BATTERIES AND PARTS THEREOF

PRODUCT CATEGORY CLASSIFICATION: UN CPC 4641, 4642, 4643, AND HS CODE 85.

C-PCR-007 (TO PCR 2024:06)

VERSION 1.0.0

VALID UNTIL 2030-08-11

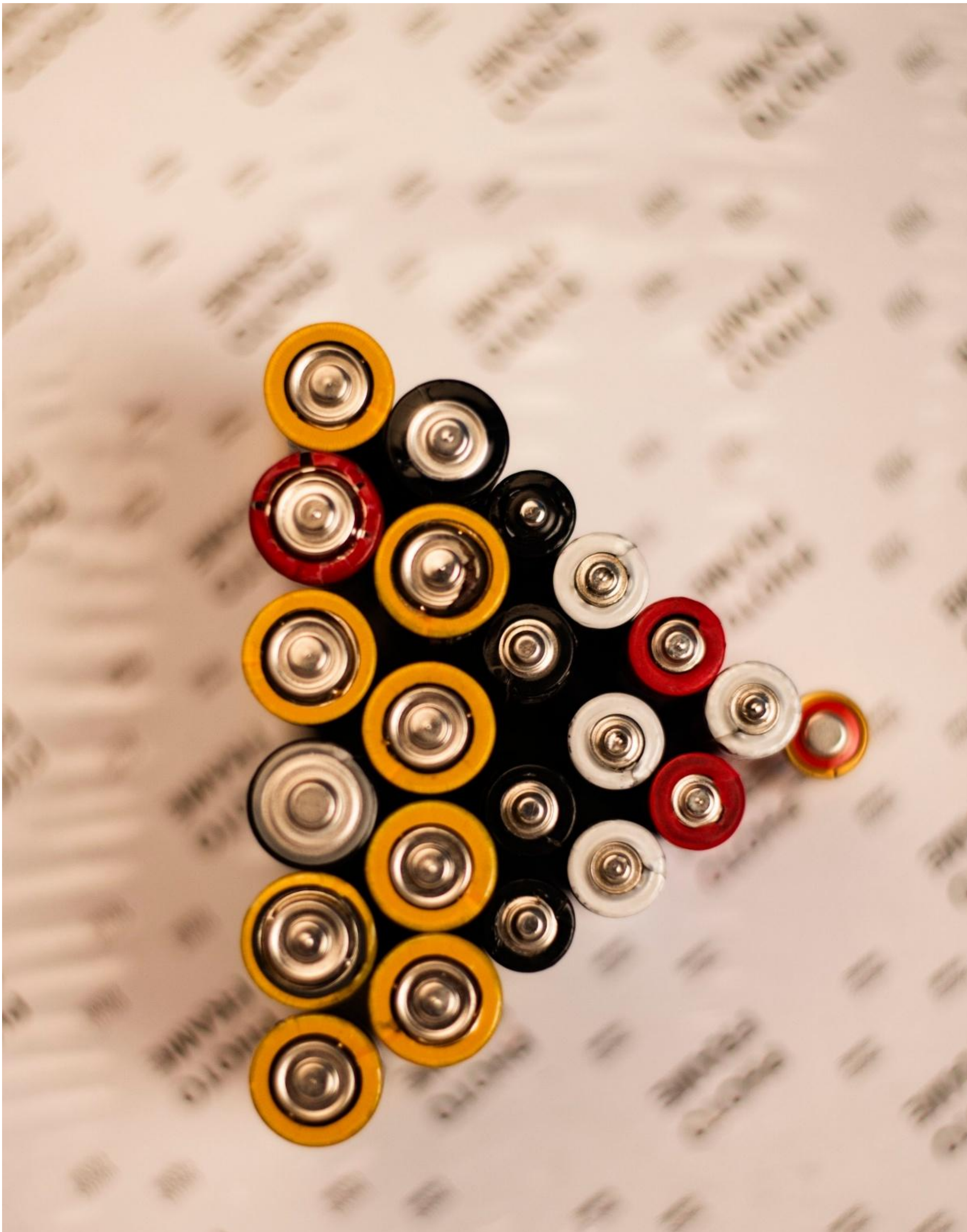

TABLE OF CONTENTS

1 INTRODUCTION

1.1 GENERAL

This document constitutes complementary Product Category Rules (c-PCR) developed in the framework of the International EPD System: a programme for type III environmental declarations[1] according to ISO 14025:2006, ISO 14040:2006, ISO 14044:2006, EN 50693:2019, IEC 63366, and PCR 2024:06 (the main PCR)[2]. Environmental Product Declarations (EPD) are voluntary documents for a company or organisation to present transparent, consistent, and verifiable information about the environmental performance of their products (goods or services).

The rules for the overall administration and operation of the programme are the General Programme Instructions (GPI), publicly available on www.environdec.com. PCRs and c-PCRs complement the GPI and the normative standards by providing specific rules and guidelines for developing an EPD for one or more specific product categories (see Figure 1). A PCR/c-PCR should enable different practitioners using the PCR/c-PCR to generate consistent results when assessing products of the same product category.

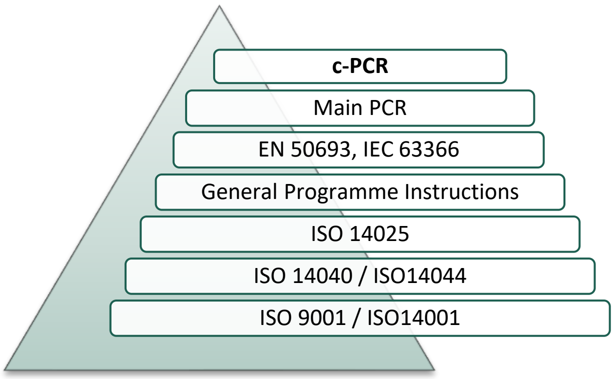

Figure 1. The hierarchy between PCRs, standards, and other documents.

The present PCR uses the following terminology:

- The term “shall” is used to indicate what is obligatory, i.e., a requirement.
- The term “should” is used to indicate a recommendation. Any deviation from a recommendation shall be justified in the EPD development process.
- The terms “may” or “can” are used to indicate an option that is permissible.

