Il ruolo dell'economia circolare nella politica energetica europea

CONSORZIO NAZIONALE OLI USATI

AIEE ASSOCIAZIONE ITALIANA ECONOMISTI DELL'ENERGIA

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Advisory Services & Studies Director

CESI S.p.A.

I materiali critici nelle tecnologie verdi e nelle batterie

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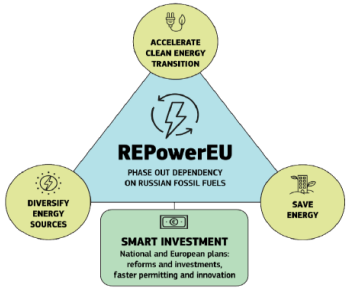
EU: between challenging goals and harsh reality

Despite the ambitious **decarbonization targets**…

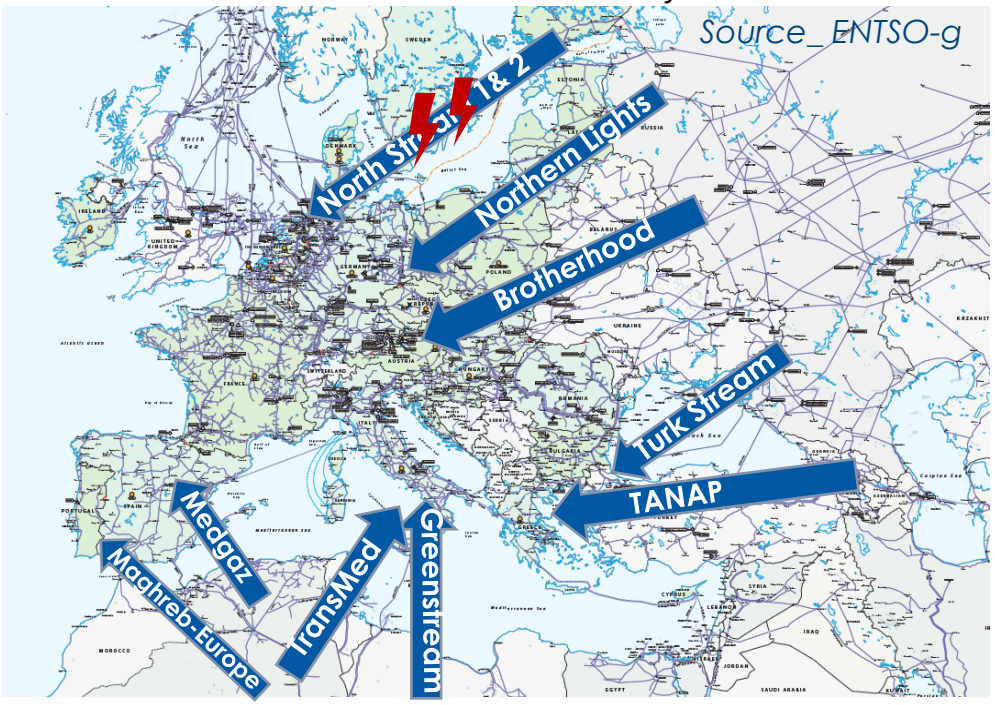
Fit for 55
DELIVERING THE
EUROPEAN GREEN DEAL
THE DECISIVE DECADE

14 July 2021

2030 Targets	Fit x 55	REPowerEU
GHG reduction vs 1990	55%	
%RES on energy consumption	40%	45%



18 May 2022



…the EU economy is **still largely based on fossil fuels**, the largest share of them are imported

EU* imports **56%** of its energy, which makes it the largest net energy importer among G20 members. EU energy bill in 2022: **€ 834 billion**

- **96%** of **crude oil imported**
- **83%** of **NG imported**
  - ✓ in **17 Member States** the dependency on NG imports exceeds 90%

Italy

- **93%** of **crude oil imported***
- **95%** of **NG imported****

The heavy dependence on imported fossil resources makes Europe **highly vulnerable to possible external shocks**

*Source: Eurostat, 2021 data

**Source: MASE, Snam, 2022 data

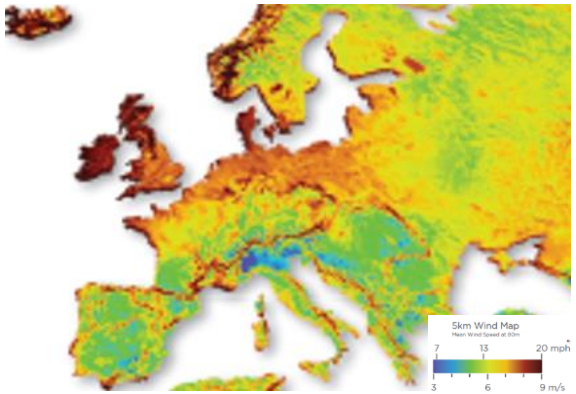
The energy transition implies a geopolitical shift for energy sources

