

18th IAEE European Conference

Critical raw materials in green economy: possible solutions

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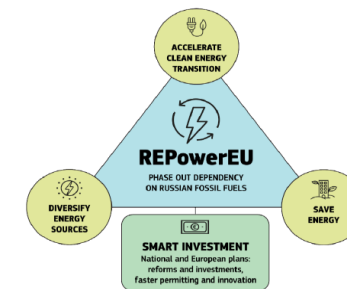
EU: between challenging goals and harsh reality

Despite the ambitious decarbonization targets...



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

- **96%** of crude oil imported
- **83%** of NG imported

✓ in 17 Member States the dependency on NG imports exceeds 90%

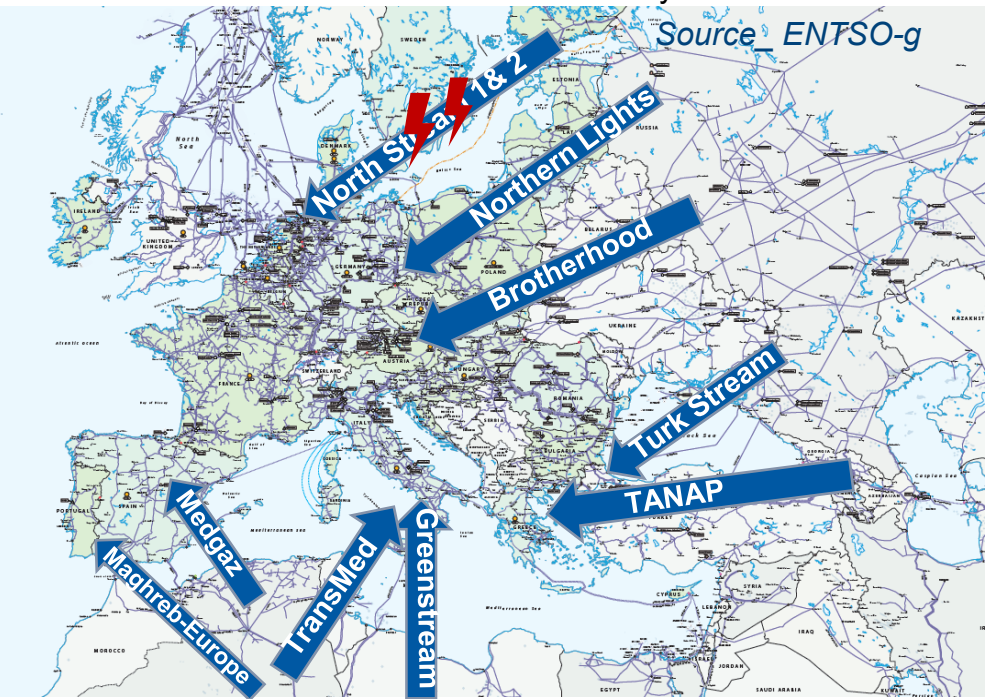
EU energy bill in 2022:
€ 834 billion

Italy

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

IT energy bill in 2022:
€ 140 billion

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



The energy transition implies a **geopolitical shift for energy sources**

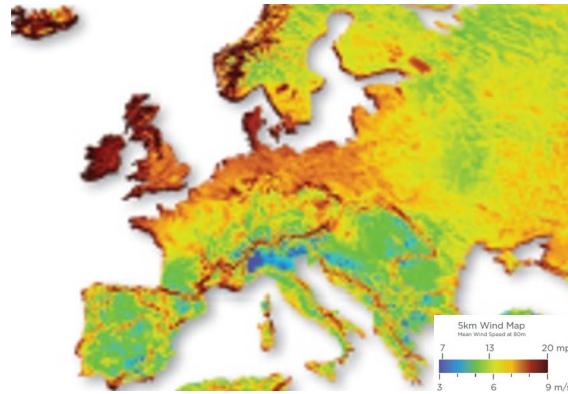
From imported Oil and Gas...

