The Advanced Rechargeable & Lithium Batteries Association

Battery-relevant resource management regulation

A new circular economy approach for advanced rechargeable batteries

About RECHARGE

RECHARGE is a non-profit association representing the multifold interests of the **advanced rechargeable and lithium battery industry** in Europe.

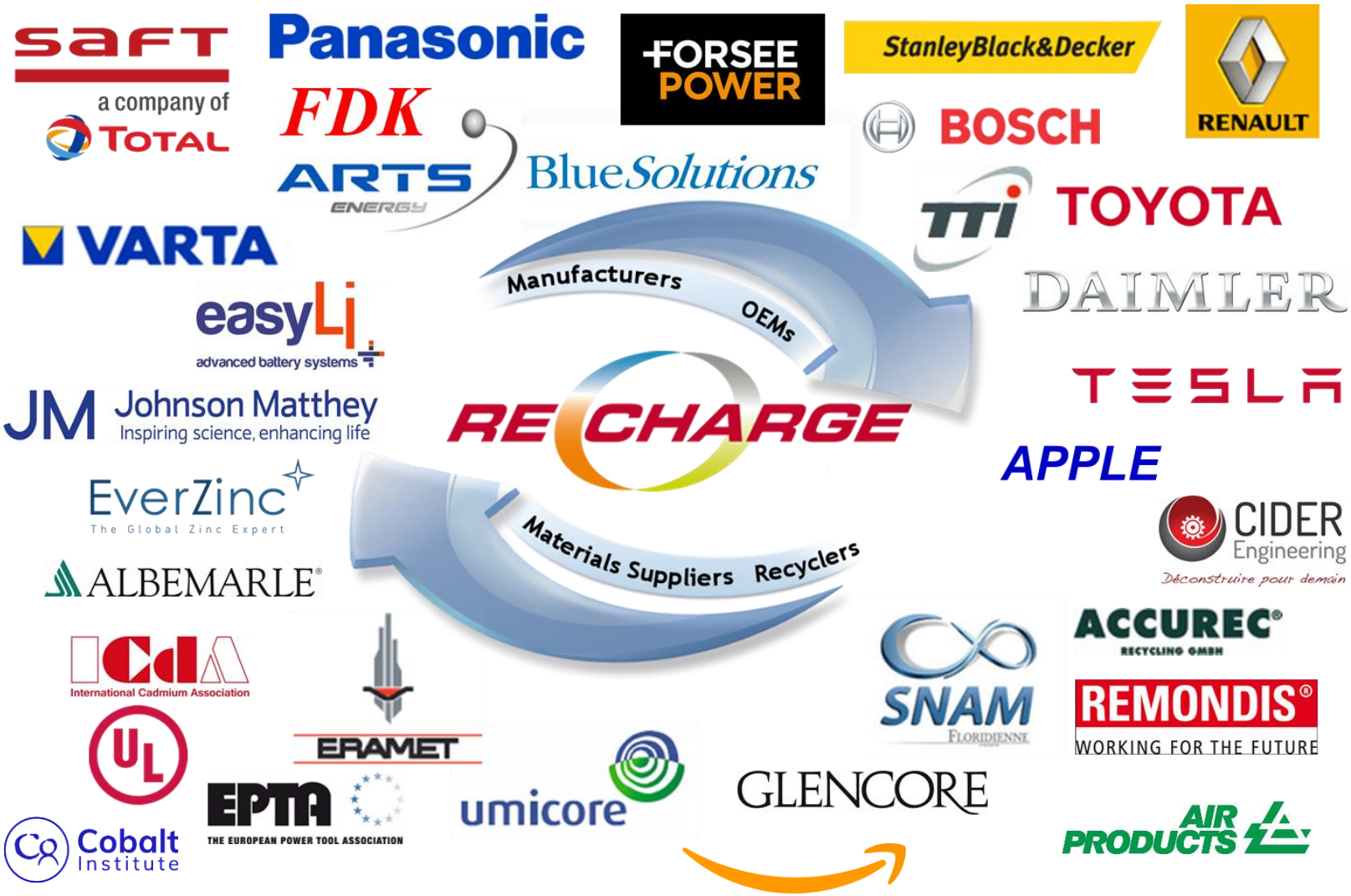
Founded in 1998, it is our mission to **promote** advanced rechargeable batteries as a technology that will **contribute** to a more sustainable society, a resource and energy efficient policy and to the achievement of a green circular economy.

