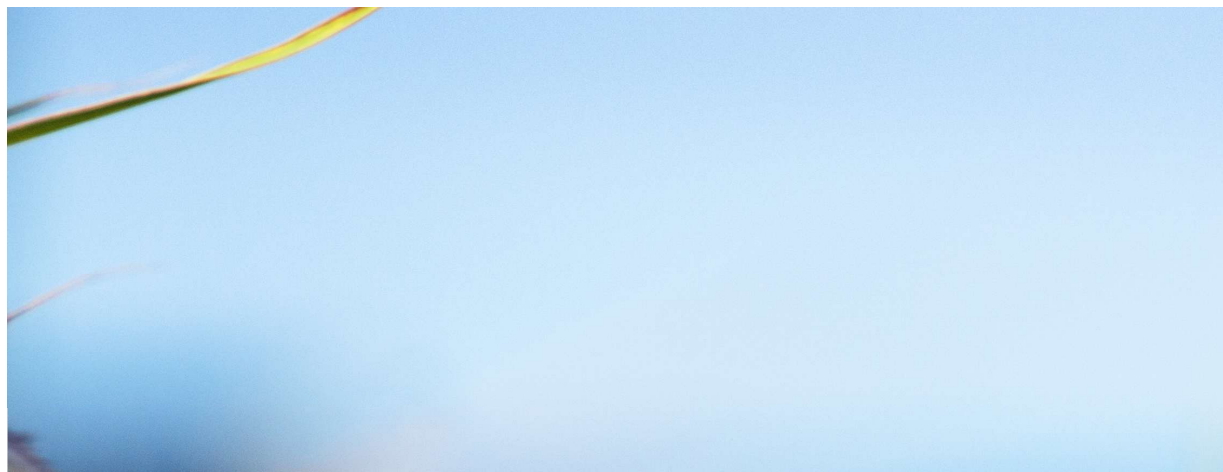




Circular Economy Challenges for Batteries and Electrical & Electronic Waste

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Fusionsolar

**Energy Storage Safety and Grid Stability
Summit 2025**



Circular economy = essential for sustainability

- The traditional linear economy (take → make → dispose) leads to massive waste and resource depletion.
- A circular economy focuses on keeping materials and products in use as long as possible through reuse, repair, remanufacture, and recycling.*
- Sustainability depends on this shift because:
 - Natural resources are finite.
 - Environmental damage from extraction and waste is accelerating (climate change, pollution).
 - Circular systems reduce carbon footprint, preserve biodiversity, and cut down pollution.
- No circular economy = no true sustainability.

**EU Circular Economy Action Plan*

Batteries and electronics = critical, fast-growing waste streams

- Batteries (especially lithium-ion) are booming due to:
 - Electric vehicles (EVs)
 - Renewable energy storage
 - Portable electronics
- Electronics are produced and discarded at an unprecedented pace:
 - Global e-waste reached over 53 million tonnes in 2020, projected to reach 75+ million tonnes by 2030.
 - Devices have short life cycles and are often difficult to repair.

These waste streams are "critical" because:

- They contain valuable critical raw materials (lithium, cobalt, gold, rare earths).
- They are also toxic if improperly disposed of (lead, mercury, cadmium, etc.).
- Currently, less than 20% of e-waste is properly recycled worldwide.

**European Environment Agency, UNDP*

81 countries

have adopted e-waste policy, legislation or regulation.

67 countries

have legal provisions on EPR for e-waste.

36 countries

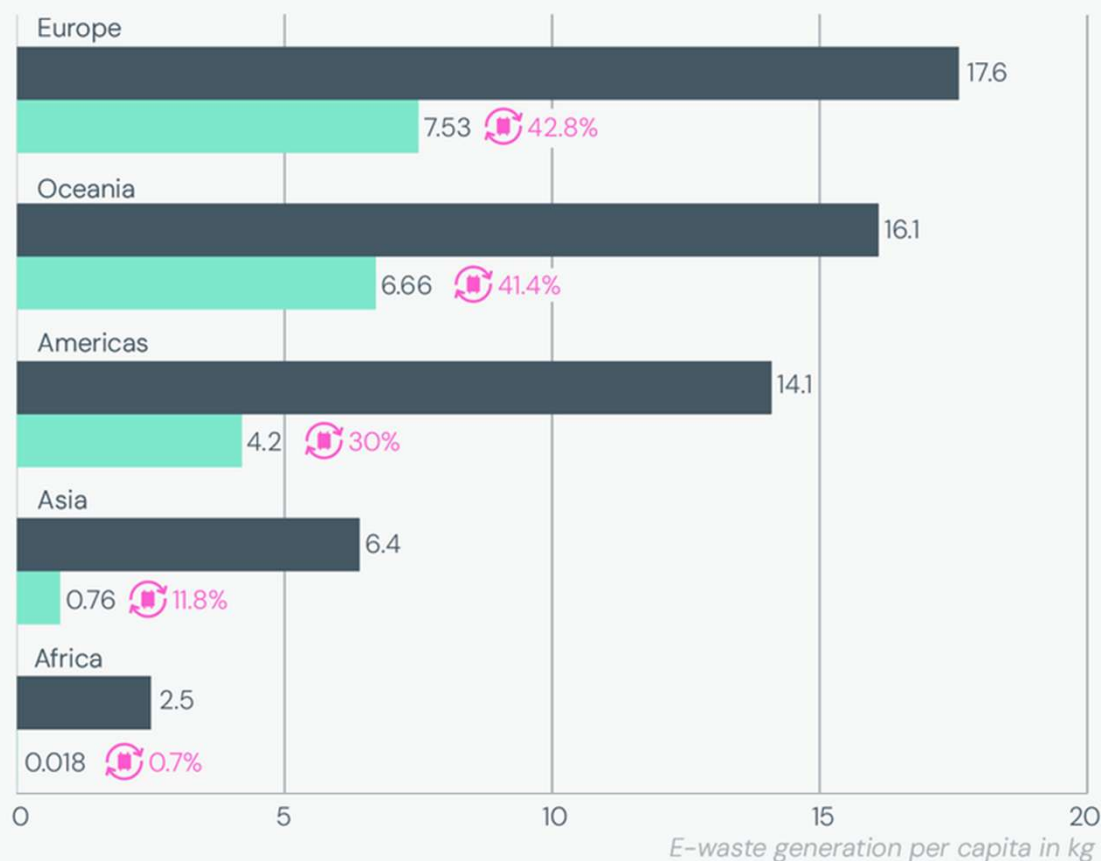
have provisions on e-waste recycling rate targets.