From imported Oil and Gas…

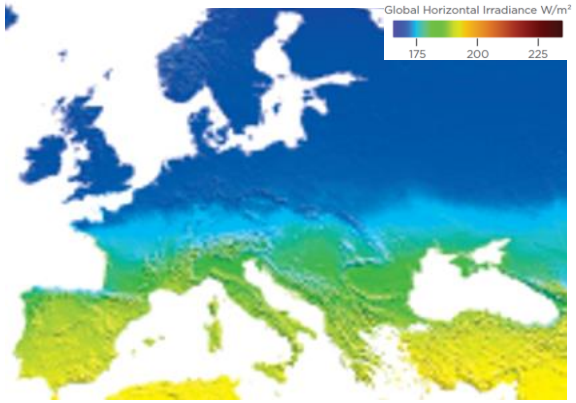
…to **exploitation of local RES**

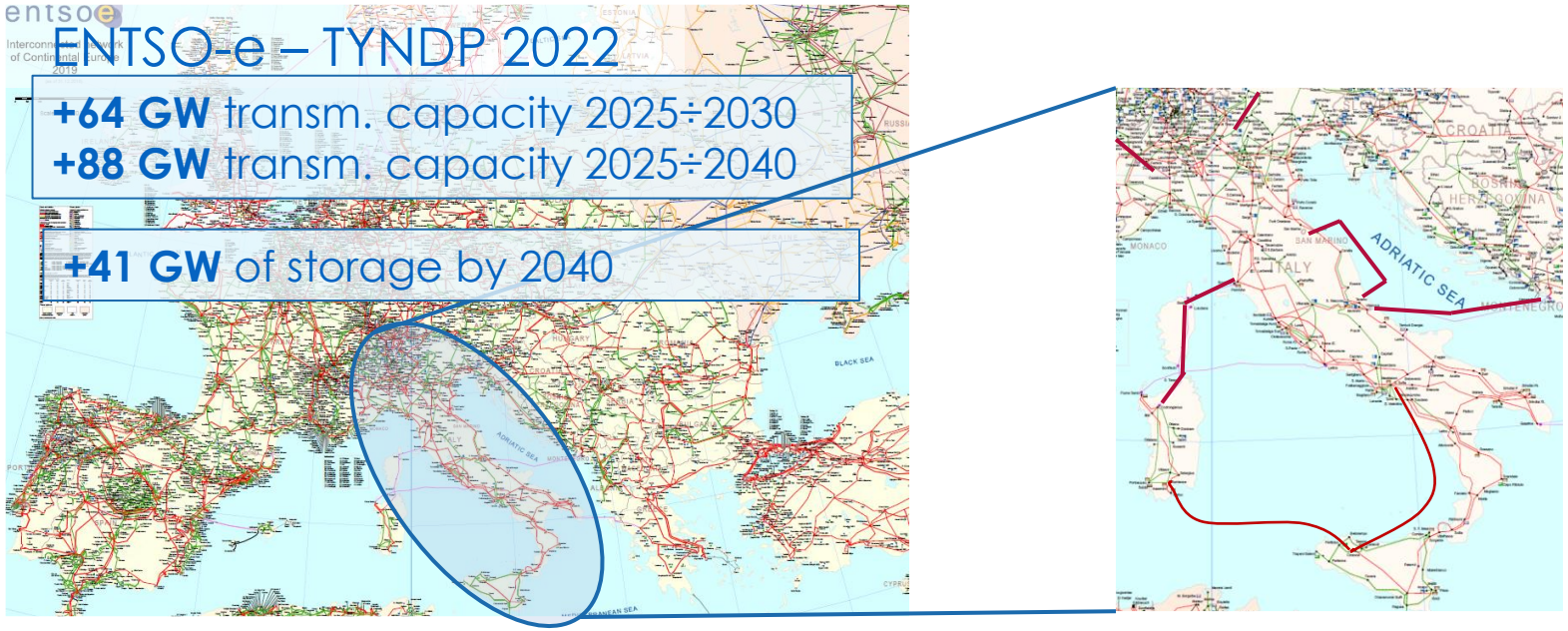
consequent growing effort in transmission capacity