For definitions of other terms used in the document, see the GPI and normative standards.

A main PCR and its c-PCRs are valid for a pre-determined period of time to ensure that it is updated at regular intervals. The latest version of the PCR and its c-PCRs are available on www.environdec.com. Stakeholder feedback on PCRs and c-PCRs is very much encouraged. Any comments on this c-PCR may be sent directly to the PCR Moderator and/or the Secretariat during its development or during its period of validity.

Any references to this PCR shall include the PCR registration number, name, and version number.

The programme operator maintains the copyright of the PCR to ensure that it is possible to publish, update, and make it available to all organisations to develop and register EPDs. Stakeholders participating in PCR development should be acknowledged in the final document and on the website.

1.2 ROLE OF THIS DOCUMENT

This document provides complementary product category rules (c-PCR) to PCR 2024:06 Electronic and electric equipment, and electronic components (non-construction), i.e. the main PCR, available at www.environdec.com. This document cannot be used by itself but shall be used together with PCR 2024:06 and the European standard EN 50693, for products within the scope of the PCR (see Section 2.2.1). It is required to use an applicable c-PCR after it has been published 90 days. It is optional to the use the c-PCR if it has been published for less than 90 days.

[1] Type III environmental declarations in the International EPD System are referred to as EPDs, Environmental Product Declarations.

[2] PCR 2024:06, which is Electronic and Electric Equipment, and Electronic Components (non-Construction).

If more than one c-PCR is applicable, the EPD owner may choose to use any of them, but it is recommended to use the one that is more specific in scope in terms of product function. An alternative is to use, and verify the EPD towards, several applicable c-PCRs, as long as there are no conflicting requirements in the c-PCRs.

If requirements in the main PCR and the c-PCR are in conflict, the requirements in the c-PCR take precedence over those in the main PCR.

See Figure 2 for an illustration on how PCR 2024:06 and this c-PCR relates to each other and the EPDs that may be based on them.

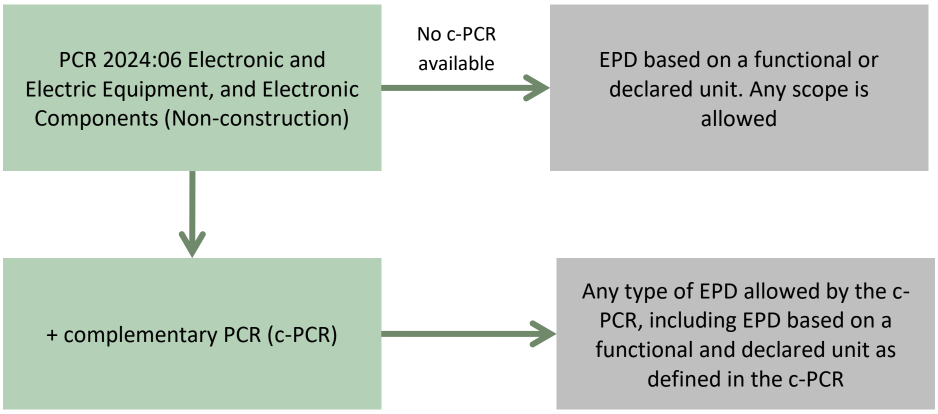

Figure 2. Overview of how PCR 2024:06 can be used directly, or together with a c-PCR, to develop an EPD. An EPD that uses a functional unit shall be based on a c-PCR. An EPD based on a declared unit can be developed without a c-PCR.

2 GENERAL INFORMATION

2.1 ADMINISTRATIVE INFORMATION

Name:	*Batteries and parts thereof*
Registration number and version:	2024:06 – c-PCR-007, Version 1.0.0
Programme:	INTERNATIONAL EPD SYSTEM The International EPD System
Programme operator:	EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden. Website: www.environdec.com E-mail: support@environdec.com
PCR Moderator:	*Qian Yang, China Merchants Testing Vehicle Technology Research Institute Co., Ltd., and cjyangqian@cmhk.com* *Qinyuan Li, China Merchants Testing Vehicle Technology Research Institute Co., Ltd., and cjliqinyuan@cmhk.com*
PCR Committee:	*China Merchants Testing Vehicle Technology Research Institute Co., Ltd., IVL Swedish Environmental Research Institute, IVL Environmental Technology (Beijing) company ltd., Contemporary Amperex Technology Co., Ltd., Geely Auto Group, FinDreams Battery Co., Ltd., Sunwoda Mobility Energy Technology Co., Ltd., SuMPO, Ramboll Group A/S, EVE Energy Co., Ltd., Jiangxi Ganfeng Battery Technology Co., Ltd., Saike REPT Power Battery System Co., Ltd., Hefei Gotion High-tech Power Energy Co., Ltd., Calb Group Co., Ltd., SVOLT Energy Technology Co., Ltd., Zhejiang ENERGEE Technology Co.,Ltd., Microvast Power Systems Co., Ltd., Wangxiang A123 Systems Corp., Chongqing Changan Automobile Co., Ltd., Seres Group Co., Ltd., NIO Co., Ltd., RENAULT (Beijing) Automobile Co., Ltd. Shanghai Branch Company, Zhengzhou Slanpower Technology Co., ltd., Tecnalia, ADEME, CICenerglGUNE, Chongqing Ecological and Environmental Monitoring Center, Chongqing Climate Change Response and Development Center(Chongqing Resource and Environment Trading Center), China Society of Automotive Engineers, Chongqing University of Technology, China Association of Productivity Promotion Centers, China Longyuan Power Group Corporation Limited.*
Publication date:	2026-08-11 See Section 8 for a version history of the PCR.
Valid until:	2030-08-11 The validity may change. See www.environdec.com for the latest version of the PCR and the latest information on its validity and transition periods between versions.
Development and updates:	The c-PCR has been developed following ISO/TS 14027, including public consultation and review. The rules for the development and updating processes are described in Section 9 of the GPI. The c-PCR is valid for a pre-determined time period to ensure that it is updated at regular intervals. When the c-PCR is about to expire, the PCR Moderator shall initiate a discussion with the Secretariat on if and how to proceed with updating the c-PCR and renewing its validity. A c-PCR may be updated before it expires, based on changes in normative standards or provided significant and well-justified proposals for changes or amendments are presented.