46 countries

have provisions on e-waste collection rate targets.

Source: The Global E-waste Monitor 2024

Amount of E-waste Generated and Collected



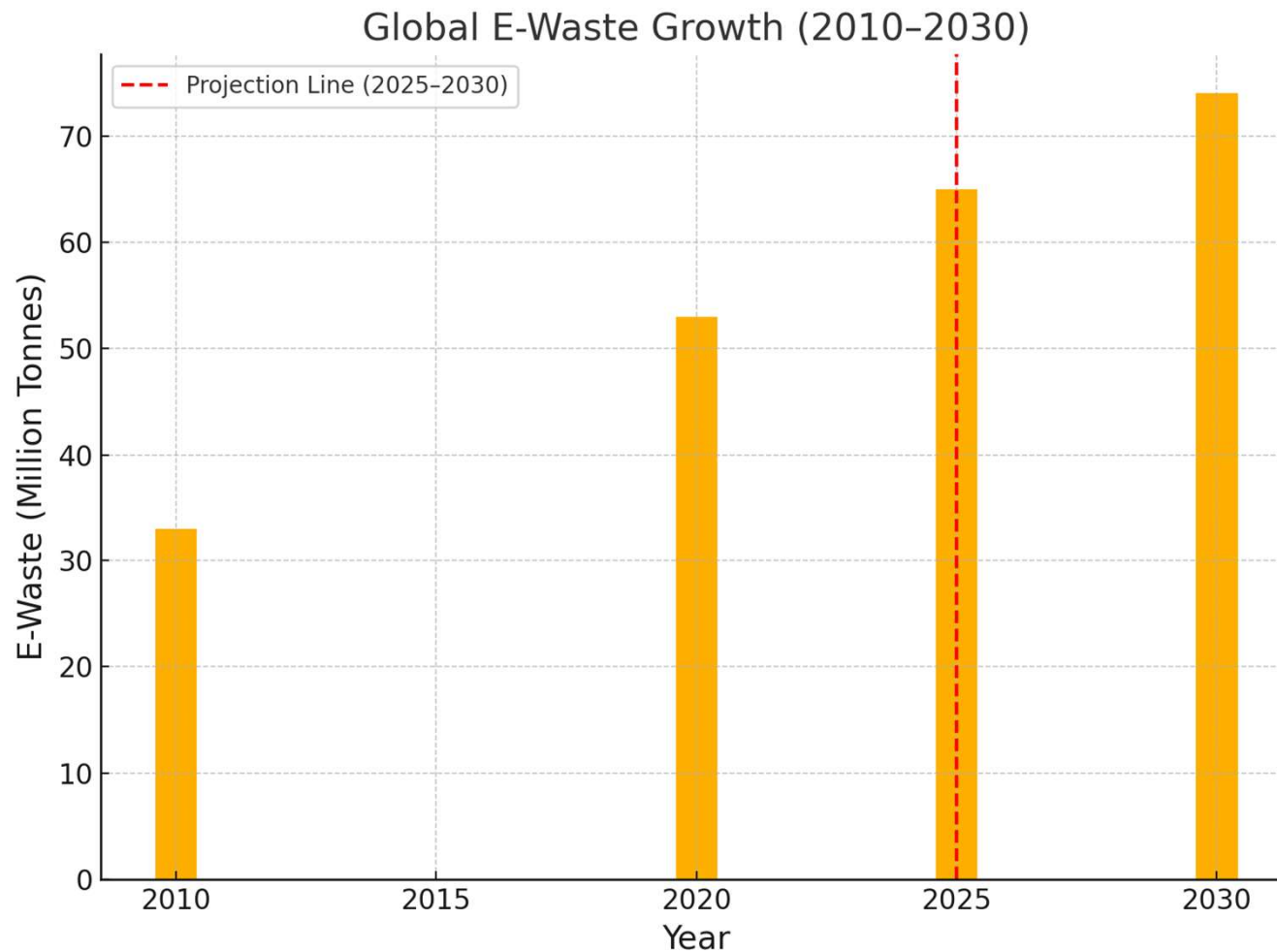
■ E-waste generated per capita in kg ■ E-waste documented to be collected and recycled per capita in kg
 🔄 Annual average formal collection and recycling rate

Minor inconsistencies may have occurred due to rounding of values during the calculations.

