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# Harmonised rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV)

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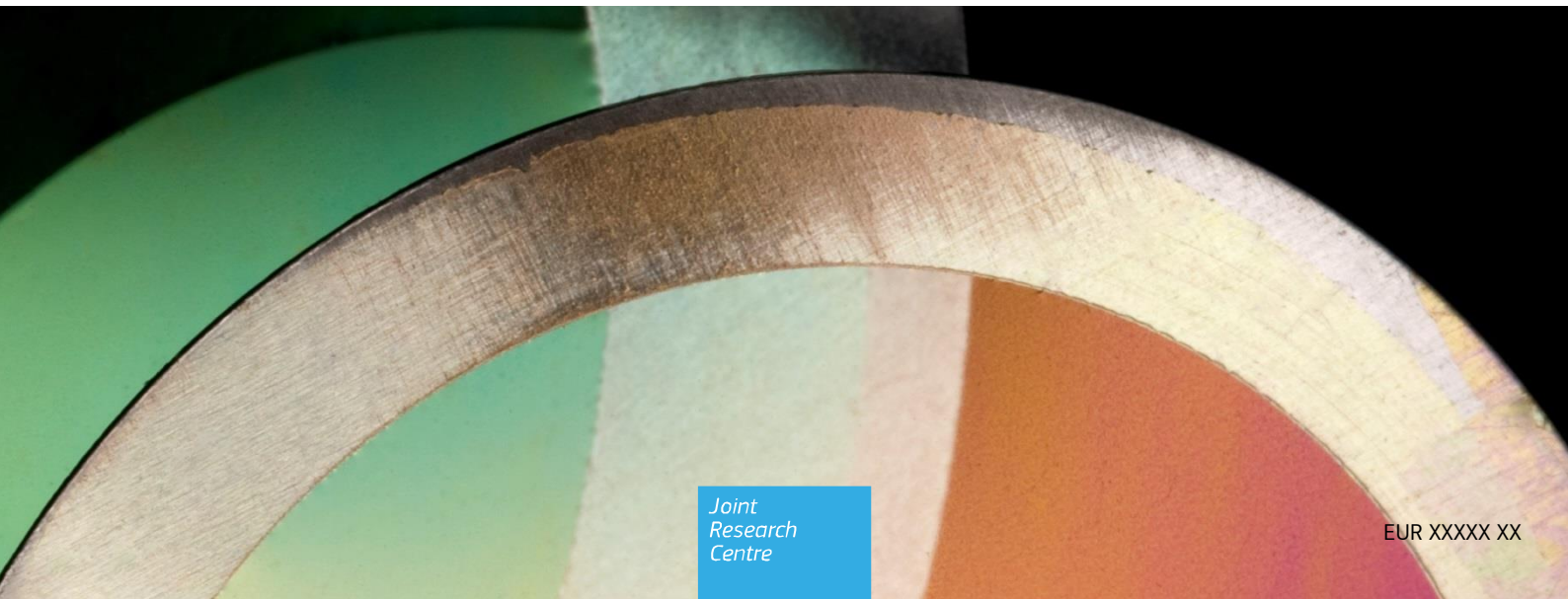
2023



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## Abstract

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## Executive summary

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# 1 Introduction

The European Union aims at being carbon neutral by 2050[1,2] and has implemented several legislations to support this transition and the sustainable development of new technologies.

Batteries are a strategic enabler to face several challenges of the current society, such as green mobility, green energy, and climate neutrality, as demonstrated by the increasing demand for batteries in several sectors. In the European Green Deal, the Commission already presented its commitment to propose legislation to ensure a safe, circular, and sustainable value chain for all batteries, including the supply of the growing market of electric vehicles. In this regard, the Battery Regulation Proposal establishes a harmonized legal framework to address the entire life cycle of batteries and provides a legal certainty to all the operators working in the supply chain by including uniform product requirements, conformity assessment procedures, and end-of-life requirements to support the recycling market.

The Battery Regulation Proposal is currently composed of 79 articles and 14 Annexes and set some rules on sustainability parameters, performance, safety, collection, recycling and second life of batteries as well as on information requirements about batteries. One of the sustainability parameters to be calculated and communicated is the carbon footprint of the batteries (CFB) specified in Article 7 of the same Regulation. The CFB quantifies the total amount of greenhouse gases as g $CO_2$ equivalent per one kWh of the total energy provided by the battery over its expected service life. 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, this Regulation will ensure that the expected massive deployment of batteries (e.g., in mobility) will be associated with minimum overall carbon emissions.

The development of the CFB shall be in line with elements included in the Annex II of the Battery Regulation Proposal and building on methodological aspects as in the latest version of the European Commission's Product Environmental Footprint (PEF) method and relevant Product Environmental Footprint Category Rules (PEFCRs). Also, technical/scientific progress in the area of life cycle assessment (e.g., to what concern life cycle impact assessment) should be reflected.

The Joint Research Centre (JRC) of the European Commission is responsible for providing technical support to the development of the secondary legislation on the CFB (in line with the requirements of the Battery Regulation Proposal – Annex II).

For the drafting of the present document, the Battery Regulation Proposal version of the 18th of January 2023[3] has been considered as the reference policy document. Article 7(1) of the Battery Regulation Proposal states that the CFB declaration will apply in different moments to EV batteries, rechargeable industrial batteries excluding those with exclusively external storage, LMT batteries, and rechargeable industrial batteries with external storage. EV batteries will be the first "18 months after entry into force of the Regulation or 12 months after the entry into force either of the delegated act or of the implementing act". For this reason, the present JRC report suggests possible CFB rules only for EV batteries, as further specified in Section 2.

Unless otherwise specified in this document, the EC Recommendation 2021/2279[4] shall be considered as general guidelines about how to determine the carbon footprint.

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[1] EC, The European Green Deal, COM/2019/640, 2019. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN .

[2] EC, A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy, COM (2018) 773, 2018. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018DC0773 .

[3] EU, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020, 2023. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=consil:ST_5469_2023_INIT

[4] EC, Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations, 2021. Available at https://eur-lex.europa.eu/eli/reco/2021/2279/oj.

*NOTE: The text of carbon footprint rules has been kept as much 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).*

## 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.
- 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

The CFB shall be declared for any EV battery that falls within the scope of Article 7 of the Battery Regulation Proposal, independent of its cell chemistry and of the actual service it will provide within the specific application. The scope of the CFB excludes batteries that have been subject to preparing for re-use, preparing for repurpose or repurposing, or remanufacturing, if the batteries had already been placed on the market or put into service before undergoing such operations (according to the Battery Regulation Proposal – Article 7 – point 3b).

*NOTE: Even if currently the most common chemistry for EV batteries is lithium-ion, the CFB rules for EV set out in the present document are as general as possible to be applicable also to other chemistries or to chemistries under development. The CFB rules could be updated in future to address more precisely specific aspects of emerging chemistries (like Mg-S, Aluminium) especially once they will achieve market maturity. Similar considerations apply to emerging anode/cathode materials for any of the possible battery chemistries and to other battery technologies.*

Unless otherwise specified in this document, the EC Recommendation 2021/2279 shall apply to providing general guidelines about how to determine the carbon footprint.

# 3 Functional Unit and Reference Flow

### *3.1.1* Functional unit for energy-providing batteries

For energy-providing batteries such as EV batteries, the **functional unit** is defined (according to the Battery Regulation Proposal – Annex II) as: *"one kWh (kilowatt-hour) of the **total energy** provided over the **service life** by the battery system, measured in kWh"*. 'Battery system' refers to batteries of any configuration subject to a mandatory CFB declaration under Article 7 of the Battery Regulation Proposal. In the following, the term 'battery' is used as equivalent.

The **total energy** (in kWh), equivalent to the **quantity of functional unit** is the total amount of electricity (in kWh) provided by the battery over its service life.

Two different approaches are used for quantifying the total energy provided over the service life, based on two different definitions of service life:

— For light duty plug-in electric vehicle batteries (categories 1-1, 1-2 and 2 according to the UN GTR No. 22[5]), the total energy shall be calculated by multiplying (a) the service life (expressed in km) with (b) the worst-case certified energy consumption of the corresponding Part B vehicle family, according to sections 5.2 and 6.1.2 of the UN GTR No. 22 (Wh/km). The service life is defined as the number of km driven until the battery reaches a State of Certified Energy (SOCE) monitored by the Battery Management System (BMS, according to the Battery Regulation Proposal - Annex VII) equal to 70% for category 1 vehicles and equal to 65% for category 2 vehicles (as specified in the Annex II of the Euro7 proposal[6]). The default service life is assumed to be 160,000 km, according to UN GTR No. 22 minimum performance requirements. The CFB declarant may declare a higher service life (expressed in km), providing documentation in support of the claim in the CFB supporting study. In this case, the corresponding total energy shall be consistent with the expected lifetime in terms of cycles (as to be declared according to Annex IV of the Battery Regulation Proposal) and with the rated energy capacity. Both the service life and the energy consumption used for the calculation of the functional unit shall be reported in the CFB supporting study.

*NOTE: The UN GTR No. 22 is a Global Technical Regulation that aims at providing "a worldwide harmonized method to set and verify minimum performance requirements on in-vehicle battery durability of Pure Electric Vehicles (PEVs) and Off-Vehicle Charging Hybrid Electric Vehicles (OVC-HEVs)". The UN GTR No. 22 states that the manufacturers have to install systems that monitor the SOCE (State of Certified Energy) and SOCR (State of Certified Range) during the life of the vehicle. The battery durability requirements define that the vehicle battery shall reach a minimum value of SOCE and SOCR at different specific points in the lifetime of the vehicles. The minimum values depend on the type of vehicle. For example, one of the Minimum Performance Requirements (MPRi) for Vehicle categories 1-1 and 1-2 in the scope of the GTR states that the SOCE shall be at least 80% after 100,000 km or 5 years and 70% after 160,000 km or 8 years. Higher values of SOCE may be declared as Declared Performance Requirement (DPRi).*

*NOTE: in support to the possibility to declare a higher service life than 160,000 km are the Annex II and Annex IV of the EURO7 proposal that also allow to declare a higher minimum lifetime.*

— For all other EV batteries under Article 7, the total energy (in kWh) shall be calculated by multiplying (a) the service life in cycles with (b) average amount of delivered energy over each cycle. The service life is defined as in Article 10 Annex IV of the battery Regulation Proposal as the expected lifetime under the reference conditions for which they have been designed in terms of cycles. The average amount of delivered energy over each cycle is equivalent to the rated energy capacity of the battery multiplied by the average discharge depth during each cycle of the cycle life test and by the medium value between initial SOCE (100%) and end-of-life SOCE. Both the service life and the rated energy capacity used for the calculation of the functional unit shall be reported in the CFB supporting study.

[5] UNECE, 2022, UN GTR No.22 (In-vehicle Battery Durability for Electrified Vehicles), available at https://unece.org/sites/default/files/2022-04/ECE_TRANS_180a22e.pdf

[6] EC (2022), Annex to the Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on type-approval of motor vehicles and engines and of systems, components and separate technical units intended for such vehicles, with respect to their emissions and battery durability (Euro 7) and repealing Regulations (EC) No 715/2007 and (EC) No 595/2009. Available at https://eur-lex.europa.eu/resource.html?uri=cellar:9a25dc0b-60db-11ed-92ed-01aa75ed71a1.0001.02/DOC_2&format=PDF

*NOTE: The service life definition will be updated when a CEN/CENELEC standard for the expected lifetime will be developed.*

The **reference flow** is the amount of product needed to fulfil the defined function and shall be measured in kg of battery per functional unit. All quantitative input and output data collected by the CFB declarant to quantify the carbon footprint shall be calculated in relation to this reference flow.