Our Goal

To act on our mission, we put all our efforts in improving the advanced rechargeable and lithium batteries industry acceptance in Europe.

To do so, it is our goal to ensure an **international level playing field** that provides continued market access for new and existing products while promoting:

- **Environmental-friendly** design, manufacturing and end-of-life management,
- Sustainable involvement of the European battery industry in **waste management, recycling targets** and **best practices,**
- **Safe manufacturing, usage, storage** and **transport** of batteries.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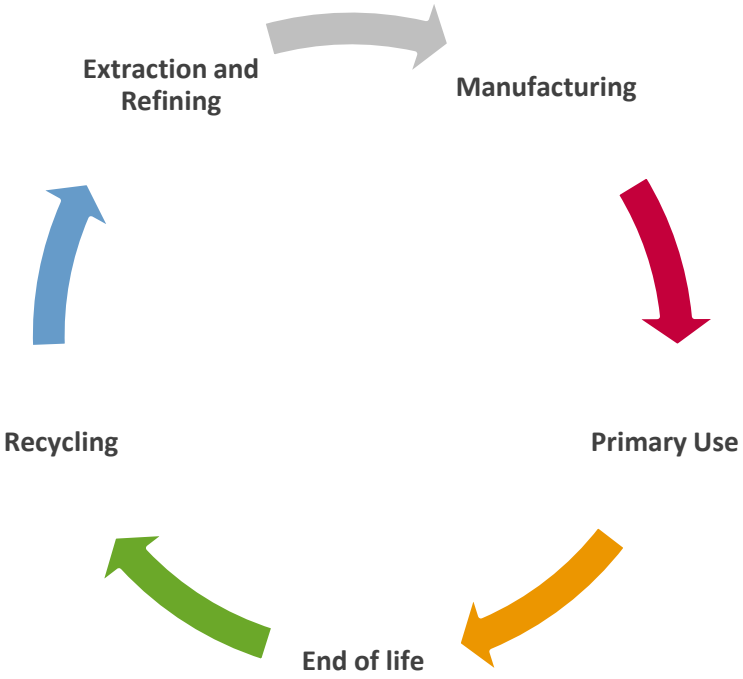
Dissipation Concept in the Battery Industry



Circular Economy

EFFICIENT USE OF RESOURCES THROUGH RECYCLING

Circularity in the battery industry: The Battery Directive

The Battery Directive 2006/66/EC regulates the appropriate treatment of end-of-life batteries:

- Battery Producers (EU-based manufacturers or importers) are required to ensure a closed-loop approach for the batteries they bring onto the European market.
- The Battery Directive, amongst others, fixes targets for collection and recycling activities to improve the environmental performance of batteries throughout their lifecycle.
- The Battery Directive, hence, is pivotal to resource management in the battery industry.

Currently, the Battery Directive is subject to a draft proposal for a legal revision.

With the goal of driving circularity in the batteries industry and to act as a thought leader on technical, social and environmental matters, RECHARGE is looking into alternative concepts for resource efficiency.

Why recycle batteries anyhow?

Advanced rechargeable and lithium batteries are at the heart of the EU's strategy for a climate-neutral future:

- they power zero-emission electric vehicles, mobile communication devices and portable power tools, and
- contribute to a smooth functioning of a decarbonized, renewables-based energy generation infrastructure.

Undoubtably, advanced rechargeable batteries are a strategic imperative for the industrial and social revolution towards a more empowered, sustainable and circular Europe.

Ensuring materials availability – both through primary raw materials supply and recovery - is hence critical to meeting the steadily increasing demand for advanced rechargeable batteries, today but especially in the future.

Which materials are commonly used in advanced rechargeable batteries?