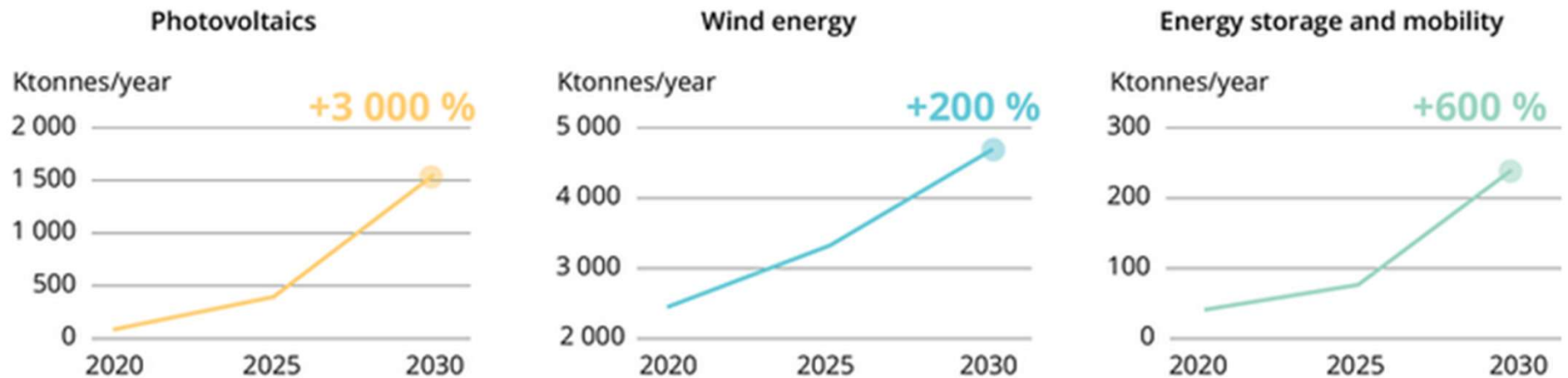
Source: The Global E-waste Monitor 2024

2022

Global E-Waste Growth (2010-2030) projection

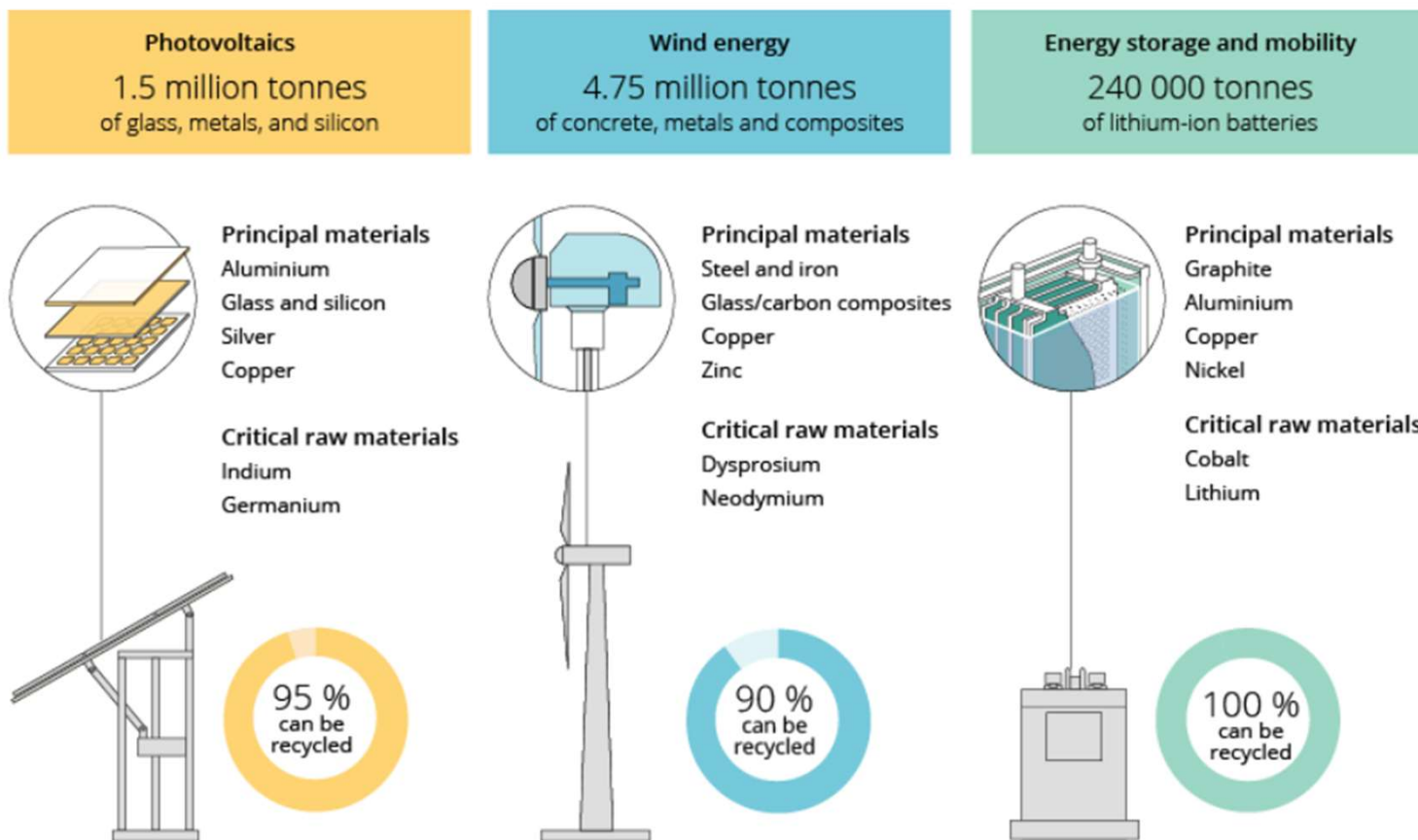


Expected growth of waste materials generated by the clean-energy infrastructure



