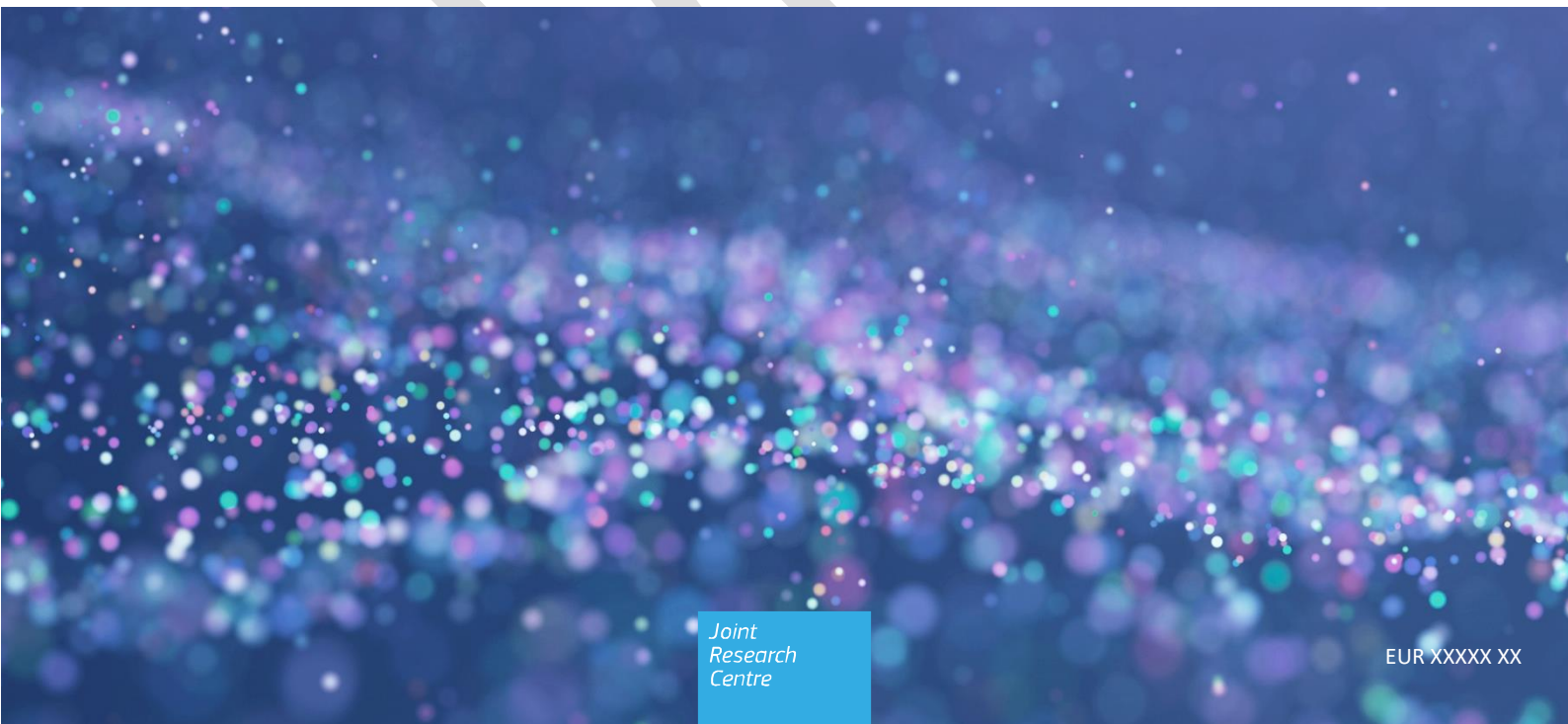
European Commission

JRC SCIENCE FOR POLICY REPORT

Methodology for calculation and verification of the carbon footprint of rechargeable industrial batteries with a capacity above 2 kWh, excluding those with exclusively external storage

2nd JRC Draft Technical Report – 25.06.2024



Joint Research Centre

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Abstract

This report provides the methodological guidelines for calculating the Carbon Footprint of industrial batteries (CFB-IND), providing the basis for the enforcement of requirements as in Article 7 of Regulation (EU) 2023/1542 (Batteries Regulation), establishing the methodology for calculation and verification of the carbon footprint of batteries. The present report is targeting industrial batteries with exclusively internal storage and with an energy storage capacity >2 kWh.

It is based on the previous JRC draft report that was distributed in December 2023 as a basis for the stakeholder consultation on the carbon footprint methodology for industrial batteries and the draft Annex to the Delegated Act on the carbon footprint methodology for electric vehicle batteries as published on "Have your Say" on April 30th 2024. In an attempt to harmonize the CFB methodologies as far as possible, maximum agreement with the CFB Rules for EV batteries was aspired, with larger passages taken over identical. All stakeholder comments provided for both the draft report on the CFB Rules IND and those submitted on the CFB Rules EV have been evaluated and incorporated when deemed appropriate.

As such, the present report is thought as an intermediate step towards the final JRC Report on the CFB Rules IND, seeking stakeholder feedback and consensus particularly for the passages that diverge from the CFB Rules for EV.

1 Introduction

The EU Batteries Regulation (Regulation (EU) 2023/1542) published the 28th of July 2023[1] sets rules on sustainability, performance, safety, collection, recycling, and second life of batteries as well as on information requirements about batteries. Among these, there is the carbon footprint of the batteries (CFB) to be determined and communicated as specified in Article 7 and the corresponding Annex II of Regulation (EU) 2023/1542. The CFB quantifies the total amount of greenhouse gases as kg of CO_2 equivalent per Functional Unit. The functional unit is defined as one kWh (kilowatt-hour) of the total energy provided by the battery system over the battery's service life, measured in kWh. For back-up batteries that have as their primary function to ensure continuity of a power source, the functional unit is defined as the ability to provide one kWmin (kilowatt-minute) of backup power capability at any moment over the lifetime of the battery.

The CFB shall be declared for "rechargeable industrial batteries with a capacity above 2 kWh, light means of transport (LMT) batteries and electric vehicle (EV) batteries placed on the Union market". CFB declarations will then be used to define the CFB performance classes and CFB thresholds that batteries entering the European market should comply with. Ultimately, Regulation (EU) 2023/1542 will ensure that the expected massive deployment of batteries will be associated with minimum overall carbon emissions. The CFB shall be accompanied by a public version and a non-public version of the CFB supporting study.

The Joint Research Centre (JRC) of the European Commission has been in charge of providing technical support to the development of the secondary legislation on the CFB (in line with the requirements of the Article 7 and Annex II of Regulation (EU) 2023/1542). The present document constitutes a draft specification of the Rules for the CFB of industrial batteries with a capacity above 2 kWh, excluding those with exclusively external storage (CFB-IND), for which the CFB declaration becomes mandatory 12 month after that for EV batteries.

Since many components of the CFB methodology are identical between all types of batteries in scope, the present report is based on the first draft of the Carbon Footprint Rules for industrial batteries (CFB-Rules IND) as published on the European Platform on LCA (EPLCA)[2] and the Annex to the Delegated Act that lays down the methodology for calculating and verifying the life-cycle carbon footprint of electric vehicle batteries as published for public consultation on 'Have your Say' on May 8th 2024 (DAA-EV)[3]. A colour coding scheme allows tracking the differences between the DAA-EV and the present document. In particular:

- The structure of this report is similar to the CFB-EV. All text that is taken over 1:1 from the DAA-EV is highlighted in blue. Any change that may still be introduced in the DAA-EV until its final form is expected to affect the corresponding text in the present report equally.
- Text written in Orange is taken from IEC63369

NOTE: The text of carbon footprint rules has been kept as concise as possible. All sections specified as "NOTE" have to be considered as explicative to the text and not be intended as part of the rules for Carbon Footprint of Batteries (CFB).

Unless otherwise specified in this document, the EF method as in the EC Recommendation 2021/2279 shall be considered as general guidelines about how to determine the carbon footprint.

1.1 Terminology

This report uses the following terminology to indicate the requirements, as:

- The term "shall" is used to indicate what is required in order to calculate the CFB.

[1] EU, Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC, 2023. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R1542#:~:text=This%20Regulation%20imposes%20battery%20due,or%20putting%20them%20into%20service .

[2] https://eplca.jrc.ec.europa.eu/EU_BatteryRegulation_Art7.html

[3] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13877-Batteries-for-electric-vehicles-carbon-footprint-methodology_en

- The term “may” is used to indicate an option that is permissible. Whenever options are available, the CFB supporting study shall include adequate argumentation and evidence to justify the chosen option.

2 Scope

This document provides rules on how to calculate the carbon footprint of rechargeable industrial batteries with a capacity above 2 kWh, excluding those with exclusively external storage (CFB-IND) within the scope of the Article 7 of Regulation (EU) 2023/1542. The CFB-IND shall be declared for any industrial battery that falls within the scope of Article 7 i.e., rechargeable industrial batteries with internal storage and a capacity greater than 2 kWh, independent of its cell chemistry and of the specific application. The scope of the CFB-IND excludes batteries that have been subject to preparation for re-use, preparation for repurposing, repurposing, or remanufacturing, and that had already been placed on the market or put into service before undergoing such operations (according to the Article 7 (point 5) of Regulation (EU) 2023/1542).

NOTE: Although the rules defined in this document are generic and applicable to any industrial battery with internal storage, independent of its chemistry, the following battery chemistries have been analysed for the testing and development of the present CFB-IND Rules (especially related to section 5.2 and 6.3), being currently considered the most relevant ones:

- *Lead-Acid (flooded, valve-regulated / sealed, tubular and all other forms - PbA)*
- *Lithium-based, including all current lihium-ion (LIB) LIB chemistries and solid-state LIB*
- *Sodium High Temperature (NaS, NaNiCl)*
- *Sodium-Ion (SIB), including aqueous sodium and hybrid ion batteries (ASIB)*
- *Nickel-Cadmium (NiCd), Nickel-Zinc (NiZn) and Nickel-Metal Hydride (NiMH)*

Other emerging chemistries like Mg-S, Aluminium, etc. could potentially become relevant in future, especially once achieving market maturity. The same applies to emerging anode / cathode materials for any of the listed battery chemistries and to other battery technologies. If deemed necessary, the CFB Rules may be updated correspondingly.

Given the broad field of application for industrial batteries, the present report distinguishes between batteries that are custom-made (CM) and those that are commercialised “off the shelf (OTS)”. CM batteries, typically larger energy storage systems (ESS) are designed and developed for a specific application in a given location according to the customer requirements. For being considered CM, batteries shall provide the corresponding evidence in the CFB supporting study, including the technical specification as provided by the manufacturer to the customer together with the delivered battery. OTS batteries in turn are produced in batches or series of uniform configuration and sold to the client without knowing the final application or use-profile beforehand. A typical example would be home storage systems or wallboxes, but also generic battery modules to be assembled in racks or similar structures, then constituting a larger, eventually CM battery. OTS batteries are designed for a typical (reference) use profile as defined by the manufacturer.

3 Calculation Rules

Two fundamentally different services can be provided by rechargeable industrial batteries:

1. The **provision of electricity** that was previously charged to the battery. While different applications have very different use profiles, they all require the battery to regularly discharge its energy content, leading to a more or less frequent cycling behaviour. Systems providing this type of service are considered to provide **repetitive energy supply (REP).** This can equally be energy supply **in mobile equipment (REP-MOB) or in stationary equipment (REP-STA)**
2. The **provision of back-up** or on-demand services, maintaining the battery in charged state and discharging only sporadically in case of power failure or blackout. In the extreme case, the grid failure or power outage never happens, and the battery is never cycled but just kept as safety reserve. Systems providing this type of service are referred to as **on-demand (OND) batteries**. Similarly to REP batteries, the OND service can be provided in **mobile (OND-MOB)** or in **stationary equipment (OND-STA)**.

NOTE: The classification is based on the IEC 63369 under development.

3.1 Impact assessment

The carbon footprint of industrial batteries shall be calculated as the amount of CO2-equivalent emitted during the life cycle stages of the battery that are within the system boundary, expressed in kilogram ('kg') CO2-equivalent, divided by the total amount of energy provided by the battery over the battery's service life determined in accordance with section 2.1. It shall be reported in kg CO2-equivalent/ kilowatt-hour ('kWh') with a resolution of 0,001 kg CO2-equivalent/kWh.

The amount of CO2-equivalent emitted shall be determined by identifying the emissions of greenhouse gases related to the materials and energy used and, where relevant, produced in the life cycle stages of the battery that are within the system boundary, in accordance with sections 2.2 to 2.7. The amount of CO2-equivalent shall be calculated from these emissions of greenhouse gases by applying the Environmental Footprint ('EF') 3.1 impact assessment method available in LCDN for the impact category "climate change".

All quantitative input and output data collected to quantify the carbon footprint shall be calculated in relation to the reference flow. The reference flow shall be calculated as the total mass of battery divided by the total amount of energy provided by the battery over the battery's service life, measured in kg/kWh.

If, over the course of time, due to changes in the bill of materials, changes in the origin of the materials, changes in processes, changes related to the use of electricity and other auxiliaries, or any other changes, the amount of CO2-equivalent emitted increases by more than 10% compared to the carbon footprint calculated, this shall be considered a change to the battery's technical characteristics relevant for the requirements of Regulation (EU) 2023/1542 and thus for the new battery model a new carbon footprint shall be calculated and a new carbon footprint declaration shall be drawn up.

3.2 Functional unit

3.2.1 Functional unit for repetitive energy supply (REP) industrial batteries

For energy-providing (REP) batteries, the **functional unit (FU)** is defined (according to Annex II of the Batteries Regulation) as *one kWh (kilowatt-hour) of the **total amount of energy** delivered by the battery over its service life, measured in kWh".*

The **total amount of energy** provided by the battery over the battery's service life ('E_{total}'), expressed in kWh, shall be calculated as follows:

$$E_{total} = energy\ capacity \cdot FEqC\ per\ year\ \cdot\ years\ of\ operation$$

Where:

— energy capacity is the useable energy capacity of the battery in kWh at the beginning of life, namely the energy available to the user when discharging a new fully charged battery until the discharge limit set by the battery management system. For OND batteries, it is the rated power multiplied by the time the battery is able to continuously discharge at this given power above minimum voltage;

— FEqC per year is the typical number of full equivalent charge-discharge cycles per year and equals 365 for all REP-type IND batteries

— *years of operation* is the service life of the battery, determined by the commercial warranty according to the following rules:

(a) the duration of the warranty on the battery in years applies; The warranty must cover the whole battery as placed on the market including all components that are required for safely and reliably providing its service (as defined in Section 4.1). If a shorter warranty is given for individual components, the corresponding replacements shall be considered for the reference flow as required for achieving the warranted battery lifetime.