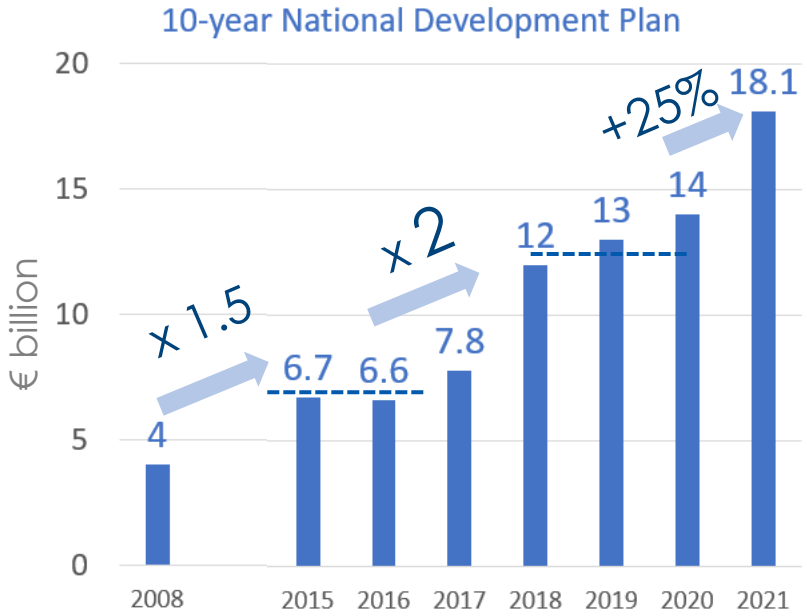
Wind producibility



Solar producibility



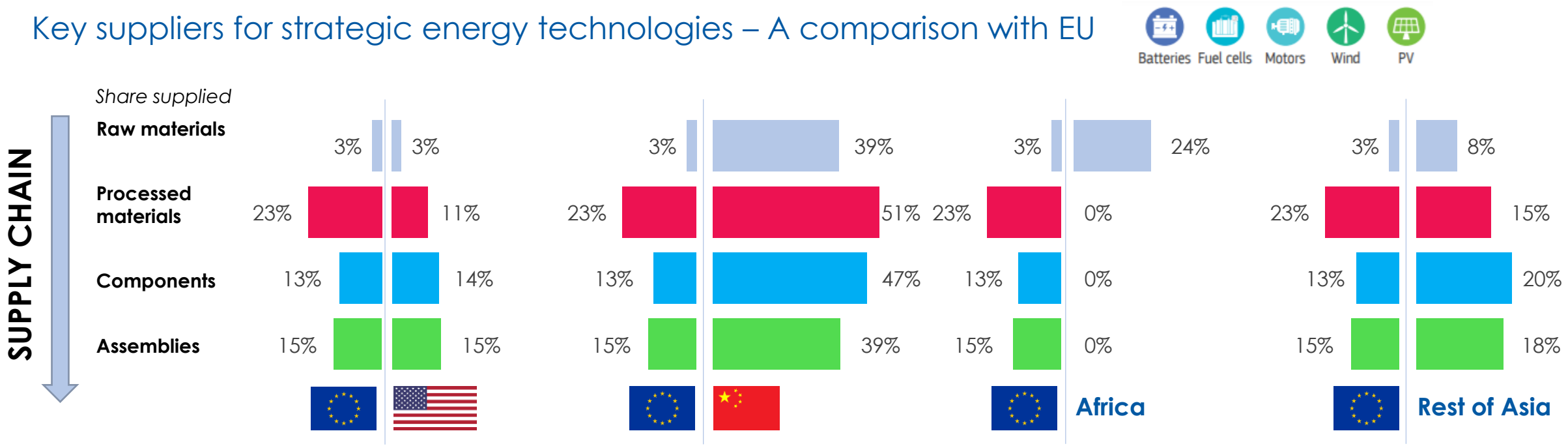


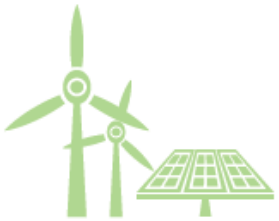


The energy transition implies a geopolitical shift for energy technologies

European Commission Report *Critical Raw Materials for Strategic Technologies and Sectors in the EU*

Key suppliers for strategic energy technologies – A comparison with EU





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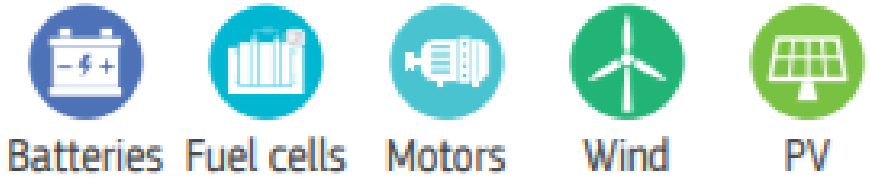
Source: CESI elaborations on Critical Raw Materials for Strategic Technologies and Sectors in the EU – European Commission

Supply chain of Critical Raw Materials (1/2)

Material	Supply risk (Very High / High)	Largest supplier to EU – Country	Largest supplier to EU – Share of EU demand supplied
LREEs	Very High	China	99%
HREEs	Very High	China	98%
Magnesium	High	China	93%
Niobium	High	Brazil	85%
Borates	High	Turkey	98%