The reference flow is calculated as the total mass of battery divided by the quantity of functional unit.

Additional services (e.g., fast charging, extended temperature range) are considered as secondary functions and shall not be measured in the functional unit. Information related to additional services may be separately disclosed, including the type of additional service provided and related standards (if any), and the environmental impact that may be associated to these additional services.

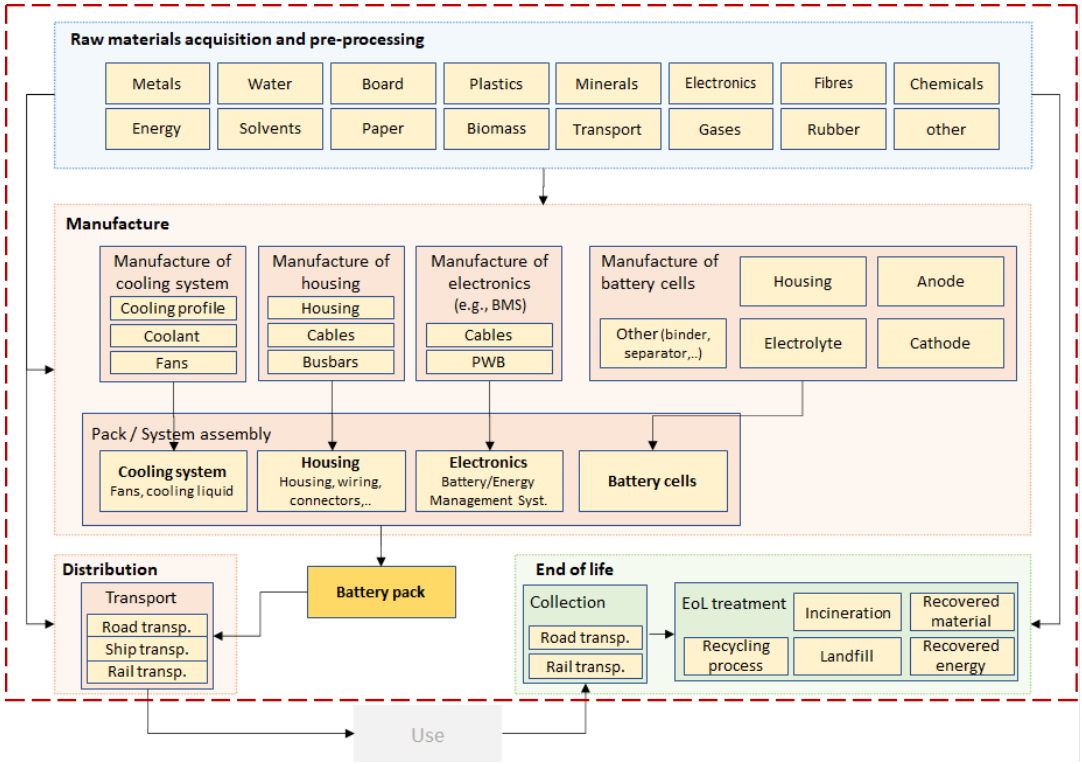
# 4 System Boundaries

The following life cycle stages (Figure 1) shall be included in the system boundaries:

- **Raw materials acquisition and pre-processing**: Includes mining and pre-processing, up to the manufacturing of components like casings and electric/electronics components.
- **Manufacturing of the battery system**: Production of cell components, assembly of cells and assembly of batteries with the cells and the electric/electronic components, including energy demand for manufacture and cell formation and other auxiliary inputs and emissions.
- **Distribution**: Final product distribution and transport to consumer, end-use customer or regional storage.
- **End-of-life (EoL)**: Collection, dismantling, recycling, and disposal.

The use-phase is, according to Article 7 and Annex II of the Battery Regulation Proposal, explicitly excluded from the CFB.

**Figure 1.** System boundaries (battery system manufacturing). PWB: Printed Wiring Board




Manufacturing of equipment (capital goods) may be excluded, as impacts have been calculated as negligible according to the Product Environmental Footprint Category Rules (PEFCR) for batteries[7]. The battery assembly process with the original equipment manufacturer (OEM) system components shall also be excluded according to the Battery Regulation Proposal. Beyond these, the only allowed cut-off are described in Sections 4.1 to 4.4.

[7] Recharge, PEFCR - Product Environmental Footprint Category Rules for High Specific Energy Rechargeable Batteries for Mobile Applications, 2018. Available at https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_Batteries.pdf.

## 4.1 Raw material acquisition and pre-processing

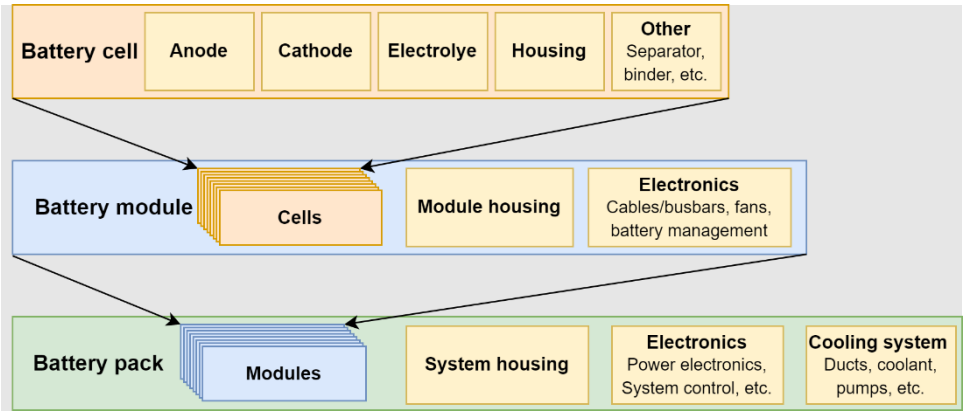
The raw material acquisition and pre-processing stage covers the extraction of resources from nature and their pre-processing until their use in product components entering (through the gate of) the battery's production facility, as described in the system boundaries (section 4). Transport of raw materials and intermediate products within and between extraction and pre-processing facilities until the battery manufacturing plant and packaging production shall be included in this life-cycle stage. Precursor production shall be included in this stage.

The use of secondary material as recycled content shall be modelled according to the Circular Footprint Formula (CFF) described in section 6.6.

## 4.2 Manufacturing

Batteries falling under the scope of this document are usually comprised of several battery cells grouped together forming a battery system. Given the wide range of applications these systems are designed for, they may come in very diverse layouts and system configurations. Typically, several battery cells are grouped together to form battery modules, which are then mounted together in a specific structure to form a battery pack for electric vehicles. A schematic representation of the considered system components is provided in Figure 2.

**Figure 2.** System components.




The manufacturing stage includes: (i) the anode and cathode production (electrode active material production and raw material preparation), (ii) the manufacture of cell components (e.g., cathode and anode, ink preparation, coating, calendaring, and slitting), (iii) assembly of cells and (iv) battery assembly with the cells and the electric/electronic components, including energy demand for manufacture and cell formation and other auxiliary inputs and emissions.

The battery manufacturing waste shall be considered in the mass balances (accounting for the corresponding inputs and outputs) and its treatment shall be modelled in this stage using the CFF (section 6.6). Scraps that are processed and re-used within the manufacturing plant ('run-around scrap') shall be disregarded, but the corresponding emissions and process inputs shall be accounted for in the manufacturing plant. The use of secondary material as recycled content shall be modelled according to the CFF.

Auxiliary inputs to the manufacturing plant that are not directly related to the battery production process (such as heating and lighting of associated office rooms, secondary services etc.) may be excluded from the system boundaries.

*NOTE: the auxiliary inputs to the manufacturing stage were estimated to be negligible: assuming a consumption of a generic office as 293 kWh/m$^2$ [8], and assuming a production area of 267,000 m$^2$ (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.*

## 4.3 Distribution

The distribution stage considers the transport of the battery from the manufacturing site to the final use site (or to a reference entry point into the market) and the storage at various points along the supply chain. The CFB shall consider the transport impacts associated with this stage. Waste from products used during this stage shall be modelled with the circular footprint formula (CFF; Section 6.6), and the results shall be included under this stage.

## 4.4 End-of-life

The end-of-life (EoL) stage begins when the product in scope and its packaging is discarded by the user and ends when the product in scope is returned to nature as a waste product or enters another product's life cycle (i.e., as a recycled input). Waste generated during the manufacturing, distribution, retail, or after use shall be included in the life cycle of the product and modelled at the life cycle stage where it occurs.

The EoL stage includes: (i) collection and pre-treatment of the waste batteries, (ii) sorting and transport to the EoL treatment facility, (iii) dismantling of the battery and its components i.e., its disassembly into battery cells and other system components, (iv) their transport to their corresponding recycling sites, (v) disassembly of components, crushing and shredding, and (vi) separation and conversion into recycled material; accounting for the specific process inputs and energy demand of the recycling processes. In case shredding or other pre-treatment processes are needed as a first (recycling) treatment, their energy consumption and emissions shall be included.

The waste management (including the benefits of producing secondary materials) shall be modelled according to the CFF.

8 Luis Pérez-Lombard, José Ortiz, Christine Pout, A review on buildings energy consumption information, Energy and Buildings, Volume 40, Issue 3, 2008, Pages 394-398, ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2007.03.007.

# 5 Impact Assessment

The impact assessment shall be done for the global warming potential (GWP100) impact category using the EF3.1 impact assessment method[9] and be reported in g $CO_2$eq/kWh.

[9] EC, Developer Environmental Footprint (EF), 2023. Available at https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.

# 6 Inventory Data

The datasets used in the CFB shall be compliant with the EF requirements:

- For all elementary flows, the nomenclature shall be aligned with the most recent version of the EF reference package available on the EF developer's page[10].
- For the process datasets and product flow, the nomenclature shall be compliant with the 'ILCD Handbook – Nomenclature and other conventions[11].

For transport, company-specific activity data (i.e., transport distances and means of transport) may be used in combination with EF-compliant datasets according to the hierarchy in section 6.3. If company-specific activity data is not available, standard transport distances shall be used according to EC Recommendation 2021/2279 (Annex I - section 4.4.3.4). The choices shall be documented in the CFB supporting study.

## 6.1 Mandatory company-specific data and datasets

Company-specific data shall be used for all the processes of the manufacturing stage. All activity data and direct elementary flows in the manufacturing stage (e.g., related to battery's anode, cathode, electrolyte, separator and cell-casing) shall refer to a specific battery model produced in a specific production plant (i.e., no default activity data shall be used). More detailed guidelines on company-specific data collection requirements are provided in Section 6.2 and on data collection requirements for the manufacturing stage in Annex 2.

