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ANNEX

ANNEX

to the

Commission Delegated Regulation

supplementing Regulation (EU) 2023/1542 of the European Parliament and of the Council by establishing the methodology for the calculation and verification of the carbon footprint of electric vehicle batteries

ANNEX

Methodology for calculation and verification of the carbon footprint of electric vehicle batteries

1. DEFINITIONS

For the purposes of this Annex the following definitions shall apply:

(1) ‘carbon footprint study’ means the study referred to in point 2, second paragraph, point (h), of part B and point 2, point 1, third paragraph, point (h), of Part C of Annex VIII to Regulation (EU) 2023/1542;

(2) ‘public version of the carbon footprint study’ means the study referred to in Article 7(1), point (g), of Regulation (EU) 2023/1542;

(3) ‘active material precursor’ means material required for the synthesis of active materials, either cathode active material precursors or anode active material precursors;

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

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

(6) ‘company-specific dataset’ means a dataset describing a company-specific process, where all the activity data are company-specific, and which relates to a specific battery model produced in a specific production plant;

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

(8) ‘environmental footprint (EF)-compliant dataset’ means a dataset developed in accordance with the Guide for EF-compliant datasets, available on the European Platform on Life Cycle Assessment (LCA);

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

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

(11) 'LCIA result dataset' means a dataset modelling a complete or partial life cycle of a product system that, apart from the product flow associated with the reference product, lists only the result of the life cycle impact assessment, which in the case where climate change is the only impact category analysed means that the result is the amount of carbon dioxide ('CO2')-equivalent;

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

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

2. CALCULATION RULES

The carbon footprint of electric vehicle batteries shall be calculated as the amount of CO_2-equivalent emitted during the life cycle stages of the battery that are within the system boundary, expressed in kilogram ('kg') CO_2-equivalent, divided by the total amount of energy provided by the battery over the battery's service life determined in accordance with section 2.1. It shall be reported in kg CO_2-equivalent/ kilowatt-hour ('kWh') with a resolution of 0,001 kg CO_2-equivalent/kWh.

The amount of CO_2-equivalent emitted shall be determined by identifying the emissions of greenhouse gases related to the materials and energy used and, where relevant, produced in the life cycle stages of the battery that are within the system boundary, in accordance with sections 2.2 to 2.7. The amount of CO_2-equivalent shall be calculated from these emissions of greenhouse gases by applying the Environmental Footprint ('EF') 3.1 impact assessment method available in LCDN for the impact category "climate change".

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

If, over the course of time, due to changes in the bill of materials, changes in the origin of the materials, changes in processes, changes related to the use of electricity and other auxiliaries, or any other changes, the amount of CO_2-equivalent emitted increases by more than 10% compared to the carbon footprint calculated, this shall be considered a change to the battery's technical characteristics relevant for the requirements of Regulation (EU) 2023/1542 and thus for the new battery model a new carbon footprint shall be calculated and a new carbon footprint declaration shall be drawn up.

2.1. Functional unit

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

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

Where:

(a) *energy capacity* is the useable energy capacity of the battery in kWh at the beginning of life, namely the energy available to the user when discharging a

new fully charged battery until the discharge limit set by the battery management system;

(b) *FEqC per year* is the typical number of full equivalent charge-discharge cycles per year and equals:

(i) 60 for batteries to be integrated into vehicles belonging to categories M1 and N1 in the meaning of the Regulation (EU) 2018/858 ('light duty vehicles');

(ii) 20 for batteries to be integrated into vehicles of category L in the meaning of the Regulation (EU) No. 168/2013 ('motorcycles');

(iii) 250 for batteries to be integrated in vehicles of categories M2, M3, N2 and N3 in the meaning of the Regulation (EU) 2018/858 ('medium-duty and heavy-duty vehicles');

(iv) the most appropriate number among the numbers referred to in points i, ii and iii for other electric vehicle batteries, selected by the manufacturer of the battery based on the usage pattern of the vehicle or vehicles the battery is to be integrated into, justified in the public version of the carbon footprint study.

(c) *years of operation* is determined by the commercial warranty according to the following rules:

(i) the duration of the warranty on the battery in years applies;

(ii) if there is no specific warranty on the battery, but a warranty on a vehicle in which the battery will be used, or parts of a vehicle that include the battery, the duration of that warranty applies;

(iii) by way of derogation of points i) and ii), if the duration of the warranty is expressed in both years and kilometres whichever one is reached first, the shortest number of the two in years applies. For this purpose, a conversion factor of 20.000 km equalling one year shall be applied for batteries to be integrated into light-duty vehicles; 5.000 km equalling one year for batteries to be integrated into motorcycles; and 60.000 km equalling one year for batteries to be integrated into medium-duty and heavy-duty vehicles;

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

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

(vi) if there is no warranty or only a warranty not compliant with the requirements under point (v), a figure of five years shall be used, except for cases where a warranty is not applicable, such as where there is no transfer of ownership of the battery or vehicle, in which case the

manufacturer of the battery shall determine the number of years of operation and justify it in the public version of the carbon footprint study.