...to **exploitation of local RES**

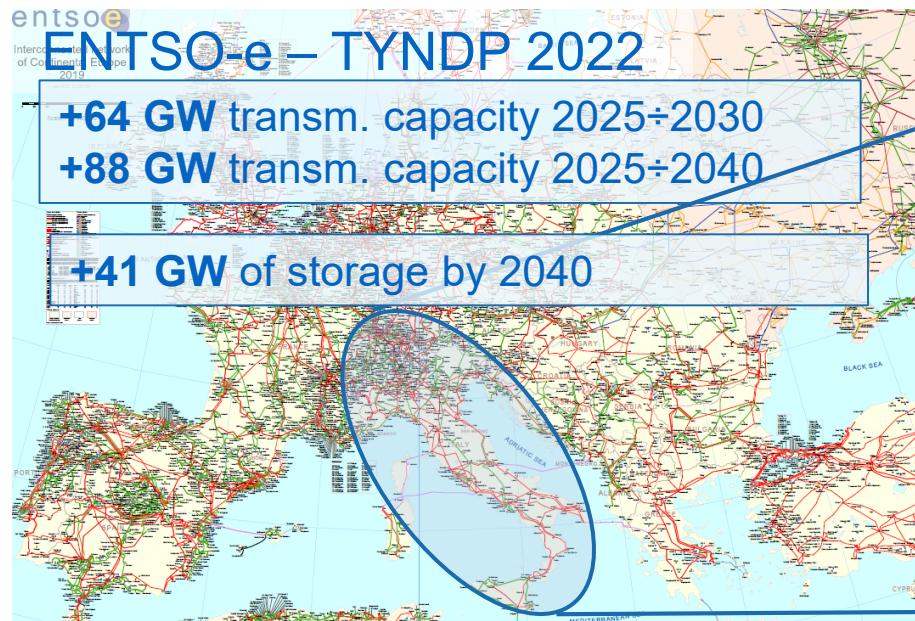
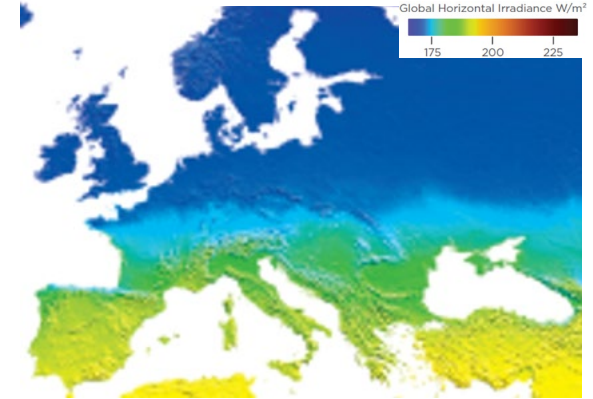