Antimony

Aluminium (foils)

Cadmium

Cobalt

Copper

Graphite/Carbon

Iron

Lead

Nickel

Phosphate

Potassium

Sodium

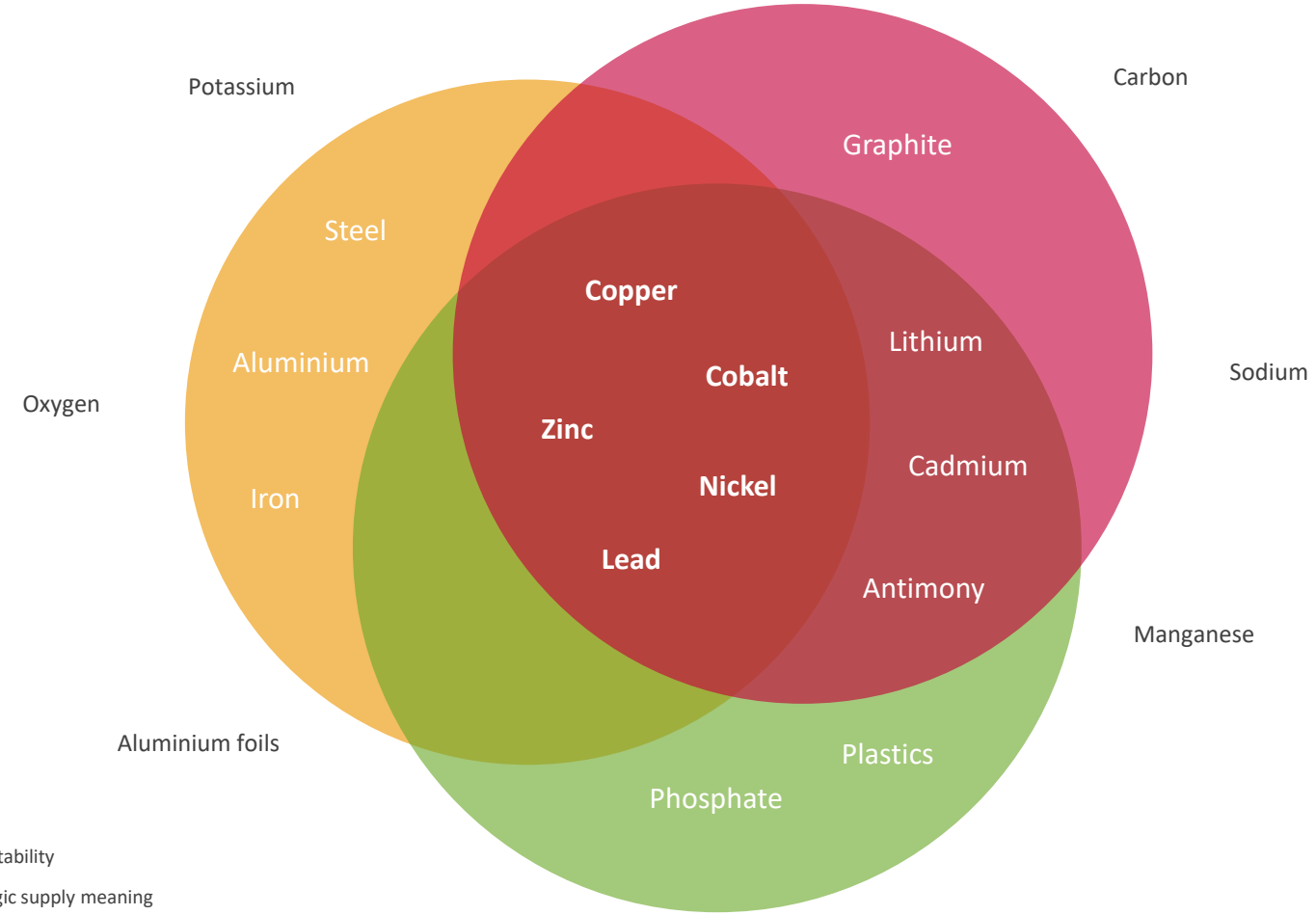
Steel

Zinc

Manganese

Lithium

…and which materials matter for battery recycling?



Which regulatory push can help improve resource efficiency in the battery[1] industry?

