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Carbon footprint calculation applicable to industrial lithium-ion batteries - Part 1: General requirements and methodology

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Carbon footprint calculation applicable to industrial lithium-ion batteries - Part 1: General requirements and methodology

FOREWORD

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IEC 63369-1 has been prepared by subcommittee SC 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC technical committee 21: Secondary cells and batteries. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
21A/948/FDIS	21A/968/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63369 series, published under the general title *Carbon footprint calculation applicable to industrial lithium-ion batteries*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

1 Scope

This part of IEC 63369 addresses general requirements and methodology, whereas intended IEC 63369-2[1] and intended IEC 63369-3[2] address applications of the methodology and default values of the CFF parameters by geographic area (see Annex B).

This document provides a comprehensive methodology for the calculation of carbon footprint of industrial type Li-ion battery from cradle to grave.

NOTE Industrial-type Li-ion battery is described in IEC 62619 or IEC 62620.

Second life and/or usage that was not intended when the battery was put on the market is not taken into account in this document.

This document, along with the other parts of this series, does not apply to batteries for portable, SLI and electric road vehicle traction applications. The definition of the parameters used for the carbon footprint calculation allows for comparability of results for all rechargeable Li-ion chemistries. Classes of representative products are defined in this document to allow comparison inside each class.

This methodology, based on the data provided by the battery manufacturer, is mainly intended to allow a carbon footprint assessment of several battery solutions over the Cumulated Requested Service (CRS). This assessment can be used in the selection process of the battery purchaser.

The methodology can also be used for a variety of purposes such as battery system development, eco-design and participation in voluntary or mandatory programs.

The methodology in this document is based exclusively on attributional life cycle assessment (LCA).

The carbon footprint calculation of charging equipment and power conversion equipment not necessary for battery functions is not covered in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14021:2016, *Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)*

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1 Under consideration.

2 Under consideration.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

– IEC Electropedia: available at https://www.electropedia.org/
– ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
primary data
foreground data
company-specific data
quantified value of a process or an activity obtained from a direct measurement, or a calculation based on direct measurements

[SOURCE: ISO 14067:2018, 3.1.6.1, modified – The terms "foreground data" and "company-specific data" have been added, and notes to entry omitted.]

3.1.2
secondary data
background data
data which do not fulfil the requirements for primary data

Note 1 to entry: As an example, secondary data can include data from databases and published literature, default emission factors from national inventories, calculated data, estimates or other representative data, when validated by competent authorities. Further 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. These industry average contain other generic data can be also considered secondary or background data.

Note 2 to entry: As an example, secondary data can include data obtained from proxy processes or estimates not directly collected, measured, or estimated by the company, but sourced from a third party LCI database or other sources.

Note 3 to entry: As an example, secondary data can include data not originating from a specific process within the supply-chain of the company performing the carbon footprint calculation report.

Note 4 to entry: As an example, secondary data can include primary data that went through a horizontal aggregation step.

Note 5 to entry: Details on secondary data selection is provided in intended IEC 63369-2 (see Annex B).

[SOURCE: ISO 14067:2018, 3.1.6.3, modified – term "background data" added, Note 2 to Note 5 added]

3.1.3
battery system
battery
<of Li-ion> system intended to provide the cumulated requested service as stated by the user which comprises one or more cells, modules or battery packs and all other components needed as per IEC 62619 and IEC 62620

Note 1 to entry: In situations where a single battery system is unable to supply the CRS, multiple battery systems need to be placed sequentially into service. The sum of those battery systems used over time to meet the CRS constitutes the battery system.

Note 2 to entry: See examples of a battery system structure in IEC 62619 or IEC 62620.

Note 3 to entry: The other equipment required to connect to the DC link or power grid such as converters, control and monitoring systems, inductors, application protection devices, etc are not part of the battery system.

3.1.4
battery manufacturer
entity which supplies the battery system(s) to meet the CRS of the application as expressed in the technical specifications from the user

Note 1 to entry: Component manufacturer that does not perform the sizing of the battery system is not defined as the battery manufacturer in this document.

3.1.5
set of conditions
group or collection of ambient and operating conditions present during the use stage

3.1.6
cumulated requested service
CRS
total amount of service requested by the buyer or the end user, expressed in duration (months or years) or delivered energy in kWh or its multiple, under e.g. representative ambient and operating conditions, as expressed in the set

3.1.7
battery system sizing
activity that defines the optimal battery system by taking in account its usage pattern and associated constraints defined by the battery system user

Note 1 to entry: The battery sizing is carried out by the battery system manufacturer and includes replacements if needed to meet the CRS.

3.1.8
battery system sizing result
total number of battery systems requested to provide the full application cumulated requested service, as calculated by the battery system manufacturer

Note 1 to entry: The sizing result is an integer, in case the battery components at the end of the CRS are still capable to provide service for extra time, the remaining part is not to be deducted

3.1.9
component manufacturer
entity which supplies a component of the battery system

Note 1 to entry: The cell or module manufacturer, as component manufacturer, does not perform the battery system sizing.