(b) if there is no specific warranty on the battery, but a warranty on the application in which the battery will be used or operated, or parts of the application that include the battery, the duration of that warranty applies unless the battery is explicitly excluded.

(c) by way of derogation of points a) and b), if the duration of the warranty is expressed in both years and cycles whichever one is reached first, the shortest number of the two in years applies. For this purpose, a conversion factor of 365 cycles (full equivalent discharge cycles) per year shall be applied. Warranties expressed only in cycles, but not in years shall not be considered.

(d) if the battery is used in multiple applications and the results of the approach in point 2) and, where applicable, 3) would be different between those applications, the shortest resulting warranty applies;

(e) only warranties that are related to a remaining energy capacity of 70% of the useable energy capacity of the battery in kWh at the beginning of life or higher of its initial value shall be taken into account in points i) to iv). Warranties that explicitly exclude any individual components that are essential for the proper functioning of the battery or that restrict the use or storage of the battery apart from conditions that are within the typical use of such batteries shall not be taken into account in points i) to iv);

(f) if there is no warranty or only a warranty not compliant with the requirements under point 5, a figure of five years shall be used, except for cases where a warranty is not applicable, such as where there is no transfer of ownership of the battery or application, in which case the manufacturer of the battery shall determine the number of years of operation and justify it in the public version of the carbon footprint study.

NOTE: the application of the battery is e.g., the train where the battery is installed.

NOTE: We explicitly welcome feedback on the average cycles per year of IND batteries. Please support your input on this by evidence.

3.2.2 Functional unit for on-demand (OND) or backup industrial batteries

On-demand batteries (such as UPS systems) are only occasionally or even never cycled, being their principal function the ability to provide power for short times e.g., in case of power outage. On-demand batteries can provide their service either in mobile equipment (OND-MOB) or in stationary equipment (OND-STA).

The **functional unit** for the CFB of OND batteries is defined as:

"Provision of 1 kWmin of backup power capability over the whole service life. Provision of backup power refers to the ability to discharge at the given power without interruption at continuous discharge above minimum voltage at any time."

The **backup power capability** provided by the battery over its service life ('P_{BU}'), expressed in kWmin, shall be calculated as follows:

$$P_{BU} = backup\ power\ capability\ \cdot\ years\ of\ operation$$

Where:

— *backup power capability* is determined by the rated power capability of the battery in kW (Pr) and its stored energy time (Tse) in minutes, available over the whole service life. Stored energy time (Tse) refers

to the time (in minutes) the battery is able to provide power at Pr above the specified minimum voltage according to IEC 62040-3. It is equivalent to the useable energy capacity [kWh] / rated power [kW] * 60.

— *years of operation* is determined by the commercial warranty according to the following rules:

i. the duration of the warranty on the battery in years applies; The warranty must cover the whole battery as placed on the market including all components that are required for safely and reliably providing its service (as defined in Section 4.1). If a shorter warranty is given for individual components, the corresponding replacements shall be considered for the reference flow as required for achieving the warranted battery lifetime.

ii. if there is no specific warranty on the battery, but a warranty on the application in which the battery will be used or operated, or parts of an application that include the battery, the duration of that warranty applies unless the battery is explicitly excluded.

iii. Warranties that limit the number of discharge events or cycles over lifetime shall not be considered.

iv. if the battery is used in multiple applications and the results of the approach in point ii) and, where applicable, iii) would be different between those applications, the shortest resulting warranty applies;

v. only warranties that are related to a remaining backup power capability of at least 70% of its initial value at the beginning of life be taken into account in points i) to iv). Warranties that explicitly exclude any individual components that are essential for the proper functioning of the battery or that restrict the use or storage of the battery apart from conditions that are within the typical use of such batteries shall not be taken into account in points i) to iv);

vi. if there is no warranty or only a warranty not compliant with the requirements under point (v), a figure of three years shall be used, except for cases where a warranty is not applicable, such as where there is no transfer of ownership of the batter or application, in which case the manufacturer of the battery shall determine the number of years of operation and justify it in the public version of the carbon footprint study.

NOTE: If the battery has to provide backup service very frequently so that a cycle limitation has to be added to the warranty, it ceases to be Backup battery and should better be declared REP.

4 System Boundaries and cut-off rules

The system boundaries define which parts of the product life-cycle and which associated life-cycle stages and processes belong to the analysed system (i.e., are required for carrying out its function as defined by the functional unit).

Batteries falling under the scope of this document are usually comprised of several battery cells grouped together forming a battery device or battery installation. Such devices or installations can have very diverse layouts and configurations, given the wide range of applications they are designed for. Typically, several battery cells are grouped together to form battery modules, which are then mounted together in a specific structure to form an operative battery device such as a rack-based stationary battery or home storage battery. Several of these devices in turn can be clustered and mounted into a common housing such as a container, forming a large battery installation. A schematic representation of the considered battery system components is provided in Figure 1. The definition of the system boundaries follows a general supply-chain logic, including all stages from raw material acquisition and pre-processing, production of the main product, product distribution, etc.

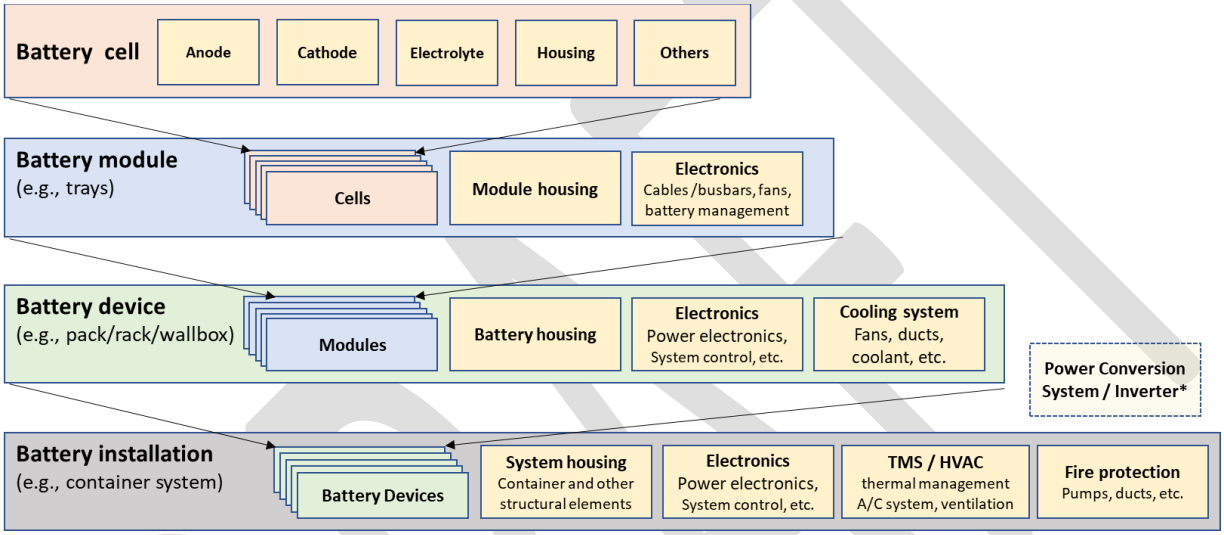

Figure 1. Battery system components. * Power Conversion System / Inverter excluded from the considered system components. Based on the JRC report on CFB-EV.

NOTE: The battery subject to the CFB declaration may be battery device, a battery installation or even a battery module, depending on the configuration of tha battery (system) as placed on the market.

4.1 System boundaries

Whenever a physical system is necessary for the battery to safely and reliably deliver its performance and is dedicated to the use of this specific battery as specified in this paragraph, it shall be inside the system boundaries and be modelled according to the present rules.

For CM batteries, the system boundaries comprise at least all components that are part of the battery system as delivered to the customer according to the corresponding technical specification, including all replacement parts and components eventually required over the specified lifetime for fulfilling the requirements of the technical specification.

For OtS systems, these comprise at least the battery system as being sold on the market including all components contained within or permanently attached to the battery housing.

If components that are essential for the safe and reliable operation of the battery are incorporated in external devices such as a charger, PCS, or are part of the application, then these components shall be included in the system boundaries and accounted for in the CFB calculation. Similarly, if a battery is installed in an existing premise and substantial modifications are needed for ensuring the battery's safe and reliable operation (such as a retrofitting of the existing fire extinguishing system or an additional containment), these components fall within the system boundaries.

Being the essential service of a battery the provision of DC power, any subsequent conversion of the delivered DC electricity (such as AC conversion, transformation), may be excluded from the system boundaries, applying subdivision according to Section 6.2.1.

NOTE: The system boundaries of OtS typically only comprise the battery system as being sold on the market including all components contained within or permanently attached to the battery housing. For CM batteries, the system boundaries comprise all components that are part of the system as delivered to the customer according to the corresponding technical specification, including all replacement parts and components eventually required over the specified lifetime for fulfilling the requirements of the technical specification

The use-phase is explicitly excluded from the system boundaries according to Article 7 and Annex II of Regulation (EU) 2023/1542

NOTE: The IEC 63369 includes all the components needed for safe operation and proper functioning of the battery in the system boundaries, such as battery-related part of the charger (if it ensures some of the BMS functions) or of the power conversion system (PCS) or of the fire suppression system (FSS) i.e., those that are required for functional safety of the battery. If some of these parts are incorporated in devices located outside of the battery, then the percentage of the external device performing the battery related function shall be allocated to the battery

NOTE: We welcome feedback on the definition of the system boundaries, safe and reliable operation and the potential exclusion of inverters or AC-related components.

NOTE: We welcome feedback on possible issues with allocation of components that may be essential for safe and reliable operation, but that are outside the physical boundaries of the battery.

4.2 Life Cycle Stages

The following life cycle stages shall be included in the system boundary:

4.2.1 Raw material acquisition and pre-processing

This life cycle stage covers all activities prior to the main product production stage, including:

- the extraction of resources from nature and their pre-processing until their use in product components entering through the gate of the first facility falling under the main product production life cycle stage;
- transport of raw materials and intermediate products within, between and from extraction and pre-processing facilities until the first facility falling under the main product production life cycle stage;
- the production of the cathode active material precursors, anode active material precursors, solvents for the electrolyte salt, the pipes and the fluid for the thermal conditioning system;

All activities and elementary flows related to the management of the waste generated during this life cycle stage shall be included in calculation of the carbon footprint of this life cycle stage.

4.2.2 Main product production

This life cycle stage covers the manufacturing of the battery including that of all components that are necessary for the battery to safely and reliably deliver its performance and that are dedicated to the use of this specific battery, and at least those that are physically contained in or permanently attached to the battery housing.

More specifically, it covers the following activities:

- cathode active material production;
- anode active material production, including the production of graphite and hard carbon from their precursors;
- anode and cathode production, including the mixing of ink components, coating of ink on collectors, drying, calendaring, slitting, grid casting, grid pasting, curing and plate formation;
- Electrolyte production, such as mixing of electrolyte salts and solvents.
- assembling the housing and the thermal conditioning system;

- Assembling the cell components into a battery cell, including stacking/winding of electrodes and separator, assembly of electrode plates with separator, assembling into a cell housing or pouch, injection of electrolyte, closing of cell, testing and electrical formation;
- Assembling the cells into modules/pack including electric/electronic components, housing, and other relevant components that are necessary for the safe and reliable operation of the battery;
- Assembling the modules/packs with electric/electronic components, housing, thermal conditioning and other relevant components into a finished battery device;
- System installation, i.e., transport of the battery devices to the site of deployment and assembly with the housing (e.g., container), power and control electronics, thermal conditioning and fire suppression system and wiring into a final battery installation.
- Retrofitting activities if the battery is installed in existing premises that require a substantial modification for ensuring the battery's safe and reliable operation (such as a retrofitting of the existing fire extinguishing system or an additional containment)
- transport operations of the final and intermediate products to the site where they are used.

The elementary flows related to the management of the waste generated during this life cycle stage shall be included in calculation of the carbon footprint of this life cycle stage. More information on how to account for manufacturing scraps and recycled content in the 'Manufacturing' life-cycle stage is provided in section 6.3.2.

4.2.3 Distribution

This life cycle stage covers the transport of the battery from the battery manufacturing site to the point of placing the battery on the market. Storage operations are not covered.

4.2.4 End of life and recycling

This life cycle stage begins when the battery or the system in which the battery is incorporated is disposed of or discarded by the user or the operator and ends when the battery concerned is returned to nature as a waste product or enters another product's life cycle as a recycled input. This life cycle stage covers at least the following activities:

- battery waste collection;
- battery preparing and dismantling;
- thermal or mechanical treatment, such as electrolyte extraction and desulphurisation, thermal deactivation, pyrolysis, shredding of the waste batteries, mechanical separation of the shredder fractions;
- battery cell recycling such as pyrometallurgical and hydrometallurgical treatment or smelting of previously separated metal fractions;
- separation and conversion into recycled material, such as recycling of the aluminium from the casing;
- recycling of electric and electronic components, such as printed wiring board ('PWB') recycling;
- energy recovery and disposal.

NOTE: Battery preparing includes activities such as battery discharge or extraction of the electrolyte.

The impacts of the transport of the waste battery or of its components to the disassembling site, of the pre-treatment of the waste batteries, such as system disassembly, of discharging and sorting, and of the dismantling of the battery and its components, are not covered, while the processes themselves are included in the mass balance.

Waste generated during the 'Raw material acquisition and pre-processing' and 'Manufacturing' life-cycle stages shall be included in the life-cycle of the product and modelled at the life-cycle stage where it occurs. No refurbishing or second life shall be considered according to Regulation (EU) 2023/1542 i.e., a battery that reaches its end of life for the first time shall be considered to enter the End-of-Life stage.