2.2. System boundary and cut-off rules

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

(a) Raw material acquisition and pre-processing

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

(a) the extraction of resources from nature and their pre-processing until their use in product components entering through the gate of the first facility falling under the main product production life cycle stage;

(b) transport of raw materials and intermediate products within, between and from extraction and pre-processing facilities until the first facility falling under the main product production life cycle stage;

(c) the production of the cathode active material precursors, anode active material precursors, solvents for the electrolyte salt, the pipes and the fluid for the thermal conditioning system;

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

(b) Main product production

This life cycle stage covers the manufacturing of the battery including that of all components that are physically contained in or permanently attached to the battery housing.

This life cycle stage covers the following activities:

(a) cathode active material production;

(b) anode active material production, including the production ofgraphite and hard carbon from its precursors;

(c) anode and cathode production, including the mixing of ink components, coating of ink on collectors, drying, calendaring, and slitting;

(d) electrolyte production, including the electrolyte salt mixing;

(e) assembling the housing and the thermal conditioning system;

(f) Assembling the cell components into a battery cell, including stacking/winding of electrodes and separator, assembling into a cell housing or pouch, injection of electrolyte, closing of cell, testing and electrical formation;

(g) Assembling the cells into modules/pack including electric/electronic components, housing, and other relevant components;

(h) Assembling the modules with electric/electronic components, housing, and other relevant components into a finished battery;

(i) transport operations of the final and intermediate products to the site where they are used.

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

(c) Distribution

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

(d) End of life and recycling

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

(a) battery waste collection;

(b) battery dismantling;

(c) thermal or mechanical treatment, such as milling of the waste batteries;

(d) battery cell recycling such as pyrometallurgical and hydrometallurgical treatment;

(e) separation and conversion into recycled material, such as recycling of the aluminium from the casing;

(f) printed wiring board ('PWB') recycling;

(g) energy recovery and disposal.

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

2.2.2. The following are not covered by any of the life cycle stages:

(a) manufacturing of capital goods, including equipment;

(b) production of packaging materials;

(c) any component, such as of the thermal conditioning system, not physically contained in or permanently attached to the housing;

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

(e) the assembly of the battery within the vehicle.

2.2.3. A general cut-off of 1% in mass may be applied to material inputs per system component, by neglecting input and output flows that make up less than 1% to the total mass of the system component.

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

(a) battery cell anode;

(b) battery cell cathode;

(c) battery cell electrolyte;

(d) battery cell housing;

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

(f) battery module housing;

(g) battery module electronics;

(h) battery pack system housing;

(i) battery packs electronics;

(j) battery pack thermal conditioning system.

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

(a) mining;

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

(c) primary extraction, either pyrometallurgical or hydrometallurgical;

(d) refining;

(e) finishing.

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

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

2.3. Data collection requirements and quality requirements

The data collection and modelling for all the processes included in the main product production and the distribution life cycle stages shall be done in accordance with section 2.3.1.

The data collection and modelling for the following processes shall be done in accordance with section 2.3.2:

(a) production of cathode active material precursors: cobalt, nickel, iron, lithium, vanadium and titanium, whether metallic or as salts;

(b) production of anode active material precursors: graphite precursors, hard carbon precursors, lithium, silicon, titanium and rare earths, whether, where applicable, metallic or as salts;

(c) production of electrolyte salt and precursors: $LiPF_6$, LiTFSI and lithium salts;

(d) production of copper;

(e) production of aluminium;

(f) production of steel.

For the processes not listed in the first, second and third paragraphs of this section, the data collection and modelling shall be done in accordance with section 2.3.3.

2.3.1. Mandatory company-specific processes

Company-specific data shall be collected in accordance with section 2.3.5.

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

(a) suppliers provide to the manufacturer the complete LCI of the process, including elementary flows, energy consumption, input material, and the recycled content 'R_1' referred to in section 2.6, and the information required for the carbon footprint study as specified in section 3.1;

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

(c) suppliers provide the complete LCI of the process, including elementary flows, energy consumption, input material, and the recycled content 'R_1' referred to in section 2.6, and the information required for the carbon footprint study as specified in section 3.1 to a third-party, such as a data management company, who combines the inputs from different suppliers and provides the manufacturer a company-specific dataset for different processes.

Where the manufacturer communicates the company-specific data in accordance with point (b), the manufacturer shall ensure that the notified body receives from the manufacturer's suppliers all the information specified in section 3.1.1 when the manufacturer lodges its application for assessment by the notified body. The manufacturer shall also ensure that a market surveillance authority receives such information upon request.

Where the manufacturer communicates the company-specific data in accordance with point (c), the manufacturer shall ensure that the notified body receives from its suppliers or from the third-party all the information specified in section 3.1.1 when the manufacturer lodges its application for assessment by the notified body. The manufacturer shall also ensure that a market surveillance authority receives such information upon request.