Recycle materials based on their weight	The current recycling efficiency target for batteries (Battery Directive 2006/66/EC) focuses on the relative importance of materials based on their weight. Today's recycling targets[2]: • 50% for lithium-ion batteries • 65% for lead-acid batteries • 75% for nickel-cadmium batteries
Recycle materials based on their classification as critical raw materials (CRM)	An alternative to defining which materials matter most for recycling, is to look at the Critical Raw Material list of the European Union. Batteries contain the following CRM-classified materials: • Cobalt • Antimony • Graphite • Fluorine • Phosphate • LREEs
Recycle materials based on their ADP	ADP (Abiotic Depletion Potential) identifies the abundance factor of a material based on its natural availability and extraction rate (= transfer of material from bio- to technosphere). ADP is a scientific model, introduced by the United Nations Environment Program/SETAC life cycle initiative and used by, amongst others, the EU's Joint Research Center.
Recycle battery-relevant materials with a high environmental and strategic impact	Based on a combined scientific model - applying the ADP, the use of materials in the battery industry and their circular availability (recycling efficiency/loss of materials) - it can be identified which materials are most relevant to the battery industry and have a significant impact on the environment and today's and tomorrow's material supply. Recycling, hence, these materials best improves the resource efficiency in the battery industry.

[1]: recycling-related regulatory push
[2]: by output weight

Which regulatory push can help improve resource efficiency in the battery[1] industry?

Recycle materials based on their weight	A recycling efficiency based on weight does not provide any qualitative indication and brings no added value to the environmental profile of a battery - nor the EU's raw material strategy. Merely increasing the recycling efficiency target will not increase recycling quality. Vague end-of-waste criteria add an additional negative factor to the current recycling efficiency.
Recycle materials based on their classification as critical raw materials	While batteries contain CRM-classified materials, the use of some of them in batteries is so low that the impact of recovering these materials is marginal compared to other industry sectors → the battery industry cannot contribute to improving their resource efficiency. Also, by concentrating the recycling efficiency on pre-defined materials, technological advancements in the batteries industry may be prevented. In addition, recycling graphite from batteries is a highly energy-intensive process with a negative impact on the environmental profile of a battery. Recycling of fluorine is already a technically and economically viable solution that does not require any regulatory push anymore.
Recycle materials based on their ADP	ADP allocates an 'abundance factor' but does not take into consideration material losses during the recycling phase. ADP, hence, does not provide any indication for recycling quality and, consequently, for resource efficiency.
Recycle battery-relevant materials with a high environmental and strategic impact	This science-based resource efficiency calculation is long-term oriented, process- and technology neutral and combines parameters of ADP and CRM. By defining the environmental and strategic impact of each material used in a battery, it is the most holistic approach to making a difference to resource efficiency by the battery industry too.