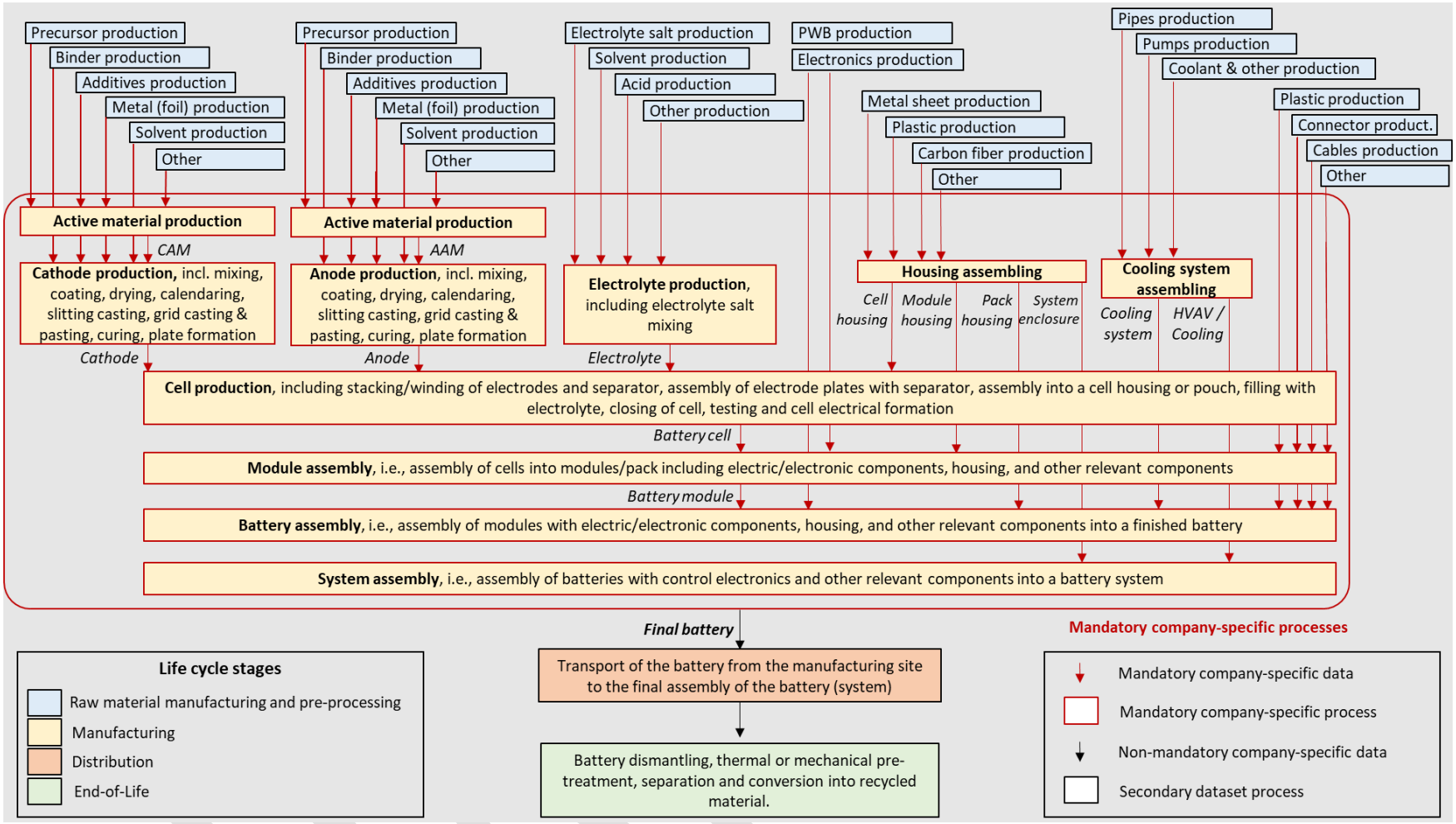

Figure 2. System boundaries of the carbon footprint of a generic industrial battery. Other types of batteries (e.g., anode-free batteries, cell-to-pack design) may have a different visualization of their system boundaries. Each square represents a process, while each arrow represents an activity data (e.g., kg of solvent, kg of additive). The different colours (blue, yellow, orange, and green) indicate to which life-cycle stage each process belongs, while red arrows and red borders indicates if a process/activity data shall be company-specific (section 6.1). Black arrows and borders indicate non-mandatory company-specific processes. PWB: Printed Wiring Board. CAM: cathode active material, AAM: anode active material

4.3 Cut-off rules

The following processes may be excluded from the modelling:

(a) manufacturing of capital goods, including equipment;

(b) production of packaging materials;

(c) any component that is external to the battery as delivered to the client / the final user (such as the building where a battery is installed in) and that is not essential for the battery's safe and reliable operation;

(d) auxiliary inputs to manufacturing plants that are not directly related to the battery production process, including heating and lighting of associated office rooms, secondary services, sales processes, administrative and research departments;

(e) Regular maintenance activities that are not associated with the replacement of components or active materials, such as revisions, cleaning, or make-up of auxiliary substances like cooling / HVAC liquids, or fire extinguishing agents

A general cut-off of 1% in mass may be applied to material inputs per system component as depicted in **Figure 1**, by neglecting input and output flows that make up less than 1% to the total mass of the system component. The total cut-off may not be more than 3% in total mass of the final battery.

The cut-off may be applied to the following system components in the main product production life cycle stage:

(a) battery cell anode;

(b) battery cell cathode;

(c) battery cell electrolyte;

(d) battery cell housing;

(e) the battery cell components other than the ones listed in points (a) to (d) combined;

(f) battery module housing;

(g) battery module electronics;

(h) battery module other

(i) battery device housing;

(j) battery device electronics;

(k) battery device other

(l) battery installation electronics

(m) battery installation fire protection

(n) battery installation thermal conditioning system.

(o) battery installation components other

The cut-off may be applied to the following system components in the raw material acquisition and pre-processing life cycle stage:

(a) mining;

(b) beneficiation or ore processing, from ore to concentrate;

(c) primary extraction, either pyrometallurgical or hydrometallurgical;

(d) refining;

(e) finishing.

Grinding media in the raw material acquisition and pre-processing life cycle stage shall be accounted for even if it might fall under the cut-off criteria.

If a cut-off is applied, the mass gap shall be closed on system component level by adding the missing mass to the material input flow with the highest specific carbon footprint on the system component level concerned. The carbon footprint study shall mention if and where the cut-off of 1% in mass has been applied.

NOTE: the auxiliary inputs to the 'Manufacturing' life-cycle stage were estimated to be negligible: assuming a consumption of a generic office as 293 kWh/m2 18, and assuming a production area of 267,000 m2 (compatible with a facility of 20 GWh/year of production capacity), the auxiliary energy consumption is estimated to be about 0.2% of the electrical energy required by the production line.

5 Data collection requirements and quality requirements

A CFB model is composed of processes that combine elementary flows with the corresponding characterisation factors, and activity data with the corresponding life-cycle inventory or carbon footprint of the underlying process.

Both data (i.e., activity data and elementary flows) from processes and the underlying sub-processes can be company-specific or secondary (i.e., taken from databases). The CFB Rules distinguish between mandatory company-specific processes (section 5.1) and non-mandatory company-specific processes (section 5.2).

All data shall be provided as LCI and activity data (i.e., before and after allocation), both per kg of the main output (product) of the modelled process and per functional unit.

5.1 Mandatory company-specific processes

The data collection and modelling for all the processes included in the main product production and the distribution life cycle stages shall be based on company-specific data. Guidelines on the collection of company-specific data are provided in Section 5.4.

The manufacturer of the battery shall ensure that the company-specific data is communicated in any of the following methods:

a) suppliers provide to the manufacturer the complete LCI of the process, including elementary flows, energy consumption, input material, and the recycled content 'R_1' referred to in section 6.3, and the information required for the carbon footprint study as specified in section 7.2.2;

b) suppliers provide the manufacturer with a company-specific dataset;

c) suppliers provide the complete LCI of the process, including elementary flows, energy consumption, input material, and the recycled content 'R_1' referred to in section 6.3, and the information required for the carbon footprint study as specified in section 7.2 to a third-party, such as a data management company, who combines the inputs from different suppliers and provides the manufacturer a company-specific dataset for the process.

Where the manufacturer communicates the company-specific data in accordance with point (b), the manufacturer shall ensure that the notified body receives from the manufacturer's suppliers all the information specified in section 7.2.1 when the manufacturer lodges its application for assessment by the notified body. The manufacturer shall also ensure that a market surveillance authority receives such information upon request.

Where the manufacturer communicates the company-specific data in accordance with point (c), the manufacturer shall ensure that the notified body receives from its suppliers or from the third-party all the information specified in section 7.2.1 when the manufacturer lodges its application for assessment by the notified body. The manufacturer shall also ensure that a market surveillance authority receives such information upon request.

a) Company-specific datasets communicated by the suppliers to the manufacturer shall be accompanied with the information needed by the manufacturer or another of its suppliers to incorporate the dataset into its carbon footprint model and shall contain at least the following information:

b) a precise description of the product for which the carbon footprint information is valid, including its origin and an unambiguous identifier;

c) the total carbon footprint declared per unit of mass of the product, in kg CO_2-equivalent per kg, or per unit of energy, in kg CO_2-equivalent per kWh;

d) the carbon footprint for each applicable life cycle stage listed in section 4.2;

e) parameters related to the quality of the product that affect its carbon footprint, such as purity or specific capacity;

f) the specific content and the carbon footprint of elements and their compounds potentially targeted by recycling processes, at least regarding steel, aluminium, copper, cobalt, nickel, manganese, lithium, graphite, silicon, titanium, vanadium, silver, gold, platinum group metals, lead and phosphorous. If such materials contain recycled content, the carbon footprint of E_{V_Mat} and $E_{recycled\_Mat}$ as defined in section 6.3.1 shall be provided.

NOTE: The information about the content of these elements and their CF is required for the end of life modelling (Section 6.3.1), allowing to credit their specific CF when recovered at their end of life.

5.2 Non-mandatory company-specific processes

Non-mandatory processes are divided into most relevant and non-most relevant processes depending on their relevance on the overall CFB calculation. Guidelines on the modelling of most relevant non-mandatory company-specific processes are provided in Section 5.2.1, and on the modelling of non-most relevant ones in Section 5.2.2.

The most relevant processes are the following:

- Production of cathode active material precursors: cobalt, nickel, iron, lithium, cadmium, lead, vanadium, rare earths, whether metallic or as chemical compounds).
- Production of anode active material precursors: lithium, titanium, nickel, lead (all either metallic or as chemical compounds), rare earths, sodium metal, silicon, graphite precursors, hard carbon precursors,
- Production of electrolyte (salt) and precursors: $LiPF_6$, LiTFSI, lithium compounds, sodium compounds, nickel compounds, solid electrolytes
- Production of copper, e.g., in the current collectors, busbars and cables.
- Production of aluminium, e.g., in the current collectors, busbars / cables and housing.
- Production of steel, e.g., in the housing.

NOTE: the most relevant processes include all that had been identified for EV batteries, plus several additional materials that have been deemed relevant for Industrial Batteries based on scientific literature and expert judgement. Examples of non-most relevant processes are the production of the solvent used in cathode and anode, of the carbon fibers used in the housing, of the PWB, the manufacturing of the plastic for the collector or housing, etc.

5.2.1 Modelling requirements of the most relevant processes

If at least one secondary dataset with a Technological Representativeness ('TeR') quality rating equal to or lower than four determined in accordance with section 5.5 is available in the datastock dedicated to the carbon footprint of batteries in the Life Cycle Data Network on the European Platform on LCA ('carbon footprint datastock') one of the following methods shall be chosen for data collection and modelling:

- the most representative secondary dataset in the list of carbon footprint datasets carbon footprint datastock shall be used. If the dataset is a partially disaggregated, the electricity dataset or datasets connected to the core process one level down the supply chain at -1 level may be changed for the average electricity consumption mix of the country where the process is occurring, modelled in accordance with section 6.1. Such choice shall be duly justified in the carbon footprint study;
- a company-specific dataset with a Data Quality Rating ('DQR') equal to or lower than two. In such case, section 5.1 shall apply.

If no secondary dataset with a TeR equal to or lower than four is available in the carbon footprint datastock, one of the following methods shall be chosen for data collection and modelling:

- a secondary dataset in line with the following hierarchy:
    - the most representative EF-compliant dataset available in LCDN. If the dataset is a partially disaggregated, the electricity dataset or datasets connected to the core process one level down the supply chain at -1 level may be changed for the average electricity consumption mix of the country where the process is occurring, modelled in accordance with section 6.1. Such choice shall be duly justified in the carbon footprint study;
    - a representative EF-compliant dataset from any other source;
    - a representative ILCD entry-level compliant dataset either from LCDN or from any other source.
- a company-specific dataset with a DQR equal to or lower than three. In such case, the methods in section 5.1 shall apply.

For each process, the method selected shall be detailed in the carbon footprint study, including any relevant assumptions and justifications such as the choice of a proxy in the case of TeR equalling four.

5.2.2 Modelling requirements for the non- most relevant (other) processes

If one or more secondary datasets with a TeR quality rating equal to or lower than four determined in accordance with section 5.5 are available in the carbon footprint datastock, the most representative secondary dataset in the carbon footprint datastock shall be used.

If no secondary dataset with a TeR quality rating equal to or lower than four is available in the carbon footprint datastock, a secondary dataset in line with the following hierarchy shall be used:

- the most representative EF-compliant dataset available in LCDN;
- a representative EF-compliant dataset from any other source;
- a representative ILCD entry-level compliant dataset either from LCDN or from any other source.

All the secondary datasets used shall be reported in the carbon footprint study.

5.3 CFB-compliant company-specific datasets

Company-specific datasets shall comply with the following requirements:

- the modelling shall be done in accordance with rules set in this document;
- the data format shall be compliant with the ILCD data format available in LCDN;
- the nomenclature of the elementary flows shall be aligned with the EF 3.1 reference package for the carbon footprint of batteries available in LCDN or the process datasets and product flow, the nomenclature shall be compliant with the ILCD Handbook Nomenclature and other conventions, available via the European Platform on LCA;
- they shall include the DQR and the values of the three DQR criteria, calculated in accordance with section 5.5;
- the meta-data information shall comply with the requirements for meta-data information set out in the Guide for EF-compliant datasets, available on the European Platform on LCA;
- the system boundaries of cradle-to-gate models shall not include the distribution and end of life and recycling life cycle stages and only the material input of the circular footprint formula referred to in section 6.3.1 shall apply;
- in case of a LCI result dataset, the dataset shall include the LCI results and the LCIA results of the climate change impact category expressed in kg of CO_2-equivalent;
- in case of a LCIA result dataset, the dataset shall include the LCIA results of the climate change impact category expressed in kg of CO_2-equivalent.

5.4 Requirements for the collection of company-specific data

The company-specific data to be collected for the creation of company-specific datasets shall include all known inputs and outputs for the processes concerned, including:

- the following inputs:
    - material inputs that end up in the product, including minerals and metals, semi-finished materials and chemical feedstocks. If materials are used in solution state, the specific concentration shall be provided. The specific concentration data on the metal and on other elements, either concentration or specific metal content shall be provided;
    - energy that is consumed directly and indirectly in the processing plant, such as electricity, steam, thermal energy required by the process, and energy and fuels required for auxiliary activities such as transport or forklifting within the plant premises;
    - auxiliaries and any other material inputs required for the manufacturing process, such as chemicals, cleaning material, lubricants, and refrigerants;

- transport distances and means of transport;
- any elementary flow.