*NOTE: the availability of the company-specific data to the CFB declarant is insured by the article 38a of the Battery Regulation Proposal that states that "The supplier of battery cells and battery modules shall provide the information and documentation necessary to comply with the requirements of this regulation when supplying battery cells or modules to the manufacturer. The information shall be provided free of charge".*

Company-specific data shall be used to build company-specific datasets in combination with company-specific datasets (see Section 6.2 on data collection requirements) or with secondary datasets (the hierarchy for the selection of secondary datasets is provided in section 6.3). All the company-specific datasets shall be EF-compliant.

For electricity, the specific rules laid out in section 6.8 shall be followed.

## 6.2 Company-specific activity data and elementary flow collection requirements

For the processes mentioned in Section 6.1, activity data and elementary flows on all inputs and outputs shall be collected, as indicated below.

**Inputs**

- Material inputs that end up in the product, e.g., minerals or metals, semi-finished materials, chemical feedstocks etc.
- Energy that is consumed directly and indirectly in the processing plant, e.g., electricity, steam, thermal energy required by the process, but also energy and fuels required for auxiliary activities such as transport or forklift within the plant premises.
- Auxiliaries, e.g., chemicals, cleaning material, lubricants, refrigerants.
- Water.

**Outputs**

- Products and by-products.
- Waste, wastewater and all kind of recovered materials.

[10] EC, Developer Environmental Footprint (EF), 2023. Available at https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.

[11] https://eplca.jrc.ec.europa.eu/uploads/MANPROJ-PR-ILCD-Handbook-Nomenclature-and-other-conventions-first-edition-ISBN-fin-v1.0-E.pdf

— Direct process emissions, e.g., $CO_2$ from the use of reductants and any other greenhouse gases.

— Combustion emissions.

Direct process emissions (e.g., oxidation of carbonaceous material during smelting or calcination or fuel combustion emissions) that are additional to the corresponding energy process (not accounted for within the corresponding dataset) and that are not monitored via measurements shall be estimated based on stoichiometric calculations.

All inputs and outputs above relate to continuous or semi-continuous industrial processes. For such processes, measurements shall be collected:

— At the points of consumption or emission directly relative to the process considered for the battery in the scope.

— If some of these data are not available (for example, the battery process is run in the same plant with multiple other processes) then a calculation for an allocation of the flows is allowed according to section 6.7, if appropriate documentation is provided in the CFB supporting study.

Company-specific data collection shall be done on an annual basis (either the most recent calendar year or fiscal year) and be provided as a yearly average. If the product for which the carbon footprint applies is produced for less than 12 months, the data shall be collected for the time period in which the product is manufactured or from the beginning of the year until the stop of production. More detailed guidelines on the company-specific data collection are provided in the Annex 1 to 3.

A company quality system (i.e., ISO 9001 or equivalent) shall be in place in order to demonstrate that the measured values are representative of a yearly average of the elementary flows dedicated to the manufacturing of the battery in the scope.

If the CFB declarant has access to company-specific data for non-mandatory processes along the supply chain, he/she may use such data following the rules of the Data Needs Matrix (see section 6.5).

## 6.3 Hierarchy for the selection of secondary datasets

The selection of the secondary datasets to be used shall be done according to the following hierarchy:

1. Use an EF-compliant dataset representative for the considered product/process registered on the Life Cycle Data Network (LCDN)[12].
2. Use an EF-compliant dataset representative for the considered product/process available from other sources.
3. Use another EF-compliant dataset as a technological proxy dataset. In such case, this information shall be included in the 'limitations' section of the CFB supporting study.
4. Use an ILCD entry level compliant dataset as a technological proxy dataset. A maximum of 10% of the overall CFB may be derived from ILCD entry level compliant datasets. The nomenclature of the elementary flows of the dataset shall be aligned with the EF 3.1 reference package. In such case, this information shall be included in the 'limitations' section of the CFB supporting study.

## 6.4 Data quality requirements

The data quality rating (DQR) shall be based on EC Recommendation 2021/2279 (Annex I, section 4.6.5).

## 6.5 Data needs matrix (DNM)

All processes required for modelling of the product and outside the list of mandatory company-specific data listed in section 6.1 shall be evaluated using the Data Needs Matrix (DNM) illustrated in Table 1. The DNM indicates for which processes company-specific data or secondary data shall or may be used, depending on the level of influence the CFB declarant has on the specific process. The following three cases are found in the DNM and are explained below:

[12] EC, Welcome to the Life Cycle Data Network, 2023. Available at https://eplca.jrc.ec.europa.eu/LCDN/.

1. Situation 1: the process is run by the CFB declarant.
2. Situation 2: the process is not run by the CFB declarant, who has however access to company-specific information.
3. Situation 3: the process is not run by the CFB declarant, who does not have access to company-specific information.

**Table 1.** Data needs matrix of the carbon footprint of batteries. *The most-relevant processes are those that together contribute more than 80% to the CFB. Identical processes taking place in different life-cycle stages (e.g. transportation, electricity use) shall be accounted for separately. Identical processes taking place within the same life-cycle stage shall be accounted for together.

| **Situation** | **Requirement** |
|---|---|
| Situation 1: the process is run by the CFB declarant | Provide company-specific data (both activity data and direct emissions) and create an EF-compliant company-specific dataset that has a DQR≤1.5, calculated following the rules in the EC Recommendation 2021/2279 (Annex I, section 4.6.5.2). The selection of the background secondary datasets shall follow the hierarchy in section 6.3. |
| Situation 2: the process is not run by the CFB declarant, who has however access to company-specific information 6.1. | Provide company-specific data (both activity data and direct emissions) and create an EF-compliant company-specific dataset that has a DQR≤1.5, calculated following the rules in the EC Recommendation 2021/2279 (Annex I, section 4.6.5.2). The selection of the background secondary datasets shall follow the hierarchy in section 6.3.<br>Or<br>Use an EF-compliant secondary dataset (following the first three steps of the hierarchy in section 6.3) and apply company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets. Recalculate the DQR of the dataset used following the rules in the EC Recommendation 2021/2279 (Annex I, section 4.6.5.3). |
| Situation 3: the process is not run by the CFB declarant, who does not have access to company-specific information 6.1. | Use an EF-compliant secondary dataset (following the first three steps of the hierarchy in section 6.3) in aggregated form. In the case of a most-relevant process*, the CFB declarant shall make the DQR criteria context-specific by re-evaluating TeR, TiR and GeR following the rules in the EC Recommendation 2021/2279 (Annex I, section 4.6.5.3), while P shall keep the original value. For the non-most-relevant processes, the CFB declarant shall take the DQR values from the original dataset. |

## 6.6 Modelling of waste and recycled content

The waste of products used during the manufacturing, distribution or after use shall be included in the modelling of the life cycle of the product. This shall be modelled and reported at the life cycle stage where the waste management occurs.

The end-of-life stage may be modelled using the standard process models (Annex 3) when these processes are performed by external/third-party companies. Company-specific activity data or company-specific datasets may be used for the waste batteries being recycled within the own premises or via a specific-recycling process if the corresponding evidence is provided in the CFB supporting study.

The Circular Footprint Formula (CFF) shall be used to model the End-of-Life of products as well as the recycled content and is a combination of "material + energy + disposal":

Material:

$$(1 - R_1) * E_v + R_1 * \left( A * E_{recycled} + (1 - A) * E_v * \frac{Q_{Sin}}{Q_p} \right) + (1 - A) * R_2 * \left( E_{recyclingEoL} - E_v^* * \frac{Q_{Sout}}{Q_p} \right)$$

Energy: $(1 - B) * R_3 * (E_{ER} - LHV * X_{ER,heat} * E_{SE,heat} - LHV * X_{ER,elec} * E_{SE,elec})$

Disposal: $(1 - R_2 - R_3) * E_D$

### 6.6.1 Parameters of the CFF

- A: allocation factor of burdens and credits between supplier and user of recycled materials.
- B: allocation factor of energy recovery processes. It applies both to burdens and credits.
- $Q_{sin}$: quality of the ingoing secondary material, i.e., the quality of the recycled material at the point of substitution.
- $Q_{Sout}$: quality of the outgoing secondary material, i.e., the quality of the recyclable material at the point of substitution.
- $Q_p$: quality of the primary material, i.e., quality of the virgin material.
- $R_1$: the proportion of material in the input to the production that has been recycled from a previous system.
- $R_2$: the proportion of the material in the product that will be recycled (or reused) in a subsequent system. $R_2$ shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant
- $R_3$: the proportion of the material in the product that is used for energy recovery at EoL.
- $E_{recycled}$ (Erec): specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.
- $E_{recyclingEoL}$ (ErecEoL): specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process.
- $E_v$: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material.
- $E^*_v$: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.
- $E_{ER}$: specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, etc.).
- $E_{SE,heat}$ and ESE,elec : specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively.
- $E_D$: specific emissions and resources consumed (per functional unit) arising from the disposal of waste material at the analysed product's EoL, without energy recovery.
- $X_{ER,heat}$ and $X_{ER,elec}$: the efficiency of the energy recovery process for both heat and electricity
- LHV: lower heating value of the material in the product used for energy recovery.

The following default values of the CFF parameters shall be used:

- Parameter A=0.2 for metals and 0.5 for plastics.
- Parameter B=0.
- Parameter $R_1$ (recycled content): By default, $R_1$ is equal to zero for all the materials, unless a different value is declared. When using a company-specific $R_1$ values other than 0, traceability throughout the supply chain is necessary, and evidences shall be provided in the CFB supporting study for verification. Material-specific values based on supply market statistics shall not accepted as a proxy for $R_1$.
- Parameter $R_2$ (recycling rates): $R_2$ default values for battery materials shall be used as provided in Table 2. Default values for additional materials shall be based on the EC Recommendation 2021/2279 (Annex II -

part C)[13]; for all other materials, it shall be assumed that $R_2$ =0. Company-specific $R_2$ values may be used only if verifiable evidence is provided together with the CFB supporting study (e.g., the setting of an own take-back scheme which allow to recycle the battery on specific plants).

*NOTE: $R_2$ values in Tab should be considered as preliminary, to be modified based on the PEFCR Battery currently under review.*

— Similarly, also the quality ratio $Q_{sout}/Q_p$ associated to the recycled content and Parameter R3 shall be taken from the general EC Recommendations 2021/2279 (Annex II - part C) unless evidence is provided for the use of diverging values.

*NOTE: For determining company-specific values for R1, the information about the recycled content within a raw material (e.g., metal sulphate), the precursors, active materials and the cell should be handed over to the next process step / manufacturer over the entire battery value chain. Manufacturers could request the corresponding information from their suppliers and verify it.*

**Table 2.** Default R2 values for specific battery materials

| Material | Default R2 | Specification |
|---|---|---|
| Nickel, cobalt, manganese | 0.95 | Cathode precursor metal salts |
| Iron and titanate | 0 | Cathode and anode precursor metal salts |
| Lithium | 0 | Lithium salts in the anode and cathode |
| Lithium, organics | 0 | Lithium salts and solvents in the Electrolyte |
| Graphite, hard carbon, silicon, etc. | 0 | Anode active materials |
| Other metals (e.g., aluminium, steel, copper) | 0.95 | Metals contained in the battery in metallic form |
| Plastic, polymers | 0.50 | Plastic in the casing. |

## 6.7 Allocation rules

If a process or facility provides more than one function, i.e., it delivers several goods and/or services ('coproducts'), it is 'multifunctional'. In these situations, all inputs and emissions linked to the process shall be partitioned between the product of interest and the other co-products in a principled manner. Systems involving multi-functionality of processes shall be modelled in line with the decision hierarchy as in EC Recommendations 2021/2279 (Annex I – section 4.5).

