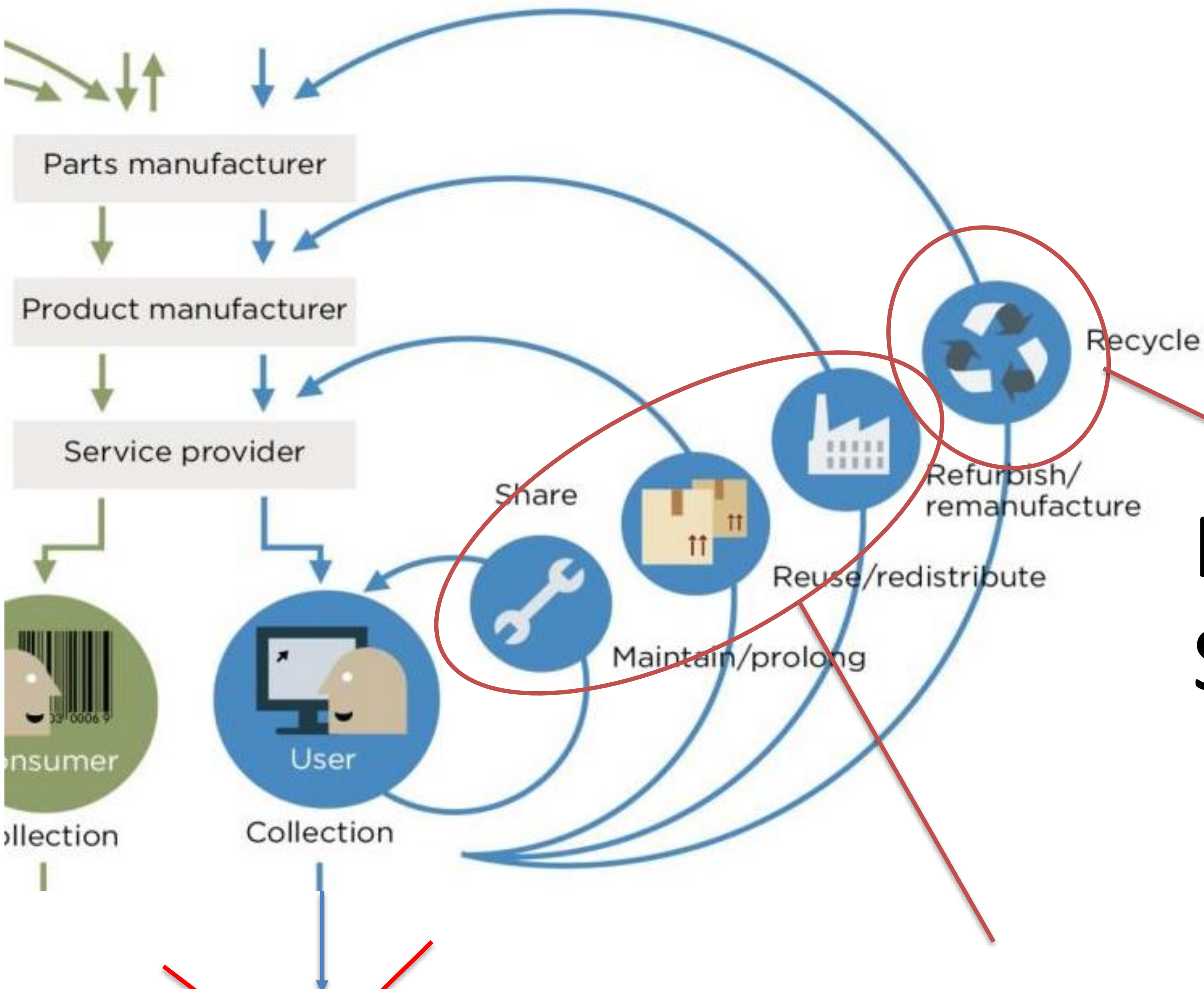
40% must be made in EU by 2030

Links to CRMA on material supply

The Circular Opportunity - Remanufacturing

Circle – products /equipment /components - materials

Primary Materials



Material re-use,
Secondary materials

Life extension

~~Waste~~

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ELLEN MACARTHUR FOUNDATION

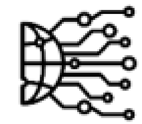
Scale Matters:

The A+BE approach to research and education in a circular built environment

Creating a shared understanding: the “Scales to Aspects” Model

CRM in buildings

Data storage and servers

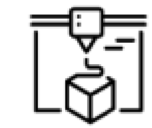


Data transmission networks

Steel use

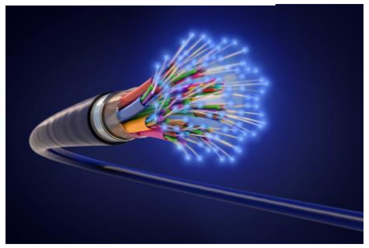
Al Al use

Construction

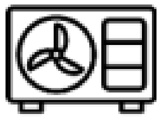


Additive manufacturing (AM)

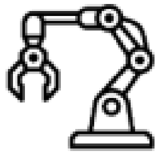
Adze Boerstra, 2022



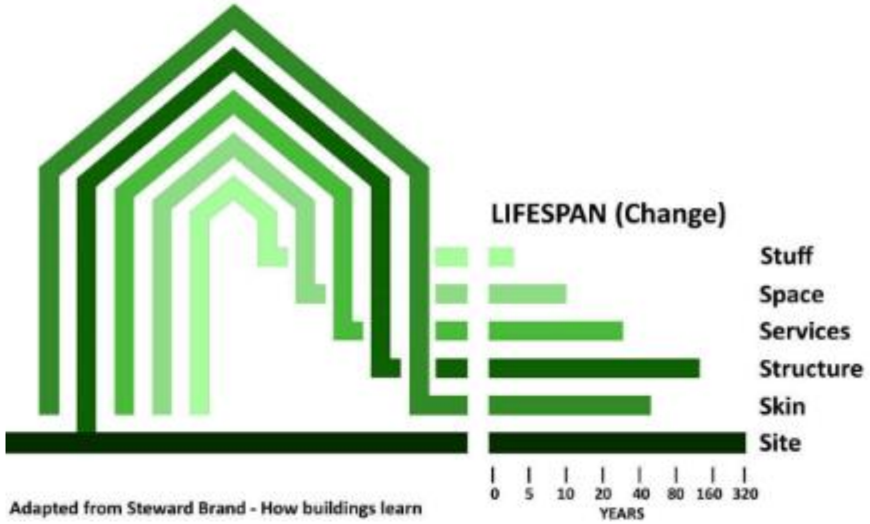
Charley Meyer, 2018

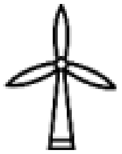


Heat pumps

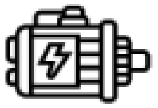


Robotics



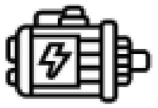


Wind turbines

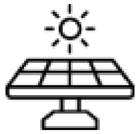


Traction motors

Tillmann Klein, 2020

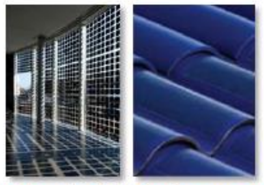


Traction motors

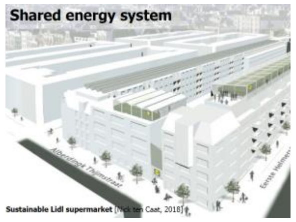


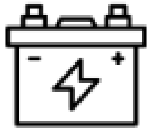
Solar photovoltaics (PV)

Urban-Integrated Phovoltaics (UIPV)



Building/Invisibly Integrated Photovoltaics (BIPV/IIPV)





Li-ion batteries

Built-Added Photovoltaics (BAPV)