Technology applications



Supply Chain

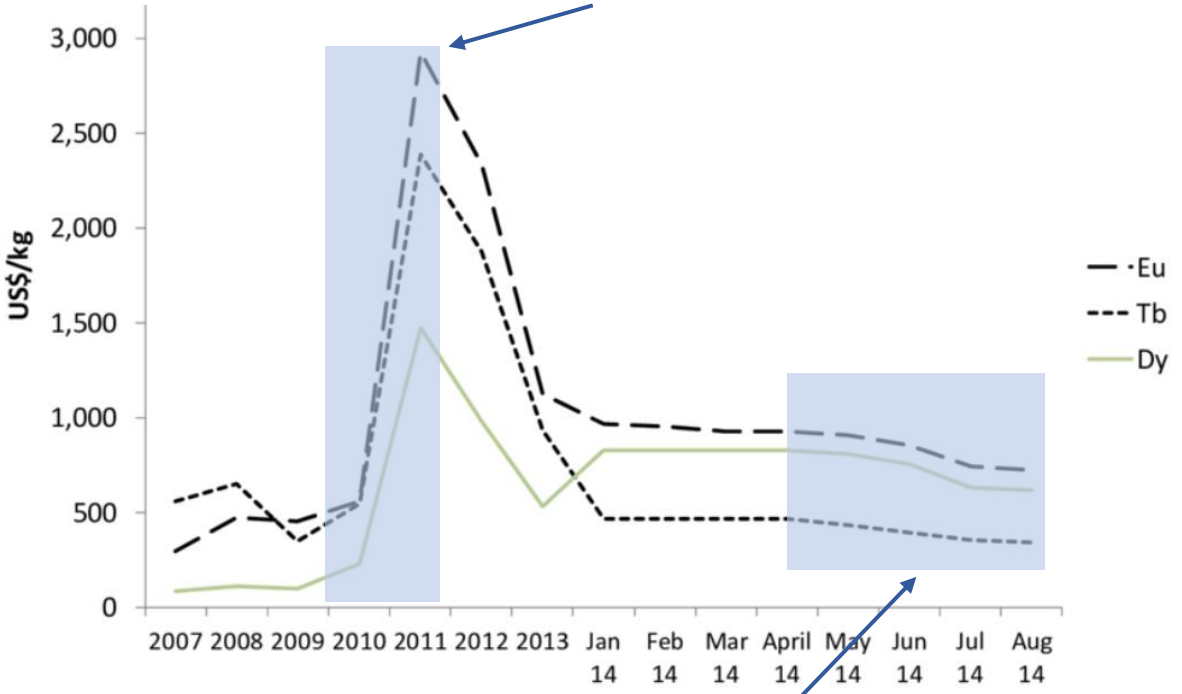
In Sept. 2020 the EU issued an updated list of **critical raw materials**. Out of 83 materials screened in their whole value chain from extraction to processing as many as **30 materials were identified as critical**, i.e. more than twofold the critical materials (14) identified in 2011.

In general, for most materials the **EU is already now reliant between 75% and 100% from import** and following the current trend the situation will be rapidly worsening in the coming years considering also the competition from other OECD and emerging countries in importing raw materials.

Source: EC Critical Raw Materials and CESI elaboration

Supply chain of Critical Raw Materials (2/2)

Restrictions on REE export imposed by **China** following a dispute with Japan



Source: ResearchGate

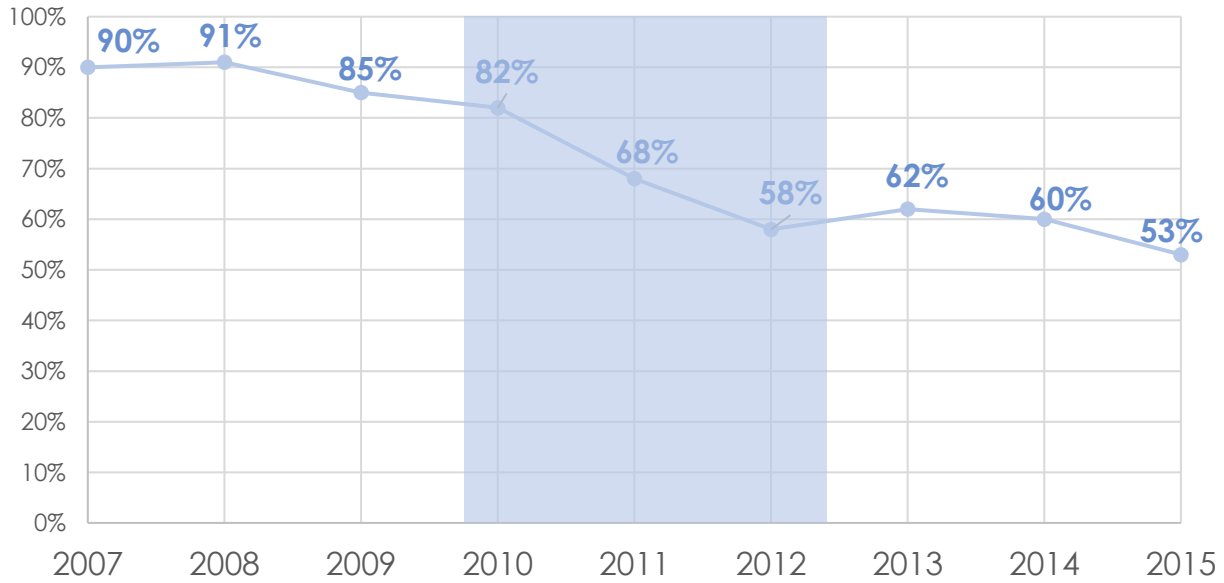
REE prices kept low by **China** to discourage competitors enter in the REE supply chain

Ineffective reactions of **EU and USA** with claim at WTO

Reaction from **Japan**:

- ✓ Higher stocks of REE
- ✓ Diversification of import

Japan: REE import from China



Availability of Critical Raw Materials (1/2)

Material	Technology applications				
	Batteries	Fuel cells	Motors	Wind	PV
LREEs[1]		✓	✓	✓	
HREEs[2]		✓	✓	✓	
Magnesium		✓			
Niobium	✓			✓	
Germanium					✓
Borates		✓	✓	✓	✓
Lithium	✓	✓			
Cobalt	✓	✓	✓		
Vanadium		✓			
Titanium	✓	✓			
Silicon metal	✓	✓	✓		✓