3.1.10
functionality class
<of battery systems> group of usage pattern of battery that presents similarities in the essential characteristics of the demand placed on the considered battery systems

Note 1 to entry: Only battery systems operating in the same functionality class can be compared in terms of battery carbon footprint.

3.1.11
functional unit
quantified performance, as stated in the end-user specifications, of the cumulated requested service provided by an industrial battery system

[SOURCE: ISO 14040:2006, 3.20, modified – deleted "of a product system for use as a reference unit" and replaced by "as stated in the user specifications, of the service provided by an industrial battery system"]

3.1.12
reference flow
amount of product needed to fulfil the cumulated requested service measured in kg of battery systems over time

Note 1 to entry: This value is expressed in kg of battery system required per kWh of total energy (REP usage) or calendar life (OND usage).

Note 2 to entry: "Reference flow" is a standard wording in LCA. All quantitative input and output data collected in the calculation report are calculated in relation to this reference flow.

3.1.13
input
product, material or energy flow that enters a unit process

Note 1 to entry: Products and materials include raw materials, intermediate products, co-products and releases.

[SOURCE: ISO 14040:2006+A1:2020, 3.21]

3.1.14
output
product, material or energy flow that leaves a unit process

Note 1 to entry: Products and materials include raw materials, intermediate products, co-products and releases.

[SOURCE: ISO 14040:2006+A1:2020, 3.25]

3.1.15
elementary flow
material or energy entering the system being studied that has 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

[SOURCE: ISO 14040:2006, 3.12]

3.1.16
product flow
products entering from or leaving to another product system

[SOURCE: ISO 14040:2006, 3.27]

3.1.17
load profile
charge and/or discharge cycle providing the energy and power as required by the application to be repeated over time

Note 1 to entry: As an example, a graph showing the variation of electrical discharge load over time, that is repeated multiple times throughout its CSR.

3.1.18
hotspot
top contributing components and processes that together contribute more than 80 % to the carbon footprint

Note 1 to entry: Hotspot is a synonym of most relevant component and process.

Note 2 to entry: Hotspot refers to the battery system under study.

3.1.19
life cycle inventory
LCI
combined set of exchanges of elementary, waste and product flows in a dataset

Note 1 to entry: Note that the acronym LCI in this document refers to 'life cycle inventory' while ISO 14040 and ISO 14044 refer to 'life cycle inventory analysis".

3.1.20
life cycle inventory dataset
LCI dataset
information on elementary, waste and product flows including metadata and evidence pertaining to process, modelling, validation and administrative data

Note 1 to entry: Structure of LCI process dataset is shown on Figure 1.

Note 2 to entry: An LCI process dataset can be a partially or fully aggregated dataset or can be a unit process dataset.

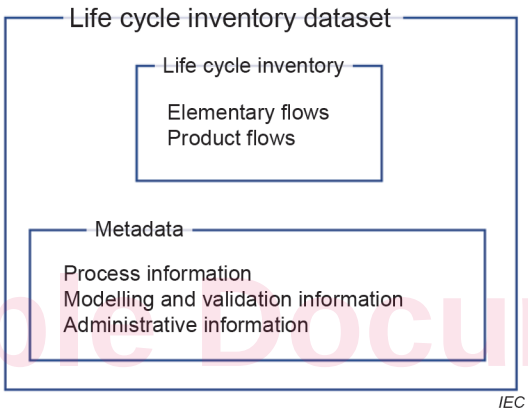

Figure 1 – Life cycle inventory dataset

Note 3 to entry: In this document, LCI dataset covers also LCIA (Life Cycle Impact Assessment) dataset.

3.1.21
compliant dataset
LCI dataset which meets all the LCI dataset requirements in this document, where each data quality indicator is rated to be at least of good quality

Note 1 to entry: A compliant dataset can be a company-specific dataset or a secondary dataset.

Note 2 to entry: The requirements for data quality are listed in Clause 9.

3.1.22
partially disaggregated dataset
dataset with a life cycle inventory that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yields a complete aggregated LCI data set

3.1.23
aggregated dataset
complete or partial life cycle of a product system that – next to the elementary flows– itemises only the product(s) of the process as reference flow(s) in the input/output list, but no other goods or services

Note 1 to entry: Aggregated datasets are also called 'LCI results' datasets.