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

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

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

(c) the carbon footprint for each applicable life cycle stage listed in section 2.2.1;

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

(e) the specific content and the carbon footprint of metals and metal salts that are targeted by the default battery cell recycling process referred to in section 2.6, at least regarding steel, aluminium, copper, cobalt, nickel, manganese, lithium, graphite, silicon, titanium, vanadium, silver, gold, platinum group metals and phosphorous. If such metals and metal salts contain recycled content, the carbon footprint of E_{V_Mat} and $E_{recycled\_Mat}$ as defined in section 2.6 shall be provided.

2.3.2. Non-mandatory most relevant processes

If at least one secondary dataset with a Technological Representativeness ('TeR') quality rating equal to or lower than four determined in accordance with section 2.3.6 is available in the datastock dedicated to the carbon footprint of batteries in the Life Cycle Data Network on the European Platform on LCA ('carbon footprint datastock') one of the following methods shall be chosen for data collection and modelling:

(a) the most representative secondary dataset in the carbon footprint datastock shall be used. If the dataset is a partially disaggregated, the electricity dataset or datasets connected to the core process one level down the supply chain at -1 level may be changed for the average electricity consumption mix of the country where the process is occurring, modelled in accordance with section 2.4. Such choice shall be duly justified in the carbon footprint study;

(b) a company-specific dataset with a Data Quality Rating ('DQR') equal to or lower than two. In such case, section 2.3.1 shall apply.

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

(a) a secondary dataset in line with the following hierarchy:

(i) the most representative EF-compliant dataset available in LCDN. If the dataset is a partially disaggregated, the electricity dataset or datasets connected to the core process one level down the supply chain at -1 level may be changed for the average electricity consumption mix of the country where the process is occurring, modelled in accordance with section 2.4. Such choice shall be duly justified in the carbon footprint study;

(ii) a representative EF-compliant dataset from any other source;

(iii) a representative ILCD entry-level compliant dataset either from LCDN or from any other source.

(b) a company-specific dataset with a DQR equal to or lower than three. In such case, the methods in section 2.3.1 shall apply.

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

2.3.3. Other processes

If one or more secondary datasets with a TeR quality rating equal to or lower than four determined in accordance with section 2.3.6 are available in the carbon footprint datastock, the most representative secondary dataset in the carbon footprint datastock shall be used.

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

(a) the most representative EF-compliant dataset available in LCDN;

(b) a representative EF-compliant dataset from any other source;

(c) a representative ILCD entry-level compliant dataset either from LCDN or from any other source.

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

2.3.4. Company-specific datasets

Company-specific datasets shall comply with the following requirements:

(a) the modelling shall be done in accordance with rules set in this Annex;

(b) the data format shall be compliant with the ILCD data format available in LCDN;

(c) the nomenclature of the elementary flows shall be aligned with the EF 3.1 reference package for the carbon footprint of batteries available in LCDNor the process datasets and product flow, the nomenclature shall be compliant with the ILCD Handbook Nomenclature and other conventions, available via the European Platform on LCA;

(d) h they shall include the DQR and the values of the three DQR criteria, calculated in accordance with section 2.3.6;

(e) the meta-data information shall comply with the requirements for meta-data information set out in the Guide for EF-compliant datasets, available on the European Platform on LCA;

(f) the system boundaries of cradle-to-gate models shall not include the distribution and end of life and recycling life cycle stages and only the material input of the circular footprint formula referred to in section 2.6 shall apply;

(g) in case of a LCI result dataset, the dataset shall include the LCI results and the LCIA results of the climate change impact category expressed in kg of CO_2-equivalent;

(h) in case of a LCIA result dataset, the dataset shall include the LCIA results of the climate change impact category expressed in kg of CO_2-equivalent.

2.3.5. Company-specific data

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

(a) the following inputs:

(i) material inputs that end up in the product, including minerals and metals, semi-finished materials and chemical feedstocks. If materials are used in solution state, the specific concentration shall be provided. The specific concentration data on the metal and on other elements, either concentration or specific metal content shall be provided;

(ii) energy that is consumed directly and indirectly in the processing plant, such as electricity, steam, thermal energy required by the process, and energy and fuels required for auxiliary activities such as transport or forklifting within the plant premises;

(iii) auxiliaries and any other material inputs required for the manufacturing process, such as chemicals, cleaning material, lubricants, and refrigerants;

(iv) transport distances and means of transport;

(v) any elementary flow.

(b) the following outputs:

(i) any material output, including wastewater;

(ii) any elementary flow,. Emissions that are not accounted for in the corresponding energy process dataset and that are not monitored via measurements shall be estimated based on stoichiometric calculations.

