Deliverable Report

Deliverable Title:

Product category rule for Al components in passenger cars in Europe

Deliverable No.	8.3
Deliverable nature	Report
Work Package (WP)	8
Task	8.1
Dissemination level [1]	Public
Number of pages	26
Keywords	PCR, LCA, EPD
Authors	Francesca Cavezza (EAA), Christian Leroy (EAA), Benedetta Nucci (EAA)
Contributors	Maria Violeta Vargas Parra (EURECAT)
Due date of deliverable	October 31st 2022
Actual submission date	October 31st 2022

Document history

V	Date	Author (Affiliation)	Actions& Approvals
V1	23.09.2022	Francesca Cavezza (EAA), Christian Leroy (EAA), Benedetta Nucci (EAA)	First draft and dissemination for review
V2	07.10.2022	Violeta Vargas Parra (EURECAT)	Review
V3	21.10.2022	Antonio Louro (EURECAT)	Review
Final	31.10.2022	Hannah Arpke (EUERCAT)	Finalisation

[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Summary

This document describes the Product Category Rule (PCR) for Aluminium Components in Cars. The purpose of a PCR is to establish in a clear and coherent manner the set of rules that will need to be followed to develop a Life Cycle Assessment (LCA) and establish the environmental footprint of a specific product or process.

Technical References

Project acronym	SALEMA
Project full title	Substitution of Critical Raw Materials on Aluminium Alloys for electrical vehicles
Call	H2020-SC5-2020-2
Grant number	101003785
Project website	salemaproject.eu
Coordinator	Fundacion Eurecat

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Disclaimer

This publication reflects only the author's view. The Agency and the European Commission are not responsible for any use that may be made of the information it contains.

Abbreviations

Abbreviation / Acronyms	Description
EoL	End of Life
EU	European Union
EPD	Environmental Product Declaration
GPI	General Programme Instructions
ISO	International Standard Association
LCA	Life-Cycle Assessment
PHEV	Plug-in hybrid electric vehicle
PCR	Product Category Rule
SI	The International System of Units
UN	United Nations

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Table of contents

Document history ... **1**

Summary ... **2**

Technical References ... **2**

Disclaimer ... **3**

Abbreviations ... **3**

Table of contents ... **4**

List of tables ... 5

List of figures ... **Error! Bookmark not defined.**

1. Introduction and Background ... **6**

1.1. Objectives of task and deliverable ... 6

2. Activities ... **6**

2.1. Methods ... 6

3. Results ... **7**

3.1. Scope of the PCR ... 7

3.1.1. Product Category Definition and Description ... 7

3.1.2. Geographical scope ... 8

3.1.3. EPD Validity ... 8

3.1.4. Existing PCRs for the product category ... 8

3.1.5. Rationale for the development of the PCR ... 9

3.1.6. Underlying studies used for PCR development ... 10

3.2. Goal and scope, life cycle inventory and life cycle impact assessment ... 10

3.2.1. Declared/Functional unit ... 10

3.2.2. **System boundary** ... 10

3.2.3. Production stage (Module A) ... 11

3.2.4. Other life cycle stages and related processes ... 13

3.2.5. Other boundary setting ... 14

3.3. System diagram ... 15

3.4. Cut-off rules ... 16

3.5. Allocation methodological aspects ... 16

3.5.1. Co-product allocation ... 16

The project has received funding from the European Union's Horizon 2020 research and
innovation programme under grant agreement No 101003785

3.5.2. Treatment of waste flows 17
3.5.3. Module D calculation principle 17
3.6. Data quality requirements and selection of data 18
3.6.1. Rules for using generic data 18
3.6.2. Examples of databases for generic data 19
3.6.1. Data quality requirements and other modelling guidance per life-cycle stage 20
3.6.2. Data quality declaration 23
3.7. Environmental performance indicators 23

4. Conclusions and Outlook 23

4.1. Next steps 23

Annex 1 - Modelling of the end-of-life stage and associated environmental aspects 25

List of tables

Table 1 List of the identified PCRs and other standardized methods 8
Table 2 allocation method for key processes in the product system 16
Table 3 Example of databases to use for generic data 19

List of figures

Figure 1 The hierarchy between PCRs and standards 7
Figure 2 System diagram illustrating the processes that shall be included in the product system, divided into upstream, core and downstream processes. The illustration of processes is not exhaustive 15