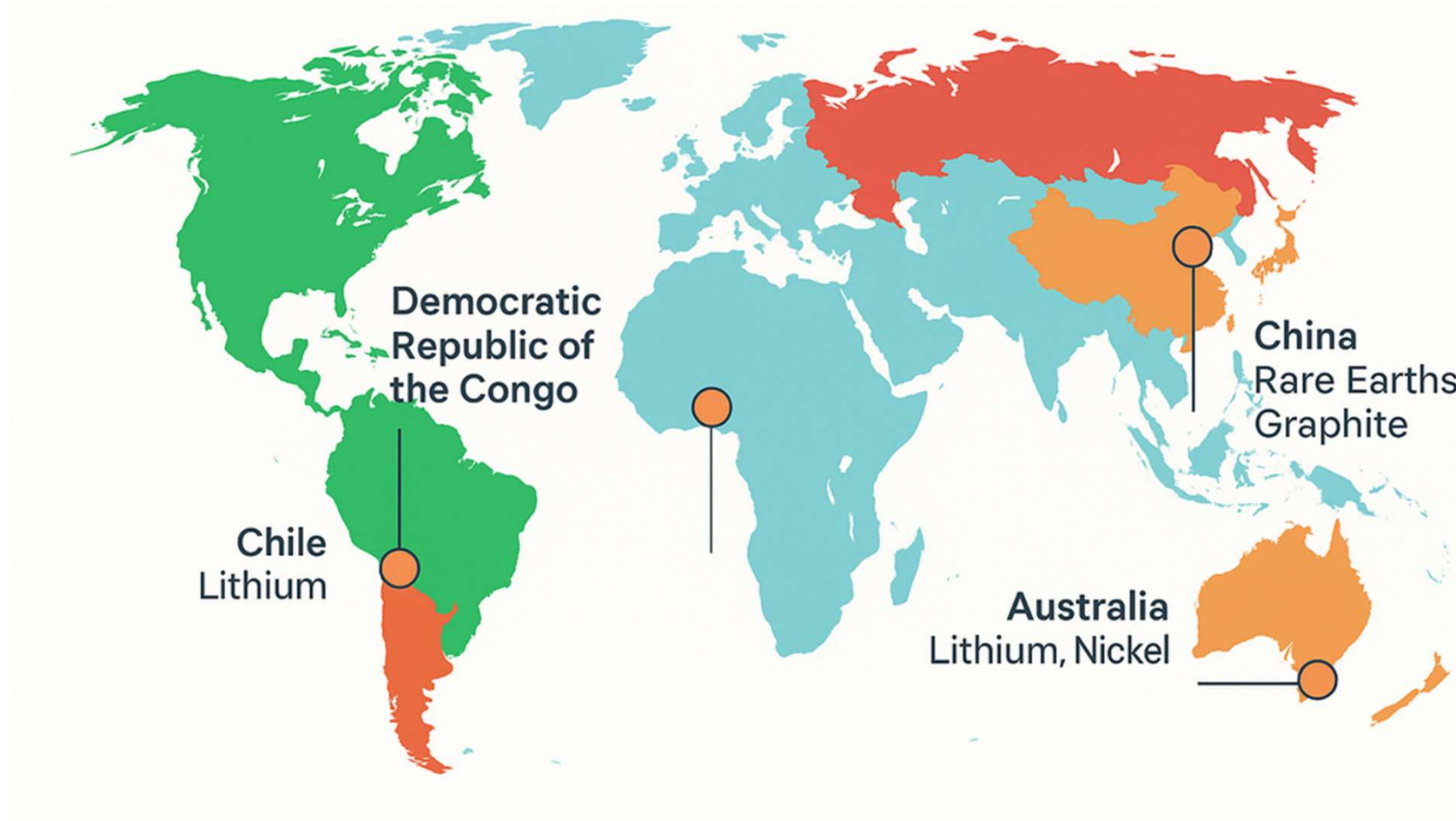
Photovoltaics – Carrara et al. (2020); IRENA (2020), Wind energy – Carrara et al. (2020); IRENA (2020), Energy Storage & Mobility – Stahl et al. (2021), adapted from [Emerging waste streams – Challenges and opportunities](#).