[1]Light Rare Earth Elements
[2]Heavy Rare Earth Elements

Availability

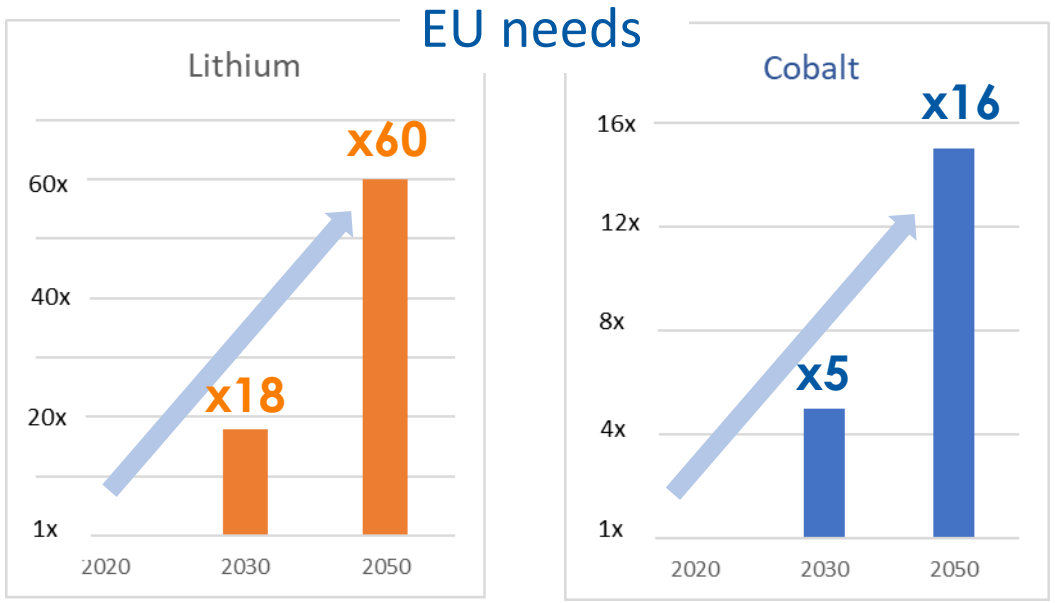
The current technologies for car batteries are based on Lithium-ion (Li-ion) or nickel-metal hydride (NiMH), containing **lithium** and **cobalt**.

Both materials are expected to face a **vertiginous rise in their consumption**.

Whereas resources of lithium are relatively abundant, though concentrated in few countries like Australia, Chile and Bolivia, cobalt is in a much shorter supply.

Source: EC Critical Raw Materials and CESI elaboration

Availability of Critical Raw Materials (2/2)



Availability & Competition

Availability: according to the US Geological Survey, cobalt world reserves that can be economically exploited with today's technologies are estimated in about **7 million tons**, which represents only 58 years referring to 2020 global demand

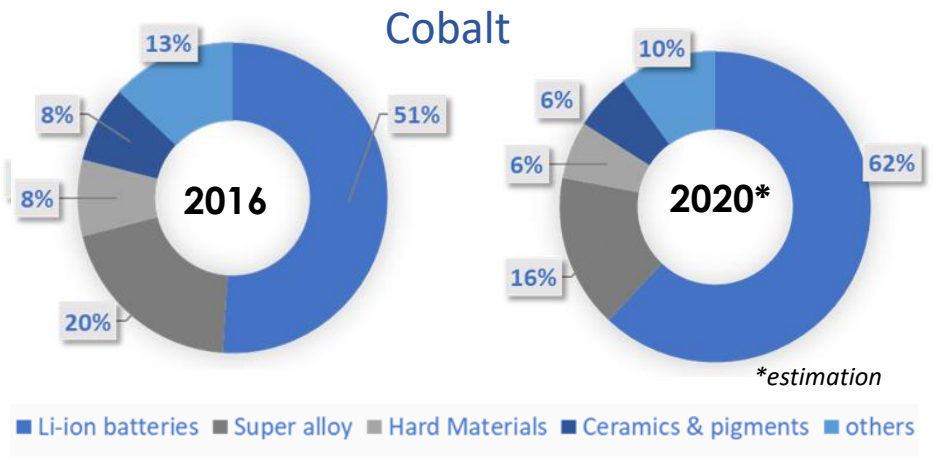
Competition with other sectors: only about **60%** of current Cobalt production is for Li-ion batteries

Lithium:

- ✓ 2020 global demand **82 kton** (est.)
- ✓ **+116%** between 2016 and 2020

Cobalt:

- ✓ 2020 global demand **120 kton** (est.)
- ✓ **+30%** between 2016 and 2020



Source: Darton Commodities

Similar considerations apply to REE, especially to HREE

Source: EC Critical Raw Materials and CESI elaboration

Measures to mitigate risks

The decarbonization pathway will help in reducing the fuel dependency, while ensuring a security of supply provided that a series of measures are undertaken

1	**Recycling**	• Labelling • R&D • 2nd life	Example: Tungsten Northvolt, Umicore, Tesla EV Batteries → stationary
2	**Substitution**	• Brushed electric motor • Cage rotors • Low % cobalt	BMW iX Vestas Mercedes
3	**New greener technologies**	• Green lithium	Bruchsal geoth. plant Upper Rhine Basin Po valley
4	**Domestic production**	• Batteries • Mining conversion	EU Battery Alliance Just Transition Mechanism