[1]: recycling-related regulatory push

Battery-relevant resource management regulation

THE RECHARGE CONCEPT

The RECHARGE concept

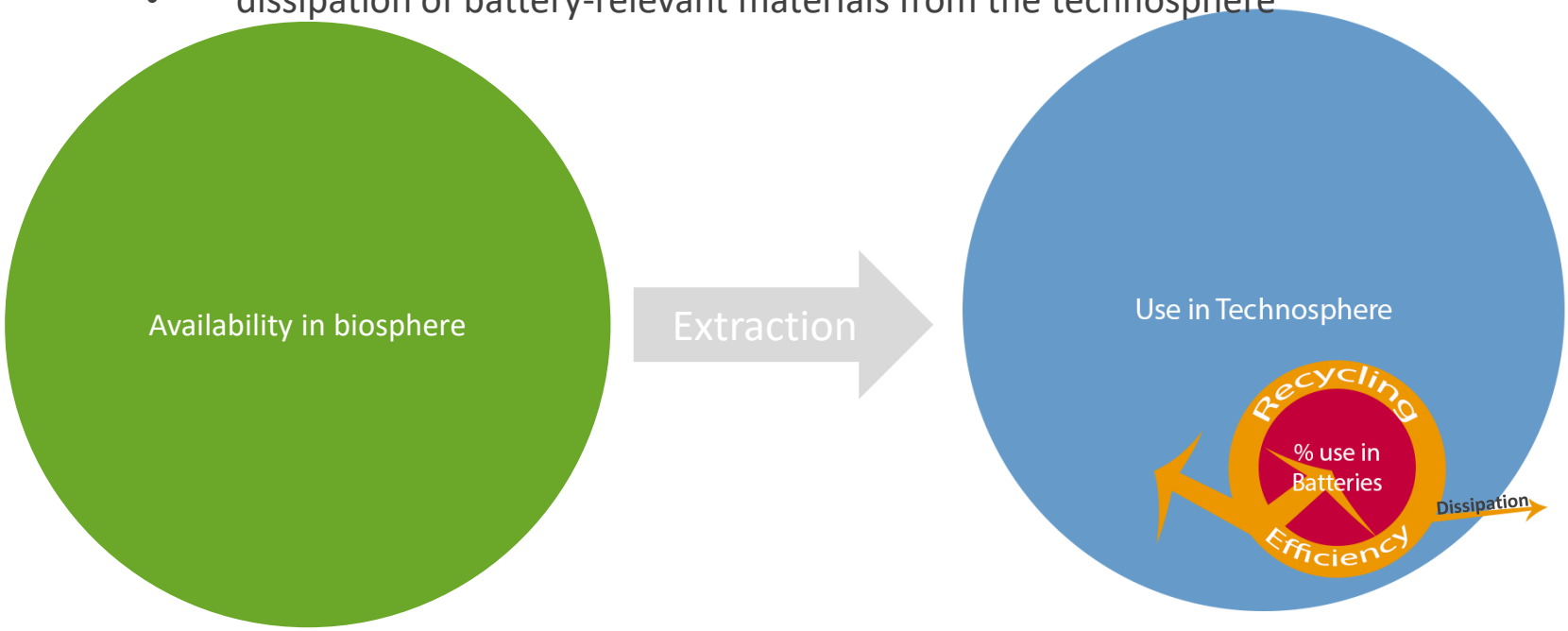
RECHARGE promotes a regulatory push for recycling materials:

- that **matter most** in the battery industry
- bring the **highest added value** to the environmental profile of batteries
- and have the highest **strategic impact on the future development of the European battery industry**

RECHARGE also supports continuity for already existing recycling processes for other materials used in batteries but that do not require a regulatory push anymore (e.g. marketability already high).

The RECHARGE concept – Step by Step

1. Identify materials that are relevant for recycling in the battery industry, based on:
   - availability of battery-relevant materials to the technosphere and
   - dissipation of battery-relevant materials from the technosphere



The RECHARGE concept – Step by Step

2. Calculate the new recycling efficiency for a battery:

Allocate to each material a characterization factor (CFi) representing the resource usage

$$CFi = ADPi \times Batt\%i$$

Calculate the recycling efficiency based on the sum of all incoming and recycled battery-relevant materials ($RE\sum i_B$)

$$RE\sum i_B = \frac{\sum(weight\ of\ recycled\ material\ i\ x\ CFi)}{\sum(weight\ of\ input\ material\ i\ x\ CFi)}$$

Mathematical principles:

- For batteries, the only moment of potential dissipation is during recycling
- Collection objective is 100%; the recycling efficiency can only be calculated based on the actual input stream; recycling efficiency cannot be calculated for waste streams that do not enter the recycling phase

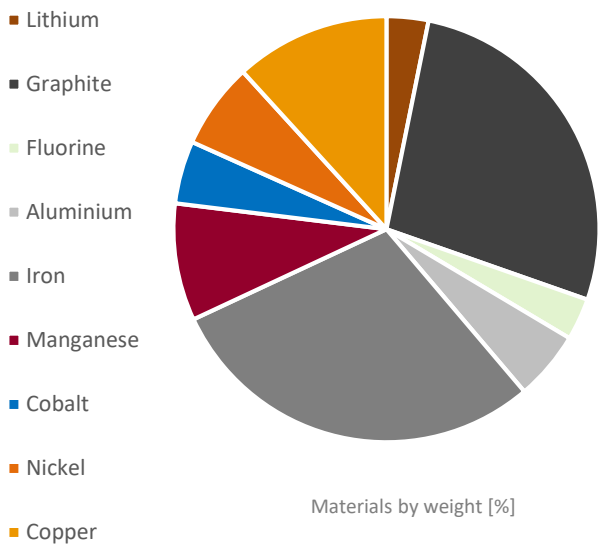
The RECHARGE concept

The recycling efficiency approach proposed by RECHARGE implies a shift from currently **weight in kg** to **weight in impact**. Impact includes current and future relevance, as well as environmental and supply meaning.