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

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

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

(b) unit, such as 'kg'

(c) bill of material or inventory data per kg main output product, before applying the circular footprint formula ('CFF') referred to in section 2.6

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

(e) LCI

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

(g) Universally Unique Identifier ('UUID')

(h) dataset name

(i) dataset location

(j) dataset type

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

(l) -1 level adjusted to [country]

(m) TeR

(n) TiR

(o) GeR

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

(q) data collection date

(r) documentation for verification

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

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

(b) the consumption of energy and auxiliaries shall preferably be based on an individual and detailed metering system that enables to attribute the energy or auxiliary consumption of the entire production to production lines, products, and time periods. Where the energy or auxiliary consumption cannot directly be related to a specific product, for example where several products are

produced in a facility while the consumption data is not available per specific product, the data shall be collected as specific as possible, such as split up into energy or auxiliary consumption for electrode manufacturing, cell assembly, cell finishing, and climatisation of clean or dry rooms. Where the energy or auxiliary consumption can be directly related to a specific process, the data of such consumption shall be used. Where the consumption data is only available for several products, for example, in case of presence of individual meters for cell assembly lines and only one general meter for a dry room in which several assembly lines produce different cells, the consumption data shall be split up by allocation in accordance with section 2.5.1. Where the process concerns a new facility, extension of capacity or exchange of entire production line, up to six of the initial months may be excluded from the data collection.

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

Company-specific emission data may be based on direct measurements or be calculated combining company-specific activity data, such as litres of fuel consumption in a boiler, with related emission factors from established sources, such as a specific emission factor for combustion of that fuel. If the process concerned is covered by EU emission trading system monitoring rules, the quantification requirements as set out in Commission Implementing Regulation (EU) 2018/2066[1] shall apply for the processes and greenhouse gases covered therein. The data may be scaled, aggregated or undergo other forms of mathematical treatment in order to bring them in line with the reference flow of the process.

Process emissions of CO_2 and other greenhouse gas emissions from chemical reactions shall be quantified from the reaction stoichiometry. If acids are obtained as by-product from emission abatement, subdivision shall be applied as referred to in section 2.5.1.

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

A company quality management system such as in accordance with ISO 9001:2015, ISO 14001:2015 or Regulation (EC) No 1221/2009 of the European Parliament and the Council[2], or equivalent shall be applied in order to demonstrate that all the activity data have been correctly collected and managed, and that they are representative of a yearly average or other period referred to of the process in scope.

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

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

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

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

Material	**Unit**	**Data**	**Specification**
Inputs			
Main input (ore, matte, etc.)			Not applicable in case of company-specific mining
Electricity			In accordance with section 2.4
Fuels for transport and machinery			Such as diesel, LNG or hydrogen
Fuels for (process) heat generation			Such as natural gas, coal / hydrogen
External heat supply (heat and steam respective of fuel)			If heat is sourced externally
Explosives			
Filling or structural material for production			Such as cement for backfilling
Acids			Such as sulphuric acid for acid leaching
Sulphur or H_2S			For on-site sulphuric acid production
Neutralizer or slagging agents			Such as lime, limestone, NaOH or MgO
Electrodes			Such as graphite electrodes
Reductants			Such as coal, charcoal or hydrogen
Chemicals			Bulk chemicals such as frother, dispersants or flocculants. Other chemicals may be aggregated and added to the major bulk chemicals.
Tyres			For specific machines at the mining stage
Technical gases			Such as nitrogen or oxygen, if purchased externally
Grinding media			Such as high strength steel balls or rods
Transport of input materials			Such as by truck, train, bark. Standard distances may be used.
Outputs			
Main product			Such as ore mined, matte, concentrated

			ore, final metal or metal salt, graphite ore, intermediate product. Assay data to be provided for specific metal contents or concentrations of ores or minerals and intermediate products
By-products			Such as sulphuric acid or other metals or metal salts than the main product. Allocation in accordance with section 2.5
Waste rock			
CO_2 (fossil) and other GHG emissions			Based on fuels and explosives if combustion emissions are not considered in the corresponding fuel or energy dataset, reductants, electrodes and other reactions where CO_2 emissions occur, such as neutralization or precipitation with limestone

2.3.6. Data quality ratings

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

(a) determine the quality rating for each of the three DQR criteria of Technological Representativeness ('TeR'), Geographical Representativeness ('GeR'), Time-related Representativeness ('TiR') for all the company-specific and secondary datasets used in the model in accordance with Table 2;

(b) calculate the carbon footprint of each process by multiplying the carbon footprint of the dataset by the corresponding activity data;

(c) calculate the carbon footprint contribution, expressed in percentage, of each process. The carbon footprint contribution is the ratio between the carbon footprint of the process divided by the sum of the values of all processes. In case a process has a negative carbon footprint, take the absolute value for this process rather than the negative value, including in the denominator;

(d) calculate the value of each DQR criterion of the declared value of the carbon footprint as a weighted average of the quality ratings of the DQR criterion concerned, weighted by the carbon footprint contribution of each process determined in point (c);

(e) calculate the DQR of the declared value of the carbon footprint as the sum of the values of the three DQR criteria divided by three.

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

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

(a) determine the quality rating for each of the three DQR criteria of Technological Representativeness ('TeR'), Geographical Representativeness ('GeR'), Time-related Representativeness ('TiR') for all the company-specific and secondary datasets used in the model of the company-specific dataset concerned in accordance with Table 2;

(b) calculate the carbon footprint of each process by multiplying the carbon footprint of the dataset by the corresponding activity data;

(c) calculate the carbon footprint contribution, expressed in percentage, of each process. The carbon footprint contribution is the ratio between the carbon footprint of the process divided by the sum of the values of all processes. In case a process has a negative carbon footprint, take the absolute value for this process rather than the negative value, including in the denominator;

(d) calculate the value of each DQR criterion of the declared value of the carbon footprint of the company-specific dataset concerned as a weighted average of the quality ratings of the DQR criterion concerned, weighted by the carbon footprint contribution of each process determined in point (c);

(e) calculate the DQR of the declared value of the carbon footprint of the company-specific dataset concerned as the sum of the values of the three DQR criteria divided by three.