E-vehicles and utility scale batteries

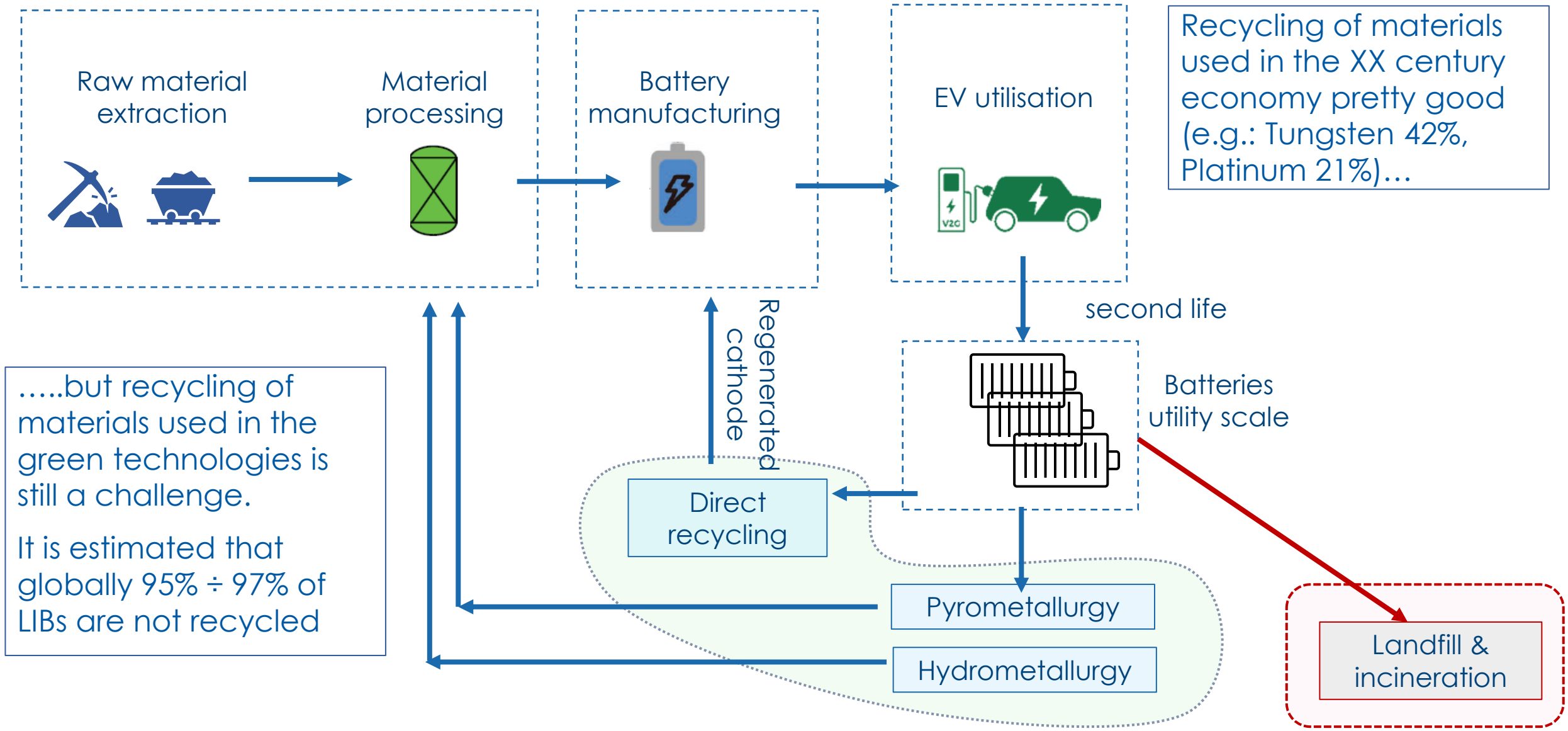
Most common technology **Lithium-Ion Battery (LIB)**