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

1. Introduction and Background

When new manufacturing processes or new materials are developed it is important to assess their environmental benefit through a holistic method which takes into account the entire life cycle of the product or service. This is the reason why Life Cycle Assessments (LCA) are developed, as they can provide a quantitative and consistent analysis of the potential environmental impacts. Programs and international standards provide some general guidance to promote consistent assessments of LCA. Specific standards are available for LCA-based environmental labels and declarations. The International Standards Organization (ISO) has classified the existing environmental labels into three typologies—types I, II, and III—and has specified the preferential principles and procedures for each one of them (ISO 14021, ISO 14024, and ISO 14025). An Environmental Product Declaration (EPD), also referred to as type III environmental declaration, is a standardized (ISO 14025) and LCA-based tool to communicate the environmental performance of a product. There are a number of requirements for how the LCA should be performed to be used as basis for an EPD. They are focused on detailed specifications on how to model the product system in the LCA, what to include, what data to use, which environmental indicators to report, etc. These requirements are developed for different product groups by the industry and are referred to as product category rules (PCRs). The aim of the PCRs is to achieve comparability in results between different producers of the same product. And as such, the PCRs are valuable and useful as basis for any type of LCA to be used in external communication of results.

The product category rule (PCR) developed in this document will address the needs of the European market and the associated electrification of the passenger cars. This document has been rooted in the Product Category Rules (PCR) in the International EPD® System (Environdec) and following the standard EN 15804:2012+A2:2019.

1.1. Objectives of task and deliverable

- Provide instruction for how the Life Cycle Assessment should be conducted including:
  - Setting the system boundaries,
  - Setting the functional/declared unit
  - Definition of use phase and end-of life options

2. Activities

2.1. Methods

This document constitutes the Product Category Rules (PCR) developed in a framework which is in conformity with a private programme for type III environmental declarations according to ISO 14025:2006, ISO 14040:2006, ISO 14044:2006, and product-specific standards such as EN 15804 and ISO 21930 for construction products. 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). A PCR should

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

enable different practitioners using the PCR to generate consistent results when assessing products of the same product category. Figure 1 shows the hierarchy between standards and PCRs.

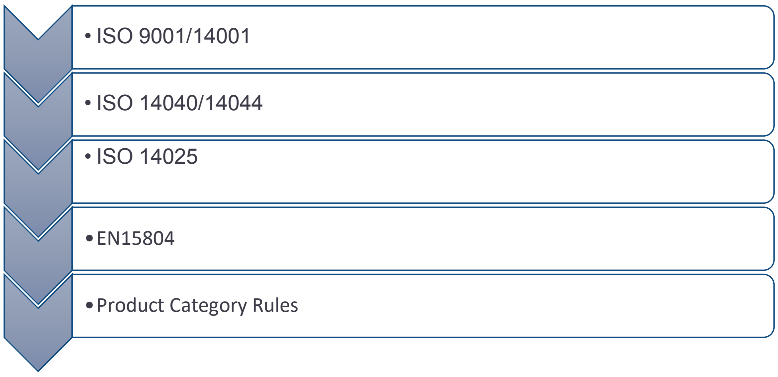


Figure 1 The hierarchy between PCRs and standards

Within the present PCR, the following terminology is adopted:

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

For definitions of further terms used in the document, see the normative standards.

3. Results

3.1. Scope of the PCR

3.1.1. Product Category Definition and Description

This document provides Product Category Rules (PCR) for the assessment of the environmental performance of aluminium component for vehicles and the declaration of this performance by an EPD. The product category corresponds to UN CPC 491 - Motor vehicles, trailers and semi-trailers; parts and accessories thereof and 492 - Bodies (coachwork) for motor vehicles; trailers and semi-trailers; parts and accessories thereof.

This document establishes requirements and principles for undertaking LCA studies of aluminium auto components with different environmental impact due to alloy composition, manufacturing technology, geometry or recycled percentage of used alloy. The requirements and principles included in this document may be used for undertaking comparative LCA studies of aluminium auto components.

An aluminium component is defined as a component, or subassembly installed on a vehicle which is, made of one or more aluminium alloys for at least 90% of its composition. This PCR does not cover their combinations with other – not aluminium- components. Aluminium alloys are defined as aluminium which contains alloying elements, where aluminium predominates by mass over each of the other elements.