Table 2
Evaluation of the DQR criteria

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

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

	secondary dataset does not provide any information on validity, the reference year of the carbon footprint is more than 4 years after the reference year of the dataset.		

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

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

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

Where:

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

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

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

2.4. Electricity modelling

The carbon footprint of the consumption of electricity shall be that of the national average electricity consumption mix, which shall be determined in accordance with section 2.3.3.

By way of derogation from the first paragraph, the carbon footprint of directly connected electricity shall apply in accordance with section 2.4.1.

2.4.1. Directly connected electricity

The carbon footprint of directly connected electricity shall apply if the electricity is supplied to the process in question from a production asset within the same installation or via a direct line as defined as defined in Article 2, point (41), of Directive (EU) 2019/944 of the European Parliament and of the Council.[3]

If the energy-consuming processing plant is connected to the electricity grid and electricity is sourced from the grid in addition to directly connected generation, including during times of low directly connected generation, all energy sourced from the grid shall be accounted for by the carbon footprint of the national average electricity consumption mix determined in accordance with section 2.3.3. The maximum amount of directly connected electricity that may be claimed in a year is the difference between the yearly total amount of electricity produced and the yearly amount of electricity injected in the grid. Evidence for the values of directly connected electricity shall be provided in the carbon footprint study.

[3] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (OJ L 158, 14.6.2019, p. 125, ELI: http://data.europa.eu/eli/dir/2019/944/oj)

If contractual instruments of any type, related to the amount of directly connected electricity intended to be claimed for the carbon footprint, have been sold to a third party, then the amount of directly connected electricity for which contractual instruments were sold to a third party shall be accounted for by the carbon footprint of the national average electricity consumption mix determined in accordance with section 2.3.3.

No credit shall apply if the amount of electricity produced exceeds the amount consumed within the defined system boundary.

The carbon footprint of the electricity production per energy type and country or region, such as the production of 1 MWh solar energy in the corresponding country or region, shall be determined in accordance with section 2.3.3. Datasets describing medium-voltage cases may be used for low-voltage cases, neglecting the conversion losses.

2.5. Allocation rules

2.5.1. Allocation of multi-functional processes

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

(a) subdivision, by splitting up the process into subprocesses that can be assigned unambiguously to one single product flow;

(b) allocation based on a relevant underlying physical relationship such as mass or energy. This shall be based on the properties that most closely represent the drivers for the corresponding input, and duly be justified and documented in the carbon footprint study;

(c) economic allocation.

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

Economic allocation shall be done based on the following values:

(a) 10-year global price averages for metals, ores and metal salts;

(b) five-year global price averages for all other commodities;

(c) five-years average for plant-specific revenues;

(d) five-year average process costs for recycling and waste treatment processes.

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

2.5.2. Allocation of energy and auxiliary inputs of production lines

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

In such case, the following hierarchy shall be used:

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

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

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

2.5.3. Allocation and modelling of the battery housing in electric vehicle batteries

Where the battery housing also provides the function of adding significant torsional stiffness to the vehicle, the modelling of the battery housing may be done as follows, in hierarchical order, if corresponding justification is provided in the public version of the carbon footprint study:

(a) physical partitioning: the components of the housing that provide function of additional torsional stiffness to the electric vehicle and that are not contributing to functions of holding the cells or modules or of integrating the battery thermal conditioning system or insulation shall be excluded from the system boundary;

(b) virtual housing approach: when physical partitioning is not feasible, the size of the housing shall be re-calculated in accordance with the size of the battery and a reference thickness for each material. This calculation shall be modelled as follows:

(i) based on the actual length ('L'), the width ('W') and the height ('H') of the battery housing, the area of the virtual housing shall be calculated as: $Area = (L \cdot W) \cdot 2 + (W \cdot H) \cdot 2 + (L \cdot H) \cdot 2$

(ii) the materials to model the virtual housing shall be the same as used in the real housing. In addition, if only one material is used in the real housing, the virtual housing shall be considered as made of such material. If more than one material is used in the real housing, only those materials accounting for at least 95% of the weight of the real 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) the "Weight" of each material in the virtual housing shall be calculated as:

$$Weight_{mat\_i} = Area \cdot Percentage_{mat\_i} \cdot t_{mat\_i} \cdot \rho_{mat\_i}$$

Where:

– *Area* is the area of the virtual housing, calculated in accordance with point (a)

– $Percentage_{mat\_i}$ is the proportion of material *i*, calculated in accordance with point (b)

– t_{mat_i} is the reference thickness of material *i*

– ρ_{mat_i} is density of material *i*

The following reference thickness values shall be used for the materials concerned:

(a) for aluminium: 2,5 millimetre ('mm');

(b) for steel: 1,75 mm;

(c) for carbon fibres based material: 2,02 mm.