— the following outputs:

- any material output, including wastewater;
- any elementary flow. Emissions that are not accounted for in the corresponding energy process dataset and that are not monitored via measurements shall be estimated based on stoichiometric calculations.

Company-specific data shall be the average of one year. However, the data may be the average of a different period if the process concerned has not yet been running for a full year or exceptionally in another case justified in the carbon footprint study.

A production process may be divided into sub-processes. The company-specific data may be collected for each process or subprocess stage separately, or for the final production as a whole. For the outputs, direct emissions and waste streams shall be recorded. For the inputs, the following parameters shall be recorded:

a) specification of the input, such as 'cobalt sulphate ($CoSO_4$ x7H_2O), primary, [provider], [country]'

b) unit, such as 'kg'

c) bill of material or inventory data per kg main output product, before applying the circular footprint formula ('CFF') referred to in section 6.3.1

d) activity data per kg main output product of the process, after applying the CFF

e) LCI

f) activity data per functional unit, after applying the CFF

g) Universally Unique Identifier ('UUID')

h) dataset name

i) dataset location

j) dataset type

k) most relevant process: 'yes' or 'no'

l) -1 level adjusted to [country]

m) TeR

n) TiR

o) GeR

p) data source, collection method or methods, and timespan

q) data collection date

r) documentation for verification

s) In the case of continuous or semi-continuous processes the following shall apply:

t) measurements shall be collected at the points of consumption or emission directly relative to the process considered for the battery in the scope;

u) the consumption of energy and auxiliaries shall preferably be based on an individual and detailed metering system that enables to attribute the energy or auxiliary consumption of the entire production to production lines, products, and time periods. Where the energy or auxiliary consumption cannot directly be related to a specific product, for example where several products are produced in a facility while the consumption data is not available per specific product, the data shall be collected as specific as possible, such as split up into energy or auxiliary consumption for electrode manufacturing, cell assembly, cell finishing, and climatisation of clean or dry rooms. Where the energy or auxiliary consumption can be directly related to a specific process, the data of such consumption shall be used. Where the consumption data is only available for several products, for example, in case of presence of

individual meters for cell assembly lines and only one general meter for a dry room in which several assembly lines produce different cells, the consumption data shall be split up by allocation in accordance with section 6.2.2. Where the process concerns a new facility, extension of capacity or exchange of entire production line, up to six of the initial months may be excluded from the data collection.

Where activity data for material inputs are not available for a specific cell or battery, but only available aggregated for several cell products, the cell mass balance may be used to determine the material inputs. In this case, the resulting bill of material shall include all facility-specific yields, such as manufacturing scrap and manufacturing waste rates, including entire cells at the end of line testing. The corresponding yield rates shall be provided in the carbon footprint study.

Company-specific emission data may be based on direct measurements or be calculated combining company-specific activity data, such as litres of fuel consumption in a boiler, with related emission factors from established sources, such as a specific emission factor for combustion of that fuel. If the process concerned is covered by EU emission trading system monitoring rules, the quantification requirements as set out in Commission Implementing Regulation (EU) 2018/2066[4] shall apply for the processes and greenhouse gases covered therein. The data may be scaled, aggregated or undergo other forms of mathematical treatment in order to bring them in line with the reference flow of the process.

Process emissions of CO_2 and other greenhouse gas emissions from chemical reactions shall be quantified from the reaction stoichiometry. If acids are obtained as by-product from emission abatement, subdivision shall be applied as referred to in section 6.2.1.

All data sources and mathematical treatments applied to the data shall be provided in carbon footprint study.

A company quality management system such as in accordance with ISO 9001:2015, ISO 14001:2015 or Regulation (EC) No 1221/2009 of the European Parliament and the Council[5], or equivalent shall be applied in order to demonstrate that all the activity data have been correctly collected and managed, and that they are representative of a yearly average or other period referred to of the process in scope.

The template in Table 1 may be used for the data collection for each of the process stages in the raw material acquisition and pre-processing life-cycle stage.

Table 1. Generic data collection template for the raw material acquisition and pre-processing life cycle stage

Material	Unit	Data	Specification
Inputs			
Main input (ore, matte, etc.)			Not applicable in case of company-specific mining
Electricity			In accordance with section 6.1
Fuels for transport and machinery			Such as diesel, LNG or hydrogen
Fuels for (process) heat generation			Such as natural gas, coal / hydrogen
External heat supply (heat and steam respective of fuel)			If heat is sourced externally
Explosives			

[4] Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334, 31.12.2018, p. 1, ELI: https://eur-lex.europa.eu/eli/reg_impl/2018/2066/oj)

[5] Regulation (EC) No 1221/2009 of the European Parliament and the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC (OJ L 342, 22.12.2009, p. 1, ELI: http://data.europa.eu/eli/reg/2009/1221/oj)

Filling or structural material for production			Such as cement for backfilling
Acids			Such as sulphuric acid for acid leaching
Sulphur or H_2S			For on-site sulphuric acid production
Neutralizer or slagging agents			Such as lime, limestone, NaOH or MgO
Electrodes			Such as graphite electrodes
Reductants			Such as coal, charcoal or hydrogen
Chemicals			Bulk chemicals such as frother, dispersants or flocculants. Other chemicals may be aggregated and added to the major bulk chemicals.
Tyres			For specific machines at the mining stage
Technical gases			Such as nitrogen or oxygen, if purchased externally
Grinding media			Such as high strength steel balls or rods
Transport of input materials			Such as by truck, train, bark. Standard distances may be used.
Outputs			
Main product			Such as ore mined, matte, concentrated ore, final metal or metal salt, graphite ore, intermediate product. Assay data to be provided for specific metal contents or concentrations of ores or minerals and intermediate products
By-products			Such as sulphuric acid or other metals or metal compounds than the main product. Allocation in accordance with section 6.2.1
Waste rock			
CO_2 (fossil) and other GHG emissions			Based on fuels and explosives if combustion emissions are not considered in the corresponding fuel or energy dataset, reductants, electrodes and other reactions where CO_2 emissions occur, such as neutralization or precipitation with limestone

5.5 Data quality rating (DQR) of the CFB declaration and of CFB-compliant datasets

A Data Quality Rating ('DQR') shall be calculated for the declared value of the carbon footprint in accordance with the following procedure:

— determine the quality rating for each of the three DQR criteria of Technological Representativeness ('TeR'), Geographical Representativeness ('GeR'), Time-related Representativeness ('TiR') for all the

company-specific and secondary datasets used in the model in accordance with Table 2; For elementary flows such as direct emissions, the value of the three DQR criteria shall be one.

- calculate the carbon footprint of each process by multiplying the carbon footprint of the dataset by the corresponding activity data;
- calculate the carbon footprint contribution, expressed in percentage, of each process. The carbon footprint contribution is the ratio between the carbon footprint of the process divided by the sum of the values of all processes. In case a process has a negative carbon footprint, take the absolute value for this process rather than the negative value, including in the denominator;
- calculate the value of each DQR criterion of the declared value of the carbon footprint as a weighted average of the quality ratings of the DQR criterion concerned, weighted by the carbon footprint contribution of each process determined in point (c);
- calculate the DQR of the declared value of the carbon footprint as the sum of the values of the three DQR criteria divided by three.

The DQR and the values of TeR, GeR, and TiR of the carbon footprint shall be provided in the public version of the carbon footprint study.

The DQR of company-specific datasets shall be calculated with the following procedure:

- determine the quality rating for each of the three DQR criteria of Technological Representativeness ('TeR'), Geographical Representativeness ('GeR'), Time-related Representativeness ('TiR') for all the company-specific and secondary datasets used in the model of the company-specific dataset concerned in accordance with Table 2;
- calculate the carbon footprint of each process by multiplying the carbon footprint of the dataset by the corresponding activity data;
- calculate the carbon footprint contribution, expressed in percentage, of each process. The carbon footprint contribution is the ratio between the carbon footprint of the process divided by the sum of the values of all processes. In case a process has a negative carbon footprint, take the absolute value for this process rather than the negative value, including in the denominator;
- calculate the value of each DQR criterion of the declared value of the carbon footprint of the company-specific dataset concerned as a weighted average of the quality ratings of the DQR criterion concerned, weighted by the carbon footprint contribution of each process determined in point (c);
- calculate the DQR of the declared value of the carbon footprint of the company-specific dataset concerned as the sum of the values of the three DQR criteria divided by three.

Table 2. Evaluation of the DQR criteria

Quality rating	$TiR_{dataset}$	$TeR_{dataset}$	$GeR_{dataset}$
1	For secondary datasets used in the modelling, the reference year of the carbon footprint is within the time validity of the secondary dataset. For company-specific datasets or if the secondary dataset does not provide any information on validity, such as in the case of ILCD-compliant datasets, the reference year of the carbon footprint is equal to the reference year of the dataset.	The technology concerned is the same as the one in scope of the dataset.	The process modelled takes place in the country for which the dataset is valid.
2	For secondary datasets used in the modelling, the reference year of the carbon footprint is	The technology concerned is included in the mix of	The process modelled takes place in the geographical region for

	maximum 2 years beyond the time validity of the secondary dataset. For company-specific datasets or if the secondary dataset does not provide any information on validity, the reference year of the carbon footprint is maximum 2 years after the reference year of the dataset.	technologies in scope of the dataset, yet with some limited differences in the production pathways.	which the dataset is valid.
3	In case of secondary datasets used in the modelling, the reference year of the carbon footprint is maximum 3 years beyond the time validity of the secondary dataset. In case of company-specific datasets or if the secondary dataset does not provide any information on validity, the reference year of the carbon footprint is maximum 3 years after the reference year of the dataset.	The technology concerned is included in the dataset, with significant differences in the production pathway.	The process modelled takes place in one of the geographical regions where the dataset is valid for, such as in the case of a global dataset.
4	In case of secondary datasets used in the modelling, the reference year of the carbon footprint is maximum 4 years beyond the time validity of the secondary dataset. In case of company-specific datasets or if the secondary dataset does not provide any information on validity, the reference year of the carbon footprint is maximum 4 years after the reference year of the dataset.	The technology concerned is similar, including in terms of systems boundaries and carbon footprint, to the modelled technologies in the dataset, meaning a technological proxy.	The process modelled takes place in a country that is not included in the geographical region or regions for which the dataset is valid, but it is estimated that there are sufficient similarities based on expert judgement.
5	In case of secondary datasets used in the modelling, the reference year of the carbon footprint is more than 4 years beyond the time validity of the secondary dataset. In case of company-specific datasets or if the secondary dataset does not provide any information on validity, the reference year of the carbon footprint is more than 4 years after the reference year of the dataset.	The technology concerned is different from those included in the scope of the dataset.	In all other cases not listed on 1-4.

Where chemicals are aggregated and added to the major bulk chemicals, as referred to in Table 1, the TeR is equal to 4.

If the electricity dataset or datasets connected to the core process at '-1 level' are changed for the average electricity consumption mix, the GeR of the dataset shall be calculated as follows:

$$GeR = GeR_{original} - \left(GeR_{original} - GeR_{modified,-1}\right) \cdot Contribution_{original,-1}$$

Where:

a) $GeR_{original}$ is the GeR of the secondary dataset before changing the dataset describing the electricity consumption in the –1 level, in accordance with Table 2;

b) $GeR_{modified,\ -1}$ is the GeR of the dataset describing the electricity consumption in the '-1 level' after the adjustment;

$Contribution_{original,-1}$ is the contribution, expressed as a percentage, of the carbon footprint impact of the electricity consumption in the '-1 level' compared to the total carbon footprint of the secondary dataset.

6 Inventory data - Modelling requirements

6.1 Electricity modelling

To be modelled as in the DAA-EV

6.2 Allocation rules

6.2.1 Allocation of multi-functional processes

If a process or facility provides more than one function, that is, it delivers several goods or services ('co-products'), all inputs and emissions linked to the process shall be partitioned between the product of interest and the other co-products in line with the following hierarchy, with specific exceptions and requirements as detailed in this section:

- subdivision, by splitting up the process into subprocesses that can be assigned unambiguously to one single product flow;
- allocation based on a relevant underlying physical relationship such as mass or energy. This shall be based on the properties that most closely represent the drivers for the corresponding input, and duly be justified and documented in the carbon footprint study;
- economic allocation.

By way of derogation from the first paragraph, economic allocation shall always be applied when the price difference between at least two of the different outputs is higher than a factor of ten. Such price differences shall be calculated based on a 10-year global price average for metals, ores and metal compounds, and five-year global price averages for all other commodities. A shorter time span may be used if evidence is provided that the global prices are not available for 10 years and 5 years, respectively.

Economic allocation shall be done based on the following values:

- 10-year global price averages for metals, ores and metal compounds;
- five-year global price averages for all other commodities;
- five-years average for plant-specific revenues;
- five-year average process costs for recycling and waste treatment processes.

All allocation factors, the approach for calculating them and the underlying data sources shall be disclosed in the carbon footprint study. If the process has been operative for shorter time, a shorter time span of minimal one year may be used to determine revenues or process costs if duly justified in the carbon footprint study. If shorter time spans are used for global prices, revenues, or process costs, the carbon footprint calculation shall be updated at the latest when sixty months average values are available.

6.2.2 Allocation of energy and auxiliary inputs of production lines

If company-specific data is collected for energy auxiliary inputs or other consumables from a plant where subdivision is not possible among the different production lines because only one monitoring device or energy meter is installed for several production lines, allocation may be applied if the production steps, production equipment, and the products themselves are similar, such as for battery cells with the same geometry, but with different properties.

In such case, the following hierarchy shall be used:

a) allocation by mass or other physical properties that most closely represent the drivers for the corresponding input. For cell manufacturing processes, allocation by mass may only be applied if all cell products have the same geometry, such as pouch, cylindrical or prismatic, and the same size, such as 'cylindrical 18650';

b) allocation using the installed capacity or another appropriate criterion. For cell manufacturing processes, the cell energy capacity expressed in kWh shall be used when point (a) is not applicable.

The applied method shall be reported and documented in the carbon footprint study, including the justification thereof. In all cases, the sum of the allocation shall equal the total measured consumption.

6.3 Recycling content and end-of-life modelling

The recycled content and the waste generated during all the life cycle stages shall be modelled with the use of the circular footprint formula ('CFF') and shall be reported at the life cycle stage where the waste generation occurs. This section describes how to apply the CFF to the recycled content and to the end of life and recycling life cycle stage of the battery in scope. For any other case, section 4.4.8 of Annex I to Commission Recommendation (EU) 2021/2279 shall apply.