Several solutions with different materials adopted

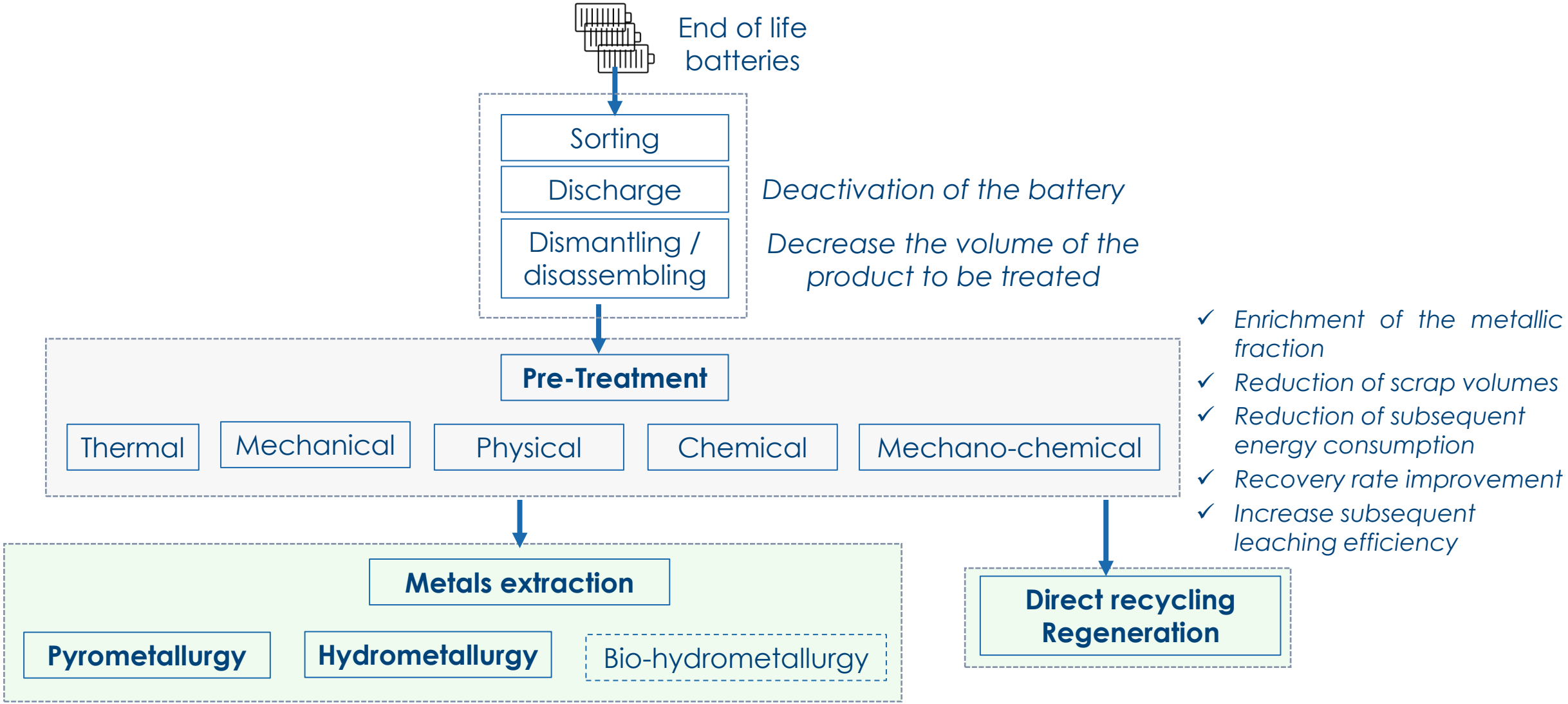
	Cathode	Anode	Specific energy at cell level	Cycles
			[Wh/kg]	[nb cycles]
NMC	Lithium nickel manganese cobalt oxide	graphite	140-200	2000+
NCA	Lithium nickel cobalt aliminum oxide	graphite	**200-250**	2000+
LMO	Lithium manganese oxide	graphite	100-140	1000-2000
LFP	Lithium iron phosphate	graphite	90-140	3000+
LFP-LTO	Lithium iron phosphate	Lithium titanate	≤ 80	**5000+**

Cathode is the most critical component
Several different critical materials contained ⇨ need for different processes for their recycling

Life cycle of batteries in a circular economy



Recycling: a complex process



Source: Elsevier "Lithium-ion batteries towards circular economy: A literature review of opportunities and issues of recycling treatments" and CESI elaborations

Comparison of different LIB recycling methods

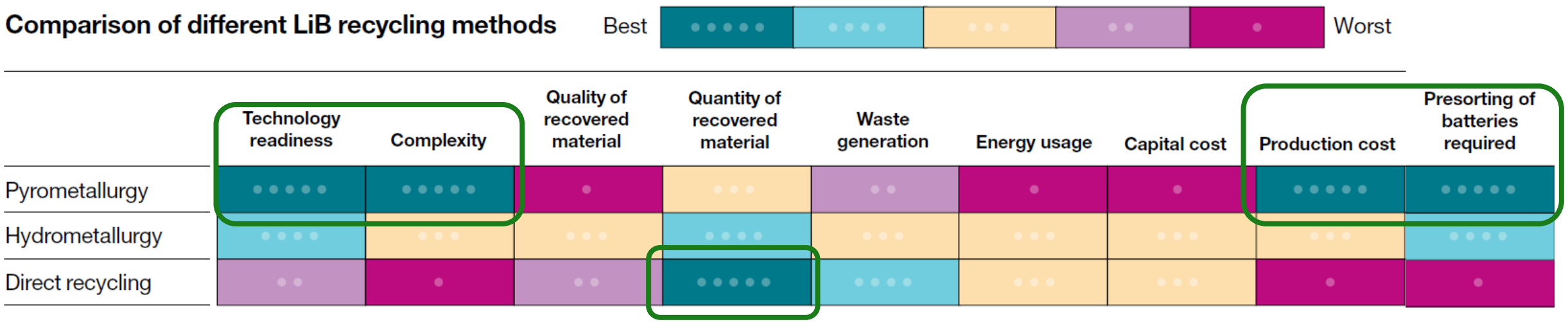
Current **challenges** in recycling processes:

- ✓ variability of input chemistries
- ✓ presence of impurities
- ✓ the safe handling of LIBs components due to electrolyte or Li atoms exposure
- ✓ scalability
- ✓ standardisation
- ✓ simplification of treatment steps
- ✓ new market developments…