consequent growing effort in transmission capacity

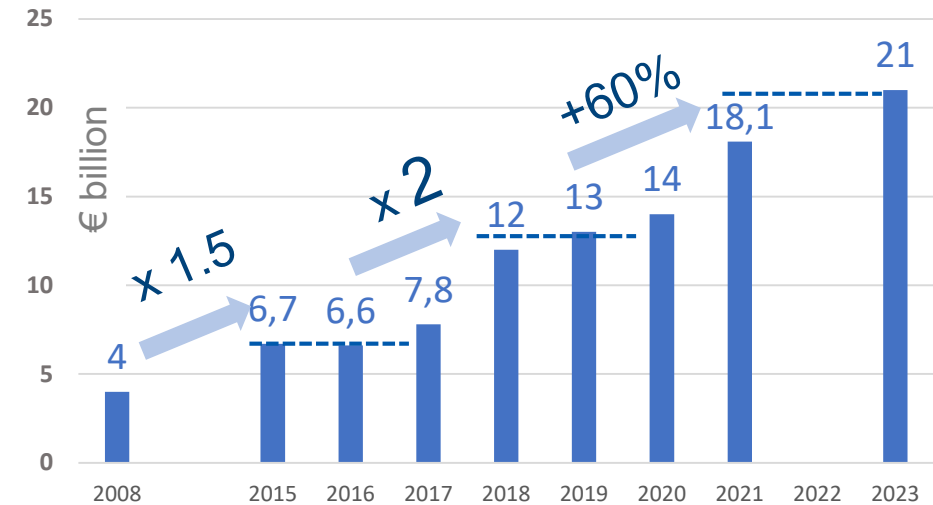
Wind producibility



Solar producibility



10-year National Development Plan

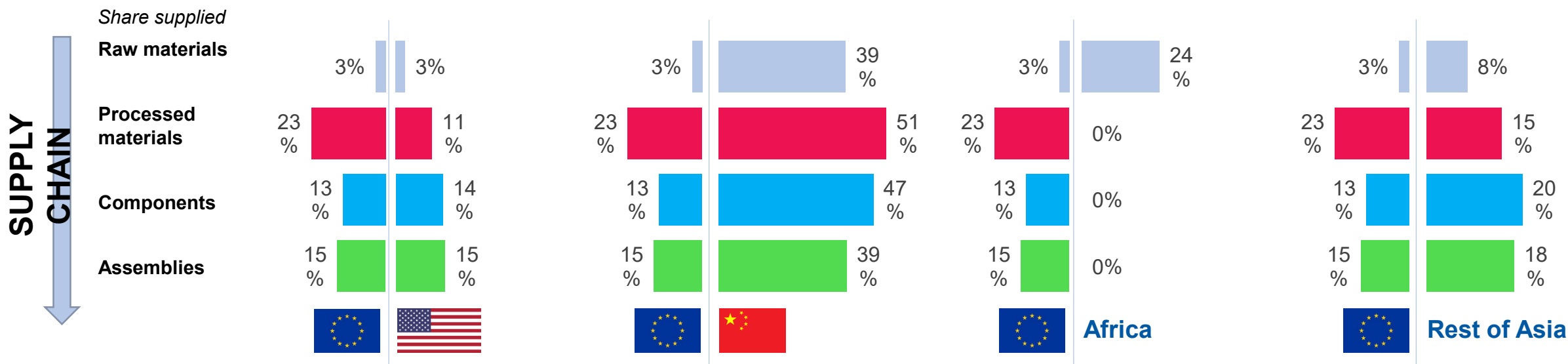
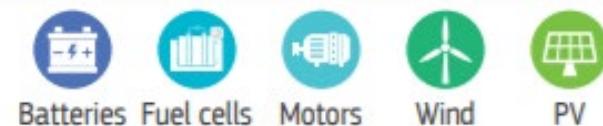


Infrastructural effort largely based on **critical raw materials**, notably **copper** and **bauxite**

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



Supply chain of Critical Raw Materials (1/2)

Material	Supply risk	Largest supplier to EU	
		Country	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

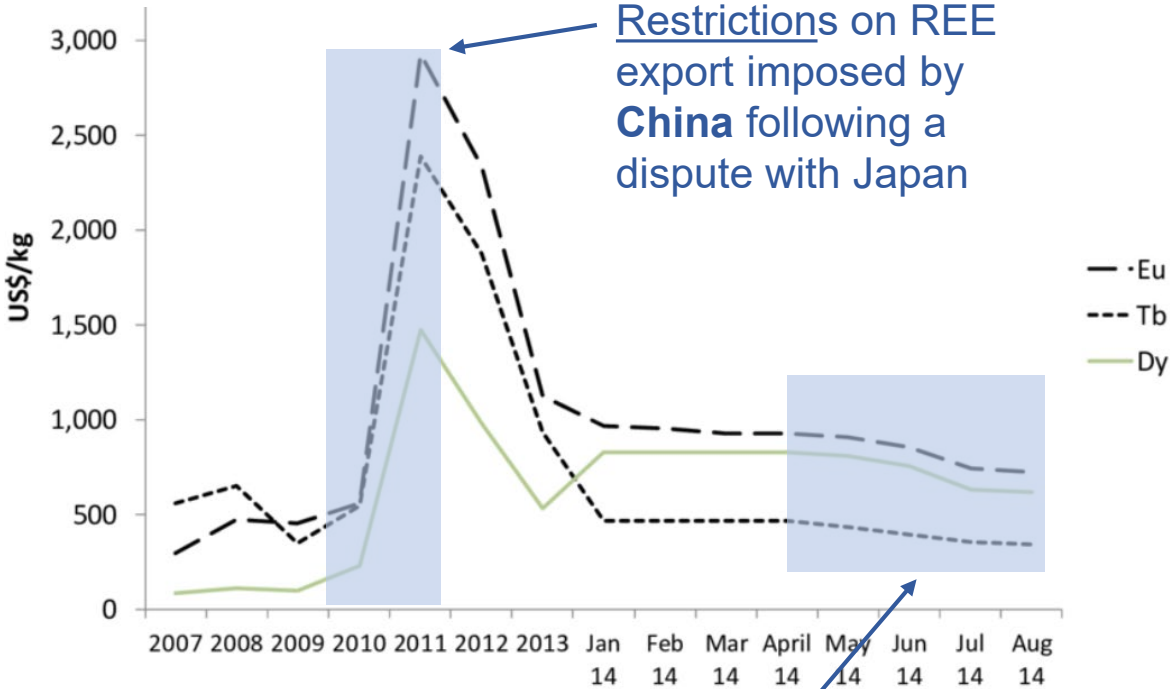
According to the new proposed EC Regulation (March 2023) as many as **34 materials were identified as critical**, i.e. more than twofold the critical materials (14) identified in 2011.