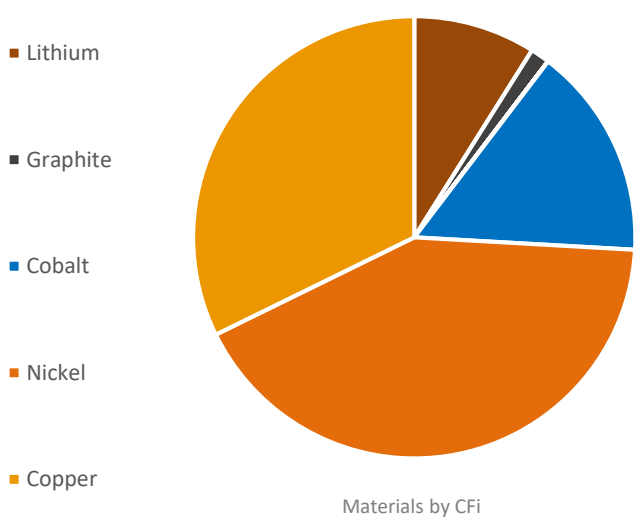
Recycle materials based on their weight	Weight in kg
Recycle materials based on their classification as critical raw materials (CRM)	Weight in supply relevance
Recycle materials based on their ADP	Weight in availability
Recycle battery-relevant materials with a high environmental and strategic impact	Weight in current and future impact

Applying the new recycling efficiency: Li-NMC

Recycling of lithium, cobalt, nickel and copper has the highest impact on the environment and secure future supply



Materials by weight [%]