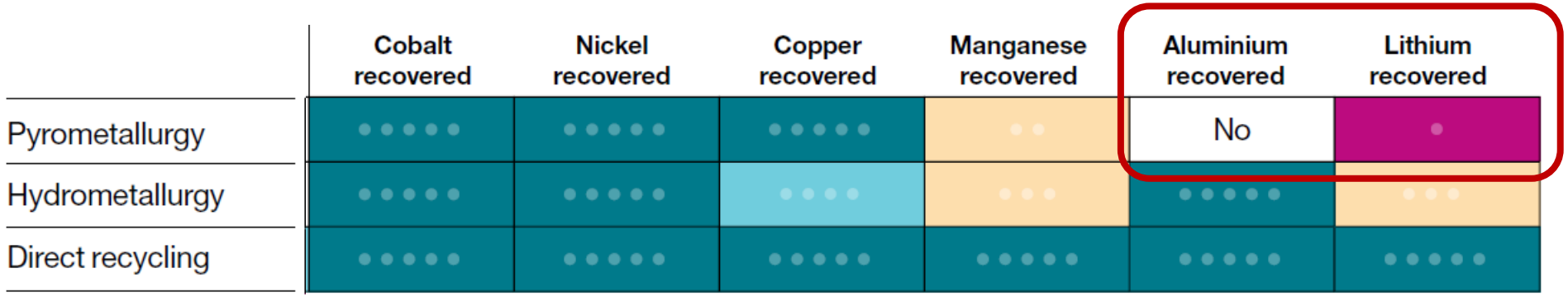
Need for flexible processes to quickly adapt to various and evolving technologies

Process	Pros	Cons
Pyrometallurgy	*- optimal technology readiness* *- easiness of procedure* *- generation of exothermic reaction reducing energy consumption*	*- high energy consumption* *- high capital costs* *- material loss in the slag* *- no recovery of Li and Al* *- process strongly dependent on LIBs chemistry*
Hydrometallurgy	*- good technology readiness* *- high recovery efficiency* *- high quantity of recovered material* *- moderate energy consumption* *- no gaseous emissions* *- recovery of all LIBs cathodic metals*	*- complexity of the process* *- production of wastewater in leaching and physical separation processes* *- selectivity of reagents* *- need of pre-treatment*
Direct recycling	*- advantageous for lower-value cathodes (e.g.: $LiMn_2O_4$, $LiFePO_4$)* *- all battery components recovered (except separators)*	*- technology so far focused on laptop and mobile phone batteries* *- process to be tailored to specific cathode formulation* *- evolving technology of batteries causing commercial reluctance to reuse materials*

Comparison of different LIB recycling methods



Materials recovered



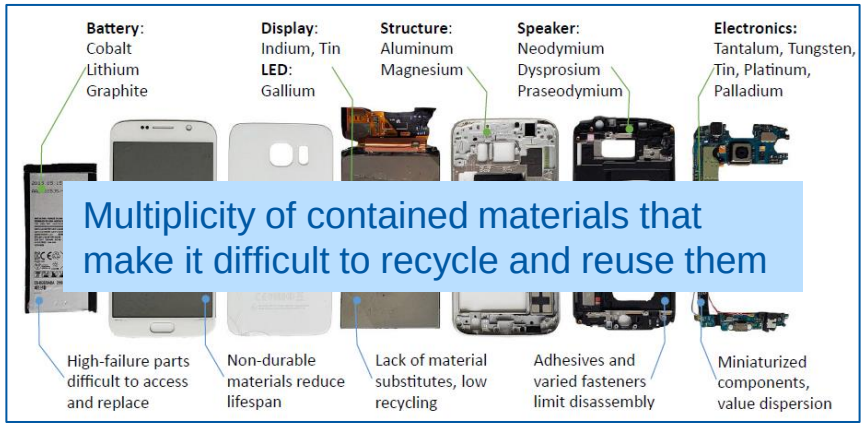
Source: https://doi.org/10.1038/s41586-019-1682-5

How to foster recycling in Circular Economy

Recycling is key to offset vulnerabilities arising from critical materials adopted in green technologies…

Measures:

- ✓ Labelling: complex mix of materials contained in batteries and other green technologies
  - QR codes
  - RFID tags
  - Standardisation of formats
  - Clear classification of inner hazardous components



Source: One Earth Perspective

- ✓ Design of components: reversible assembly

- ✓ R&D of recycling process aimed at reducing:
  - GHG emissions compared with primary production
  - Energy consumption

- ✓ Political driver: see the "European Green Deal's Circular Economy Action Plan"

…but without forgetting all possible solutions to ensure energy independency (**substitution**, **domestic production** and **green technologies** for extracting and processing raw materials)

Growing awareness on external vulnerabilities…

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06-MAG-2021
da pag. 1-24
foglio 1 / 2
Superficie 34 %

AGENZIA INTERNAZIONALE DELL'ENERGIA

«Fate scorte di litio e rame»

Sissi Bellomo —*a pag. 24*

L'Aie: obiettivi sul clima a rischio senza litio e rame, servono scorte strategiche

LE FIGARO
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La pénurie de minerais stratégiques menace

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Agir vite et ensemble

Green&Blue
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da pag. 29 / foglio 1
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Che vita sarebbe senza il neodimio?

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di Davide Madeddu
18 agosto 2021

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Miniere, tra Piemonte e Lazio parte la caccia a litio e cobalto

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Prometeia: metalli green, rialzo dei prezzi duraturo

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di Marcello Minenna
5 febbraio 2023

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di Beda Romano
12 gennaio 2023

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