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)

Years 2010-2011



Source: ResearchGate

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

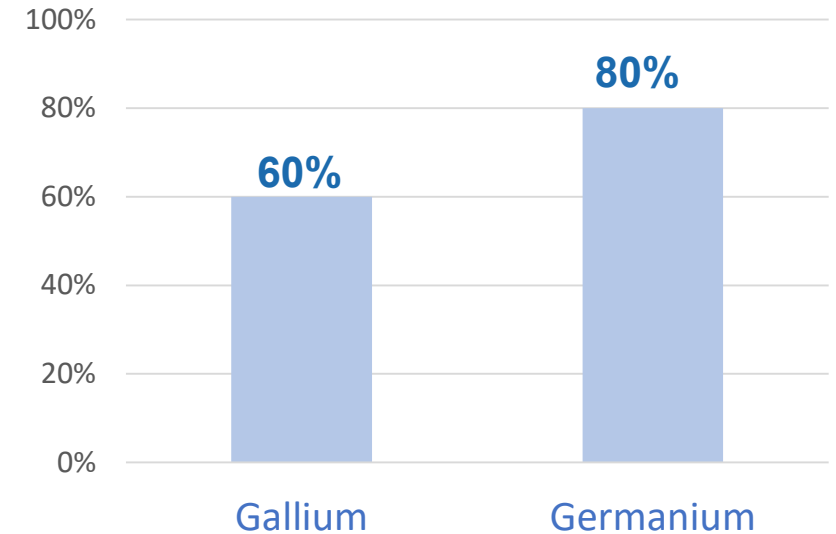
Ineffective reactions of **EU and USA** with claim at WTO

Reaction from **Japan**:

- ✓ Higher stocks of REE
- ✓ Diversification of import

Year 2023

China Global Production



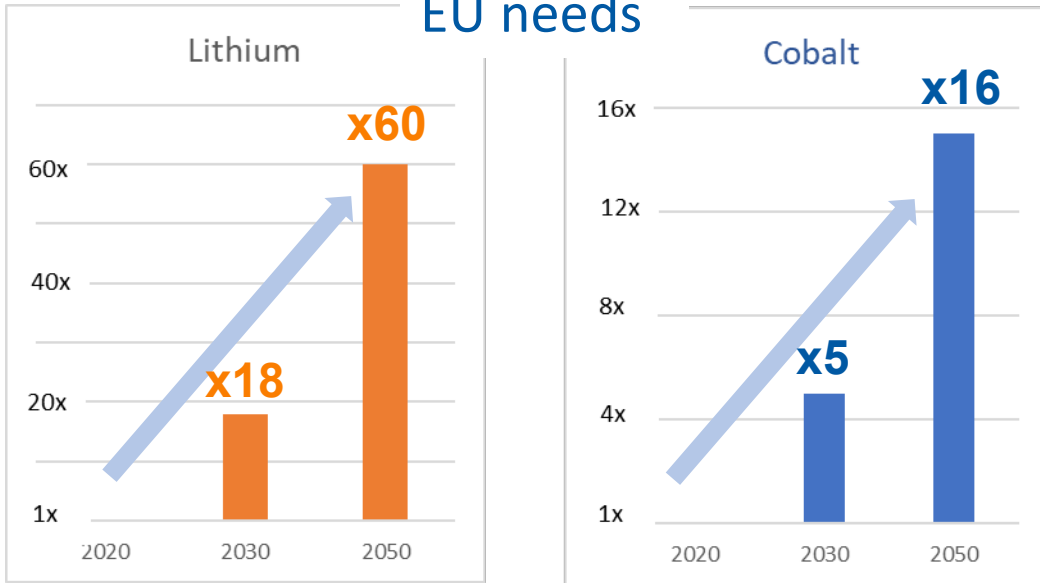
Source: Critical Raw Material Alliance

From 1st August 2023 selected restriction by China of strategic metals export, notably Gallium and Germanium to “safeguard national security and interest”

Further signal by **China** of a possible “weaponization” of CRM supply chain ?

Availability & Competition on Critical Raw Materials

EU needs



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

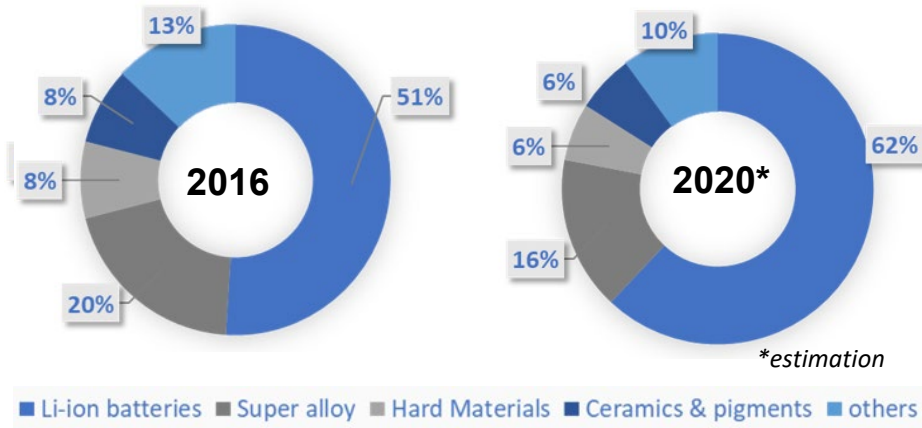
Competition with other sectors: only about **60%** of current Cobalt production is for Li-ion batteries

Lithium:

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

Cobalt:

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



Similar considerations apply to REE, especially to HREE

Source: Darton Commodities

Measures to mitigate risks

Political Initiatives

→ 1

Political measures

- EC proposal of a CRM regulation
- European Chips Act
- EU Battery Alliance

Technical Initiatives

2

Recycling

- Labelling
 - R&D
 - 2nd life
- Example: Tungsten
Northvolt, Umicore, Tesla
EV Batteries → stationary

3

Substitution

- Brushed electric motor
 - Cage rotors / new magnets
 - Low % cobalt
- BMW iX
Vestas / GreenSpur
Mercedes

4

New greener technologies

- Green lithium
- Bruchsal geoth. plant
Upper Rhine Basin
Po valley / Central Italy

5

Domestic production

- Batteries
 - Mining conversion
- EU Battery Alliance
EU Critical Raw Material Act

The political driver

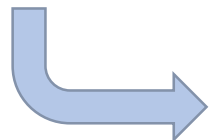
Proposal of a new regulation establishing a framework for “**ensuring a secure and sustainable supply of critical raw materials**” – March 2023

Updated list of:

- ✓ Strategic raw materials: **16**
- ✓ Critical raw materials: **34**

2030 targets for domestic capacities along the strategic raw material supply chain:

- ✓ At least **10%** of the EU's annual consumption for **extraction**,
- ✓ At least **40%** of the EU's annual consumption for **processing**,
- ✓ At least **15%** of the EU's annual consumption for **recycling**,
- ✓ **Not more than 65%** of the Union's annual consumption of each strategic raw material at any relevant stage of processing from a **single third country**



Technical initiatives, notably R&D, to translate these objectives into reality



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Complexity of recycling materials adopted in green technologies

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 aluminum 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