If economic allocation is applied, minimum 12 months global price averages shall be used, with the allocation factors and underlying data sources disclosed in the CFB supporting study.

### 6.7.1 Economic allocation in processes where base metals and precious metals are in the output

When the 'raw material acquisition and pre-processing' stage is modelled with company-specific data, economic allocation shall be applied where platinum group metals (iridium, osmium, palladium, platinum, rhodium, ruthenium) or other precious metals (e.g., gold and silver) are separated from base metals or other low value fractions. Economic allocation shall be applied only at the process step where the precious metal is extracted, as the economic value and mass output is very disparate compared to base metals, such as copper, nickel or cobalt.

10-year average global market prices shall be applied to avoid the impact of high volatility of metals in the global market. The used market prices shall reflect the specific conditions in terms of e.g., purity or other properties which have an impact on the global market price. The prices and the sources used for the economic allocation shall be reported in the CFB supporting study.

[13] List of values for R2 are available at: https://eplca.jrc.ec.europa.eu/permalink/Annex_C_V2.1_May2020.xlsx

### 6.7.2 Allocation of energy and auxiliary inputs of production lines

If company-specific data is collected for energy auxiliary inputs or other consumables and subdivision is not possible, allocation of the corresponding inputs may be done. This applies if only one meter (e.g., for electricity) is available for several production lines of a plant or if a process step (e.g., dry room) processes products from different production lines. The following preference order applies:

— Allocation by mass or other physical properties that most closely represent the drivers for the corresponding input

— Allocation using the installed capacity or another appropriate criterium.

This may only be done if the production steps, production equipment, and the products themselves are similar, e.g., battery cells with the same geometry, but different properties. The chosen method needs to be reported and documented in the CFB supporting study, including the reasoning why the approach was taken. Especially if a proprietary criterium is used the rationale for its choice shall be clearly explained and justified. In all cases, the sum of the allocation shall equal the total energy consumption (measured).

### 6.7.3 Allocation and modelling of the battery casing/housing in EV batteries

The casing/housing of the EV battery delivers the following functions: A) holding the cells or modules; B) integrating the battery cooling system and / or insulation.

In case of battery casing/housing providing additional functions to the electric vehicle (e.g., torsional stiffness, crash resistance, etc) beyond the two main functions A) and B) above, then the modelling of the battery casing/housing may be done as following (in hierarchical order) if corresponding justification is provided in the CFB supporting study:

1. i) physical partitioning: the components of the casing/housing that provide one or more functions to the electric vehicle (and not contributing to functions A) and B) above) shall be excluded from the system boundary.
2. ii) virtual casing/housing approach: when physical partitioning is not feasible, a virtual casing/housing shall be modelled (i.e., the size of the casing/housing shall be re-calculated according to the size of the battery and a reference thickness for each material). The virtual casing/housing shall be modelled as:
    (a) The size of the casing/housing will be re-calculated according to the size of the battery. Based on the actual Length (**L**), the Width (**W**) and the Hight (**H**) of the battery casing/housing, the Area of the virtual casing/housing will be defined as:
    (b) $Area=(L\cdot W)\cdot 2+(W\cdot H)\cdot 2+(L\cdot H)\cdot 2$
    (c) The materials to model the virtual casing/housing shall be the same as used in the real casing/housing.
        i. If only one material is used in the real casing/housing: the virtual casing/housing will be considered as made of such material.
        ii. If more than one material is used in the real casing/housing, only those materials accounting for at least 95% of the weight of the real casing/housing shall be considered. Those materials shall be selected in decreasing order of importance, from the material contributing most to the material contributing the least in terms of weight, until the minimum threshold of 95% is reached. Once the materials are selected, the mass of the different materials shall be normalized to 100%.
        iii. If no information is available concerning the material composition of the real casing/housing, then a default virtual casing/housing made of 100% aluminium shall be used.
    (d) The "Weight" of each material in the virtual casing/housing shall be calculated as:

$$Weight_{mat\_i}=Area\cdot \text{Percentage}_{mati}\cdot t_{mat\ i}\cdot \rho_{mat\ i}$$

Where:

— Area: total area of the virtual casing/housing, as calculated in point 1) above

— $\text{Percentage}_{mati}$: proportion of material *i*, as calculated in point 2)

— $t_{mati}$: reference thickness of material *i*

— $\rho mati$: density of material *i*

*NOTE: Reference thickness values for different materials could be e.g., aluminium, 2.5 mm; steel, 1.75 mm; carbon fibers, 2.02 mm.*

The implementation of the virtual housing approach shall be reported in detail in the CFB supporting study, including all assumptions used.

## 6.8 Electricity modelling

### 6.8.1 General guidelines

The following section introduces two types of electricity mixes: (i) the <u>average</u> consumption grid mix which reflects the total electricity mix over a defined grid including green claimed or tracked electricity, and (ii) the <u>residual</u> consumption grid mix, which characterizes the unclaimed, untracked or publicly shared electricity only.

The following electricity mix shall be used, in hierarchical order:

1. The on-site generated electricity shall be used according to the conditions described in section 6.8.2. On-site electricity shall be modelled according to the DNM.
2. If the electricity is purchased from a supplier, the supplier-specific electricity product[14] shall be used if:
    (a) available, and
    (b) the set of minimum criteria to ensure the contractual instruments are reliable (described in section 6.8.2) is met.

    The supplier-specific electricity products shall be modelled according to the DNM.
3. The supplier-specific total electricity mix shall be used if:
    (a) available, and
    (b) the set of minimum criteria to ensure the contractual instruments are reliable is met.

    The supplier-specific electricity mix shall be modelled according to the DNM.
4. The country-specific *residual* consumption grid mix shall be used. Country-specific means the country in which the life cycle stage or activity occurs. This may be an EU or non-EU country. The residual consumption grid mix characterizes the unclaimed, untracked or publicly shared electricity and prevents double counting with the use of supplier-specific electricity mixes in (a) and (b). In the case of very large countries in which several electrical grids operate, the *grid-specific residual* consumption grid mix shall be used if available. More information on the how to model the country-specific residual consumption grid mix can be found in section 6.8.3. Residual electricity shall be modelled according to section 6.8.4 “How to model ‘country-specific residual grid mix, consumption mix’.
5. If no country- or grid- specific *residual* consumption grid mix is available, use the country- or grid-specific *average* consumption mix.

The environmental integrity of the use of supplier-specific electricity mixes depends on ensuring that contractual instruments (for tracking) are **reliable and unique**. Without this, the CFB lacks the accuracy and consistency needed to drive product/corporate electricity procurement decisions and accurate consideration of the supplier-specific mix by buyers of electricity. Therefore, a set of **minimum criteria** that relate to the integrity of the contractual instruments as reliable conveyers of environmental footprint information has been identified.

The direct use of emission values from e.g., a grid operating or certificate-issuing entity is not permitted. The electricity mix used in the CFB and the corresponding emission factors shall be reported in the CFB supporting study.

[14] See EN ISO 14067:2018

*NOTE: certificates for the contractual instruments could include an estimation of the carbon footprint of the electricity delivered. However, there is no guarantee that such data are EF-compliant.*

### 6.8.2 On-site electricity generation

On-site electricity generation is given if electricity is supplied to the plant from a production asset within the premises of the energy-consuming plant or if the production asset is connected to the energy-using plant by means of a direct and dedicated connection.

If the energy-consuming plant is also connected to the electricity grid and electricity is sourced from the grid in addition to on-site generation (e.g., during times of low on-site generation), all energy sourced from the grid shall be accounted for according to the rules laid out in section 6.8.1.

The amount of on-site generated energy that may be accounted for is the difference between the total energy demand of the production site and the amount of energy sourced from the grid.

Two situations apply to the on-site generated electricity:

1. No contractual instruments have been sold to a third party: the CFB declarant shall model its own electricity mix for the amount of on-site generated electricity.
2. Contractual instruments have been sold to a third party: the CFB declarant shall use 'country-specific residual consumption (grid) mix'.

If the total amount of electricity produced on-site exceeds the amount consumed on-site within the defined system boundary and is sold to, e.g., the electricity grid, this system may be seen as a multi-functional situation. The system will provide two functions (e.g., product + electricity) and the following rules shall be followed.

3. If possible, apply subdivision. This applies both to separate electricity productions or to a common electricity production where you may allocate, based on electricity amounts, the upstream and direct emissions to your own consumption and to the share you sell to a third party (e.g., if a company uses a windmill on its production site and exports 30% of the produced electricity, emissions related to 70% of produced electricity shall be accounted for in the CFB).
4. If not possible, direct substitution shall be used. The country-specific residual consumption (grid) mix shall be used as substitution[15]. Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.

Electricity from facilities for which the attributes have been sold off (via contracts or certificates) shall be characterised as having the environmental attributes of the country residual consumption mix where the facility is located.

### 6.8.3 Set of minimum criteria to ensure contractual instruments from suppliers are reliable

A supplier-specific electricity product/mix may be used if the CFB declarant ensures that the contractual instrument meets the criteria specified below.

A contractual instrument used for electricity modelling shall meet the following criteria.

#### *6.8.3.1 Criterion 1 – convey attributes*

- Convey the energy type mix associated with the unit of electricity produced, include an explanation of the calculation method used to determine this mix, and the geographical location where the energy is generated.
- The energy type mix shall be based on delivered electricity, incorporating certificates sourced and retired (obtained, acquired or withdrawn) on behalf of the relevant company (for the supplier-specific product) or on behalf of the supplier's customers (for the supplier-specific electricity mix).

#### *6.8.3.2 Criterion 2 – be a unique claim*

- Be the only instrument that carries the environmental attribute claim associated with that quantity of electricity generated.

[15] For some countries, this option is a best case rather than a worst case.

— Be tracked and redeemed, retired, or cancelled by or on behalf of the company (e.g., by an audit of contracts, third party certification, or handled automatically through other disclosure registries, systems, or mechanisms).

— The quantity of generated electricity associated with the instrument and its energy type mix is reported and considered for the determination of the country-or grid- specific residual grid mix, and this residual grid mix is disclosed publicly.

— Allows for the unambiguous identification of the type, age and location and capacity of the energy generation facility to which it refers.

— The energy generation facility to which it refers is located in a country with a tracking system in place that meets the minimum criteria for tracking systems specified in this section.

— In case the energy generation facility to which it refers is located in a country with a multi-certificate tracking system, it is accompanied by any additional contractual instruments from the supplier necessary to show and ensure there is no double counting.

— Be issued by a tracking system that fulfils the following criteria:

- Is based on objective, non-discriminatory and transparent criteria for the issuing certificates;
- Allows certificates to be valid no longer than 12 months after the production of the relevant energy unit;
- Relies on accurate, reliable and fraud-resistant mechanisms for the issuance, transfer and cancellation of certificates;
- Entrusts the issuance of certificates, as well as the supervision of their transfer and cancellation of certificates, to an entity or entities:
- Is independent of energy production, trade and supply activities, and of any commercial interest of customers on whose behalf certificates are redeemed, retired, or cancelled;
- Whose activities are governed by transparent rules and procedures laid down by law;
- Whose decisions may be challenged and reviewed in the context of proceedings before an independent judiciary.