	When there has been an update of the c-PCR, the new version should be used to develop EPDs. For small updates (change of third-digit version number), the previous version is normally immediately removed from the PCR library on www.environdec.com and there is no transition period. For medium updates (change of second-digit version number), the previous version of the c-PCR is valid in parallel during a transition period of at least 90 days, but not exceeding its previously set validity period. For large updates (change of first-digit version number), the previous version is valid in parallel during a transition period of at least 180 days, but not exceeding its previously set validity period. In case a c-PCR is developed by a CEN Product TC, the standard will replace this c-PCR, with a transition period of at least 90 days under which both are valid. Stakeholder feedback on PCRs is very much encouraged. Any comments on this PCR may be sent directly to the PCR Moderator and/or the Secretariat during its development or during its period of validity.
Standards and documents conformance:	▪ General Programme Instructions of the International EPD System, version 5.0.1 ▪ PCR 2024:06 Electronic and electric equipment, and electronic components (non-construction), version 1.0.1 ▪ EN 50693:2019 ▪ IEC 63366:2023 ▪ ISO 14025:2006, ISO 14040:2006, ISO 14044:2006[3] ▪ ISO 15686 series (these standards are referenced regarding service life general principles and estimation)
PCR language(s):	At the time of publication, this PCR was available in English. If the PCR is available in several languages, these are available on www.environdec.com. In case of translated versions, the English version takes precedence in case of any discrepancies.

2.2 SCOPE

2.2.1 PRODUCT CATEGORY DEFINITION AND DESCRIPTION

This document provides complementary Product Category Rules (c-PCR) for the assessment of the environmental performance of battery and parts thereof and the declaration of this performance by an EPD. The product category corresponds to UN CPC[4] 464 accumulators, primary cells and primary batteries, and parts thereof, as well as battery and parts of thereof under HS code[5] 85 electrical machinery and equipment and parts thereof.

A non-exhaustive list of products falling under the scope of this c-PCR is shown in Table 1.

[3] Some rules influencing EPD development are independent of the GPI version referred to in the PCR. For example, the latest rules on EPD verification procedures in the GPI shall be followed within 90 days of its publication. See Section 5.1 in the GPI for a description of the four categories of rules and when they shall be followed.

[4] The UN CPC divisions can be consulted at: https://unstats.un.org/unsd/classifications/Family/Detail/1074.

[5] The Harmonized System (HS) Codes can be consulted at: https://www.trade.gov/industry-classification-systems.

Table 1. Product group

UN CPC and HS code	Categories under Regulation (EU) 2023/1542	Description of Regulation (EU) 2023/1542	Product example (but not limited to)
UN CPC: ▪ 4641 Primary cells and primary batteries ▪ 4642 Electric accumulators ▪ 4643 Parts of primary cells, primary batteries and electric accumulators (including separators) **HS code:** ▪ 85 electrical machinery and equipment and parts thereof	Portable Battery	A battery that is sealed, weighs 5 kg or less, is not designed specifically for industrial use and is neither an electric vehicle battery, an LMT[6] battery, nor an SLI[7] battery	▪ Alkaline Batteries ▪ Lithium Batteries ▪ Lead-Acid Batteries ▪ Lithium Polymer Batteries
	Industrial Battery	General industrial battery: a battery that is specifically designed for industrial uses, intended for industrial uses after having been subject to preparation for repurposing or repurposing, or any other battery that weighs more than 5 kg and that is neither an electric vehicle battery, an LMT battery, nor an SLI battery.	▪ Lead-Acid Batteries ▪ Nickel-Cadmium (Ni-Cd) Batteries ▪ Nickel-Metal Hydride (NiMH) Batteries ▪ Lithium Metal Batteries ▪ Alkaline Batteries ▪ Fuel cells
		Stationary battery energy storage system: an industrial battery with internal storage that is specifically designed to store from and deliver electric energy to the grid or store for and deliver electric energy to end-users, regardless of where and by whom the battery is being used.	▪ Nickel-Cadmium (Ni-Cd) Batteries ▪ Sodium-Sulphur (NaS) Batteries ▪ Flow Batteries ▪ Lithium Iron Phosphate (LiFePO4) Batteries ▪ Lithium Titanate (LTO) Batteries
	Starting, Lighting and Ignition (SLI) Battery	A battery that is specifically designed to supply electric power for starting, lighting, or ignition and that can also be used for auxiliary or backup purposes in vehicles, other means of transport or machinery.	▪ Lead-Acid Batteries ▪ Nickel-Metal Hydride (NiMH) Batteries ▪ Lithium Iron Phosphate (LiFePO4) Batteries
	Electric Vehicle (EV) Battery	A battery that is specifically designed to provide electric power for traction in hybrid or electric vehicles of category L as provided for in Regulation (EU) No 168/2013, that weighs more than 25 kg, or a battery that is specifically designed to provide electric power for traction in hybrid or electric vehicles of categories M, N or O as provided for in Regulation (EU) 2018/858.	▪ Lithium Iron Phosphate (LiFePO4) Batteries ▪ Nickel-Metal Hydride (NiMH) Batteries ▪ Lithium Cobalt Oxide (LCO) Batteries ▪ Lithium Manganese Oxide (LMO) Batteries ▪ Lithium Nickel Cobalt Manganese Oxide (NCM) Batteries ▪ Lithium Nickel Cobalt Aluminium Oxide (NCA) Batteries ▪ Lithium Titanate (LTO) Batteries ▪ Solid-State Batteries ▪ Lead-Acid batteries

[6] Light means of transport batteries.

[7] Starting, lighting and ignition batteries.