Material recovery opportunities arising annually from the clean-energy sector by 2030



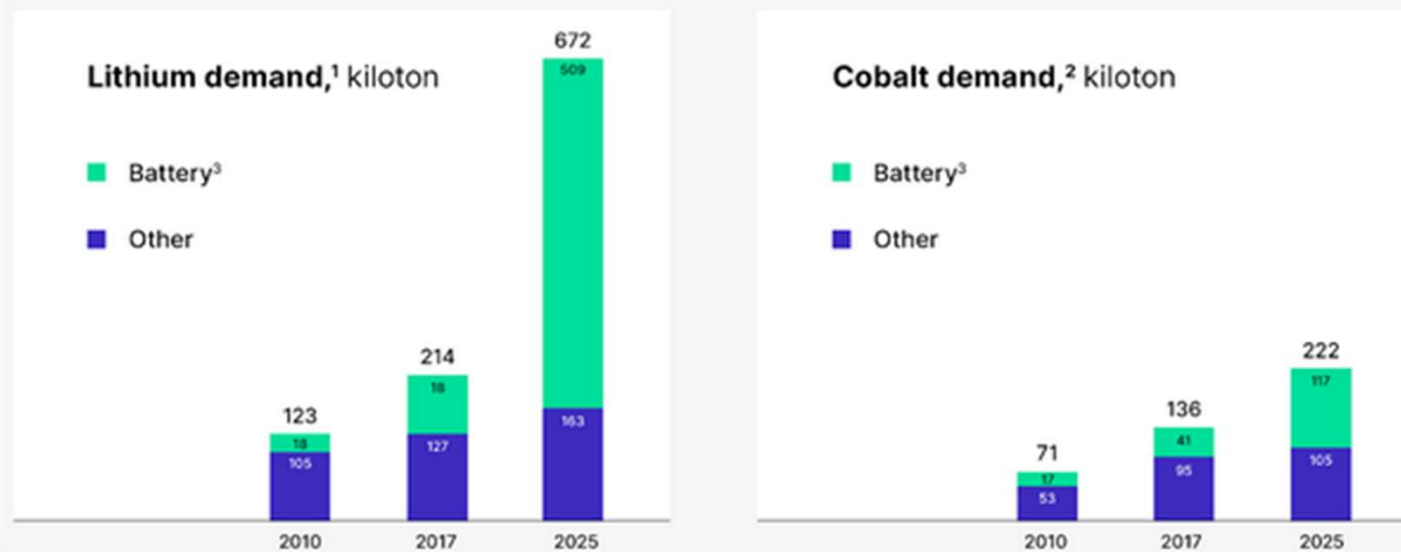
Source: EEA

Key Mining Locations for Battery Materials



Projected demand for lithium and cobalt in the battery industry

Demand for lithium and cobalt will continue to evolve



Source: <https://www.circularise.com/blogs/eu-battery-passport-regulation-requirements>

REGULATION (EU) 2023/1542 concerning batteries and waste batteries

- Regulation (EU) 2023/1542 establishes a comprehensive legal framework for the sustainability, safety, and circular economy of all types of batteries placed on the EU market.
- It sets strict requirements across the entire battery life cycle — from design, production, and labelling, to collection, recycling, and reuse. It introduces mandatory recycled material content, a digital "battery passport" for tracking, due diligence rules on sourcing raw materials, and ambitious collection and recycling targets.
- The regulation applies to batteries for portable use, electric vehicles (EVs), industrial use, and energy storage, ensuring they are safer, longer-lasting, and more environmentally sustainable.
- Its ultimate goal is to reduce environmental and social impacts, promote circular economy practices, and strengthen the EU's strategic autonomy in battery supply chains.