3.1.24
point of substitution
point in the value chain where secondary materials substitute primary materials

3.2 Abbreviated terms

ACF	Application carbon footprint
BCF	Battery system carbon footprint (in kg of CO_2 equivalent)
BESS	Battery energy storage system
BOM	Bill of materials
BTMS	Battery thermal management system
CFF	Circular footprint formula
CFP	Carbon footprint of product (in kg of CO_2 equivalent) for components or accessories
CRS	Cumulated requested service
$CO_{2\ eq}$	CO_2 equivalent
DC link	Direct current link
DQR	Data quality rating
EF	Elementary flow
EmF	Emission factor
EOL	End of life
ESS	Energy storage system
FSS	Fire suppression system
FU	Functional unit
GHG	Greenhouse gas
GOO	Guarantee of origin
GWP	Global warming potential
IEA	International energy agency
IPCC	Intergovernmental panel on climate change
LCA	Life cycle assessment
LCI	Life cycle inventory
LFP	Lithium iron phosphate
LMO	Lithium manganese oxide
LTO	Lithium titanium oxide
MOB	Mobile equipment
NMC	Nickel manganese cobalt
OEM	Original equipment manufacturer
OND	Applications with sporadic on-demand energy delivery
PCB	Printed circuit board
PCS	Power conversion system
PE	Polyethylene
PP	Polypropylene
PPA	Power purchase agreement
PV	Photovoltaic
PWB	Printed wiring board

REC Renewable energy certificate
REP Applications with frequent and repetitive charge and discharge cycles
SLI Starting, lighting and ignition
STA Stationary equipment
UPS Uninterruptible power supply
Wh Watt hour (energy unit)

4 General information

This document, together with the other intended parts of the IEC 63369 series, provides the necessary guidance and structure to ensure that all BCF calculations for industrial Li-ion batteries and their components are derived, verified and presented in a consistent and comparable way.

The methodology can be used to assess the carbon footprint of single, multiple or all stages of the life of a battery, e.g. limited to collect data for components in the case of single stage (for instance cell manufacturing) or multiple stages (for instance cell and module manufacturing).

In all cases, the knowledge of the CRS is a prerequisite for such a calculation, as the calculation is done based on the whole CRS with cumulated number of battery systems requested to provide the full application CRS.

Electrical energy provided or accepted by the battery in the application is already taken into account at the application level, i.e. it is not to be accounted for in the BCF calculation.

However, any electrical, thermal or mechanical energy consumed during charge, discharge and storage by auxiliary components of the battery, as defined in 7.3, shall be taken in account in the BCF calculation (e.g. powering of the BTMS is impacting the expected service life).

5 Classification of services offered by industrial Li-ion batteries

5.1 General

Industrial Li-ion batteries are used in a large variety of applications and for proper battery carbon footprint calculations, their main services shall be identified and categorized in classes in order to compare only the carbon footprint of batteries providing similar services.

The following classes are covered in this document and other intended parts:

– applications with frequent repetitive charge and discharge cycles in mobile equipment (REP-MOB);
– applications with frequent repetitive charge and discharge cycles in stationary equipment (REP-STA);
– applications with sporadic on-demand energy delivery in mobile equipment (OND-MOB);
– applications with sporadic on-demand energy delivery in stationary equipment (OND-STA).

Each of these service classes requires an application-oriented adaptation of their design when their application is either mobile or stationary, due to very different and distinctive construction features, operating environments and safety requirements. This results in significant differences in their BOM.

Mobile equipment is defined in this document as being equipment which can move or be moved while in operation, for example as mentioned in IEC 62619, forklift trucks, golf carts and similar lightweight vehicles, automated guided vehicles, railway vehicles, marine vessels, at the exclusion of batteries for SLI and electric road vehicle traction applications.

Stationary equipment is defined in this document as being all fixed equipment or equipment that cannot be easily moved.

The specific uses of industrial Li-ion cells and batteries considered in this document are itemized in 5.2 to 5.4.

5.2 Repetitive energy supply

5.2.1 Repetitive energy supply in mobile equipment ("REP-MOB") class

The battery very frequently, e.g. daily, stores and supplies energy for mobile equipment as required over its service life.

The metric for this duty is the total energy to be discharged in kWh over the CRS. Every cycle should meet "the ability to achieve the requested power profile" over the CRS.

NOTE In such an application, the specific volumetric and gravimetric energy density of the battery is of key importance.

5.2.2 Repetitive energy supply in stationary equipment ("REP-STA") class

The battery stores and very frequently supplies energy to stationary equipment as required over its service life.

The metric for this duty is the total energy to be discharged in kWh over the CRS. Every cycle should meet "the ability to achieve the requested power profile" over the CRS.

NOTE 1 In such an application, the specific volumetric energy density of the battery is of key importance.

In order to compare the BCF of batteries with similar functionalities, this classification is divided into two parts to reflect significant differences in the bill of materials (see 7.4.2), e.g. fire suppression systems in large industrial BESS applications are not necessarily needed in some smaller ones.

NOTE 2 The capability of a BESS is typically conveyed with a Watt (power) and Wh (energy) value e.g., 35 MW/70 MWh. Such key performance values imply that nominally 35 MW of discharge power can result in a delivery of 70 MWh of energy or at most over 2 h of discharge duration. (70 MWh/35 MW=2 h).

5.3 On-demand energy supply

5.3.1 On-demand energy supply in mobile equipment ("OND-MOB") class

The battery supplies auxiliary energy in mobile equipment whenever main power is lost and as required over its service life.

The metric for this duty is the ability to meet the requested power profile over the CRS expressed in years.

NOTE In such an application, the specific volumetric and gravimetric energy density of the battery is of key importance.