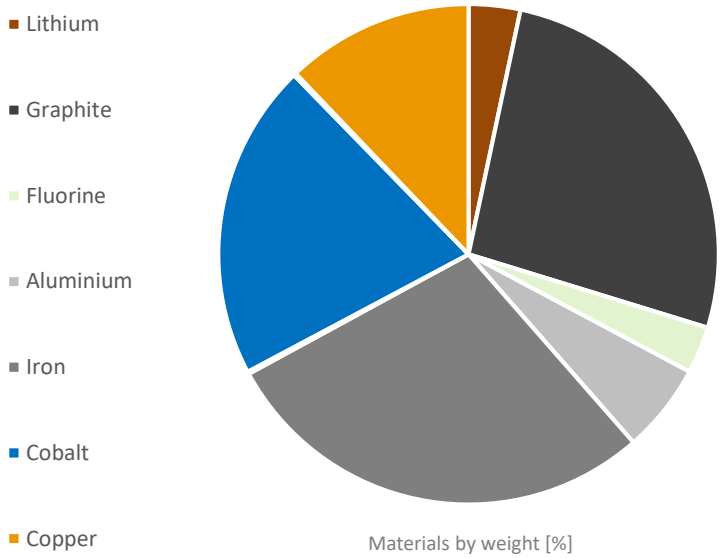


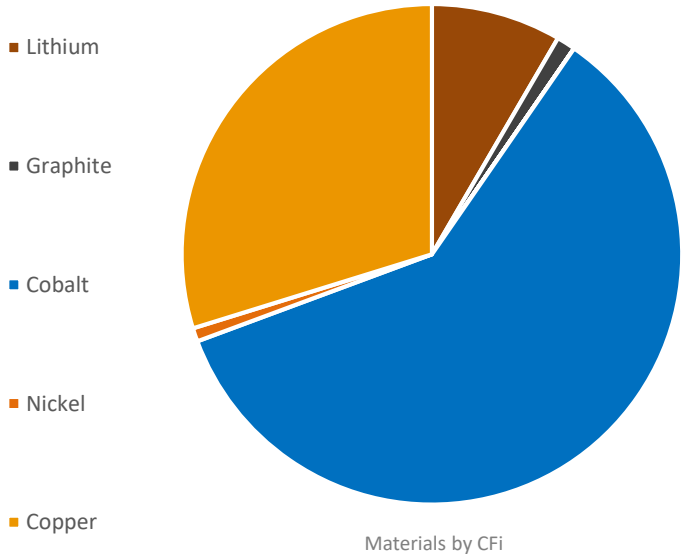
Materials by CFi

Materials by weight [%]: does not contain oxygen and plastics

Applying the new recycling efficiency: Li-Co

Recycling of lithium, cobalt and copper has the highest impact on the environment and secure future supply