#### *6.8.3.3 Criterion 3 – be as close as possible to the period to which the contractual instrument is applied*

- Ensure that certificates are valid no longer than 12 months after the production of the relevant energy unit;

#### *6.8.3.4 Criterion 4 - Be sourced from the same market in which the reporting entity's electricity-consuming operations are located and to which the instrument is applied*

To claim the use of renewable electricity, companies shall source renewable electricity from within the boundary of the market in which they are consuming the electricity.

The "market boundary" refers to an area in which[16]:

— The laws and regulatory framework governing the electricity sector are consistent between the areas of production and consumption.

— There is a physical interconnection between the point of generation and the point of consumption of renewable electricity. When interconnection happens across different grids, there shall be an entity that coordinates and tracks the exchange between such grids.

— The countries' utilities/energy suppliers recognize each other's energy sourcing instruments and have a system in place to prevent double counting of claims

[16] CDP Scope 2 Technical Guidance-: Accounting of Scope 2 emissions; Chapter 2.3 - "Claiming renewable electricity use: the market boundary criteria". The document can be downloaded from https://www.irecstandard.org/credibility/.

### 6.8.4 How to model 'country-specific residual grid mix, consumption mix'

The CFB declarant shall use EF-compliant datasets for residual consumption grid mix registered on the LCDN [11]. If no dataset for the specific country / grid is available, the following approach shall be used:

1. Determine the country residual consumption grid mix (e.g., X% of MWh produced with hydro energy, Y% of MWh produced with coal power plant) as provided by the country-specific issuing body

*NOTE: An example for a country-specific issuing body is the Association of Issuing Bodies[17] i.e., the organisation which governs the European Energy Certificate System.*

5. Combine them with EF-compliant datasets (following the hierarchy defined in section 6.3) per energy type and country/region (e.g., LCI dataset for the production of 1MWh hydro energy in the corresponding country/region).

If no country-specific residual consumption grid mix is available, use the country-specific average consumption mix:

1. Activity data related to country consumption mix per detailed energy type shall be determined based on:
    (a) domestic production mix per production technology;
    (b) import quantity and from which neighbouring countries;
    (c) transmission losses;
    (d) distribution losses;
    (e) Type of fuel supply (share of resources used, by import and/or domestic supply).

These data are available in International Energy Agency (IEA) publications.

2. Available LCI datasets per fuel and generation technology; the LCI datasets available are generally specific to a country or a region in terms of:
    (a) fuel supply (share of resources used, by import and/ or domestic supply);
    (b) energy carrier properties (e.g., element and energy contents);
    (c) technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.

### 6.8.5 A single location with multiple products and more than one electricity mix

This section describes how to proceed if only some of the electricity consumed is covered by a supplier-specific mix or on-site electricity generation and how to account for the electricity mix of products produced at the same location.

In general, the subdivision of electricity supply used among multiple products is based on a physical relationship (e.g., number of pieces or kg of product).

If the consumed electricity comes from more than one electricity mix, each mix source shall be used in terms of its proportion in the total kWh consumed. For example, if a fraction of this total kWh consumed comes from a specific supplier, a supplier-specific electricity mix shall be used for this amount. See Section 6.8.2 for on-site electricity use.

A specific type of electricity may be allocated to one specific product under the following conditions: .

1. If the production (and the related electricity consumption) of a product occurs in a separate site (building), the energy type that is physically related to this site may be used.
2. If the production (and the related electricity consumption) of a product occurs in a space shared with specific energy metering or purchase records or electricity bills, the product-specific information (measure, record, bill) may be used.

[17] Association of issuing bodies, 2023. Available at http://www.aib-net.org.

### 6.8.6 For multiple locations producing one product

The CFB shall refer to a specific battery model produced in a specific production plant and referred to the electricity consumed in that specific facility.

However, in case a process in the battery supply-chain is located in different locations or sold in different countries, the electricity mix shall reflect the ratios of production or ratios of sales between countries/regions. To determine the ratio, a physical unit shall be used (e.g., number of pieces or kg of product). For CFB where such data are not available, the DNM applies.

## 6.9 Sampling

According to Annex II (5) of the Battery Regulation Proposal, sampling of data collected from different plants is not allowed for the CFB.

# 7 Verification

The verification of the CFB shall be carried out in compliance with the general requirements included in the Battery Regulation Proposal and EC Recommendation 2021/2279 (Annex I – Section 8).

In particular:

- The verification shall cover at least the points as specified in the EF Recommendations 2021/2279 (Annex II – Section 8.4);
- Additional details of the verification are specified in the present and following sections.

## 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, his 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 7.2.

The notified body may request further information if needed.

The notified body shall verify and validate the application to determine whether the declared carbon footprint and the supporting information is reliable, credible and correct.

## 7.2 Technical documentation

The technical documentation includes the CFB supporting study and the public version of the CFB supporting study.

The CFB declarant shall produce a CFB supporting study that shall document in a systematic, orderly and comprehensive manner all steps taken in the CFB.

The supporting study shall at least include detailed description and documentation of:

1. Any data put into the calculation, including:
    (a) The details of all the company-specific activity data, including the bill of materials and/or ingredients (e.g., substance names, units and quantities, including information on origin, grades/ purities, recycled content and other technically and/or environmentally relevant characterisation of these) indicating to which life-cycle stages they belong.
    (b) The company-specific elementary flows.
    (c) The procedure used for company-specific data collection/estimation/calculation and the data collection period.
    (d) EF-compliant secondary datasets used (including secondary datasets from the LCDN and from other sources), and ILCD entry-level datasets used for the calculation of the carbon footprint.
2. The model used for the CFB calculation.
3. Any underlying documentation needed to establish the reliability of the company-specific data and/or additional steps and datasets, including the service life, the worst-case certified energy consumption, the rated energy capacity, the electricity mix, the recycling processes, the recycled content, the recycling rate, the transport activity data, the assumptions behind the virtual housing, and all the limitations of the CFB.

Where necessary, information provided to verifiers shall include confidential information. Confidential information shall be used only during the verification process.

Documentation shall include also a public version of the CFB supporting study (to be available online) in line with the Battery Regulation Proposal (Article 7 – section 1 point g).

## 7.3 Verification and validation techniques

The notified body shall ensure that:

- The data and information used for the calculation of the carbon footprint are consistent, reliable and traceable; and
- Any calculations performed do not include significant mistakes.

The notified body shall combine review of the documentation (described in section 7.2) and validation of the model used to calculate the carbon footprint of the battery. In particular, the notified body shall access the model to verify its structure, the data used, and its consistency with the carbon footprint supporting study.

The review of the documentation includes the CFB supporting study and the public version of the supporting study, through available or requested underlying documentation. The notified body may organise the documental review either as an "at desk" or "on site" exercise, or as a mix of the two. The verification of the company-specific data shall always be organised through a visit of the production site(s) the data refer to.

The notified body shall as a minimum:

- Ensure that all secondary datasets used in the model are appropriate and in compliance with the requirements laid out in the present rules for CFB;
- Ensure that the verification of company-specific data includes:
    - Coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;
    - Plausibility, quality and accuracy of the data;
    - Quality and accuracy of the underlying documentation.
- Ensure the correct application of the electricity modelling rules as prescribed in the present rules for CFB;
- Assess and confirm whether the calculations are of acceptable accuracy, reliable, are appropriate and performed in accordance with the CFB rules specified in this document
- Confirm the correct application of conversion of measurement units;
- Evaluate whether the methods for making estimates are appropriate and have been applied consistently;
- Assess alternatives to estimations or choices made to determine whether a conservative choice has been selected;
- Identify uncertainties that are greater than expected and assess the effect of the identified uncertainty on the CFB results.

## 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 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 is not hindering 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.

# 8 Conclusions

[to be defined]

## References

## List of abbreviations

| | |
|---|---|
| BMS | Battery Management System |
| CFB | Carbon Footprint of Batteries |
| CFF | Circular Footprint Formula |
| DNM | Data Needs Matrix |
| DPRi | Declared Performance Requirement |
| DQR | Data Quality Rating |
| EF | Environmental Footprint |
| EoL | End-of-Life |
| EPLCA | European Platform for Life Cycle Assessment |
| EV | Electric Vehicle |
| FU | Functional Unit |
| GWP100 | Global Warming Potential 100-years |
| HEV | Hybrid Electric Vehicle |
| ILCD | International Life Cycle Data |
| JRC | Joint Research Centre |
| LCI | Life Cycle Inventory |
| LCDN | Life Cycle Data Network |
| LMT | Light Means of Transport |
| MPRi | Minimum Performance Requirement |
| OEM | Original Equipment Manufacturer |
| OVC-HEV | Off-Vehicle Charging Hybrid Electric Vehicle |
| PEF | Product Environmental Footprint |
| PEFCR | Product Environmental Footprint Category Rules |
| PEV | Pure Electric Vehicle |
| PWB | Printed Wiring Board |
| SOCE | State of Certified Energy |
| SOCR | State of Certified Range |
| UN GTR | United Nations Global Technical Regulation |

## List of definitions

'Accreditation' means accreditation as defined in Article 2(10) of Regulation (EC) No 765/2008 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Annex II).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

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

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

'Battery system' refers to batteries of any configuration subject to a mandatory CFB declaration under the Battery Regulation Proposal (article 7). 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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal - 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 (Battery Regulation Proposal – Article 2).

'CFB declarant' means the legal subject/entity that has the obligation to declare the CFB according to the Battery Regulation Proposal.

'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.

'Company-specific data' refers to directly measured or collected data from one or multiple facilities (site-specific data) that are representative for the activities of the company. It includes company-specific activity data and direct elementary flows. It is synonymous to 'primary data' (Battery Regulation Proposal – Annex II) or 'supply-chain specific data' or 'manufacturer-specific' data.

'Company-specific dataset' means the dataset (disaggregated or aggregated) compiled with company-specific data. In most cases the activity data is company-specific while the underlying sub-processes are datasets derived from background databases.

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

'Conformity assessment body' means a body that performs conformity assessment activities including calibration, testing, certification and inspection (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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.

'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 (Battery Regulation Proposal – Article 2).

'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 data sets"); 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.

'Electric vehicle battery' or 'EV battery' means any battery specifically designed to provide electric power for the traction to hybrid or electric vehicles of L category as provided for in Regulation (EU) No 168/2013, and with a weight above 25 kg, or designed to provide electric power for the traction to hybrid or electric vehicles of M, N or O categories as provided for in Regulation (EU) 2018/858 (Battery Regulation Proposal – Article 2).

'Functional unit' Qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated (Battery Regulation Proposal – Article 2).

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

'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) (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'Life cycle inventory' Combined set of exchanges of elementary, waste and product flows in a LCI dataset.

'Life cycle inventory 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.

'Partially disaggregated dataset' means dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yield a complete aggregated LCI data set.

'Placing on the market' means the first making available of a battery on the Union market (A Battery Regulation Proposal – Article 2).

'Rechargeable battery' means a battery that is designed to be electrically recharged (Battery Regulation Proposal – Article 2).

'Data Needs Matrix' (DNM) describes the requirements for the use of company specific data and secondary data, depending on the level of influence the CFB declarant has on the processes along the value chain.