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

Comparison of different LIB recycling methods



	Technology readiness	Complexity	Quality of recovered material	Quantity of recovered material	Waste generation	Energy usage	Capital cost	Production cost	Presorting of batteries required
Pyrometallurgy
Hydrometallurgy
Direct recycling

Materials recovered

	Cobalt recovered	Nickel recovered	Copper recovered	Manganese recovered	Aluminium recovered	Lithium recovered
Pyrometallurgy	No
Hydrometallurgy
Direct recycling

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

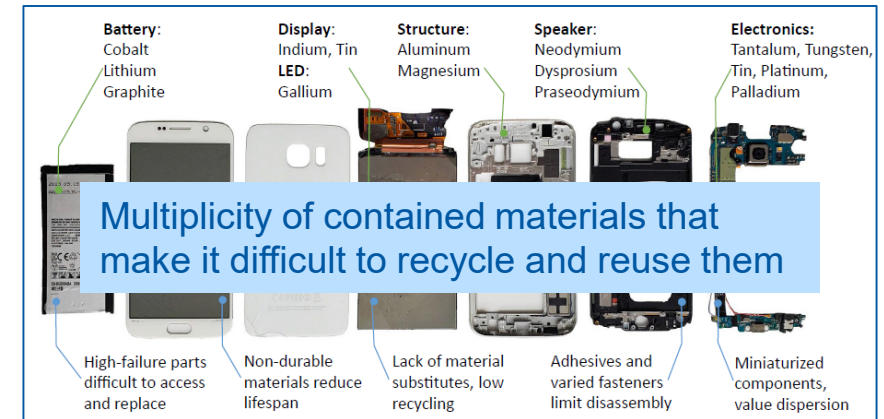
✓ **Design of components:** reversible assembly

✓ **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)



Source: One Earth Perspective

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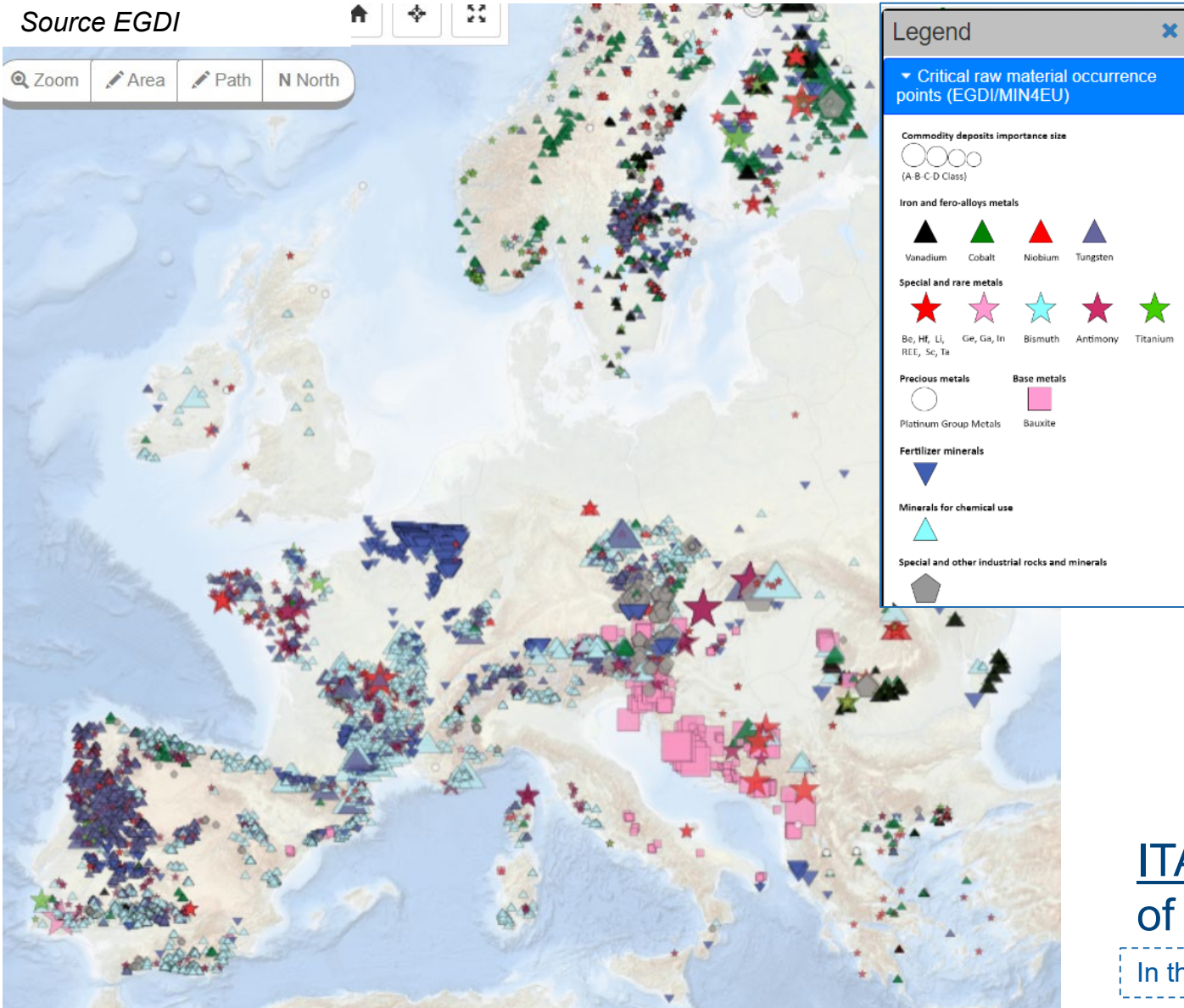
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EU Critical Raw Material Act