EV BATTERY

Circularise Battery Passport

Battery ID: 0xe2...DB05



200 kg



Batch Traceability



ACCESS VIA **SMART QUESTIONING**

Required information



Battery type



Durability



Battery model



Performance

Additional information



Product Name



GHG Emissions



Manufacturing Site



Declaration of conformity



Recycled content



Hazardous substances



End of life collection information



Certifications



Battery health



Supply chain due diligence policy

Chain of custody



09/07/2022, 10:00

Battery serviced

06/10/2021, 08:10

[Car] sold to consumer

20/09/2021, 15:26

Battery build into [car]

08/09/2021, 14:55

Battery sold to [automotive OEM]

Scan for a
**Battery
Passport**



Digital Product Passports by CIRCULARISE

The battery passport as an enabler for sustainable and transparent supply chains



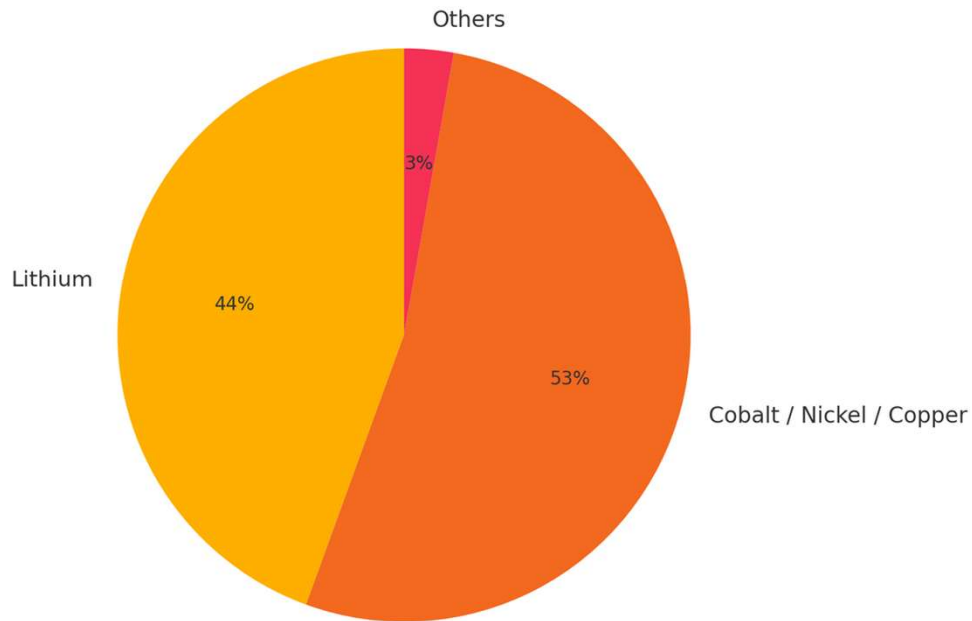
What information will need to be included in the battery passport?

The battery passport must contain information on the following:

- Identification of the battery in the form of a unique identifier.
- Basic characteristics of the battery including type and model.
- Statistics on performance and durability must be updated over the battery lifecycle by parties conducting repair or repurposing of the battery.
- Carbon footprint specific to the manufacturing site and batch of batteries.
- Technical documentation on the electrochemical performance and durability of the battery must be provided, including details on how this data was obtained. This is to ensure the batteries meet the minimum requirements for battery performance and capacity in order to guarantee batteries on the market are operational and efficient over a sufficient lifetime.

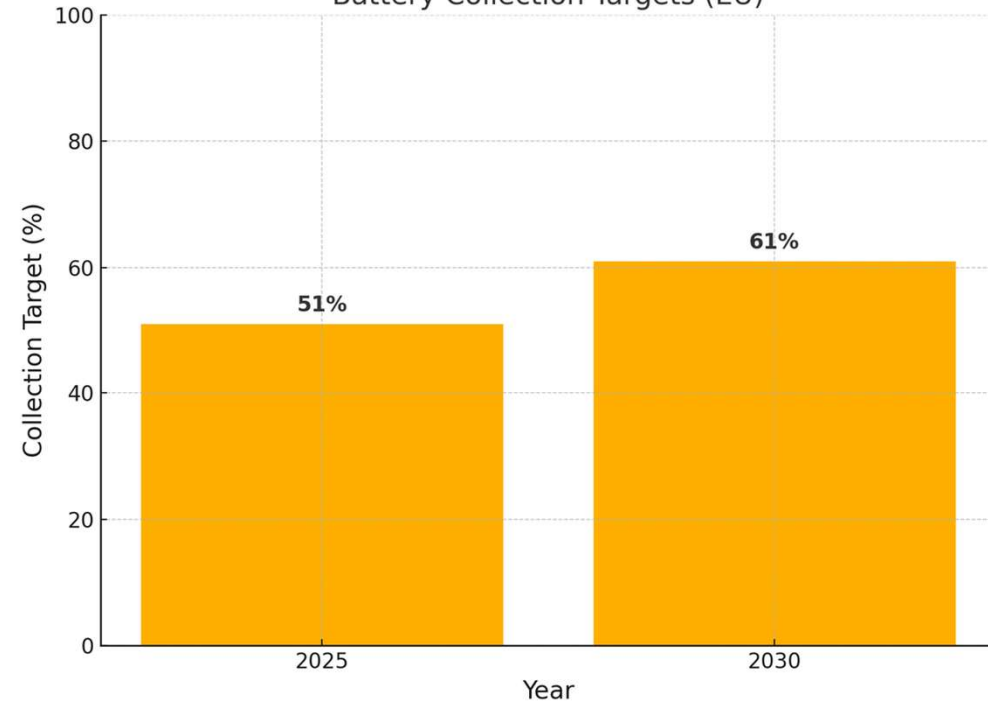
Material Recovery Targets from Batteries (EU 2030)