'Importer' means any natural or legal person established within the Union who places a battery on the market from a third country (Battery Regulation Proposal – Article 2).

'ILCD entry level compliant dataset (ILCD-EL)' means a dataset developed in agreement with the ISO 14040 and 14044 in terms of methodological compliance; in agreement with "International Reference Life Cycle Data System (ILCD) Data Network - Compliance rules and entry-level requirements" in terms of meta data compliance; in agreement with the "EF 3.1 Reference Package" for nomenclature and characterization 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 (Battery Regulation Proposal – Article 2).

'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. (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 Battery Regulation Proposal – Article 2).

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

'Notified body' means a conformity assessment body notified in accordance with Chapter V of this Regulation (see Battery Regulation Proposal – Article 2).

'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 Battery Regulation Proposal – Article 2).

'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. (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'Rechargeable battery' means a battery that is designed to be electrically recharged (Battery Regulation Proposal – Article 2).

'Recycler' means any natural or legal person who carries out recycling in a permitted facility (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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.

'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 (Battery Regulation Proposal – Article 2).

'State of charge' means the available energy in a battery expressed as a percentage of rated capacity as declared by the manufacturer (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'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 (Battery Regulation Proposal – Article 2).

'System boundary' Aspects included or excluded from the life cycle study (Battery Regulation Proposal – Annex II).

'Technical specification' means a document that prescribes technical requirements to be fulfilled by a product, process or service (Battery Regulation Proposal – Article 2).

'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.

'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' (Battery Regulation Proposal – Article 2).

'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).

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

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 (Battery Regulation Proposal – Article 2).

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 (Battery Regulation Proposal – Article 2).

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# Annexes

## Annex 1. Data collection requirements - Raw material acquisition and pre-processing

This section describes the generic data collection procedure for the raw material acquisition and pre-processing stage. The period for data collection is annual. This may be either calendar year or fiscal year but shall be declared in the data collection sheet provided together with the technical documentation.

The specific production processes / technologies of each metal / metal salt / metal product shall be assigned to the following

generic process stages:

- Mining
- Beneficiation / ore processing (from ore to concentrate)
- Primary extraction (pyrometallurgical or hydrometallurgical)
- Refining
- Finishing

Each of the above-mentioned generic production stages shall have a reference to which all inputs and outputs are referred to (their corresponding reference flow), as shown generically in Figure 3 - Figure 7. The light grey shaded process displays the primary activity data of the production process, and the dark grey flow the principal process input (linking it to the previous process that produced it). The other input flows refer to secondary datasets for the purchased goods and services, using supplier-specific activity data.

It is important that for the main reference flows, the specific assay data on the target metal and other elements included (concentration or specific metal content) are reported with the reference flows to allow a proper mass balance check.

In case materials or components (such as ore concentrates or mattes) are produced in several locations for a specific output material (e.g., nickel sulphate), the data shall be collected for all locations, and a weighted average shall be calculated.

**Figure 3.** Generic mining process

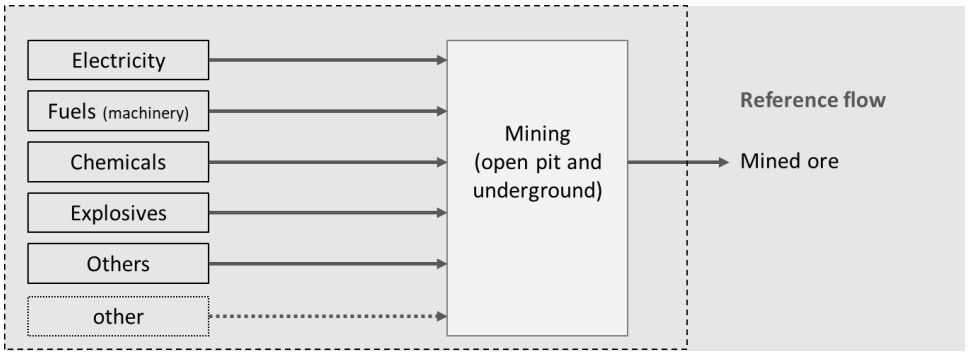


**Figure 4.** Generic beneficiation process

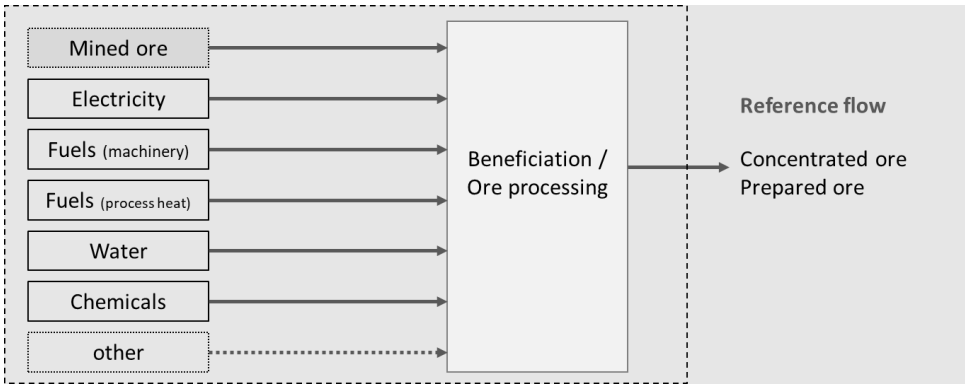



**Figure 5.** Generic primary extraction process

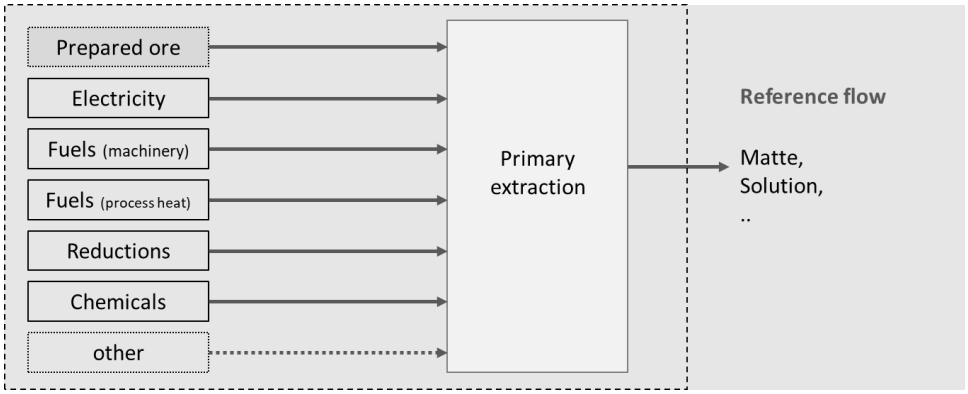



**Figure 6.** Generic refining process

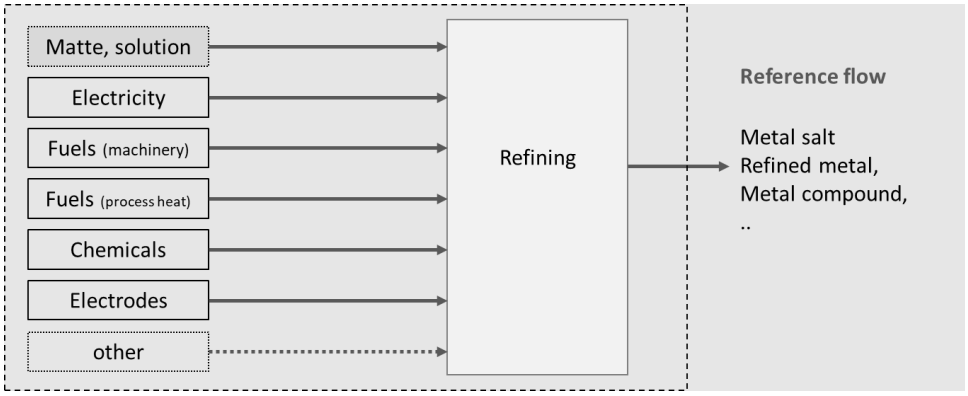
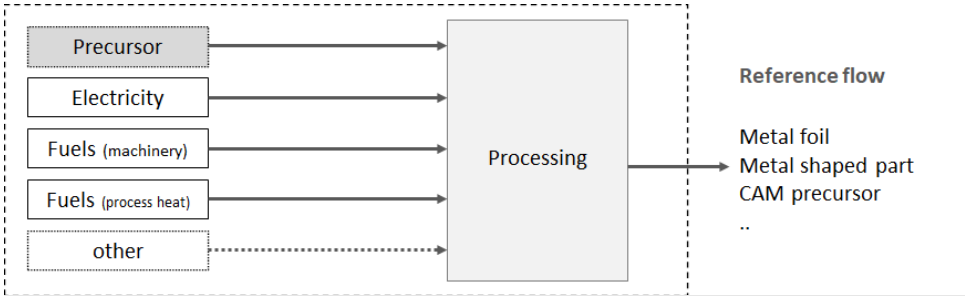



**Figure 7.** Generic finishing process




Data collection for each of the process stages may then be done with the help of Table 3.

1140 **Table 3.** Generic data collection template for raw material acquisition and pre-processing

| Material | Unit | Data | Specification |
|---|---|---|---|
| *Input* | | | |
| Main input (ore, matte, etc.) | | | Empty in case of primary mining |
| Electricity | | | According to section 6.8 |
| Fuels for transport and machinery | | | E.g. Diesel / LNG / hydrogen |
| Fuels for (process) heat generation | | | E .g. Natural Gas, coal / hydrogen |
| External heat supply (Heat & Steam respective of fuel) | | | If heat is sourced externally |
| Explosives | | | |
| Filling or structural material (for production) | | | e.g., cement for backfilling |
| Acids | | | e.g., Sulphuric Acid for acid leaching |
| Sulphur / $H_2S$ | | | For on-site sulphuric acid production |
| Neutralizer or slagging agents | | | E.g., lime, limestone, NaOH, MgO etc.. |
| Electrodes | | | e.g., graphite electrodes |
| Reductants | | | e.g., Coal, charcoal, hydrogen |
| Chemicals | | | Bulk chemicals (e.g., frother, dispersants or flocculants). Other chemicals may be aggregated and added to the major bulk chemicals |
| Tires | | | For specific machines (mining stage) |
| Technical gases | | | E.g., nitrogen, oxygen, etc., if purchased externally |
| Grinding media | | | e.g., steel balls / rods (high Cr steel ~10% and low Cr steel ) |
| Transport (of input materials). | | | e.g., truck, train, bark, etc. Standard distances may be used |
| *Output* | | | |
| Main product | | | E.g., ere mined, matte, concentrated ore, final metal (salt), intermediate product, assay data to be provided for specific metal contents / concentrations of ores / minerals and intermediate products |
| By-products | | | e.g., sulphuric acid, other metals / metal salts than the main product. Allocation according to section 6.7. |
| Overburden | | | |

| | | | |
|---|---|---|---|
| Waste rock | | | |
| $CO_2$ (fossil) and other GHG emissions | | | Based on Fuels & Explosives (if combustion emissions are not considered in the corresponding fuel / energy dataset), reductants, electrodes and other reactions where $CO_2$ emissions occur (e.g., neutralization or precipitation with limestone) |

For multi-output processes (e.g., more than one metal product is obtained), the allocation shall be done as defined in section 6.7. Sulphuric acid production shall be considered within the system boundaries since it is an essential part of the production process to avoid the acidification of the surroundings of the plant. The produced and sold sulphuric acid shall be allocated by using system expansion according to section 6.7.