The CFF shall not be used for any materials or objects rejected during the battery manufacturing process that are re-used as an integral part in the same process and that do not need to be recycled, such as run-around scrap. However, emissions and process inputs associated with their processing shall be accounted for in the corresponding life cycle stage.

The end of life and recycling life-cycle stage of the battery shall be modelled with the default battery recycling process specified in this section. While Tables 4 to 6 provide the parameters of the default battery cell recycling process, a different, company-specific battery cell recycling process may be applied only for the share of the batteries for which evidence is provided that they will be recycled in a specific recycling plant operating at commercial scale and that the specific recycling process corresponds to the battery model for which the carbon footprint is declared. Such specific recycling process shall be modelled with company specific data in accordance with section 5.1. In case company-specific battery cell recycling process is applied, modified assumptions and the corresponding evidence shall be detailed in the carbon footprint study. The justification for applying a company-specific battery cell recycling process shall be provided in the public version of the carbon footprint study.

A different company-specific return rate may be used only for the share of batteries covered by an ownership business models where the property of the battery stays with the manufacturer, where contractual evidence of higher return rates is provided, including evidence that the batteries covered under that rate are recycled in accordance with Regulation (EU) 2023/1542.

6.3.1 The CFF applied to the battery in scope

The Circular Footprint Formula (CFF) describes the allocation of impacts and credits from the EoL handling of the battery. The following rules apply:

- The default recycled content of the materials in the battery scope shall be zero unless evidence of the traceability throughout the supply-chain is provided in the CFB supporting study.
- The modelling requirements for the 'End-of-life' life cycle stage depend on the battery chemistry of the battery in scope (i.e., the battery for which the CFB is developed and declared). For some batteries, it is assumed that only a fraction of the batteries is properly returned and sent to (manual) dismantling (Figure 3). The outputs of the dismantling are the battery cell and remaining battery components that are sent to individual recycling processes (steel and aluminium from the housing; copper, PWB for recovering gold, silver, copper and palladium, cables for recovering copper). The remaining fraction of the batteries is assumed to be not properly returned and treated (named as "non-collected" batteries in Figure 3) and assumed to be roughly dismantled (with a process similar to that for properly returned batteries above, but without carrying out the recycling of the PWB), whereas battery cells are assumed to be landfilled. The sorted plastic is sent to energy recovery and the rest to landfill. The dismantled battery cell is then sent to the default battery cell recycling process, which varies according to the battery cell chemistry:
    1. The default battery cell recycling process for lithium-ion, sodium-ion, nickel metal hydride, nickel-cadmium batteries and similar battery chemistries that are based on closed battery cells with liquid electrolytes operating at room temperature such as sealed pouch, round cell or prismatic cells, shall be modelled according to Table 4 and Table 5, assuming a combination of a pyrometallurgical and hydrometallurgical treatment (that recovers copper, nickel sulphate, and cobalt sulphate).
    2. The default battery cell recycling process for lead-acid batteries shall be modelled according to Table 6, using default EF datasets

3. For other battery chemistries that do not fall under any of the previous categories, no established battery cell recycling processes yet exist and therefore no battery cell recycling shall be modelled (no material recovery from battery cells).

NOTE: We welcome feedback on recycling processes for batteries that do not fall under category1 or 2, such as sodium-sulphur batteries. Please provide quantitative data or references if possible that allow for modelling of such processes

— A company-specific collection rate may be used only for the share of batteries covered by an ownership business models where the property of the battery stays with the manufacturer and higher collection rates may be proved.

— A company-specific battery cell recycling process may be used only for the share of the batteries for which the CFB declarant is able to provide evidence that the same batteries will be recycled in a specific recycling plant and that the specific recycling process corresponds to the battery model for which the CFB is declared. The corresponding evidence shall be provided in the CFB supporting study.

— The impacts of collecting and dismantling the waste batteries shall not be included in the model (i.e., they are defined as cut-off in section 4.3). The collection rate is expressed with the parameters R_{coll} in the equation below, while the efficiency of the dismantling is assumed to be 100%.

— The impacts of the battery cell recycling shall not be allocated per material but shall be allocated to the full battery using an average A per battery cell.

— The impacts of recycling of the PWB shall not be allocated per material but shall be allocated to the full PWB using an average A per the PWB.

— The incineration with energy recovery only applies to the plastic waste from the dismantling of the properly returned batteries. The energy recovery from plastics in the battery cells is instead accounted for by the default battery cell recycling process.

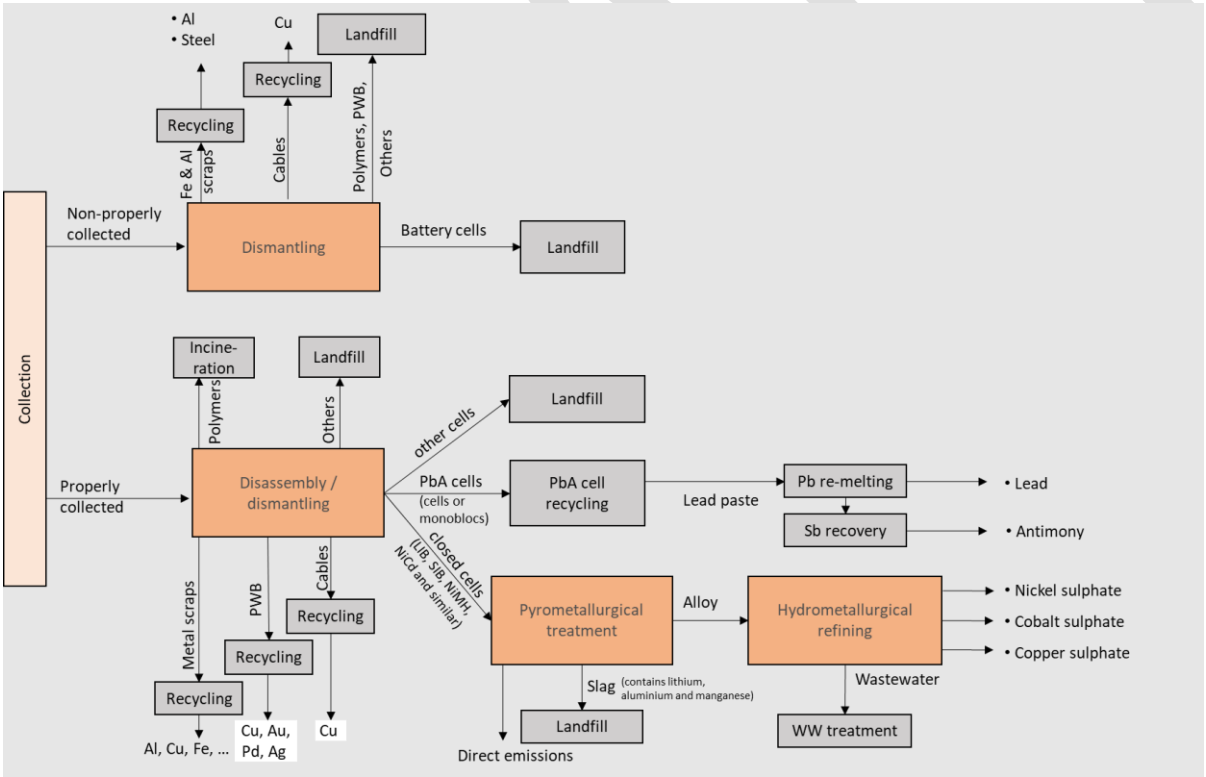

Figure 3. Schematic flowsheet of the default 'End-of-life' life-cycle stage of the battery in scope. PWB: printed wiring board

The below equations describe how to use the CFF to the battery in scope. The CFF shall be applied per material, unless specified differently in the description of the single parameters. In particular:

— The impacts of the battery cell recycling shall not be allocated per material but shall be allocated to the full battery using an average allocation factor per battery cell;

— The impacts of recycling of the PWB shall not be allocated per material but shall be allocated to the full PWB using an average allocation factor per the PWB.

For clarity, the CFF is divided into several terms, related with different processes along the production and end-of-life stage. All individual terms shall be summed to obtain the final result.

— Impacts of using primary and secondary materials ('material input'):

$$\sum_{Mat}[(1-R_{1\_Mat})\cdot E_{V\_Mat}+R_{1\_Mat}\cdot(A_{Mat}\cdot E_{recycled\_Mat}+(1-A_{Mat})\cdot E_{V\_Mat}\cdot\frac{Q_{Sin\_Mat}}{Q_{P\_Mat}})]$$

— Impacts and credits of producing secondary materials from dismantling, to account for steel and aluminium from the housing and copper from the cables ('dismantling'):

  - Materials from the properly returned fraction of the battery:

$$R_{Return}\cdot\sum_{Mat}[(1-A_{Mat})\cdot R_{rec,c\_Mat}\cdot(E_{recEoL\_Mat}-E^{*}_{V\_Mat}\cdot\frac{Q_{Sout\_Mat}}{Q_{P\_Mat}})]$$

  - Materials from the non-properly returned fraction of the battery:

$$+(1-R_{Return})\cdot\sum_{Mat}[(1-A_{Mat})\cdot R_{rec,nc\_Mat}\cdot(E_{recEoL\_Mat}-E^{*}_{V\_Mat}\cdot\frac{Q_{Sout\_Mat}}{Q_{P\_Mat}})]$$

— Impacts and credits of producing secondary materials from the PWB recycling after the battery dismantling, to account for copper, gold, silver and palladium ('electronics recycling'):

$$R_{Return}\cdot[(1-A_{PWB})\cdot E_{recEoL_{PWB}}-\sum_{Mat}[(1-A_{Mat})\cdot(R_{rec,c_{Mat}}\cdot E^{*}_{V_{Mat}}\cdot\frac{Q_{Sout_{Mat}}}{Q_{P_{Mat}}})]]$$

— Impacts and credits of producing secondary materials from the battery cell recycling, to account for copper, nickel sulphate and cobalt sulphate in the default end of life and recycling life cycle stage ('cell recycling'):

$$R_{Return}\cdot\left(\left(1-A_{Batterycell}\right)\cdot E_{recEoL\_Batterycell}\right)+R_{Return}\cdot\sum_{Mat}[(1-A_{Mat})\cdot R_{rec,c\_Mat}\cdot(E_{recEoL\_Mat}-E^{*}_{V\_Mat}\cdot\frac{Q_{Sout\_Mat}}{Q_{P\_Mat}})]$$

— Impacts due to energy recovery of the plastic from the dismantling of the properly returned battery waste ('energy recovery'):

$$R_{Return}\cdot\sum_{Mat}[(1-B)\cdot R_{3,c\_Mat}\cdot(E_{ER_{Mat}})]$$

— Impacts of disposal ('disposal'):

  - PWB, polymers, battery cell, and other materials not-being recycled, deriving from the dismantling of the non-properly returned battery waste:
  - $(1-R_{Return})\cdot\sum_{Mat}[(1-R_{rec,nc_{Mat}})\cdot(E_{D_{Mat}})]$
  - Other materials not-being recycled, deriving from the dismantling of the properly returned battery waste
  - $R_{Return}\cdot\sum_{Mat}[(1-R_{rec,c_{Mat}}-R_{3,c_{Mat}})\cdot(E_{D_{Mat}})]$

Where:

a) A_{Mat} is the material-specific allocation factor of burdens and credits between two life cycles, the one supplying and the one using recycled material, aiming to reflect market realities. The values for A_{Mat} shall be taken from Table 3. In case a material is not included in Table 3, reference application-specific values shall be taken from Part C of Annex II to Commission Recommendation (EU) 2021/2279. If no

such values for a specific application are there available, then material-specific values for A_{Mat} may be used from the same source. If such values of parameter A_{Mat} for the considered materials are not available either, a value of 0,5 shall be used;

b) $A_{Batterycell}$ is the battery-specific allocation factor and shall be equal to 0,2;

c) A_{PWB} is the PWB-specific allocation factor and shall be equal to 0,2;

d) B is the allocation factor of energy recovery processes and shall be equal to 0;

e) R_{1_Mat} is the material-specific recycled content, meaning the proportion of material in the input to the production that has been recycled from a previous system. R_1 is by default equal to 0 for all the materials, unless evidence for a specific value is provided in the carbon footprint study, based on traceability of the supply-chain. Acceptable evidence shall include the documentation referred to in Article 8(1) of Regulation (EU) 2023/1542. Specific values based on supply market statistics are not acceptable;

f) R_{Return} is the battery return rate, meaning the rate of end-of-life batteries that are properly returned for removal of parts and components multiplied with a 100% collection of contained batteries to be recycled in accordance with Regulation (EU) 2023/1542. For STA batteries, R_{Return} is equal to 0.95 by default, while for MOB batteries, R_{Return} is by default equal to 0,8, unless evidence is provided in the carbon footprint study for a different company-specific value. This may only be done for the share of batteries covered by an ownership business model where the property of the battery stays with the manufacturer and evidence of such ownership model shall be provided in the carbon footprint study together with evidence of the higher return rate, including evidence that the batteries covered under that rate will be recycled in accordance with Regulation (EU) 2023/1542;

NOTE: The return rate represents the percentage of industrial batteries that are not treated in a battery cell recycling process.