For other materials, an appropriate reference thickness shall be used.

The implementation of the virtual housing approach shall be reported in detail in the carbon footprint study, including all assumptions used, with details of the model and experimental values used, including details concerning the reference thickness values for any materials other than aluminium, steel or carbon fibres based material.

A value of torsional stiffness of the vehicle with battery housing and a value of torsional stiffness of the vehicle without battery housing shall be reported in the carbon footprint study. If the torsional stiffness with battery housing is more than 10% higher than the stiffness without battery housing, then the battery housing shall be considered to contribute significantly to the stiffness of the vehicle.

For a battery used in different vehicle models, the approach in this section can only be applied if there is a significant contribution to the stiffness for all vehicle models the battery is used in.

2.6. Recycled content and end of life modelling

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

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

The end of life and recycling life-cycle stage of the battery shall be modelled with the default battery recycling process specified in this section. A different company-specific return rate may be used only for the share of batteries covered by an ownership business models where the property of the battery stays with the manufacturer, where contractual evidence of higher return rates is provided, including evidence that the batteries covered under that rate are

recycled in accordance with Regulation (EU) 2023/1542. While Tables 4 and 5 provide the parameters of the default battery cell recycling process, a different, company-specific battery cell recycling process may be applied only for the share of the batteries for which evidence is provided that they will be recycled in a specific recycling plant operating at commercial scale and that the specific recycling process corresponds to the battery model for which the carbon footprint is declared. Such specific recycling process shall be modelled with company specific data in accordance with section 2.3.5. In case company-specific battery cell recycling process is applied, modified assumptions and the corresponding evidence shall be detailed in the carbon footprint study. The justification for applying a company-specific battery cell recycling process shall be provided in the public version of the carbon footprint study.

The CFF shall be applied per material, unless specified differently in the description of the single parameters. In particular:

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

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

The contribution of the following six terms of the CFF shall be determined in accordance with the equations specified and summed up to obtain the final result:

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

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

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

(a) Materials from the properly collected fraction of the battery:

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

(b) Materials from the non-properly collected fraction of the battery:

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

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

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

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

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

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

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

(6) Impacts of disposal ('disposal'):

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

– Other materials not-being recycled, deriving from the dismantling of the properly collected battery waste

$$R_{Return} \cdot \sum_{Mat}[(1 - R_{rec,c_{Mat}} - R_{3,c_{Mat}}) \cdot (E_{D_{Mat}})]$$

Where:

(a) A_{Mat} is the material-specific allocation factor of burdens and credits between two life cycles, the one supplying and the one using recycled material, aiming to reflect market realities. The values for A_{Mat} shall be taken from Table 3. In case a material is not included in Table 3, reference application-specific values shall be taken from Part C of Annex II to Commission Recommendation (EU) 2021/2279. If no such values for a specific application are there available, then material-specific values for A_{Mat} may be used from the same source. If such values of parameter A_{Mat} for the considered materials are not available either, a value of 0,5 shall be used;

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

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

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

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

(f) R_{Return} is the battery return rate, meaning the rate of end-of-life vehicles that are properly de-registered for removal of parts and components multiplied with a 100% collection of contained batteries to be recycled in accordance with Regulation (EU) 2023/1542. R_{Return} is by default equal to 0,8, unless evidence

is provided in the carbon footprint study for a different company-specific value. This may only be done for the share of batteries covered by an ownership business model where the property of the battery stays with the manufacturer and evidence of such ownership model shall be provided in the carbon footprint study together with evidence of the higher return rate, including evidence that the batteries covered under that rate will be recycled in accordance with Regulation (EU) 2023/1542;

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

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

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

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

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

(l) $E_{recEoL\_Batterycell}$ is the specific emissions and resources consumed arising from the battery cell recycling. $E_{recEoL\_Batterycell}$ is accounted for on battery level and not per material. $E_{recEoL\_Batterycell}$ shall be modelled using the default values provided in Tables 4 and 5. Different company-specific recycling processes may be used only for the share of the batteries for which contractual evidence is provided that they will be recycled in a specific recycling plant and that the

specific recycling process corresponds to the battery model for which the carbon footprint is declared. In this case, the company-specific battery cell recycling process shall refer to the recycling plant operating at the time of the battery being placed on the market. The mass and composition of the battery used for the company-specific battery cell recycling process shall reflect to the mass and composition of the battery for which the carbon footprint is declared. The justification for modelling a company-specific battery cell recycling process shall be provided in the public version of the carbon footprint study. . In case a company-specific battery cell process is applied, the options in section 2.3.1 shall apply, to be read as applying to the recycler rather than the supplier. In the default battery recycling process, data use shall reflect recycling processes taking place in Europe;

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

(n) E_{recEoL_PWB} is the specific emissions and resources consumed arising from the PWB recycling following the dismantling of the properly collected waste batteries. E_{recEoL_PWB} shall be determined in accordance with section 2.3.3;