UN CPC and HS code	Categories under Regulation (EU) 2023/1542	Description of Regulation (EU) 2023/1542	Product example (but not limited to)
	Light Means of Transport (LMT) Battery	A battery that is sealed, weighs 25 kg or less and is specifically designed to provide electric power for the traction of wheeled vehicles that can be powered by an electric motor alone or by a combination of motor and human power, including type-approved vehicles of category L within the meaning of Regulation (EU) No 168/2013 of the European Parliament and of the Council, and that is not an electric vehicle battery.	▪ Lead-Acid Batteries ▪ Lithium Iron Phosphate (LiFePO4) Batteries ▪ Nickel-Metal Hydride (NiMH) Batteries ▪ Lithium Cobalt Oxide (LCO) Batteries ▪ Lithium Manganese Oxide (LMO) Batteries ▪ Lithium Nickel Cobalt Manganese Oxide (NCM) Batteries ▪ Lithium Nickel Cobalt Aluminium Oxide (NCA) Batteries ▪ Lithium Titanate (LTO) Batteries ▪ Solid-State Batteries

In addition to the above products, this c-PCR can be used for components of the battery, including but not limited to:

- Battery cell, and components of the battery cell, such as:
  - Battery cell anode;
  - Battery cell cathode;
  - Battery cell electrolyte;
  - Battery cell housing;
- Battery module housing;
- Battery module electronics;
- Battery pack system housing;
- Battery packs electronics;
- Battery pack thermal conditioning system.

2.2.2 GEOGRAPHICAL SCOPE

This c-PCR may be used globally.

2.2.3 EPD VALIDITY

See section 2.2.3 of the main PCR (PCR 2024:06).

3 REVIEW AND BACKGROUND INFORMATION

This c-PCR was developed in accordance with the PCR development process described in the GPI of the International EPD System, including open consultation and review.

3.1 OPEN CONSULTATION

3.1.1 VERSION 1.0.0, 2026-08-11

This PCR was available for open consultation from 2025-11-05 until 2025 -12-26, during which any stakeholder was able to provide comments by contacting the PCR Moderator and/or the Secretariat.

Stakeholders were invited via e-mail or other means to take part in the open consultation and were encouraged to forward the invitation to other relevant stakeholders. The following stakeholders provided comments during the open consultation and agreed to be listed as contributors in the c-PCR and on www.environdec.com:

- Julia Lindholm, IVL Swedish Environmental Research Institute
- Kadam Lokesh, Ricardo EE
- Kristin Fransson, Emanuel Glans, and Mats Zackrisson, RISE Research Institutes of Sweden
- Frederick Ganster, CD Trojan
- Necati Görkem Aydoğan, Metsims Sustainability Consulting
- Noh-hyun Lim, IGSC

3.2 PCR REVIEW

3.2.1 VERSION 1.0.0, 2026-08-11

PCR review panel:	The Technical Committee of the International EPD System. A full list of members is available on www.environdec.com. The review panel may be contacted via support@environdec.com. Members of the Technical Committee were requested to state any potential conflict of interest with the PCR Committee, and if there were conflicts of interest they were excused from the review.
Chair of the PCR review:	Noa Meron
Review dates:	2026-04-14 until 2026-06-01

3.3 EXISTING PCRS FOR THE PRODUCT CATEGORY

As part of the development of this c-PCR, existing PCRs/c-PCRs and other internationally standardised methods that could potentially act as c-PCRs were considered to avoid unnecessary overlaps in scope and to ensure harmonisation with established methods of relevance for the product category. The existence of such documents was checked among the following EPD programmes and European or international standardisation bodies:

- International EPD System. www.environdec.com.
- EPD Italy
- PEP ecopassport
- Joint Research Center of European Unite

- The European Parliament and of the Council
- European Commission
- SuMPO EPD

Table 2 lists the identified PCRs and other standardised methods (except for the main PCR).

Table 2. Existing PCRs and other internationally standardised methods that were considered to avoid overlap in scope and to ensure harmonisation with established methods.

Name of PCR/standard, including registration number	EPD programme/ standardisation body	Version number/date of publication	Scope
PEFCR - Product Environmental Footprint Category Rules for High Specific Energy Rechargeable Batteries for Mobile Applications	European Commission	July 2024	CPA (European classification of products by activity) code: 27.20.23. (27. Electrical 666 equipment/20. Batteries and accumulators/23. Nickel-cadmium, nickel metal hydride, lithium-ion, lithium 667 polymer, nickel-iron and other electric accumulators)
EPDItaly 021： PCR for Energy Storage	EPD Italy	2021-03-29	CPC 464
PEP-PCR-ed4 Product Category Rules for Electrical, Electronic and HVAC-R Products	PEP ecopassport	2021-09-06	Electrical, Electronic and HVAC-R Products
Regulation (EU) 2023/1542	The European Parliament and of the Council	2023-07-28	Electric vehicle batteries, rechargeable industrial batteries and LMT batteries
Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB EV) Final draft	Joint Research Center of European Unite	2024-04-29 (Draft)	Electric vehicle batteries
Annex - Ares (2024) 3131389 (Draft act) (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)	European Commission	2024-05-28 (Draft)	Electric vehicle batteries
Rules for the calculation of the Carbon Footprint of Industrial Batteries without external storage (CFB-IND)	European Commission	2025-04-11	Industrial Batteries without external storage
A Product Category Rule for Electrical and Electronic Products and Parts	SuMPO EPD	2025-11-20	Electrical and Electronic Products and Parts
A Product Category Rule for Reuse lead-acid battery	SuMPO EPD	2023-09-01	Reuse lead-acid battery

3.4 REASONING FOR DEVELOPMENT OF THE C-PCR

This c-PCR was developed to enable publication of EPDs for the product category defined in Section 2.2.1 based on ISO 14025, ISO 14040/14044, EN 50693, and the PCR 2024:06. The c-PCR enables different practitioners to generate consistent results when assessing the environmental impact of products of the same product category, and thereby it supports comparability of products within a product category.