Europe has a fair amount of CRM potential



SWEDEN: announced the discovery of the greatest rare earth deposit in Europe



NORWAY: launched an ESIA for mining of minerals from the bottom of the sea

ITALY: the underground contains at least **15** out of 34 CRM

In the XVIII century the largest European Cobalt mine was in Piedmont

The obstacles: the social acceptance of mining activities

ITALY:

08-APR-2022
da pag. 1-3 / foglio 1 / 2

Il Sole **24 ORE**
Dir. Resp.: Fabio Tamburini
Tiratura: 81177 Diffusione: 137712 Lettori: 756000 (0004135)

Energia. In arrivo 42 bocciature di diritti di ricerca su 45 nuovi impianti
Le applicazioni delle regole Pitesai colpiscono anche i 108 siti già in funzione

Produzione nazionale. Delle 123 concessioni minerarie, di cui 108 relative al gas, oltre il 70% con le nuove norme ricade in aree definite «non idonee»

SWEDEN:

Analisi | **Materie prime**

Terre rare trovate in Svezia, perché l'entusiasmo rischia di essere prematuro

Stoccolma esulta per la nuova scoperta, ma perché porti frutti serviranno esplorazioni, verifiche e autorizzazioni

Awareness of the EUROPEAN COMMISSION who in the CRM regulation recognizes the need for...

Continued efforts are needed to address concerns related to **public awareness and acceptance.** Efficient and comprehensive public consultation processes and transparent and constant communication with those concerned, including with Indigenous Peoples and with the public at large when applicable, can contribute to addressing these challenges.

EC COM(2023) 165 final

Concluding remarks

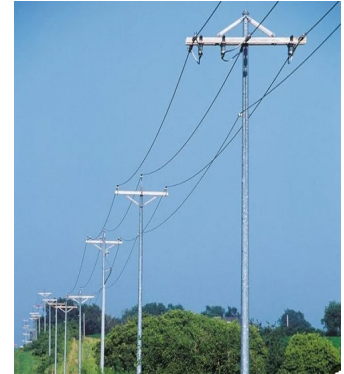
✓ **Reskilling**: need for re-creating adequate skills in the mining sector

✓ **Sustainability indicators** for each component of green technologies including conventional equipment

carbon footprint considering the whole supply chain
➔



Timber poles
VS
steel tubular
poles



✓ **Monitoring** of green technologies and related needs for metals, especially CRM

➔ Italy: OICME (Italian Observatory of Critical Materials for Energy) initiative launched in Rome last June 2023



Un'iniziativa



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Knowledge Partner 2023



Further reading on CRM: CESI Energy Journal, issue: May 2022 (www.cesi.it/energy-journal)



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