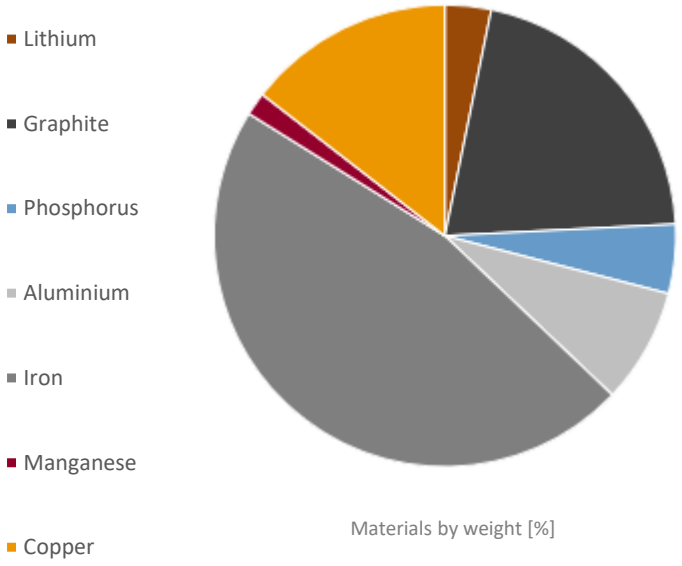


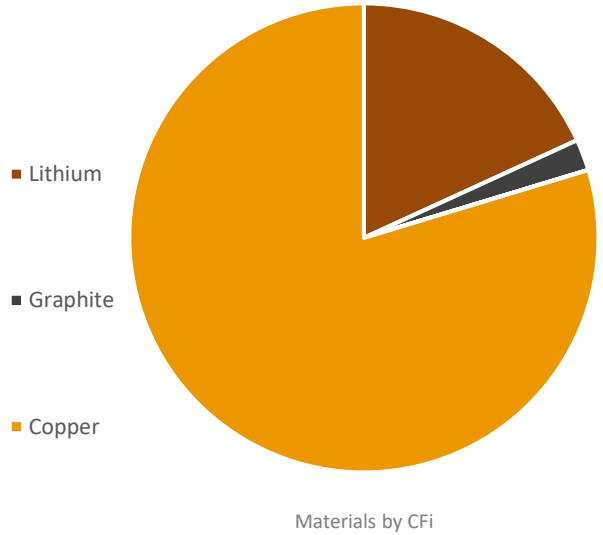


Materials by weight [%]: does not contain oxygen and plastics

Applying the new recycling efficiency: Li-LFP

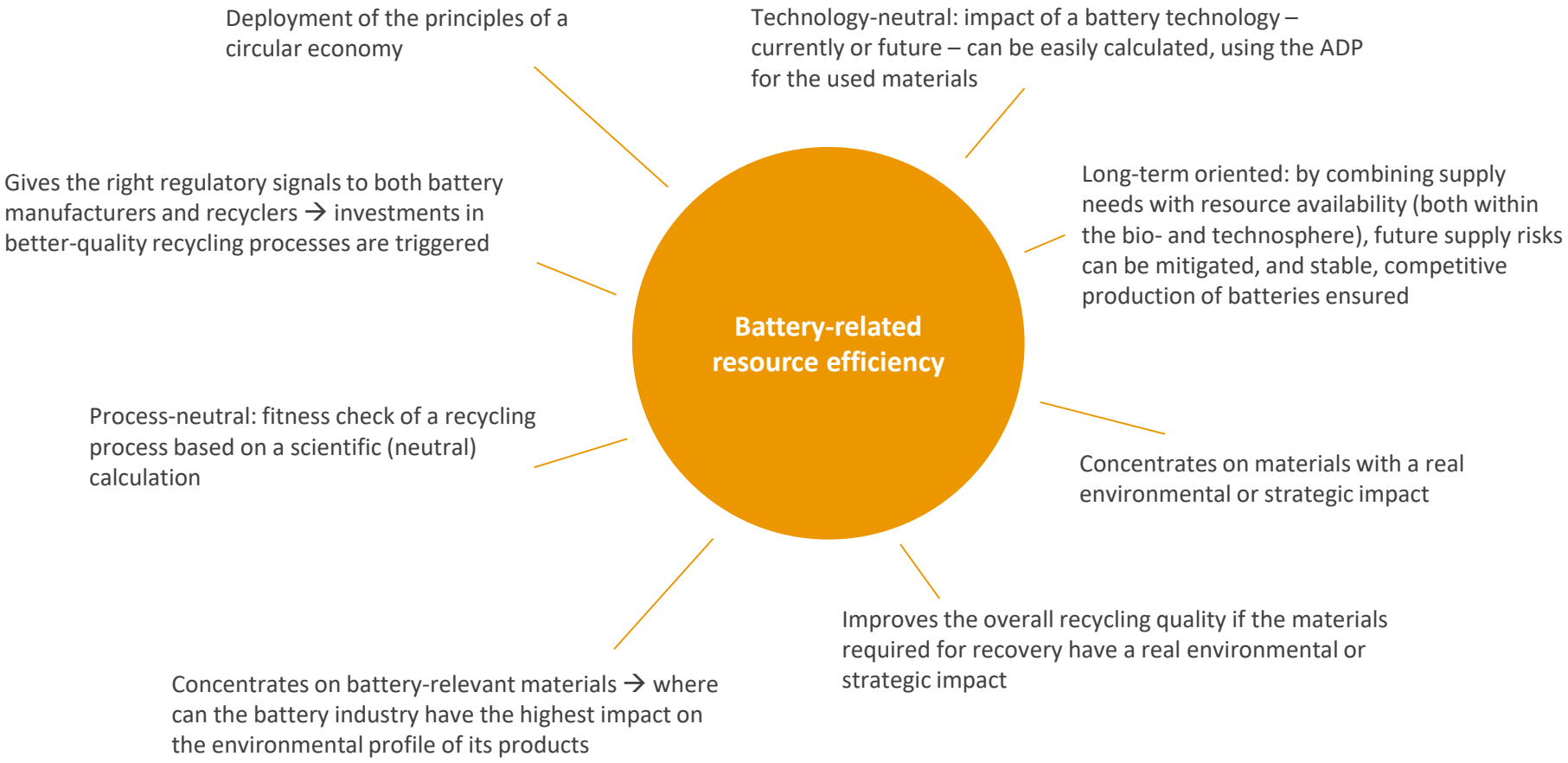
Recycling of lithium and copper has the highest impact on the environment and secure future supply





Materials by weight [%]: does not contain oxygen and plastics

The RECHARGE concept



The RECHARGE concept

What is needed for the implementation of the battery-relevant resource efficiency approach?

- Database for the % usage of materials in the battery industry
- Pre-defined revision timeline for the ADP and % usage of materials in the battery industry (e.g. every five years)
- Agreed % of recycling efficiency rate amongst all stakeholders: what recycling rate is technically, environmentally and economically viable?
- Definition of the scope of dissipation: as of when can materials not be recovered for recycling anymore, independent of time or location?
- Legal measures to improve collection performance. To control resource dissipation to its highest level and, therefore, improve the circularity in the industry, collecting used batteries is a main criterion. The RECHARGE concept does not provide a legislative proposal for improving the collection performance. It does provide a legislative proposal for improving the recycling efficiency.

Thank you

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