Other important inputs to be considered (as indicated in Table 3) are cement, required within the production of the base metal (e.g., cement used for backfilling tailings into mine), electrodes and corresponding carbon emissions (e.g., for reduction of metal salts), explosives for mining and other auxiliaries. Process emissions of $CO_2$ and other GHG from chemical reactions shall be quantified from reaction stoichiometry (e.g., precipitation or neutralization with limestone, carbon electrodes, reduction processes with coke, ..).

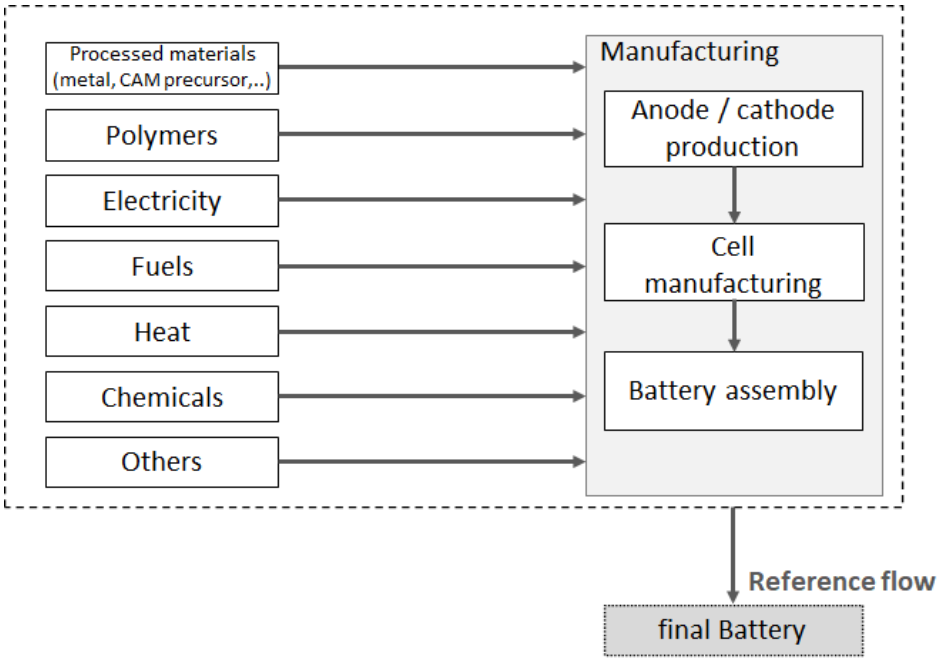
Since many specific chemicals are typically used without a corresponding secondary dataset being available, these may be aggregated in terms of mass and be accounted for together with the bulk chemicals. For instance, in the beneficiation stage all chemicals may be accounted for as 'frother, dispersants, and flocculants', which typically take the biggest contributor (mass), using this as a proxy for all categorised chemicals. Grinding media shall be collected even if it might fall under the cut-off criteria.

## Annex 2. Data collection requirements - Manufacturing

Manufacturing includes the production of anode and cathode, battery cells (and components) and the assembly of the final battery pack / system (Figure 8). Data collection shall be done on a mass basis and be specific to the manufacturing location of each (intermediate) product. In case materials or components (such as cathode active materials or battery cells) are produced in several locations for the battery for which the CFB shall be calculated, the data shall be collected for all locations, and a weighted average shall be calculated. If cathode or anode production takes place within the same premises as the cell production, aggregated data for the two stages might be used.

Scrap rates shall be considered in each process stage separately, accounting for the increased material input due to scrap and manufacturing waste losses and for the corresponding scrap/waste treatment, including the corresponding recycling credits according to the CFF (section 6.6). Secondary datasets may be used for recycling processes.

**Figure 8.** Generic manufacturing process




### A.2.1 Cathode and anode production

Activity data collection for cathode and anode (active material) production shall be done according to Table 4, following the data collection requirements according to section 6.2). If the cathode active material production (e.g., NMC622) is done in a different plant than the cathode production, also the active material (AM) production shall be modelled according to Table 4, using a corresponding subset of inputs.

**Table 4.** Generic data collection template for cathode and anode production

| Component | Unit | Data | Specification / Dataset |
|---|---|---|---|
| ***Input*** | | | |
| AM Precursor material | kg | | e.g., Nickel sulphate ($NiSO_4$ x $6H_2O$). |
| AM Precursor material | kg | | e.g., Cobalt sulphate ($CoSO_4$ x 7H2O). |
| AM Precursor material | kg | | e.g., Manganese sulphate ($MnSO_4$ x $H_2O$). |
| AM Precursor material | kg | | e.g., Lithium carbonate ($Li_2CO_3$), Lithium hydroxide (LiOH x $H_2O$) |
| Bulk chemicals | kg | | e.g., Sodium hydroxide (NaOH), Sodium bicarbonate ($Na_2CO_3$), Ammonia solution ($NH_4OH$) |
| Anode active material | kg | | Anode powder, e.g., natural graphite, artificial graphite |
| Current collector | kg | | e.g., copper, aluminium |
| Binder | kg | | e.g., Polyvinylidene fluoride (PVDF), Carboxymethyl cellulose (CMC), Styrene butadiene rubber (SBR) |
| Additives | kg | | e.g., Carbon black, Silicon, carbon nanotubes |
| Dopants | kg | | e.g. $TiO_2$, $ZrO_2$, MgO, $Al_2O_3$ |
| Auxiliaries | kg | | e.g., water, oxygen, |
| Electricity | kWh | | e.g., Aluminium foil |
| Fuels for (process) heat generation | MJ | | e.g. Natural Gas/ coal / hydrogen |
| External heat supply (Heat & Steam respective of fuel) | MJ | | If heat is sourced externally |

| | | | |
|---|---|---|---|
| ***Output*** | | | |
| Main product | kg | | e.g., cathode material precursor, NMC622 cathode, LFP cathode, LTO anode, ... |
| By-product | kg | | e.g., sodium sulphate |
| Waste to treatment | kg | | Treatment by landfill, incineration, etc. |
| Waste to recycling | kg | | Production waste treated by an external recycling facility. |
| GHG emissions | Kg $CO_2$eq | | Direct process emissions (from reactions) and emissions from fuel combustion |

If precursor materials are used in solution state, the specific concentration shall be provided. Direct carbon dioxide emissions from e.g., calcination step shall be considered. Inputs for by-product processing and purification shall be considered until the plant gate; allocation may be done in this case according to section 6.7.

### A 2.2 Cell production

The cell production stage may be divided into the three main steps: electrode manufacturing, the cell assembly, and the cell finishing, or even be further subdivided into the individual processes. Company-specific data may be collected for each process stage separately (or even on a higher level of disaggregation), or for the cell production as a whole, as long as all process steps are covered in the company-specific data collection. A summary list of materials possibly needed for the cell manufacturing is given in Table 5.

Table 5. Generic data collection template for cell manufacturing

| Component | Unit | Data | Specification |
|---|---|---|---|
| ***Input*** | | | |
| Anode | kg | | From anode production |
| Cathode | kg | | From cathode production |
| Anode current collector tap | kg | | e.g., Copper foil, aluminium foil |
| Cathode current collector tap | kg | | e.g., Aluminium foil |
| Separator | kg | | e.g., Polypropylene (PP), Polyethylene (PE), ceramic |
| Electrolyte solvent | kg | | e.g., Dimethyl carbonate, Ethylene carbonate, Propylene carbonate, Vinylene carbonate |
| Electrolyte salt | kg | | e.g., Lithium hexafluorophosphate (LiPF6) |
| Housing | kg | | e.g., Aluminium foil, steel, Polymers (PP, PE, Nylon,..) |
| Lid | kg | | e.g., Aluminium foil / case |
| Solvent | kg | | e.g., N-Methyl-2-pyrrolidone (NMP), Water |
| Auxiliaries | kg | | e.g., solvents, glues |
| Electricity | kWh | | acc. to Section 6.8. |
| Thermal energy | MJ | | e.g., steam, heat externally purchased |
| Fuels | MJ | | e.g., natural gas for on-site heat generation |
| ***Outputs*** | | | |
| Primary product | kg | | Battery cell |
| Waste | kg | | Production waste going to waste treatment |
| Scrap | kg | | Production waste going to recycling. |
| GHG emissions | kg $CO_2$eq | | from combustion, chemical reactions (e.g., calcination) or thermal waste treatment (e.g., solvent thermal treatment). |

In case activity data for material inputs (e.g., from a management system) are not available for a specific cell (only available aggregated for several cell products), a bill-of-material (BoM) may be used to compile the material inputs. The BoM shall include facility-specific yields, e.g., cuttings or individual scrap rates (including entire cells at the end of line testing).

For waste products that are recovered and re-used for the same purpose within the production premises (e.g., recovered and re-used solvents, re-used active materials), only the net input shall be accounted for. If recovered products are used for other purpose (e.g., solvents for cleaning, materials as filling material) within the premises, the corresponding amounts shall not be deducted from the inputs.

*Energy consumption and auxiliaries*

The energy consumption (but also auxiliaries, e.g., process water, compressed air, etc.) shall be based on an individual and detailed metering system to be able to split the energy / auxiliary consumption of the entire cell manufacturing into lines, products, and time periods. In case the energy / auxiliary consumption cannot directly be related to a specific product (e.g., several products produced in a facility, but consumption data is not always available per specific product), the data shall be collected as specific as possible, e.g., split up into energy /auxiliary consumption for electrode manufacturing, cell assembly, cell finishing, as well as climatization of clean / dry rooms. In case the energy / auxiliary consumption can be directly related to a specific process (e.g., electrode manufacturing), this data shall be used, in case the consumption data is only available for several cell products (e.g., individual meters for cell assembly lines, but only one meter for a dry room, in which several assembly lines produce different cells), the consumption data shall be split up by allocation: In case all cell products have the same geometry (pouch, cylindrical or prismatic) and the same size (e.g., cylindrical 18650), the allocation shall be done by number of cells, otherwise allocation shall be done by energy capacity (kWh).

*Start-up period of new facilities*

A start-up period for a new facility (new location, extension of capacity or exchange of entire production line) of maximum six months may be used to exclude non-representative energy consumption due to low utilization rates (e.g., load-independent energy consumers like dry room, climatization, etc. ).

### A 2.3 Battery assembly

Battery assembly covers the assembly of the battery module and the assembly of the battery itself. For both processes (or assembly steps), company-specific data shall be collected. Activity data for module and battery assembly shall be collected separately if they take place at different companies or locations. Table 6 provides a summary list of materials possibly needed for the battery assembly step.