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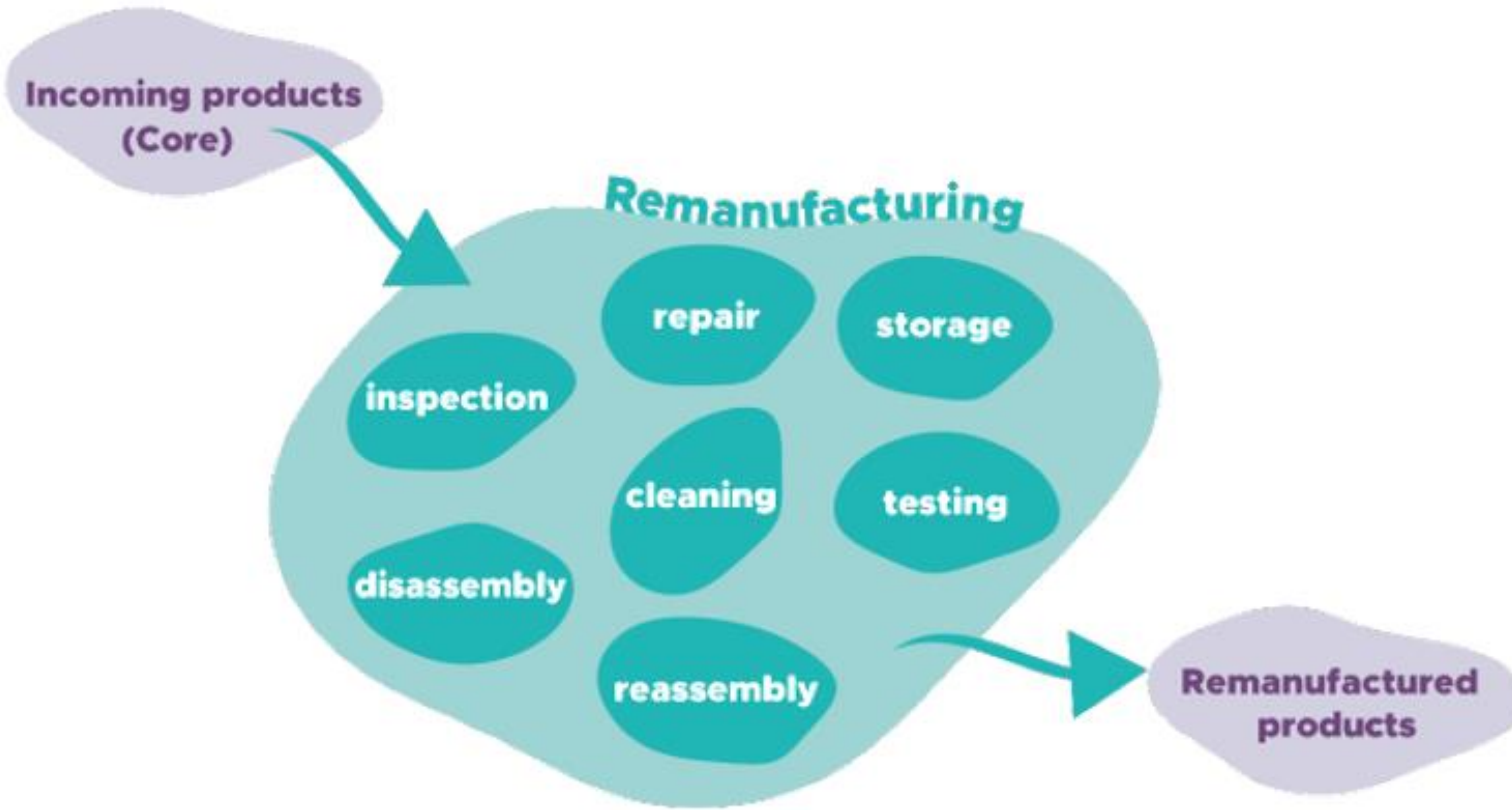
Circular direction of travel: The strategies - remanufacturing

Circular economy (↑ Increasing circularity) … Linear economy

Circular economy	Strategies	
Smarter product use and manufacture	R0 Refuse	Make product rebundant by abandoning its function or by offering the same function with a radically different product
	R1 Rethink	Make product use more intensive (e.g. by sharing product)
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	R3 Reuse	Reuse by another consumer of discarded product, which is still in good condition and fullfils its original function
	R4 Repair	Repair and maintenance of defective product so it can be used with its original function
	R5 Refurbish	Restore an old product and bring it up to date
	R6 Remanufacture	Use parts of discarded product in a new product with the same function
	R7 Repurpose	Use discarded product or its parts in a new product with a different function
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9 Recover	Incineration of material with energy recovery

Not repaired, not refurbished, but through a factory, in a box, as good as (or better than) new, with a warranty, and **you can’t tell the difference**.

Source: (Kirchherr, et al., 2017)



A generic remanufacturing process and its seven process steps
Adapted from Sundin and Bras (2005)

European Remanufacturing Council

The ambition is to triple the value of Europe's remanufacturing sector to €100 billion by 2030.

Our aim must

be at least 1%

Right?

This project is funded by the European Union

Conseil Européen de Remanufacture

TU Delft

SusCritMooc
irtc International Round Table on Materials Criticality
irtc training
eit RawMaterials Connecting matters
Co-funded by the European Union

Remanufacturing LeanReManufacturing Lean
eit Manufacturing
Co-funded by the European Union

Pop-Machina
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Thank you…

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