3.5 UNDERLYING STUDIES USED FOR PCR DEVELOPMENT

The methodological choices made during the development of this c-PCR (declared/functional unit, system boundary, allocation methods, impact categories, data quality rules, etc.) were primarily based on the following underlying studies:

- Accardo, A.; Dotelli, G.; Musa, M. L.; Spessa, E (2021) Life Cycle Assessment of an NMC Battery for Application to Electric Light-Duty Commercial Vehicles and Comparison with a Sodium-Nickel-Chloride Battery. Applied Sciences.
- Agency, U. S. E. P (2013) Application of Life Cycle Assessment to Nanoscale Technology: Lithium-ion Batteries for Electric Vehicles.
- Andreasi Bassi, S., Peters, J.F., Candelaresi, D., Valente, A., Ferrara, N., Mathieux, F., Ardente, F. (2023) Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFBEV) JRC Science for Policy Report.
- Bauer, C.; Hofer, J.; Althaus, H.-J.; Del Duce, A.; Simons (2015) A. The environmental performance of current and future passenger vehicles: Life cycle assessment based on a novel scenario analysis framework. Applied Energy.
- Benveniste, G.; Sánchez, A.; Rallo, H.; Corchero, C.; Amante, B (2022) Comparative life cycle assessment of Li-Sulphur and Li-ion batteries for electric vehicles. Resources, Conservation & Recycling Advances.
- Chordia, M.; Nordelöf, A.; Ellingsen, L. A.-W (2021) Environmental life cycle implications of upscaling lithium-ion battery production. The International Journal of Life Cycle Assessment.
- Dai, Q.; Kelly, J. C.; Gaines, L.; Wang, M (2019) Life Cycle Analysis of Lithium-Ion Batteries for Automotive Applications. Batteries.
- Das J, Kleiman A, Rehman A U, Verma R, Young M H (2024) The Cobalt Supply Chain and Environmental Life Cycle Impacts of Lithium-Ion Battery Energy Storage Systems. Sustainability.
- Deng, Y.; Li, J.; Li, T.; Zhang, J.; Yang, F.; Yuan, C (2017) Life cycle assessment of high capacity molybdenum disulfide lithium-ion battery for electric vehicles. Energy.
- Deng, Y.; Ma, L.; Li, T.; Li, J.; Yuan, C (2018) Life Cycle Assessment of Silicon-Nanotube-Based Lithium Ion Battery for Electric Vehicles. ACS Sustainable Chemistry & Engineering.
- Dolci G, Tua C, Grosso M, Rigamonti L (2016) Life cycle assessment of consumption choices: a comparison between disposable and rechargeable household batteries. The International Journal of Life Cycle Assessment.
- Dunn, J. B.; Gaines, L.; Sullivan, J.; Wang, M. Q (2012) Impact of Recycling on Cradle-to-Gate Energy Consumption and Greenhouse Gas Emissions of Automotive Lithium-Ion Batteries. Environmental Science & Technology.
- Ellingsen L A W, Hung C R, Strømman A H (2017) Identifying key assumptions and differences in life cycle assessment studies of lithium-ion traction batteries with focus on greenhouse gas emissions. Transportation Research Part D: Transport and Environment.
- Erik Emilsson, Lisbeth Dahllöf (2019) Lithium-Ion Vehicle Battery Production Status 2019 on Energy Use, CO2 Emissions, Use of Metals, Products Environmental Footprint, and Recycling. IVL Swedish Environmental Research Institute.
- Andreasi Bassi, S., Ardente, F., Candelaresi, D., Eynard, U., Ferronato, N. and Peters, J. (2025) Rules for the calculation of the Carbon Footprint of Industrial Batteries without external storage (CFB-IND), European Commission: Joint Research Centre, Publications Office of the European Union, Luxembourg, https://data.europa.eu/doi/10.2760/6346639, JRC141282.
- Faria, R.; Marques, P.; Garcia, R.; Moura, P.; Freire, F.; Delgado, J.; de Almeida, A. T (2014) Primary and secondary use of electric mobility batteries from a life cycle perspective. Journal of Power Sources.
- Giordano, A.; Fischbeck, P.; Matthews, H. S (2018) Environmental and economic comparison of diesel and battery electric delivery vans to inform city logistics fleet replacement strategies. Transportation Research Part D: Transport and Environment.
- Gouveia J, Mendes A, Monteiro R, Mata T, Caetano N, Martins A (2020) Life cycle assessment of a vanadium flow battery. Energy Reports.
- Hao, H.; Mu, Z.; Jiang, S.; Liu, Z.; Zhao, F (2017) GHG Emissions from the Production of Lithium-Ion Batteries for Electric Vehicles in China. In Sustainability.
- Hemmati M, Bayati N, Ebel T (2024) Life Cycle Assessment and Costing of Large-Scale Battery Energy Storage Integration in Lombok's Power Grid. Batteries.
- Hiremath M, Derendorf K, Vogt T (2015) Comparative life cycle assessment of battery storage systems for stationary applications. Environmental Science & Technology.
- Hischier R, C. M Lehmann M, Scharnhorst W (2007) Life cycle inventories of electric and electronic equipments: production, use and disposal.