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

(p) Q_p is the quality of the primary material;

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

(r) Q_{sout} is the quality of the outgoing secondary material, meaning the quality of the recyclable material at the point of substitution. Default values for Q_{sout} / Q_p are provided in Table 3. Higher values are allowed only if a company-specific battery cell recycling process is modelled and if evidence is provided in the carbon footprint study, such as through technical specifications of the secondary material demonstrating that is ‘battery-grade’;

(s) E_{ER} is the specific emissions and resources consumed arising from the energy recovery of the polymers from the battery waste dismantling, for both the properly collected and the non-properly collected waste batteries, including both the direct emissions of the incineration plants and the credits due to the

avoided energy production. E_{ER} shall be determined in accordance with section 2.3.3. If the secondary datasets for energy recovery do not include the credits from the production of energy, the credits shall be modelled using the lower heating value of the polymers substituting the European energy mix;

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

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

If datasets used already include the allocation with the factor A_{Mat}, then they shall not be allocated again.

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

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

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

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

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

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

n/a = not applicable

Table 4
Default values for battery cell recycling process per kg of battery cell: pyrometallurgical treatment

Component	Unit	Default value	Specification / dataset	
Inputs				
End of life battery cells	kg	1,00	From disassembly	
Electricity	kWh	1,00	Electricity mix	

Process heat	MJ	2,288	Thermal energy from natural gas	
Process heat	MJ	0,237	Thermal energy from diesel fuel	
Limestone washed	kg	0,136	Limestone production, technology mix	
Silica sand	kg	0,119	Silica sand, production mix	
Quicklime (CAO)	kg	0,085	Quicklime production, technology mix	
Carbon black	kg	0,001	Carbon black production, technology mix	
Transport from the dissembling to the battery cell recycling plant	km	130	Transport by truck (>32 t, EURO 4);	
Transport from the dissembling to the battery cell recycling plant	km	240	Transport by train (average freight train)	
Transport from the dissembling to the battery cell recycling plantf	km	270	Transport by ship (barge).	
Outputs				
Metal alloy	kg	0,209	To hydrometallurgical treatment	
Slag	kg	0,712	Landfill of inert slag	
Emissions	kg CO_2-equivalent	1,194	Direct process emissions (all greenhouse gases)	

Table 5
Default values for battery cell recycling process per kg of battery cell: hydrometallurgical treatment.

Component	Unit	Default value	Specification / dataset	
Inputs				
Metal alloy	kg	0,34		
Electricity	kWh	0,085	Electricity mix	
Process heat	MJ	1,847	Thermal energy from natural gas	
Hydrochloric acid (100%)	kg	0,017	HCl production, technology mix	
Hydrogen peroxide (100%)	kg	0,305	Hydrogen peroxide, production, technology mix	
Soda (sodium carbonate)	kg	0,017	Soda production, technology mix	
Sodium hydroxide (100%; caustic soda)	kg	0,458	Sodium hydroxide production, technology mix	
Sulphuric acid aq. (96%)	kg	0,881	Sulphuric acid production, technology mix	
Water (tap water)	m^3	0,003		
Outputs				
Recovered metals	kg		Such as aluminium, copper, steel and stainless steel	Credit for each specific metal according to its content in the battery cell and parameters R_{Return}, A, R_{rec}, and Q_{sout}/Q_p
Recovered metal salts	kg		Such as cobalt sulphate and nickel sulphate	Credit for each specific metal salt according to its stoichiometric content in the battery cell and parameters R_{Return}, A, R_{rec}, and Q_{sout}/Q_p

Wastewater	m^3	0,00864	Wastewater treatment, average	

2.6.1. The CFF applied to manufacturing waste

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

The CFF shall be applied to all manufacturing waste using the same formula as in section 2.6, with the following modifications:

(a) the equations for 'material input' and 'dismantling' shall not apply;

(b) the equation for 'electronics recycling' shall only apply if the manufacturing waste contains PWB waste;

(c) R_{Return} shall be equal to 1; and

(d) $E_{recEoL\_Batterycell}$ shall only apply to waste fractions that consist of compound battery cell components, such as coated electrode cut-offs and final cells rejected at the end of the manufacturing line. In all the other cases, $E_{recEoL\_Batterycell}$ shall be equal to 0.

2.7. Transport up to and including distribution

For transport in the main product production life cycle stage, in the distribution life cycle stage, and in the raw material acquisition and pre-processing life cycle stage between processes for which company-specific data is used pursuant to sections 2.3.1, where relevant, and 2.3.2, company-specific data shall be used for the distance, in combination with secondary dataset corresponding to the actual transport mode and the actual category of the transport means, such the category of truck used.