NOTE: We welcome any input on the return rates for industrial batteries, especially any evidence that may support these values

g) R_{rec,c_Mat} is the material-specific recycling yield for the properly returned fraction of batteries, meaning the proportion of the material in the properly returned fraction of batteries that will be recycled in a subsequent system taking into consideration only the recycling yield. It does not include return rate and dismantling efficiency. Default values for R_{rec,c_Mat} are provided in Table 3. Different company-specific values may be used for R_{rec,c_Mat} in case a company-specific battery cell recycling is applied and the corresponding evidence is provided in the carbon footprint supporting study. In case such company-specific values are applied, they shall be calculated as the ratio between the mass of the secondary material produced and the mass of the material entering the recycling process. In the case of copper, gold, silver or palladium from the PWB recycling, R_{rec,c_Mat} refers to the kg of such material per kg of PWB input and only the default values provided in Table 3 shall be used;

h) R_{rec,nc_Mat} is the material-specific recycling yield for the non-properly returned fraction of batteries, meaning the proportion of the material in the non-properly returned fraction of batteries that will be recycled in a subsequent system taking into consideration only the recycling yield. It does not include return rate and dismantling efficiency. The values for R_{rec,nc_Mat} shall be taken from Table 3;

i) R_{3,c_Mat} is the proportion of the material that is used for energy recovery at the end of life of the properly returned waste batteries. For polymers R_{3,c_Mat} shall be 100%. For other materials, R_{3,c_Mat} shall be 0 unless evidence for a different value is provided in the carbon footprint study;

j) E_{V_Mat} is the specific emissions and resources consumed arising from the acquisition and pre-processing of primary material;

k) $E_{recycled\_Mat}$ is the specific emissions and resources consumed arising from the recycling process of the recycled material. Collection, sorting, and transportation of the waste used to produce the secondary material are excluded. The allocation of a multi-material process to the single material shall follow the allocation hierarchy set out in section 2.5.1. It shall include the management of the waste of the recycling process and the wastewater treatment when applicable. In case $E_{recEoL\_Batterycell}$ is modelled with a company-specific process taking place outside Europe, the geographical scope of $E_{recycled\_Mat}$ data shall be changed accordingly;

NOTE: Erecycled_Mat is either a most relevant process or a non-most relevant process (section 6.2)

l) $E_{recEoL\_Batterycell}$ is the specific emissions and resources consumed arising from the battery cell recycling. $E_{recEoL\_Batterycell}$ is accounted for on battery level and not per material. $E_{recEoL\_Batterycell}$ shall be modelled using the default values provided in

1. Table 4 and Table 5 for lithium-ion, sodium-ion, nickel metal hydride, nickel-cadmium batteries and similar battery chemistries that are based on closed battery cells with liquid electrolytes operating at room temperature such as sealed pouch, round cell or prismatic cells)
2. Table 6 for lead-acid batteries.
3. For all other battery chemistries, such as sodium high temperature batteries, no specific cell recycling process sis available and the battery cells are assumed to be sent to landfill.

Different company-specific recycling processes may be used only for the share of the batteries for which contractual evidence is provided that they will be recycled in a specific recycling plant and that the specific recycling process corresponds to the battery model for which the carbon footprint is declared. In this case, the company-specific battery cell recycling process shall refer to the recycling plant operating at the time of the battery being placed on the market. The mass and composition of the battery used for the company-specific battery cell recycling process shall reflect to the mass and composition of the battery for which the carbon footprint is declared. The justification for modelling a company-specific battery cell recycling process shall be provided in the public version of the carbon footprint study. In case a company-specific battery cell recycling process is applied, the options in section 5.1 shall apply, to be read as applying to the recycler rather than the supplier. In the default battery recycling process, data use shall reflect recycling processes taking place in Europe;

m) E_{recEoL_Mat} is the specific emissions and resources consumed arising from any additional recycling process that is needed to produce secondary material. In the default battery recycling process, data use shall reflect recycling processes taking place in Europe, both for the properly returned waste batteries and the non-properly returned waste batteries. In case $E_{recEoL\_Batterycell}$ is modelled with a company-specific process taking place outside Europe, the geographical scope of E_{recEoL_Mat} data in the cell recycling shall be changed accordingly. For all the outputs of the battery cell recycling process, E_{recEoL_Mat} includes all the additional recycling processes not included in the battery cell recycling, such as sorting and re-melting of metal waste from the casing into secondary metals. It is equal to zero for the default battery cell recycling process since the obtained products in this default process do not require further post-processing;

NOTE: $E_{recEoL\_Battery\ cell}$ includes all process inputs and direct emissions of the battery cell recycling process. E_{recEoL_Mat} are the specific burdens (carbon footprint) associated with the re-processing of the metal fractions separated during recycling, such as sorting and re-melting of aluminium scrap into secondary aluminium. E_{recEoL_Mat} is zero for all materials that leave the battery cell recycling process as final product i.e., directly replacing the equivalent primary product such as cobalt sulphate or nickel sulphate as in the default EoL life cycle stage. $E_{recEoL_{Mat}}$ is not zero for any output of the battery cell recycling process that needs additional processes before being sold as secondary material. (e.g., sorting, cleaning and remelting to metal ingots).

n) E_{recEoL_PWB} is the specific emissions and resources consumed arising from the PWB recycling following the dismantling of the properly returned waste batteries. E_{recEoL_PWB} shall be determined in accordance with section 5.2.2;

o) $E^*_{V\_Mat}$ is the specific emissions and resources consumed arising from the acquisition and pre-processing of primary material assumed to be substituted by recyclable materials. $E^*_{V\_Mat}$ shall be modelled based on the European average production or, when the European average production is not available, based on the global average production. However, $E^*_{V\_Mat}$ shall be equal to E_{V_Mat} when E_{V_Mat} is lower than the applied average production;

p) Q_p is the quality of the primary material;

q) Q_{sin} is the quality of the ingoing secondary material, meaning the quality of the recycled material at the point of substitution. Values for Q_{sin} / Q_p shall be taken from Table 3;

r) Q_{sout} is the quality of the outgoing secondary material, meaning the quality of the recyclable material at the point of substitution. Default values for Q_{sout} / Q_p are provided in Table 3. Higher values are allowed only if a company-specific battery cell recycling process is modelled and if evidence is provided in the

carbon footprint study, such as through technical specifications of the secondary material demonstrating that is 'battery-grade';

s) E_{ER} is the specific emissions and resources consumed arising from the energy recovery of the polymers from the battery waste dismantling, for both the properly returned and the non-properly returned waste batteries, including both the direct emissions of the incineration plants and the credits due to the avoided energy production. E_{ER} shall be determined in accordance with section 5.2.2. If the secondary datasets for energy recovery do not include the credits from the production of energy, the credits shall be modelled using the lower heating value of the polymers substituting the European energy mix;

t) E_D is the specific emissions and resources consumed arising from the disposal of waste material at the analysed product's end of life, without energy recovery.

If datasets used for PWB recycling include the credits from the production of secondary material, the credits for specific materials shall be set to zero.

If datasets used already include the allocation with the factor AMat, then they shall not be allocated again.

To apply the CFF correctly along the battery supply-chain, the company-specific R1 of e.g., any raw material, precursors, active material, shall be handed over to the next process step / manufacturer even in case of CFB-compliant company-specific datasets.

Table 3. Default values for the parameters for the end of life and recycling life cycle stage

				For the properly returned waste batteries		**For the non-properly returned waste batteries**	
	A_{Mat}	R_{1_Mat}	Q_{sin}/Q_p	R_{rec,c_Mat}	$Q_{Sout,c}/Q_p$	R_{rec,nc_Mat}	$Q_{Sout,nc}/Q_p$
Al metal (from the dismantling)	0,2	0 (*)	1	0,9	1	0,9	1
Al metal (cells)	0,2	0 (*)	1	0 (*)	1	0	1
Antimony	0,2	0	1	0,9	1	0	1
Cu metal (from the dismantling)	0,2	0 (*)	1	0,9	1	0,9	1
Cu metal (cells)	0,2	0 (*)	1	0,9 (*)	1	0	1
Fe metal (from the dismantling)	0,2	0 (*)	1	0,9	1	0,9	1
Fe metal (cells)	0,2	0 (*)	1	0 (*)	1	0	1
Lead	0.5	0	1	0,9	1	0,8	1
Polymers (from the dismantling)	0,5	0 (*)	1	0	0,8	0	0,8
Other materials (from the dismantling)	0,5	0 (*)	1	0	n/a	0	n/a
Au from PWB	0,2	0 (*)	1	$1,4 \times 10^{-5}$ (**)	1	0	1

Cu from PWB	0,2	0 (*)	1	0,11 (**)	1	0	1
Ag from PWB	0,2	0 (*)	1	9,77 x 10^{-4} (**)	1	0	1
Pd from PWB	0,2	0 (*)	1	9,31 x 10^{-8} (**)	1	0	1
Co compounds (cell)	0,2	0 (*)	1	0,9 (*)	0,8 (*)	0	0,8
Ni compounds (cell)	0,2	0 (*)	1	0,9 (*)	0,8 (*)	0	n/a
Mn compounds (cell)	0,2	0 (*)	1	0 (*)	0,8 (*)	0	n/a
Li compounds (cell)	0,2	0 (*)	1	0 (*)	0,8 (*)	0	n/a
Tin	0,2	0	1				
Other metals and metal compounds	0,2	0 (*)	1	0 (*)	0,8 (*)	0	n/a
Graphite / hard carbon (cell)	0,2	0 (*)	1	0 (*)	0,8 (*)	0	n/a
Other materials (cell)	0,5 (***)	0 (*)	1 (***)	0 (***)	0,8 (***)	0	n/a

(*) Company-specific values may be used under the conditions set out in this section.

(**) Value shall be applied per kg of recycled PWB.

(***) Additional materials may be accounted for if a company-specific battery cell recycling process is modelled.

n/a = not applicable

Table 4. Default cell recycling model for recycling of LIB, NiMH, SIB and other battery cells of similar layout, inventory data per kg of battery cell, pyrometallurgical treatment. Equal to the CFB-EV.

Component	**Unit**	**Default value**	**Specification / dataset**	
Inputs				
End of life battery cells	kg	1,00	From disassembly	
Electricity	kWh	1,00	Electricity mix	
Process heat	MJ	2,288	Thermal energy from natural gas	

Process heat	MJ	0,237	Thermal energy from diesel fuel	
Limestone washed	kg	0,136	Limestone production, technology mix	
Silica sand	kg	0,119	Silica sand, production mix	
Quicklime (CAO)	kg	0,085	Quicklime production, technology mix	
Carbon black	kg	0,001	Carbon black production, technology mix	
Transport from the dissembling to the battery cell recycling plant	km	130	Transport by truck (>32 t, EURO 4);	
Transport from the dissembling to the battery cell recycling plant	km	240	Transport by train (average freight train)	
Transport from the dissembling to the battery cell recycling plantf	km	270	Transport by ship (barge).	
Outputs				
Metal alloy	kg	0,34	To hydrometallurgical treatment	
Slag	kg	0,712	Landfill of inert slag	
Emissions	kg CO_2-equivalent	1,194	Direct process emissions (all greenhouse gases)	

933 *Source: JRC analysis.*

934 **Table 5.** Default recycling model for recycling of LIB, NiMH, SIB and other battery cells of similar layout, inventory data per
935 kg of battery cell, hydrometallurgical treatment.

Component	**Unit**	**Default value**	**Specification / dataset**	
Inputs				
Metal alloy	kg	0,34		
Electricity	kWh	0,085	Electricity mix	

Process heat	MJ	1,847	Thermal energy from natural gas	
Hydrochloric acid (100%)	kg	0,017	HCl production, technology mix	
Hydrogen peroxide (100%)	kg	0,305	Hydrogen peroxide, production, technology mix	
Soda (sodium carbonate)	kg	0,017	Soda production, technology mix	
Sodium hydroxide (100%; caustic soda)	kg	0,458	Sodium hydroxide production, technology mix	
Sulphuric acid aq. (96%)	kg	0,881	Sulphuric acid production, technology mix	
Water (tap water)	m3	0,003		
Outputs				
Recovered metals	kg		Such as aluminium, copper, steel and stainless steel	Credit for each specific metal according to its content in the battery cell and parameters RReturn, A, Rrec, and Qsout/Qp
Recovered metal salts	kg		Such as cobalt sulphate and nickel sulphate	Credit for each specific metal salt according to its stoichiometric content in the battery cell and parameters RReturn, A, Rrec, and Qsout/Qp
Wastewater	m3	0,00864	Wastewater treatment, average	

Source: JRC analysis.

Table 6. Default recycling model for recycling of PbA battery cells or monoblocs, inventory data per kg of battery cell.

Component	Unit	Default value	Dataset	Specification
EoL PbA battery	kg	1	--	
Battery preparation and shredding	kg	1	Recycling of lead into lead scrap, from PbA batteries	Dataset for PbA battery recycling. NOTE: Mass allocation in

				dataset -> account for per kg of output
Re-melting of lead paste into secondary lead	kg	0,72	Secondary lead; secondary production, melting of lead scrap	Based on average lead content in PbA batteries
Outputs				
Recovered metals	kg		e.g., lead, antimony	Credit for each specific metal according to its content in the battery cell and parameters Rcoll, A, Rrec and 'Qsout/Qp' of the CFF
Plastic components to incineration	kg		Incineration PP; waste-to-energy plant with dry flue gas treatment	Plastic fraction to incineration according to its content in the battery cell and CFF parameters
Other material to incineration	kg		Waste incineration of inert material; waste-to-energy plant with dry flue gas treatment	Other materials not recovered
Inert material to landfill	Kg		EF: Landfill of inert material (other materials)	Others fraction to landfill according to its content in the battery cell and CFF parameters
Lead to landfill	kg		Landfill of inert (lead);	Lead fraction to landfill according to its content in the battery cell and CFF parameters

Source: JRC analysis.

6.3.2 The CFF applied to manufacturing waste

All manufacturing waste shall be considered in the modelling. The total amount of manufacturing waste shall be consistent with the bill of materials, the mass balance of the final product and the yield rates of the manufacturing processes.

The CFF shall be applied to all manufacturing waste using the same formula as in section 6.3.1, with the following modifications:

- the equations for 'material input' and 'dismantling' shall not apply;
- the equation for 'electronics recycling' shall only apply if the manufacturing waste contains PWB waste;
- RReturn shall be equal to 1; and
- ErecEoL_Batterycell shall only apply to waste fractions that consist of compound battery cell components, such as coated electrode cut-offs and final cells rejected at the end of the manufacturing line. In all the other cases, ErecEoL_Batterycell shall be equal to 0.

6.4 Transport

For transport in the main product production life cycle stage, in the distribution life cycle stage, and in the raw material acquisition and pre-processing life cycle stage between processes for which company-specific data is

used pursuant to sections 2.3.1, where relevant, and 2.3.2, company-specific data shall be used for the distance, in combination with secondary dataset corresponding to the actual transport mode and the actual category of the transport means, such the category of truck used.

For other transport in the raw material acquisition and pre-processing life cycle stage the manufacturer shall verify whether the datasets applied for that life-cycle stage include all relevant transport. If that is not the case, the manufacturer shall complement these so that transport is accounted for, based on information from their own supply chain or based on average market data and supply chain analyses

The categories of the transport means and the estimated distances shall be reported in the carbon footprint study.

7 Verification

7.1 Application for verification

The CFB declarant shall lodge an application for verification of the CFB to a notified body according to the Battery Regulation Proposal.
The application shall make it possible to understand the design, material composition and manufacture of the product, as well as all steps taken, and data used in the calculation of the carbon footprint. It shall include at least:

— The name and address of the CFB declarant and, if the application is lodged by the authorised representative, its name and address as well.

— A written declaration that the same application has not been lodged with any other notified body.

— The carbon footprint calculated in line with the present carbon footprint rules.

— The technical documentation described in section 8.2.