- Immendoerfer A, Tietze I, Hottenroth H, Viere T (2017) Life-cycle impacts of pumped hydropower storage and battery storage. International Journal of Energy and Environmental Engineering.
- Ishihara K, K. N., Terada N, Iwahori T (2002) Environmental burdens of large lithium-ion batteries developed in a Japanese national project. Cent. Res. Inst. Electr. Power Ind.
- Jasper F B, Späthe J, Baumann M, Peters J, Ruhland J, Weil M (2022) Life cycle assessment (LCA) of a battery home storage system based on primary data. Journal of Cleaner Production.
- Jiang, T.; Wang, H.; Jin, Q (2024) Comparison of three typical lithium-ion batteries for pure electric vehicles from the perspective of life cycle assessment. Clean Technologies and Environmental Policy.
- Kallitsis, E.; Korre, A.; Kelsall, G.; Kupfersberger, M.; Nie, Z (2020) Environmental life cycle assessment of the production in China of lithium-ion batteries with nickel-cobalt-manganese cathodes utilising novel electrode chemistries. Journal of Cleaner Production.
- Kelly, J. C.; Dai, Q.; Wang, M (2020) Globally regional life cycle analysis of automotive lithium-ion nickel manganese cobalt batteries. Mitigation and Adaptation Strategies for Global Change.
- Li, B.; Gao, X.; Li, J.; Yuan, C (2014) Life Cycle Environmental Impact of High-Capacity Lithium Ion Battery with Silicon Nanowires Anode for Electric Vehicles. Environmental Science & Technology.
- Linda Ager-Wick Ellingsen, B. S. a. A. H. S (2016) The size and range effect: lifecycle greenhouse gas emissions of electric vehicles. Environmental Research Letters.
- Linda Ager-Wick Ellingsen, G. M.-B., Bhawna Singh, et, al (2013) Life Cycle Assessment of a Lithium-Ion Battery Vehicle Pack. Resources, Conservation and Recycling.
- Liu, L., 2020. Life cycle assessment of a lithium-ion battery pack for energy storage systems: the environmental impact of a grid-connected battery energy storage system.
- Llamas-Orozco, J. A.; Meng, F.; Walker, G. S.; Abdul-Manan, A. F. N.; MacLean, H. L.; Posen, I. D.; McKechnie, J (2023) Estimating the environmental impacts of global lithium-ion battery supply chain: A temporal, geographical, and technological perspective. PNAS Nexus.
- Longo S, Antonucci V, Cellura M, Ferraro M (2014) Life cycle assessment of storage systems: the case study of a sodium/nickel chloride battery. Journal of Cleaner Production.
- Majeau-Bettez, G.; Hawkins, T. R.; Strømman, A. H (2011) Life Cycle Environmental Assessment of Lithium-Ion and Nickel Metal Hydride Batteries for Plug-In Hybrid and Battery Electric Vehicles. Environmental Science & Technology.
- Marques, P.; Garcia, R.; Kulay, L.; Freire, F (2019) Comparative life cycle assessment of lithium-ion batteries for electric vehicles addressing capacity fade. Journal of Cleaner Production.
- Martin Linder, Tomas Nauclér, Stefan Nekovar, Alexander Pfeiffer, Nikola Vekić (2023) The race to decarbonize electric-vehicle batteries Automotive & Assembly Practice from Mckinsey & company.
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- Notter, D. A.; Gauch, M.; Widmer, R.; Wäger, P.; Stamp, A.; Zah, R (2010) Althaus, H.-J. Contribution of Li-Ion Batteries to the Environmental Impact of Electric Vehicles. Environmental Science & Technology.
- Nugent, D.; Sovacool, B. K (2014) Assessing the lifecycle greenhouse gas emissions from solar PV and wind energy: A critical meta-survey. Energy Policy.
- Peng Z, Gong X, Du S (2024) Life cycle assessment of $LiCoO_2$ battery recycling for mobile phones. Chinese Journal of Environmental Engineering.
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- Quan, J.; Zhao, S.; Song, D.; Wang, T.; He, W.; Li, G (2022) Comparative life cycle assessment of LFP and NCM batteries including the secondary use and different recycling technologies. Science of The Total Environment.
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- Shittu E, Suman R, Ravikumar M K, Shukla A, Zhao G, Patil S, Baker J (2022) Life cycle assessment of soluble lead redox flow battery. Journal of Cleaner Production.
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4 LCA METHOD

This section provides rules for the LCA method used to develop an EPD for the product category as defined in Section 2.2.1.The basic rules of the LCA method are set in the main PCR (PCR 2024:06) and the Annex A of the GPI, and this section only includes additions, specifications and deviations to the rules set in the GPI. Guidance and examples of applying the LCA method are also available on www.environdec.com/methodology.

4.1 MODELLING APPROACH

See section A.1 of the GPI 5.0.1.

4.2 DECLARED/FUNCTIONAL UNIT

As per ISO 14040: 2006, the primary purpose of a functional unit is to provide a reference to which the inputs and outputs are related, and this reference is necessary to ensure comparability of the LCA results. Different from the declared unit, the functional unit shall define the quantification of the functions of a product.

Any declared or functional unit shall be clearly defined and documented in the EPD, so that it can be considered when comparing EPDs. The environmental performance results shall be expressed per functional or declared unit.

4.2.1 FUNCTIONAL UNIT

When the battery has a clear application, the functional unit shall be defined with combination of the specific application. For example, when the battery is used in vehicles, then, its function is to supply electrical current at a desired voltage range. Thus, the functional unit (FU) is defined as 1 kWh of the total energy provided over the service life by the battery system (measured in kWh) with its packaging.

For battery cells[8], the functional unit shall be used and is defined as 1kWh (kilowatt-hour) of the total energy provided by the battery cells over the battery's service life, measured in kWh. The total energy is obtained from the number of cycles multiplied by the amount of delivered energy over each cycle.

4.2.2 DECLARED UNIT

Only in cases where a functional unit cannot be defined, a declared unit can be used. For the components of the battery (except for battery cells), the declared unit shall be one kilogram of the declared product with the product packaging[9] (the weight of the packaging is not included in the one kilogram of the declared product).

4.2.3 TECHNICAL SPECIFICATION, LIFESPAN AND REFERENCE SERVICE LIFE (RSL)

The technical specifications and lifespan considerations for batteries are critical in defining their usability and sustainability. This c-PCR strictly follows the requirement of the PCR 2024:06. Based on instruction of the PCR, this c-PCR gives more details in this section. The operational lifespans, warranties, service life definitions, performance benchmarks, and international classifications should be applied for evaluating batteries' reference service life (RSL). The RSL shall be declared in the functional unit. When the RSL is difficult to define, the declared unit, based on the mass of the product, may be used instead. In such case, the RSL may also be declared and explained in the EPD if desired by the EPD owner. When RSL is declared in the EPD report, the RSL calculation methodology and process shall be clearly stated in the EPD report.

The following technical specification of the product shall be presented in the LCA and in the EPD report[10]:

- Dimension (mm*mm*mm),

[8] According to (EU) 2023/1542, 'battery cell' means the basic functional unit in a battery, composed of electrodes, electrolyte, container, terminals and, if applicable, separators, and containing the active materials the reaction of which generates electrical energy.

[9] To clarify, the definition of the product packaging in this c-PCR is for distribution of the product, which is NOT the battery pack.

[10] For battery and cells products, the technical specifications shall be specified in the LCA and EPD reports; for other parts of the battery that applied for EPD, e.g., the outer pack of the battery, which is a structural material of the battery, only the relevant parts of the technical specifications listed on this page shall be reported.

- Weight (g and/or kg),
- Capacity (Ah),
- Voltage (V).