Material Recovery Targets from Batteries (EU 2030)



Battery Collection Targets (EU 2030)

Battery Collection Targets (EU)



Opportunities and challenges for selected energy technologies

Photovoltaic (PV)	
Opportunities	■ 95 % of the materials can be recycled (e.g. glass, copper, aluminium, etc.)
Challenges	■ Key challenges in PV recycling, both in economic and technological terms, are the delamination, separation and purification of the silicon from the glass and the semiconductor thin film. ■ Other challenges for recycling of PV modules come from the presence of hazardous substances such as cadmium, arsenic, lead, antimony, polyvinyl fluoride and polyvinylidene fluoride. ■ Difficulties also arise due to access issues for working on panels installed at height, which is often not anticipated at the design stage of PV systems.

*European Environment Agency

Opportunities and challenges for selected energy technologies

Energy storage	
Opportunities	▪ All metals used in batteries can be recycled. Cobalt and nickel could be valuable enough to make recycling profitable, depending on price levels and the amounts recoverable within batteries. ▪ Increased circularity can be supported through modular/standardised design to promote remanufacturing; and enhanced information about the content of high impact materials.
Challenges	▪ There is a variety of different battery designs requiring specific and different logistics approaches. ▪ The infrastructure to transport and store the growing number of waste batteries is deficient and needs to be built up to cope with predicted future high volumes of EoL batteries. ▪ Currently, there is also a lack of battery recycling technologies and large-scale recycling capacities in Europe. ▪ Economic efficiency of battery recycling can be difficult to achieve, due to fluctuating material values. ▪ Measures to reduce safety risks of a "thermal runaway" during logistics and reprocessing are expensive.

Battery recycling falls under the **Extended Producer Responsibility (EPR)**, according to European and national legislation.

What does **Extended Producer Responsibility** for batteries mean?

- **EU Regulation 2023/1542** on batteries and accumulators (and its amendments) stipulates that **battery producers are responsible for the collection, recycling and environmentally sound management of their waste.**
- **This means that companies that manufacture or import batteries into the market are required to:**
 - ✓ **Organise or finance collection and recycling schemes**
 - ✓ **Ensure that batteries are not disposed of in common waste**
 - ✓ **Comply with collection and recycling rates** set by legislation
 - ✓ **Inform consumers** about the correct disposal and recycling of batteries

Battery recycling clearly falls under the Extended Producer Responsibility, and companies that place **batteries** on the market have a **legal obligation** to contribute to their proper management.   

Notes: Cyprus



The only licensed collective system is for household batteries weighing up to two kilograms, and no individual system is licensed.

It is recommended* to assess the need for promoting the licensing of collective or individual systems, or the expansion of the existing system, for the management of WEEE (Waste Electrical and Electronic Equipment) weighing more than two kilograms, in order to ensure that the management of all types of WEEE complies with national and EU legislation.

Obligation to register in the Registry

- Producers* register themselves or through the collective system representing them.
- The Minister may impose a registration fee.

**"Producer" means producer' means any manufacturer, importer or distributor or other natural or legal person that, irrespective of the selling technique used, including by means of distance contracts, either:*

- Manufacture or design batteries under your own name or trademark within an EU Member State.
- Resell batteries under your own name or trademark, even if made by another manufacturer (their name does not appear).
- Import and supply batteries for the first time professionally from another EU country or a third country.
- Sell batteries directly to end-users across borders via distance contracts (e.g., online sales), even if based in another EU country or outside the EU.

ΑΡΜΟΔΙΑ ΑΡΧΗ
Για επίσημη χρήση μόνο

Αρ. Μητρώου:
Ημερομηνία Λήψης:

ΚΥΠΡΙΑΚΗ



ΔΗΜΟΚΡΑΤΙΑ

ΑΙΤΗΣΗ¹ ΓΙΑ ΕΓΓΡΑΦΗ² ΣΤΑ ΜΗΤΡΩΟ ΠΑΡΑΓΩΓΩΝ

ΑΠΟΒΛΗΤΩΝ ΗΛΕΚΤΡΙΚΩΝ ΣΤΗΛΩΝ ΚΑΙ ΣΥΣΣΩΡΕΥΤΩΝ

Σύμφωνα με
τον Κανονισμό 18(2) των Περί Αποβλήτων
(Απόβλητα Ηλεκτρικών Στηλών ή Συσσωρευτών)
Κανονισμών του 2009 και 2012 (Κ.Δ.Π. 125/2009, Κ.Δ.Π. 79/2012 & Κ.Δ.Π. 56/2016)