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

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

3. VERIFICATION RULES

3.1. Documentation for verification

3.1.1. Carbon footprint study

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

It shall include detailed description and documentation of:

(a) the carbon footprint model used for the calculation;

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

(c) the functional unit and all the information needed to calculate it;

(d) the details of all the company-specific data, including:

(i) one or more tables containing all LCI, activity data and elementary flows, the corresponding background dataset used, if applicable, and the values of the DQR criteria of each dataset (‘inventory tables’). The tables shall include the list of parameters provided in section 2.3.5, including the bill of materials or ingredients, such as substance names, units and quantities, information on origin, grades or purities, yield rates, where applicable, recycled content and other technically or environmentally relevant characterisation, the procedure used for company-specific data collection, estimation and calculation, the data source where applicable, the data collection period, and a justification if data collection is done for periods of time other than the default timeframes specified in this Annex;

(ii) to which life cycle stage they belong;

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

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

(e) the details of all secondary and company-specific datasets used, including:

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

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

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

(f) the details of how the carbon footprint of electricity use was determined, including:

(i) where applicable, evidence for the values used for directly connected generated electricity;

(ii) where applicable, which datasets have been used for the average electricity consumption mix;

(g) the details of how allocation was applied, including:

(i) indication of the multifunctional processes for which an allocation was applied and the allocation factors used;

(ii) which point of the hierarchy in section 2.5.1 was applied in each case with a justification of why any earlier points in the hierarchy could not be applied;

(iii) in case of allocation based on physical relationships, which physical relationship has been used, a justification thereof, and the underlying data sources;

(iv) in case of economic allocation, the prices and the corresponding sources including the considered timespans used for the economic allocation, and justification for any timespans applied that are shorter than the default ones;

(v) the datasets or activity data to which the allocation factors apply shall be indicated in the inventory tables;

(vi) if allocation is done for energy and auxiliary inputs of production lines as referred to in section 2.5.2, the method applied and a justification thereof;

(vii) the implementation of the virtual housing approach, including all assumptions and dimensioning parameters used with details of the model and experimental values used, including details concerning the reference thickness values for any materials other than aluminium, steel or carbon fibres based material, a tabulated mass balance of the real housing and of the virtual housing, the value of torsional stiffness of the vehicle with battery housing and the value of torsional stiffness of the vehicle without battery housing, and the carbon footprint of the battery when using the real housing;

(h) the details of the recycled content and end of life modelling, including:

(i) the parameters used in the CFF for all materials with evidence for the cases where values other than the default values were used;

(ii) in case of recycled content higher than zero, the evidence for the recycled content share;

(iii) in case of a company-specific return rate, the evidence for the share of the batteries are covered by an ownership business model where the property of the battery stays with the manufacturer together with evidence of the higher return rate, including evidence that the batteries covered under that rate will be recycled in accordance with Regulation (EU) 2023/1542;

(iv) in case of a company-specific battery cell recycling process, the evidence that the batteries will be recycled in a specific recycling plant and that the recycling process corresponds to the battery model for which the carbon footprint is declared;

(i) the categories of the transport means and the estimated distances;

(j) the public version of the carbon footprint study.

3.1.2. Public version of the carbon footprint study

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

(a) information about the battery model;

(b) information about the geographical location of the battery manufacturing plant;

(c) the total life-cycle carbon footprint expressed in kg CO_2-equivalent per kWh of total energy delivered;

(d) the carbon footprint of each life cycle stage listed in section 2.2, expressed in kg CO_2-equivalent per kWh of total energy delivered;

(e) the reference year of the carbon footprint calculation;

(f) the DQR score and the values of the single DQR criteria calculated in accordance with section 2.3.6;

(g) the rated energy capacity of the battery in kWh;

(h) the total amount of CO_2-equivalent emitted during the life cycle of the battery, expressed in kg CO_2-equivalent, and the total amount of energy provided by the battery over its service life as used for the carbon footprint calculation, in kWh;

(i) information on each dataset used: the name of the dataset, for which life cycle stage or stages and which process or processes it was used, whether it is a company-specific dataset or a secondary dataset, its source in case of secondary datasets, its values of the DQR criteria, and its time validity;

(j) information on electricity modelling:

  (i) where applicable, the energy type used for directly connected electricity generation;

  (ii) where applicable, the specification of which dataset or datasets listed pursuant to point (m) have been used for the average electricity consumption mix;

(k) information on allocation:

  (i) indication of the multifunctional processes for which an allocation was applied;

  (ii) which point of the hierarchy in section 2.5.1 was applied in each case and a justification why any earlier points in the hierarchy could not be applied;

  (iii) the justification for a virtual housing approach, where applied;

(l) information on recycled content and end of life modelling:

  (i) in case of recycled content higher than zero, information on the recycled content share;

  (ii) in case of a company-specific collection rate, information on the share of the batteries are covered by an ownership business model;

  (iii) the justification for modelling a company-specific battery cell recycling process, where applied.

3.2. Verification and validation techniques

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

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

(b) calculations performed are correct.

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

(a) the manufacturer's premises;

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

(c) the cathode active material production premises;

(d) the anode active material production premises; and

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

The notified body shall verify that:

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

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

(i) coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;

(ii) plausibility, quality and accuracy of the data;

(iii) quality and accuracy of the underlying documentation.

(c) the electricity modelling rules as prescribed in this Annex are correctly applied;

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

(e) conversion of measurement units are correctly applied;

(f) methods for making estimates are appropriate and have been applied consistently.

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