4.3 SYSTEM BOUNDARY

The system boundary of the product life cycle determines the processes to be included or excluded in the assessment. The scope of this c-PCR and EPDs based on it is *cradle-to-grave* for battery and cell. For other components of the battery the boundary may be limited to *cradle-to-gate*.

The expression "*cradle-to-grave*" means that the following processes shall be included within the system boundaries, when applicable:

- Raw material extraction
- Production of components
- Manufacturing
- Transport
- Installation process
- Use of the product
- Maintenance / Repair
- De-installation process
- Waste processing for reuse, recycling, energy recovery and the final disposal (e.g., landfill)

The expression "*cradle-to-gate*" means that the following processes shall be included within the system boundaries, when applicable:

- Raw material extraction
- Production of components
- Manufacturing

For more details on the life cycle stages included in EPDs based on this c-PCR, see Section 4.3.1

All environmentally relevant processes shall be included, so that at minimum 99% of the total energy use, mass of product content, and environmental impact is accounted for (see Section 4.4).

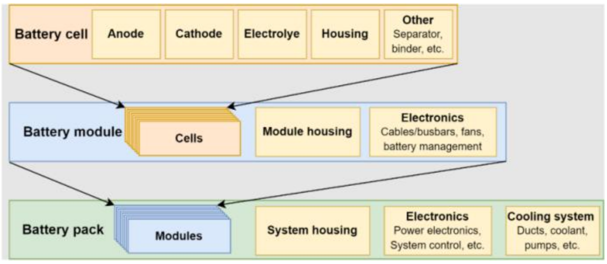

Figure 3. System components. The inner boxes depict the individual components of each product e.g., the battery cell comprises the components 'anode', 'cathode', 'electrolyte', 'housing' and 'other', while the components of the battery module are 'cells', 'housing' and 'electronics'.

4.3.1 LIFE-CYCLE STAGES AND INFORMATION MODULES

For different data quality rules and for the presentation of results, the life cycle shall be divided into four main stages:

- Manufacturing stage
- Distribution stage
- Use stage
- End-of-life stage

Two additional life-cycle stages shall also be included, if relevant:

- Installation stage
- De-installation stage

For the use stage, as power consumption calculations vary by battery type, a comprehensive list of calculation methods for all battery types is not possible. Calculation can be done according to national, regional, or other relevant regulations or standards. The method used shall be clearly declared in the LCA and EPD report.

If the EPD owner cannot declare a better calculation method, to standardise, the energy consumption during the use stage of the battery shall be defined by the energy losses occurring whenever the energy storage system is charged and discharged, linked to charging/discharging efficiency losses (e.g. Joule effect, thermodynamic inefficiencies). These losses shall be calculated using the following formula:

$$E_{loss}[kWh] = \sum_{i=0}^{RSL} \left(\frac{E_{useful,i} \times N_{cycles} \times 365}{DCRTE_i} \right) \times (1 - DCRTE_i)$$

Where:

- **E_loss** – Total energy loss over the battery's reference service life [kWh]
- **RSL** – Reference Service Life; the number of years considered in the assessment (e.g. RSL = 10 means i ranges from 0 to 10)
- **E_useful,i** – Maximum energy dischargeable from the energy storage system (DC side) in year i, at maximum power, without rest time, and at Nominal Operating Temperature [kWh]
- **DC RTEi** – DC Round-Trip Efficiency in year i; defined as energy discharged divided by energy charged, measured at the DC power terminal at maximum power and Nominal Operating Temperature [dimensionless, 0 to 1]
- **N_cycles** – Number of full charge/discharge cycles per day; in the reference scenario, 1 full cycle per day shall be assumed unless otherwise declared [cycles/day]
- **365** – Number of days in one year [days/year]
- **i** – Year index over the reference service life, ranging from 0 to RSL

Table 3 shows the relevant life cycle stages and related processes to be included when applicable (depends on the main PCR (PCR 2024:06)), as well as the correspondence to modules A1 to C4 as per EN 15804+A2 .

Table 3. *Life cycle stages and processes to include for different EPD applications.*

Life cycle stages	Processes for battery and cell	Processes for components except for cell
Manufacturing (Module A1-A3)	Material and components supply (A1)	Material and components supply (A1)
	Transport (A2)	Transport (A2)
	Manufacturing including all assembly and testing steps (A3)	Manufacturing including all assembly and testing steps (A3)
Distribution (Module A4)	Transport from gate to site/point of sale (A4)	Not included.
Installation (Module A5)	Installation at point of use (A5)	Not included.
Use (Module B1-B7)	Use (B1)	Not included.
	Maintenance (B2)	Not included.
	Repair (optional) (B3)	Not included.
	Reuse (optional) (B4)	Not included.
	Refurbishment (optional) (B5)	Not included.
	Operational energy use (B6)	Not included.
	Operational water use (B7)	Not included.
De-installation (Module C1)	De-installation from point of use (C1)	Not included.
End of life (Module C2-C4)	Transport (C2)	Not included.
	Waste processing (C3)	Not included.
	Disposal (C4)	Not included.

For details of each stage, please see section 4.3.1.1 to 4.3.1.6 of the main PCR (PCR 2024:06).

4.3.2 INFRASTRUCTURE AND CAPITAL GOODS

See section 4.3.2 of the main PCR (PCR 2024:06).

4.3.3 OTHER BOUNDARY SETTING RULES

See section 4.3.3 of the main PCR (PCR 2024:06).