For batteries that provide additional functions to the vehicle, allocation may apply (see Section 6.7)

Table 6. Generic data collection template for battery assembly

| Component | Unit | Data | Specification |
|---|---|---|---|
| ***Input*** | | | |
| Battery cells / modules | kg | | From cell production |
| Housing | kg | | e.g., Steel, aluminium, polyamide, .. |
| Gap filler | kg | | e.g., aluminium |
| Structural elements | kg | | e.g., Aluminium, steel, polymers |
| Cooling plate / heat exchanger | kg | | e.g., aluminium, copper, steel |
| Cables / harness | kg | | e.g., copper, polymers (insulation, such as PVC or silicone), |
| Busbars / terminals | kg | | e.g., aluminium, copper, polymers (insulation, such as PVC or silicone), .. |
| Connectors | kg | | |
| Fixation (screws, nuts, bolts, clips etc.) | kg | | e.g., aluminium, steel, PP |
| Insulation | kg | | e.g., PU foam, mica, .. |
| Coolant | kg | | e.g., glycol, water, .. |
| Battery management system | kg | | e.g., printed wiring board, microcontrollers,.. |
| Electronic components | kg | | e.g., power electronics, relays, fuses, transistors, resistors, capacitors, .. |
| Thermal management system | kg | | e.g., sensors, printed wiring board, microcontrollers,.. |
| Cooling system | kg | | e.g., stainless steel pipes, pumps, .. |
| Other | kg | | e.g., tape, glue, .. |
| Electricity | kWh | | acc. to Section 6.8. |

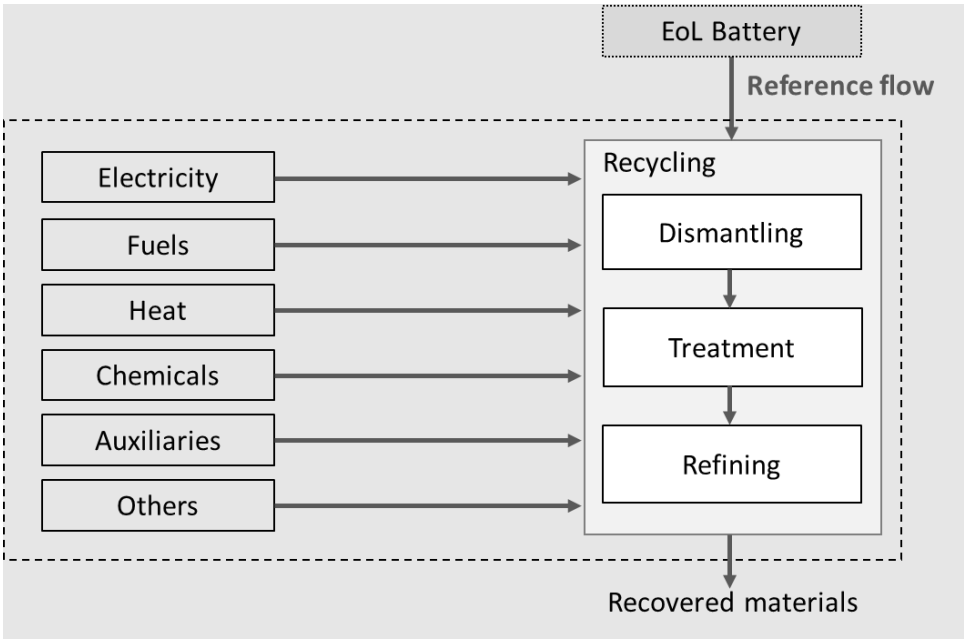
| | | | |
|---|---|---|---|
| Thermal energy | MJ | | e.g., steam, heat externally purchased |
| Fuels | MJ | | e.g., natural gas for on-site heat generation |
| Auxiliaries | kg | | e.g., Water, solvents, .. |
| ***Outputs*** | | | |
| Battery module / pack | kg | | Detailed performance parameters for conversion of CF to different FU (Article 10 of the Battery Regulation Proposal) |
| Waste | kg | | waste going to final waste treatment e.g., separator cut-off, mixed or contaminated plastic waste, |
| Scrap and waste to recycling | kg | | e.g., Metal scrap, recovered solvents, scrapped cells, polymers |
| GHG emissions | Kg $CO_2$eq | | from combustion or thermal waste treatment (e.g., solvent thermal treatment). |

## Annex 3. Data collection requirements – End-of-life and Recycling

The EoL and Recycling stage includes transport of the EoL battery to the treatment facility and its treatment in dedicated recycling processes. The generic battery recycling process consists of battery dismantling / disassembly, treatment of the battery cells via the specific recycling process (hydrometallurgical or pyrometallurgical) and the refining of the obtained materials into new battery materials of products that are sold otherwise on the market. A generalized flowsheet of a generic recycling process is depicted in Figure 9.

As for the manufacturing stage, the recycling process steps may be modelled in aggregated form or as individual process stages. Since no specific secondary datasets are available for battery recycling, a standard recycling process model may be used, as provided in the following.

**Figure 9.** Generic recycling process




If the EoL stage is not modelled based on company-specific data, a standard recycling model shall be used according to the default values provided in Table 8. The standard recycling process considers disassembly of the battery pack, a pyrometallurgical treatment of the battery cells followed by a hydrometallurgical treatment of the obtained metal alloy fraction [new PEFCR]. The recycling / recovery efficiency shall be considered within the R2 value of the CFF. Table 7 to Table 9 provide guidelines and standard default values to be used for modelling the recycling stage. If the generic recycling model is used for the EoL stage, also the default R2 values according to Table 2 shall be applied (different R2 values may be used for recycling processes modelled based on company-specific data).

The disassembly process shall be modelled based on the specific composition of the battery pack and modules (housing, cooling system and electronics, excluding battery cells), assuming that batteries are completely disassembled to cell level, with all materials that the battery packs and modules are made of going to individual dedicated recycling or waste treatment processes. Recycling credits and the share of each material going to waste are determined by the CFF.

The battery cells separated from the pack / modules in the disassembly stage are then transferred to a pyrometallurgical treatment. Standard process inputs- and outpts per kg of battery cell processed are provided in Table 8 and 9. The outputs of recovered materials can be adjusted

**Table 7.** Generic recycling model for battery recycling, dismantling

| Component | Unit | Default value | Specification | |
|---|---|---|---|---|
| ***Input*** | | | | |
| EoL battery | kg | | | Whole battery |
| Electricity | kW | 0 | Process inputs | No process inputs accounted for disassembly |
| Auxiliaries | kg | 0 | Process inputs | No process inputs accounted for disassembly |
| Recycling of metals | kg | | Specific secondary datasets for recycling of metals (specific recycling process inputs) | Fraction of each specific metal that goes to recycling acc. to parameter R2 of the CFF |
| Landfill of metals | kg | | Specific secondary datasets for landfill of metals (specific waste treatment process inputs and emissions) | Fraction of each specific metal that goes to landfill parameter R2 and R3 of the CFF |
| Incineration of metals | kg | | Specific secondary datasets for waste incineration of metals (specific waste treatment process inputs and emissions) | Fraction of each specific metal that goes to incineration parameter R2 and R3 of the CFF |
| Recycling of polymers | kg | | Specific secondary datasets for recycling of polymer | Fraction of each specific polymer that goes to recycling parameter R2 of the CFF |
| Landfill of polymers | kg | | Specific secondary datasets for landfill of polymers (specific waste treatment process inputs and emissions) | Fraction of each specific polymer that goes to landfill parameter R2 and R3 of the CFF |
| Incineration of polymers | kg | | Specific secondary datasets for waste incineration of polymers (specific waste treatment process inputs and emissions) | Fraction of each specific polymer that goes to incineration according to parameter R2 and R3 of the CFF |
| EoL of electronic components | kg | | Specific secondary datasets for recycling of electronic components | Secondary datasets include recycling credits (CFF), no further waste treatment and credits to be accounted for |
| | | | | |
| ***Outputs*** | | | | |
| Recovered metals | kg | | e.g., Aluminium, Copper, steel, stainless steel, .. | Credit for each specific metal according to parameter R2 and 'Qsout/Qp' of the CFF. Credit based on secondary data for corresponding primary material |

| | | | | |
|---|---|---|---|---|
| Recovered polymers | kg | | e.g., PE, PP, PA, Nylon, .. | Credit according to parameter R2 and 'Qsout/Qp' of the CFF. Credit based on secondary data for corresponding primary material |
| Others | kg | | e.g., insulation, ceramics, cooling liquid .. | To waste treatment (no recycling; split between landfill and incineration acc. To country-specific CFF default values |
| Electronics | kg | | | |
| Battery cells | | | To pyrometallurgical treatment | Fraction of cells contained in battery pack |

1247 **Table 8.** Generic recycling model for battery recycling, pyrometallurgical treatment

| Component | Unit | Default value | Specification / dataset | |
|---|---|---|---|---|
| ***Input*** | | | | |
| **EoL battery cells** | **kg** | **1.00** | From disassembly | |
| Electricity | kWh | 1.00 | | |
| Process heat | MJ | 0.23800 | Thermal energy from natural gas ( 90%) | |
| Process heat | MJ | 2.26800 | Steam from natural gas (90%) | |
| Process heat | MJ | 0.23800 | Thermal energy from light fuel oil | |
| Limestone washed | kg | 0.14200 | Lime production, technology mix | |
| Silica sand | kg | 0.12200 | Silica sand, production mix | |
| Quicklime (CAO) | kg | 0.08000 | Quicklime production, technology mix | |
| Carbon black | kg | 0.00100 | | |
| | | | | |
| ***Outputs*** | | | | |
| Metal alloy | kg | 0.57700 | To hydrometallurgical treatment | |
| Slag | kg | 0.71100 | Landfill of inert slag | |
| Emissions | Kg CO2eq | 1.19448 | Direct process emissions (all greenhouse gases) | May be adjusted according to specific battery cell composition (estimated based on stoichiometric calculation, assuming complete oxidation of all organic / carbonaceous compounds during pyrometallurgy) |

1248 **Table 9.** Generic recycling model for battery recycling, hydrometallurgical refining

| Component | Unit | Default value | Specification / dataset | |
|---|---|---|---|---|
| ***Input*** | | | | |
| Metal alloy | kg | 0.57700 | Default value, if output from previous stage is different, all process inputs below shall be adjusted correspondingly | |

| | | | | |
|---|---|---|---|---|
| Electricity | kWh | 0.0248 | | |
| Process heat | MJ | 1.84218 | Thermal energy from natural gas ( 90%) | |
| Process heat | MJ | 0 | Steam from natural gas (90%) | |
| Process heat | MJ | 0.04058 | Thermal energy from light fuel oil | |
| Ammonium nitrate | kg | 0.02435 | | |
| Hydrochloric acid (100%) | kg | 0.00974 | | |
| Hydrogen peroxide (100%) | kg | 0.30027 | | |
| Soda (sodium carbonate) | kg | 0.01623 | | |
| Sodium hydroxide (100%; caustic soda) | kg | 0.45446 | | |
| Sulphuric acid aq. (96%) | kg | 0.87646 | | |
| Water (tap water) | kg | 0.00278 | | |
| | | | | |
| ***Outputs*** | | | | |
| Recovered metals | kg | | e.g., Aluminium, Copper, steel, stainless steel, .. | Credit for each specific metal according to its content in the battery cell and parameter R2 and 'Qsout/Qp' of the CFF |
| Recovered metal salts | kg | | e.g., Water, solvents, .. | Credit for each specific metal according to its content in the battery cell and parameter R2 and 'Qsout/Qp' of the CFF |
| Wastewater | m3 | 0.00278 | Wastewater treatment, average | |

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