The notified body may request further information if needed.

The notified body shall verify and validate the application to determine.

7.2 Technical documentation

7.2.1 Public version of the CFB supporting study

The public version of the carbon footprint study shall give meaningful information to consumers and other end-users on the calculation of the carbon footprint and shall include:

- information about the battery model;
- information about the geographical location of the battery manufacturing plant;
- the total life-cycle carbon footprint expressed in kg CO_2-equivalent per kWh of total energy delivered;
- the carbon footprint of each life cycle stage listed in section 4.2, expressed in kg CO_2-equivalent per kWh of total energy delivered;
- the reference year of the carbon footprint calculation;
- the DQR score and the values of the single DQR criteria calculated in accordance with section 5.5;
- the rated (useable) energy capacity of the battery in kWh and its rated power in kW;
- the total amount of CO_2-equivalent emitted during the life cycle of the battery, expressed in kg CO_2-equivalent, and the total amount of energy provided by the battery over its service life as used for the carbon footprint calculation, in kWh;
- information on each dataset used: the name of the dataset, for which life cycle stage or stages and which process or processes it was used, whether it is a company-specific dataset or a secondary dataset, its source in case of secondary datasets, its values of the DQR criteria, and its time validity;
- information on electricity modelling:
    - where applicable, the energy type used for directly connected electricity generation;
    - where applicable, the specification of which dataset or datasets listed pursuant to point (m) have been used for the average electricity consumption mix;
- information on allocation:
    - indication of the multifunctional processes for which an allocation was applied;
    - which point of the hierarchy in section 6.2.1 was applied in each case and a justification why any earlier points in the hierarchy could not be applied;
    - the justification for a virtual housing approach, where applied;

- information on recycled content and end of life modelling:
- in case of recycled content higher than zero, information on the recycled content share;
- in case of a company-specific collection rate, information on the share of the batteries are covered by an ownership business model;
- the justification for modelling a company-specific battery cell recycling process, where applied.

7.2.2 Non-public version of the CFB supporting study

The carbon footprint study shall document in a systematic, orderly and comprehensive manner all steps taken for calculating the carbon footprint.

It shall include detailed description and documentation of:

— the carbon footprint model used for the calculation;

— any cut-off applied in the modelling, the resulting mass balance gap and an indication to which activity data or dataset the missing mass is assigned;

— the functional unit and all the information needed to calculate it, including, for CM batteries, the technical specification that the manufacturer provides to the customer and containing the specified service life in years, the requested application load profile for which the battery is designed, including operation temperatures (at least average and 90% percentile), depth of discharge, extreme discharge/ charge events, maintenance requirements and replacements of system components, and the total energy that would be provided over lifetime of the system.;

— the details of all the company-specific data, including:

— one or more tables containing all LCI, activity data and elementary flows, the corresponding background dataset used, if applicable, and the values of the DQR criteria of each dataset ('inventory tables'). The tables shall include the list of parameters provided in section 5.1, including the bill of materials or ingredients, such as substance names, units and quantities, information on origin, grades or purities, yield rates, where applicable, recycled content and other technically or environmentally relevant characterisation, the procedure used for company-specific data collection, estimation and calculation, the data source where applicable, the data collection period, and a justification if data collection is done for periods of time other than the default timeframes specified in this Annex;

— to which life cycle stage they belong;

— an indication of whether they have been used for modelling the mandatory company-specific or non-mandatory company-specific processes;

— all data sources, mathematical treatments applied to the data, and any underlying documentation needed to establish the reliability of the company-specific data.

— the details of all secondary and company-specific datasets used, including:

— for non-mandatory most relevant processes, whether secondary or company-specific datasets were used, the method of selecting the datasets including any relevant assumptions and justifications such as the choice of a proxy in the case of TeR equalling four, which datasets were used, whether the electricity in the '-1 level' was changed and, in case it was changed, the justification for such change. In case company-specific datasets were used for non-mandatory most relevant processes in the raw material acquisition and pre-processing life cycle stage, the reference flow, the specific concentration of the target element (if applicable), and other substances contained as impurities in the main product (target material), in concentration or specific content of relevant elements, to allow a proper mass balance check;

— for all secondary datasets the exact name of the dataset, the source, its UUID, location, dataset type ('LCI result' or 'partially terminated'), the values of the DQR criteria, and the time validity;

— for all the company-specific datasets, the exact name of the dataset, its UUID, location, dataset type ('LCI result' or 'partially terminated'), the values of the DQR criteria, and the time validity;

— the details of how the carbon footprint of electricity use was determined, including:

- where applicable, evidence for the values used for directly connected generated electricity;
- where applicable, which datasets have been used for the average electricity consumption mix;
- the details of how allocation was applied, including:
- indication of the multifunctional processes for which an allocation was applied and the allocation factors used;
- which point of the hierarchy in section 6.2.1 was applied in each case with a justification of why any earlier points in the hierarchy could not be applied;
- in case of allocation based on physical relationships, which physical relationship has been used, a justification thereof, and the underlying data sources;
- in case of economic allocation, the prices and the corresponding sources including the considered timespans used for the economic allocation, and justification for any timespans applied that are shorter than the default ones;
- the datasets or activity data to which the allocation factors apply shall be indicated in the inventory tables;
- if allocation is done for energy and auxiliary inputs of production lines as referred to in section 2.5.2, the method applied and a justification thereof;
- the implementation of the virtual housing approach, including all assumptions and dimensioning parameters used with details of the model and experimental values used, including details concerning the reference thickness values for any materials other than aluminium, steel or carbon fibres based material, a tabulated mass balance of the real housing and of the virtual housing, the value of torsional stiffness of the vehicle with battery housing and the value of torsional stiffness of the vehicle without battery housing, and the carbon footprint of the battery when using the real housing;
- the details of the recycled content and end of life modelling, including:
- the parameters used in the CFF for all materials with evidence for the cases where values other than the default values were used;
- in case of recycled content higher than zero, the evidence for the recycled content share;
- in case of a company-specific return rate, the evidence for the share of the batteries that are covered by an ownership business model where the property of the battery stays with the manufacturer together with evidence of the higher return rate, including evidence that the batteries covered under that rate will be recycled in accordance with Regulation (EU) 2023/1542;
- in case of a company-specific battery cell recycling process, the evidence that the batteries will be recycled in a specific recycling plant and that the recycling process corresponds to the battery model for which the carbon footprint is declared;
- the categories of the transport means and the estimated distances;
- the public version of the carbon footprint study.

7.3 Verification and validation techniques

The notified body shall assess whether the carbon footprint declared meets the requirements set out in this Annex. It shall verify that:

a) data and information used for the calculation of the carbon footprint are consistent, reliable and traceable; and

b) calculations performed are correct.

The assessment shall include a review of the carbon footprint study, the public version of the carbon footprint study, and, where appropriate, the model used to calculate the carbon footprint. For batteries manufactured in series, it shall include an assessment visit to:

a) the manufacturer's premises;

b) the cell, anode, and cathode production premises;

c) the cathode active material production premises;

d) the anode active material production premises; and

e) where considered important on the basis of the carbon footprint study, the premises of one or more of any other production sites for which company-specific data were collected.

The notified body shall verify that:

— all secondary datasets used in the model are appropriate and in compliance with the requirements laid out in this Annex;

— all company-specific data used in the model are appropriate and in compliance with the requirements laid out in this Annex, addressing in the verification:

  - coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;
  - plausibility, quality and accuracy of the data;
  - quality and accuracy of the underlying documentation.

— the electricity modelling rules as prescribed in this Annex are correctly applied;

— calculations are of acceptable accuracy, reliable, are appropriate and performed in accordance with requirements laid out in this Annex;

— conversion of measurement units are correctly applied;

— methods for making estimates are appropriate and have been applied consistently.

The notified body shall identify uncertainties that are higher than expected and assess the effect of the identified uncertainty on the total carbon footprint.

7.4 Data confidentiality

Data for verification shall be presented to the notified body in a systematic and comprehensive way. All the documentation supporting the validation shall be provided to the notified body, including the CFB model, confidential information, data, and the CFB supporting study(s) (including the public version of the CFB supporting study). The notified body shall treat all information and data undergoing verification as confidential and shall use them only during the verification process.

The CFB supporting study may exclude confidential data and information, provided that:

— Only input information is excluded and all output information is included.

— It provides the notified body with sufficient information of the nature of the data and information excluded, as well as the reasoning for excluding them.

— The notified body shall evaluate whether the non-disclosed information hinders the review of the CFB.

— The CFB declarant keeps a file of the non-disclosed information for possible future re-evaluation of the decision for non-disclosure.

NOTE: Business data could be of confidential nature because of competition aspects, intellectual property rights or similar legal restrictions. Therefore, business data identified as confidential and provided during the verification process can be kept confidential. Hence, the notified body will not disseminate or otherwise retain for use, without the organisation's permission, any information disclosed to them during the course of the verification process. The CFB declarant could ask the notified body and its verifier(s) to sign a non-disclosure agreement (NDA).

Confidential information and data shall not be included in the public version of the CFB supporting study.

List of abbreviations

AC	Alternating current
ASIB	Aqueous Sodium-Ion Battery
BMS	Battery Management System
CFB	Carbon Footprint of Batteries
CFF	Circular Footprint Formula
CSS	Container Storage System
DC	Direct Current
EF	Environmental Footprint
E/P	Energy-to-Power ratio i.e., the ratio between energy and power rating (kWh/kW)
EMS	Energy Management System
EoL	End Of Life
EV	Electric Vehicle
FCE	Full Cycle Equivalents
FU	Functional Unit
GWP	Global Warming Potential
LCO	Lithium Cobalt Oxide (cathode material)
LFP	Lithium Iron Phosphate (cathode material)
LIB	Lithium-Ion Battery
LMO	Lithium Cobalt Oxide (cathode material)
LTO	Lithium Titanate Oxide (anode material)
Na-S	Sodium-Sulfur (battery)
Na-NiCl	Sodium-Nickel Chloride (battery), also known as ZEBRA battery
NCA	Lithium Nickel Cobalt Aluminium Oxide (cathode material)
NiCd	Nickel-Cadmium (battery)
NiMH	Nickel Metal Hydride (battery)
NiZn	Nickel-Zinc (battery)
NMC	Lithium Nickel Manganese Cobalt Oxide (cathode material)
PbA	Lead Acid (battery)
PCS	Power Conversion System
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PR	Primary Regulation
PV	Photovoltaics
PWB	Printed Wiring Board
RF	Reference Flow
SBS	Stationary Battery System
SIB	Sodium-Ion Battery

TMS	Thermal Management System
UPS	Uninterruptible Power Supply

List of definitions

'Accreditation' means accreditation as defined in Article 2(10) of Regulation (EC) No 765/2008 (Article 2 of Regulation (EU) 2023/1542).

'Active Material' refers to the materials within the battery material which react chemically to produce electric energy when the battery cell discharges or to store electric energy when the battery is being charged. They are the main constituents of the anode and cathode, respectively. For lithium-ion batteries, anode active materials are typically graphites, sometimes doped with silicon, or spinels such as lithium titanate. Cathode active materials (CAM) are typically layered oxides such as NMC or NCA, but also polyanionic materials such as LFP

'active material precursor' means material required for the synthesis of active materials, either cathode active material precursors or anode active material precursors;

'Activity data' means the information associated with processes while modelling Life-cycle Inventories (LCI). The aggregated LCI results of the process chains that represent the activities of a process are each multiplied by the corresponding activity data and then combined to derive the carbon footprint associated with that process (Annex II Regulation (EU) 2023/1542).

'Aggregated dataset' means life-cycle inventory (LCI) of multiple unit processes (e.g. material or energy production) or life-cycle stages (cradle-to-gate), but for which the inputs and outputs are provided only at the aggregated level. NOTE: Aggregated datasets are also called "LCI results", "cumulative inventory" or "system processes" datasets.

'Battery' means any device delivering electrical energy generated by direct conversion of chemical energy, having internal or external storage, and consisting of one or more non-rechargeable or rechargeable battery cells, modules or of packs of them, including a battery that has been subject to preparing for re-use, preparing for repurpose or repurposing, or remanufacturing (Article 2 of Regulation (EU) 2023/1542).

'Battery cell' means the basic functional unit in a battery constituted by electrodes, electrolyte, container, terminals and, if applicable, separators, and containing the active materials the reaction of which generates electrical energy (Article 2 of Regulation (EU) 2023/1542).

'Battery management system' (BMS) means an electronic device that controls or manages the electric and thermal functions of the battery in order to ensure the battery's safety, performance and service life, that manages and stores the data on the parameters for determining the state of health and expected lifetime of batteries laid down in Annex VII and that communicates with the vehicle, light mean of transport or appliance in which the battery is incorporated, or with a public or private charging infrastructure (Article 2 of Regulation (EU) 2023/1542).

'Battery manufacturing waste' means the materials or objects rejected during the battery manufacturing process, which cannot be re-used as an integral part in the same process and need to be recycled (Article 2 of Regulation (EU) 2023/1542).

'Battery module' means a set of battery cells that are connected together or encapsulated within an outer housing to protect the cells against external impact, and which is meant to be used either stand-alone or in combination with other modules (Article 2 of Regulation (EU) 2023/1542).

'Battery pack' means any set of battery cells or modules that are connected together or encapsulated within an outer housing, so as to form a complete unit that the end-user is not intended to split up or open (Article 2 of Regulation (EU) 2023/1542).

'Battery system' refers to batteries of any configuration subject to a mandatory CFB declaration under the Article 7 of Regulation (EU) 2023/1542. In this report, the term 'battery' is used as equivalent.

'Battery due diligence' means the obligations of the economic operator, in relation to its management system, risk management, third party verifications and surveillance by notified bodies and disclosure of information with a view to identifying, preventing and addressing actual and potential social and environmental risks linked to the sourcing, processing and trading of the raw materials and secondary raw materials required for battery manufacturing including suppliers in the chain and their subsidiaries or subcontractors that perform such activities (Article 2 of Regulation (EU) 2023/1542).

'Battery model' means a version of a battery of which all units share the same technical characteristics relevant for sustainability and safety requirements and labelling, marking and information requirements pursuant to this Regulation and the same model identifier (Article 2 of Regulation (EU) 2023/1542).

'Bill of materials' means list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture the product in scope of the study (Regulation (EU) 2023/1542 - Annex II).

'Carbon footprint' means the sum of greenhouse gas (GHG) emissions and GHG removals in a product system, expressed as carbon dioxide (CO2) equivalents and based on a Product Environmental Footprint (PEF) study using the single impact category of climate change (Article 2 of Regulation (EU) 2023/1542).