4.4 SYSTEM DIAGRAM

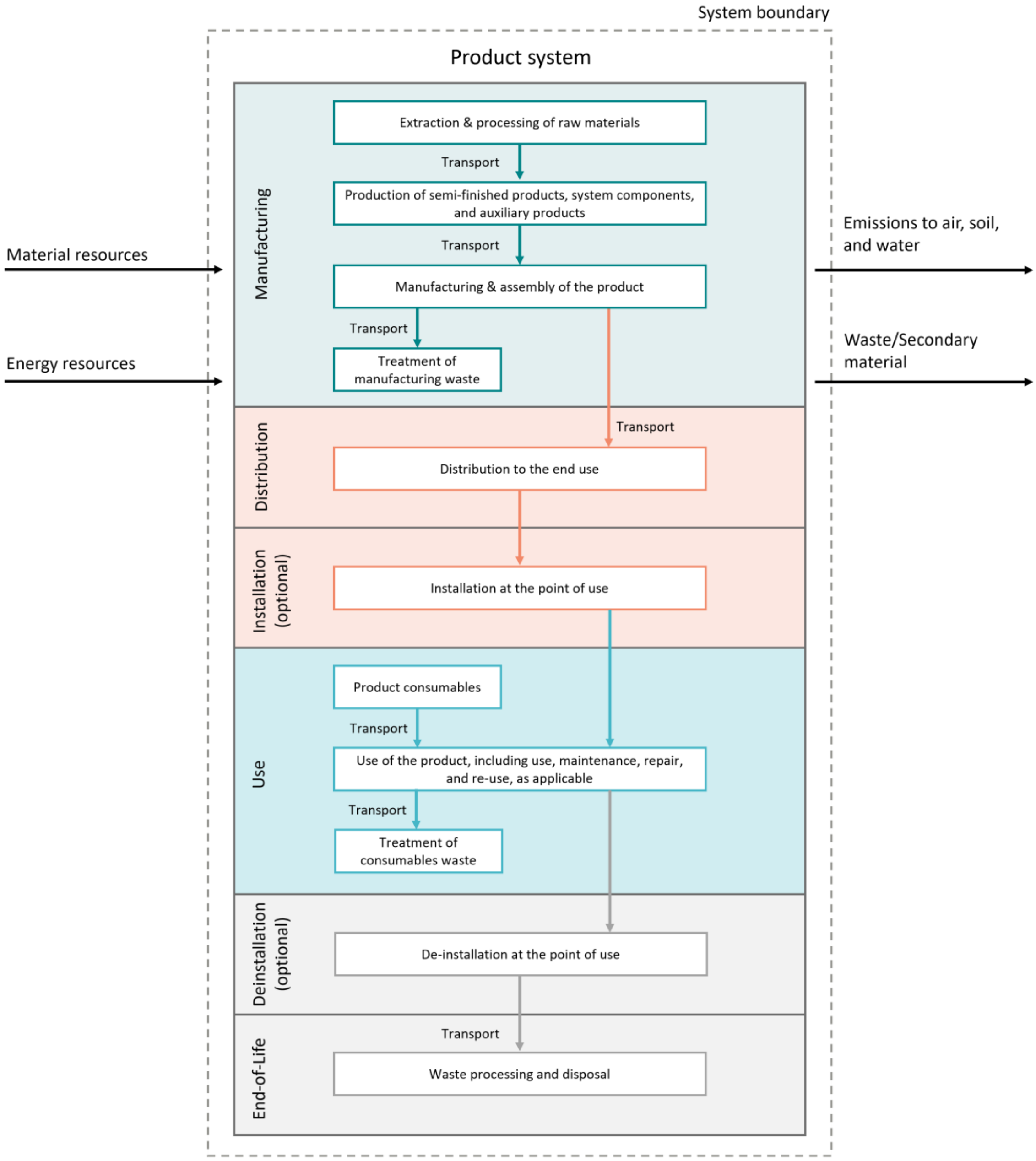

Figure 4. System diagram illustrating the processes that shall be included in the product system, divided into the life-cycle stages. The illustration of processes to include may not be exhaustive.

4.5 CUT-OFF RULES

See section 4.5 of the main PCR (PCR 2024:06).

To be noted, the cut-off rule for EPDs based on this c-PCR is 1% over the product life cycle. In other words, inputs/outputs that are known or expected to contribute more than 1% to the results of any of the environmental performance indicators shall be included. The 1% cut-off does not include LCI data that are explicitly outside the system boundary according to the GPI, the c-PCR, or any normative reference standard referenced to in the c-PCR.

4.6 ALLOCATION RULES

See section 4.6 of the main PCR (PCR 2024:06).

4.6.1 ALLOCATION OF CO-PRODUCTS

See section 4.6.1 of the main PCR (PCR 2024:06).

Comparing to the main PCR, this c-PCR specifies a clear percentage for the allocation of co-products, specifically in Point 2 (ii) of the main PCR: the difference in revenue per mass (or per energy unit in case of electricity, heat or similar) from the products and co-products is lower than 25%.

4.6.2 ALLOCATION OF WASTE

See section 4.6.2 of the main PCR (PCR 2024:06).

For this c-PCR, the rules in Section G.4 of EN 50693 shall be used to calculate the benefits of substituted production of primary material and/or energy.

4.7 DATA AND DATA QUALITY RULES

See section 4.7 of the main PCR (PCR 2024:06).

For EPDs developed under this c-PCR, the data quality assessment should give particular consideration to the representativeness of datasets for the extraction and refining of critical raw materials, including the geographical location, resource type, and extraction and refining technologies.

4.8 OTHER LCA RULES

See section A.6 of the GPI.

4.9 ENVIRONMENTAL PERFORMANCE INDICATORS

See section 4.8 of the main PCR (PCR 2024:06).

4.10 SPECIFIC RULES FOR THIS C-PCR

See section 2.2.1 of this c-PCR.

4.11 SPECIFIC RULES PER EPD TYPE

See section 4.9 of the main PCR (PCR 2024:06).

5 CONTENT AND FORMAT OF EPD

See section 5 of the main PCR (PCR 2024:06).

It shall be clearly stated on the cover page of the EPD either the EPD is valid for battery, battery cells or components.

When the official detailed carbon footprint calculation methodology of the Regulation (EU) 2023/1542 has been released (e.g. official publication of the Annex - Ares (2024) 3131389 (Draft act)), the EPD owner may choose to add the carbon footprint results that have been accounted for and verified with reference to the Regulation (EU) 2023/1542 as additional information to the EPD report.

6 LIST OF ABBREVIATIONS

See section 6 of the main PCR (2024:06).

7 REFERENCES

Standard, regulations, and laws:

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8 VERSION HISTORY OF PCR

VERSION 1.0.0, 2026-08-11

Original version of the c-PCR

BATTERIES AND PARTS THEREOF

PRODUCT CATEGORY CLASSIFICATION: UN CPC 4641, 4642, 4643, AND HS CODE 85.