Για τη συμπλήρωση της αίτησης δίνονται οδηγίες στη σελίδα 5

ΣΗΜΕΙΩΣΤΕ ✓ ΟΠΟΥ ΕΦΑΡΜΟΖΕΤΑΙ

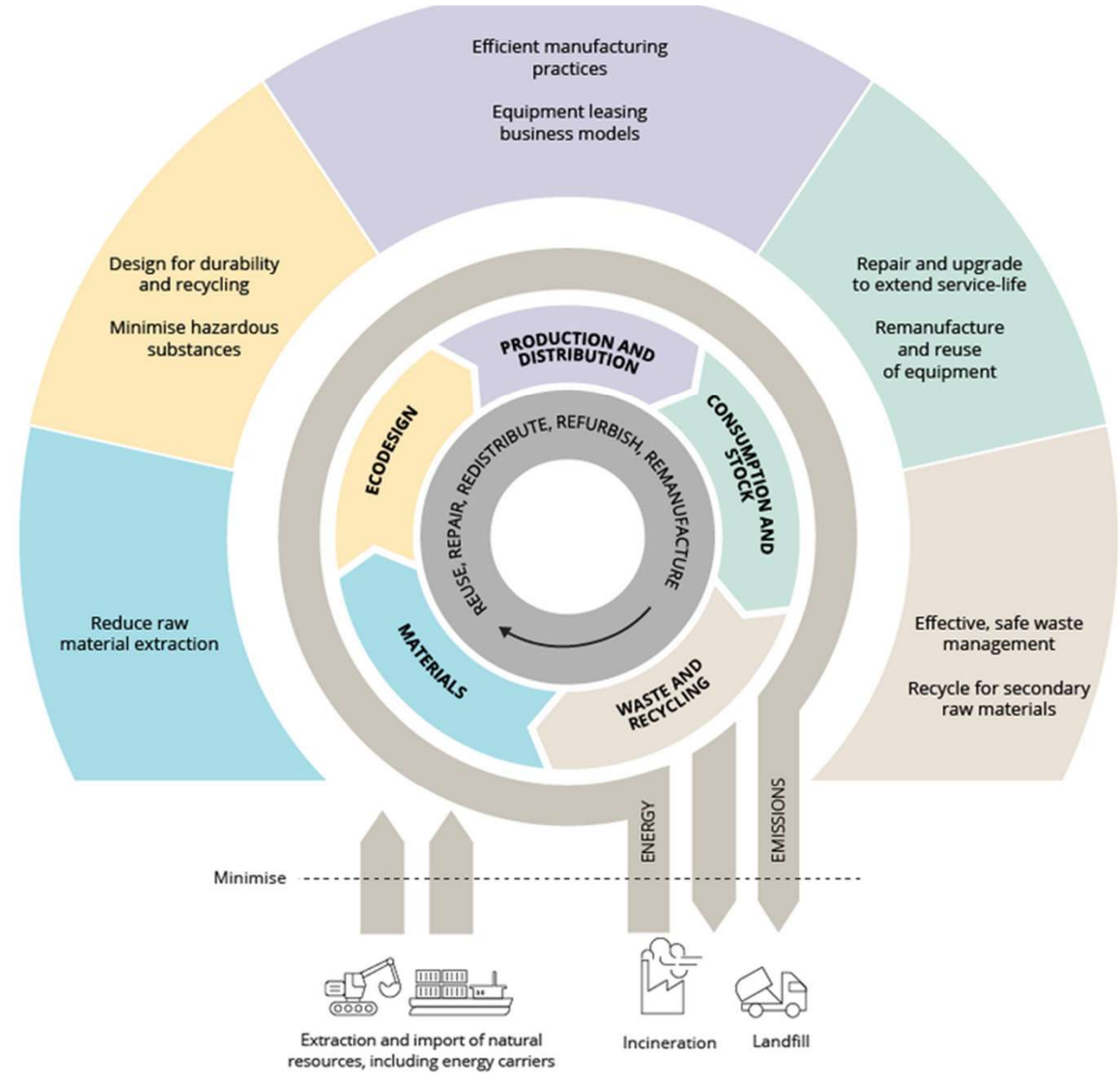
ΠΑΡΑΓΩΓΟΣ³ Ο ΟΠΟΙΟΣ

- ☐ διαθέτει για πρώτη φορά στην Κυπριακή Δημοκρατία ηλεκτρικές στήλες ή/και συσσωρευτές
- ☐ διαθέτει για πρώτη φορά στην Κυπριακή Δημοκρατία ηλεκτρικές στήλες ή/και συσσωρευτές ενσωματωμένες σε ηλεκτρικό ή ηλεκτρονικό εξοπλισμό
- ☐ διαθέτει για πρώτη φορά στην Κυπριακή Δημοκρατία ηλεκτρικές στήλες ή/και συσσωρευτές ενσωματωμένες σε οχήματα μεταφοράς

Νέα Εγγραφή ☐

Ανανέωση Εγγραφής ☐

Circular clean-energy system



Source: EEA

*European Environment Agency

Urgent need for better solutions

Existing systems for recycling and reusing batteries/electronics are fragmented, inefficient, and underdeveloped.

Without improvement:

- Resource scarcity will worsen.
- Environmental pollution will rise.
- Opportunities for economic growth via circular business models will be lost.

Better solutions include:

- Eco-design (products easier to repair/recycle).
- Advanced recycling technologies (e.g., hydrometallurgy for lithium).
- Policy measures (e.g., Extended Producer Responsibility, mandatory recycling targets).
- Consumer behaviour changes (repair culture, longer product use).



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Together we can be better!**