'CFB-compliant company-specific dataset' means a company-specific dataset that respects the requirements defined in section 5.3. A CFB-compliant company-specific dataset can be either a LCI dataset or a LCIA dataset

'Characterisation factor' means a factor derived from a characterisation model which is applied to convert an assigned life-cycle inventory result to the common unit of a LCIA impact category.

'Circular Footprint Formula' describes how burdens and benefits from disposal and recovery of the product or service assessed as well as use of secondary materials (i.e., recycled content) into that product or service are allocated to the system under study.

'Climate change' is the LCIA impact category considering all inputs and outputs that result in greenhouse gas (GHG) emissions. The consequences include increased average global temperatures and sudden regional climatic changes.

'Company-specific dataset' means a dataset (disaggregated or aggregated) compiled with company-specific data. The activity data and direct elementary exchanges of company-specific data sets shall refer to company-specific information, while the underlying sub-processes may be modelled with company-specific or secondary datasets.

'Conformity assessment' means the process demonstrating whether the sustainability, safety, labelling, information or due diligence requirements of this Regulation have been fulfilled (Article 2 of Regulation (EU) 2023/1542).

'Conformity assessment body' means a body that performs conformity assessment activities including calibration, testing, certification and inspection (Article 2 of Regulation (EU) 2023/1542).

'Data' includes activity data and elementary flows.

'dataset' means a document or file with life cycle information of a specified product or other reference such as a process, covering its descriptive metadata and either its quantitative life cycle inventory in case of a life cycle inventory ('LCI') result dataset or its carbon footprint in case of a life cycle impact assessment ('LCIA') result dataset;

'Data collection period' means the date(s) or time period(s) when the data was collected. Note that this does NOT refer to e.g., the publication dates of papers or books from which the data may stem, but to the original data collection period.

'Distributor' means any natural or legal person in the supply-chain, other than the manufacturer or the importer, who makes a battery available on the market (Article 2 of Regulation (EU) 2023/1542).

'Economic operator' means the manufacturer, the authorised representative, the importer, the distributor or the fulfilment service provider or any other natural or legal person who is subject to obligations in relation to manufacturing batteries, preparing batteries for reuse, preparing batteries for repurpose, repurposing, or remanufacturing, of batteries, making them available or placing them on the market, including on-line placing on the market, or putting them into service in accordance with this Regulation (Article 2 of Regulation (EU) 2023/1542).

'EF-compliant dataset' means dataset developed in compliance with the EF requirements in terms of modelling and methodological compliance (in agreement with the "Commission Recommendation (EU) 2021/2279"); meta data compliance (in agreement with Fazio et al. 2020, "Guide on EF compliant

datasets"); nomenclature, and characterization factors in agreement with the "EF 3.1 Reference Package"). The DQR of each single data quality indicator shall be lower or equal than 3.

'elementary flows' means the materials or energy entering the system being studied that have been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation.;

'Functional unit' means the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated (Article 2 of Regulation (EU) 2023/1542).

'Harmonised standard' means a standard as defined in Article 2(1)(c) of Regulation (EU) No 1025/2012 (Article 2 of Regulation (EU) 2023/1542).

'ILCD entry-level compliant dataset' means a dataset developed in accordance with the compliance rules and entry-level requirements of the International Reference Lifecycle Data System ('ILCD') Data Network, available on the European Platform on LCA, and in accordance with the EF Reference Package, available in the Life Cycle Data Network on the European Platform on LCA ('LCDN'), for nomenclature and characterisation factors compliance;

'Industrial battery' means any battery: - designed specifically for industrial uses, or – intended for industrial uses after being subject to preparing for repurpose or repurposing, or – any other battery with a weight above 5 kg that is not a LMT battery, an electric vehicle battery or a SLI battery (Article 2 of Regulation (EU) 2023/1542).

'Importer' means any natural or legal person established within the Union who places a battery on the market from a third country (Article 2 of Regulation (EU) 2023/1542).

'Independent operator' means a natural or legal person who is independent from the manufacturer and the producer and is directly or indirectly involved in the repair, maintenance or repurposing of batteries, and include waste management operators, repairers, manufacturers or distributors of repair equipment, tools or spare parts, as well as publishers of technical information, operators offering inspection and testing services, operators offering training for installers, manufacturers and repairers of equipment for alternative-fuel vehicles (Article 2 of Regulation (EU) 2023/1542).

'Intermediate product' means the output form of a unit process that in turn is input to other unit processes which require further transformation within the system. An intermediate product is a product that requires further processing before it is saleable to the final consumer

'LCI result dataset' means a dataset modelling a complete or partial life cycle of a product system that, apart from the product flow associated with the reference product, lists only elementary flows;

'LCIA result dataset' means a dataset modelling a complete or partial life cycle of a product system that, apart from the product flow associated with the reference product, lists only the result of the life cycle impact assessment, which in the case where climate change is the only impact category analysed means that the result is the amount of carbon dioxide ('CO_2')-equivalent;

'Life-cycle' means the consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal (ISO 14040:2006 or equivalent) (Article 2 of Regulation (EU) 2023/1542).

'Life-cycle assessment (LCA)' means the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life-cycle.

'Life-cycle inventory (LCI)' means the combined set of exchanges of elementary, waste and product flows in a LCI dataset.

'Life-cycle inventory (LCI) dataset' means a document or file with life-cycle information of a specified product or other reference (e.g., site, process), covering descriptive metadata and quantitative life-cycle inventory. A LCI dataset could be a unit process dataset, partially disaggregated or an aggregated dataset.

'Life-cycle impact assessment (LCIA)' is a phase of the life-cycle assessment that aims to understand and evaluate the magnitude and significance of the potential environmental impacts for a system throughout the life-cycle. The LCIA methods provide impact characterisation factors for elementary flows to aggregate the impact, to obtain a limited number of midpoint and/or damage indicators.

'Life-cycle impact assessment (LCIA) dataset' means a document or file with life-cycle information of a specified product or other reference (e.g., site, process), covering descriptive metadata and quantitative life-cycle impact assessment results.

'Light means of transport battery' or 'LMT battery' means any battery that is sealed and weights below or equal to 25 kg, designed to provide electric power for the traction to wheeled vehicles that can be powered by the electric motor alone or by a combination of motor and human power including type-approved vehicle of category L in the meaning of Regulation (EU) No 168/2013, and that is not an electric vehicle battery. (Article 2 of the Battery Regulation Proposal).

'Making available on the market' means any supply of a battery for distribution or use on the Union market in the course of a commercial activity, whether in return for payment or free of charge (Article 2 of Regulation (EU) 2023/1542).

'Manufacturer' means any natural or legal person who manufacturers a battery or has a battery designed or manufactured, and markets that battery under its own name or trademark or puts it into service for its own purposes (see Article 2 of Regulation (EU) 2023/1542).

'most representative secondary dataset' means the secondary dataset having the highest technological representativeness ('TeR') quality rating or, if there are several datasets with the same TeR, the one with the highest geographical representativeness ('GeR') quality rating, or, in the absence of information on the geographical provenience of the material concerned, the one representing the global average;

'National accreditation body' means a national accreditation body as defined in Article 2(11) of Regulation (EC) No 765/2008 (see Article 2 of Regulation (EU) 2023/1542).

'Notified body' means a conformity assessment body notified in accordance with Chapter V of this Regulation (see Article 2 of Regulation (EU) 2023/1542).

'partially disaggregated dataset' means a dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yields a complete aggregated LCI dataset;

'partially disaggregated dataset at -1 level' means a partially disaggregated dataset that contains elementary flows and activity data for one level down in the supply-chain, while all complementing underlying datasets are in their aggregated form;

'Placing on the market' means the first making available of a battery on the Union market (A Article 2 of Regulation (EU) 2023/1542).

'Rechargeable battery' means a battery that is designed to be electrically recharged (Article 2 of Regulation (EU) 2023/1542).

'Preparing for repurpose' means any operation, by which parts of or a complete waste battery is prepared so that it can be used for a different purpose or application than the one that it was originally designed for.

'Preparation for recycling' means treatment of waste batteries prior to any recycling process, which shall, inter alia, include storage, handling, dismantling of battery packs or separation of fractions that are not part of the battery itself (see Article 2 of Regulation (EU) 2023/1542).

'Producer' means any manufacturer, importer or distributor or other natural or legal person who, irrespective of the selling technique used, including by means of distance contracts as defined in Article 2(7) of Directive 2011/83/EU, alternatively: (i) is established in a Member State and manufactures batteries under its own name or trademark, or has batteries designed or manufactured and supplies them for the first time under its own name or trademark, including those incorporated in appliances, light means of transport or vehicles, within the territory of that Member State; (ii) is established in a Member State and resells within the territory of that Member State, under its own name or trademark, batteries, including those incorporated in appliances, light means of transport or vehicles, manufactured by others. A reseller is not regarded as the 'producer' if the brand of the manufacturer appears on the batteries, as provided for in point (i); (iii) is established in a Member State and supplies for the first time in this Member State on a professional basis, batteries, including those incorporated in appliances, light means of transport or vehicles, from a third country or from another Member State;

(iv) sells batteries, including those incorporated in appliances, light means of transport or vehicles, by means of distance communication directly to end-users, that are either private households or other than private households, in a Member State, and is established in another Member State or in a third country. (Article 2 of Regulation (EU) 2023/1542).

'Putting into service' means the first use, for its intended purpose, in the Union, of a battery, without having been placed on the market previously (Article 2 of Regulation (EU) 2023/1542).

'Rechargeable battery' means a battery that is designed to be electrically recharged (Article 2 of Regulation (EU) 2023/1542).

'Recycler' means any natural or legal person who carries out recycling in a permitted facility (Article 2 of Regulation (EU) 2023/1542).

'Recycling efficiency' of a recycling process means the ratio obtained by dividing the mass of output fractions accounting for recycling by the mass of the waste batteries input fraction, expressed as a percentage (Article 2 of Regulation (EU) 2023/1542).

'Reference flow' means the measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit.

'Remanufacturing' means any technical operation on a used battery that includes the disassembly and evaluation of all its battery modules and cells and the use of a certain amount of battery cells and modules, new, used or recovered from waste, or other battery components, to restore the battery capacity to at least 90% of the original rated battery capacity, and where the state of health of all individual battery cells is homogeneous, not differing more than 3% from one another, and results in the battery being used for the same purpose or application than the one for which the battery was originally designed (Article 2 of Regulation (EU) 2023/1542).

'Representative dataset' means a dataset having a DQR for technological representativeness (TeR) less or equal to 2 and DQR for temporal and geographical representativeness (TiR and GR) lower and equal than 3.

'Repurposing' means any operation that results in parts or the complete battery that is not a waste battery, being used for a different purpose or application than the one that the battery was originally designed for (Article 2 of Regulation (EU) 2023/1542).

'Residual consumption mix' is the energy source mix that is left over once the reliably tracked consumption is taken out from the generation mix. The residual consumption mix is used where an end-user is sourcing electricity from unknown origin: the energy source mix of it shall be considered as residual consumption mix. A residual consumption mix is an integral part of an energy certificate system for disclosure towards consumers, in order to prevent double counting in energy source disclosure.

'Secondary data' means data not from a specific process within the supply-chain of the company performing a carbon footprint study. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third party LCI database or other sources. Secondary data includes industry average data (e.g., from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and may also be based on financial data, and contain proxy data, and other generic data.

'Secondary datasets' refers to any dataset that is not company-specific, e.g., from a database.

'SLI battery' means any battery designed to supply electric power for starter, lighting, or ignition and may also be used for auxiliary or backup purposes in vehicles, other means of transport or machinery; Starting, lighting and ignition (Article 2 of Regulation (EU) 2023/1542).

'State of charge' means the available energy in a battery expressed as a percentage of rated capacity as declared by the manufacturer (Article 2 of Regulation (EU) 2023/1542).

'State of health' means a measure of the general condition of a rechargeable battery and its ability to deliver the specified performance compared with its initial condition (Article 2 of Regulation (EU) 2023/1542).

'Stationary battery energy storage system' means an industrial battery with internal storage specifically designed to store and deliver electric energy from and into the grid or store and deliver electric energy to end-user, regardless of where and by whom this battery is being used (Article 2 of Regulation (EU) 2023/1542).

'System boundary' indicates which aspects is included or excluded from the life-cycle study (Annex II of the Battery Regulation Proposal). The system boundary defines which parts of the product life-cycle and which associated life-cycle stages and processes belong to the analysed system (i.e. are required for carrying out its function as defined by the functional unit), except for those processes excluded based on the cut-off rule.

'Technical specification' means a document that prescribes technical requirements to be fulfilled by a product, process or service (Article 2 of Regulation (EU) 2023/1542).

'Technological proxy dataset' means process dataset describing an alternative product for which process data exist and it is assumed to have similar carbon footprint to the process in scope. Suitable proxy process datasets may differ for technological scope from the target process, but it shall involve the same life-cycle stages.

'Technologically representative secondary dataset' means that the secondary dataset has a Technological Representativeness (section 6.3.4) ≤ 4.

'Regional storage' physical place, located in the EU, where batteries are stored before they are transported to the place of installation.

'Treatment' means any activity carried out on waste batteries after they have been handed over to a facility for sorting, preparing for re-use, preparing for repurpose, preparation for recycling, or recycling' (Article 2 of Regulation (EU) 2023/1542).

'Tracking system' (electricity) means a system applying the process of assigning electricity generation attributes to electricity consumption.

'Unit process' means the smallest element considered in the LCI for which input and output data are quantified (based on ISO 14040:2006).

'Useable energy capacity' means the energy discharge capacity of the battery that can effectively be discharged from the battery under consideration of the limitations set by the BMS (such as maximum depth of discharge for increasing lifetime).

'Waste battery' means any battery which is waste within the meaning of Article 3(1) of Directive 2008/98/EC (Article 2 of Regulation (EU) 2023/1542).

The definitions of 'waste', 'waste holder', 'waste management', 'prevention', 'collection', 'separate collection', 'extended producer responsibility scheme', 'reuse', 'preparing for re-use', 'material recovery' and 'recycling' laid down in Article 3 of Directive 2008/98/EC shall apply (Article 2 of Regulation (EU) 2023/1542).

The definitions of 'market surveillance', 'market surveillance authority', 'fulfilment service provider', 'corrective action', 'end-user', 'recall' and 'withdrawal', as well as of 'risk' in relation to requirements of Chapters I, IV, VI, VII, IX and Annex V, Annex VIII and Annex XIII, laid down in Article 3 of Regulation (EU) 2019/1020 shall apply (Article 2 of Regulation (EU) 2023/1542).

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