The project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101003785

This PCR enables LCAs to be conducted for all aluminium auto components installed on road vehicles with different powertrains (e.g., internal combustion engine, fully electric vehicle, PHEV) but restricted to single-deck, double-deck, rigid or articulated road vehicles of category M1, M2 or M3 as defined in Regulation (EU) 2018/858 (and its amendments):

- Category M1: Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat, when they are classified as buses
- Category M2: Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes.
- Category M3: Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes.

3.1.2. Geographical scope

This PCR aims to cover first the European region but it may be used for other geographical scope, i.e. at global level.

Inventoried data should be representative for the current production processes and for the site where each process takes place. When addressed, the scenarios and data for modelling use and EoL stages should be representative for the geographical area covered.

3.1.3. EPD Validity

An EPD based on this PCR shall be valid for a 5-year period starting from the date of the verification report ("approval date").

An EPD shall be updated and re-verified during its validity if changes in technology or other circumstances have led to:

- an increase of 10% or more of any of the declared indicators of environmental impact,
- errors in the declared information, or
- significant changes to the declared product information, content declaration, or additional environmental, social or economic information.

3.1.4. Existing PCRs for the product category

Table 1 lists the identified PCRs and other standardized methods.

Table 1 List of the identified PCRs and other standardized methods

NAME OF PCR/STANDARD	PROGRAMME/ STANDARDISATION BODY	REGISTRATION NUMBER, VERSION NUMBER/DATE OF PUBLICATION	SCOPE

Part B: Requirements on the EPD for Products of aluminium and aluminium alloys	IBU	V. 1.0 2013-04-11	No overlap in scope. Rules for developing EPDs for aluminium products and alloys in construction
Product Environmental Footprint Category Rules (PEFCR) for Metal Sheets for Various Applications	European Commission	28/06/19 expired on 31/12/2021	No overlap in scope. It addresses only metal sheets.
EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products	Prepared by CENTC 350	Approved by CEN on 10 September 2013 and includes Amendment 2 approved by CEN on 21 July 2019	
PCR Under development - Basic aluminium products and special alloys	EPD international System	Under development (15/10/22 published)	No overlap in scope. It addresses only semi-finished product made of Al or Al alloys.
PCR Under development - - **prEN17662** PCR Steel and Aluminium structural products, and other metal products, for use in construction works	prepared by CENTC135 –It complements the core rules for all construction products and services as established in EN 15804:2012+A2:2019.	Under development	No overlap in scope. It addresses only Al products used as structural element in construction

3.1.5. Rationale for the development of the PCR

This PCR was developed to enable publication of EPDs for this product category based on ISO 14025, ISO 14040/14044. The PCR enables different practitioners to generate consistent and harmonised results when assessing the environmental impact of products of the same product category, and thereby it supports comparability of products within a product category.

Furthermore, it responds to an increasing interest from the sector in developing EPDs, being aware of the environmental implications of their activities and products and the will to

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

communicate their environmental performances with transparency, consistency, and uniformity, emphasize the relevance to develop this PCR.

3.1.6. Underlying studies used for PCR development

The key methodological choices made in this PCR (declared/functional unit, system boundary, allocation methods, impact categories, data quality rules, etc.) were primarily based on EN 15804:2012+A2:2019 complemented with the following underlying studies:

- European Aluminium, 2018. Environmental Profile Report. Life-Cycle inventory data for aluminium production and transformation processes in Europe.
- Reconciling recycling at production stage and end of life stage in EN 15804: the case of metal construction products, C Leroy, N Avery, L Tikana and S Grund, 2019 IOP Conf. Ser.: Earth Environ. Sci.
- Directorate General for Climate Action EU, 2020 Determining the environmental impacts of conventional and alternatively fuelled vehicles through LCA

3.2. Goal and scope, life cycle inventory and life cycle impact assessment

3.2.1. Declared/Functional unit

The declared unit is 1 mass unit (eg kilogram or tonne) of fabricated aluminium product, or in alternative, an aluminium component as defined in Section 3.1.1 .The declared unit, and its mass, shall be specified in the EPD. A declared unit is used instead of the functional unit when the exact product function is not established or is unknown. It should be applied when an EPD covers one or more life cycle stages by information modules (i.e.: cradle to gate and cradle to gate with options) and when the EPD is not based on full life cycle (cradle to grave).

The reference flow and the bill of materials shall be reported in the EPD. The bill of materials shall include the list of alloying elements included in the component and the percentage contribution of each of them to the total weight of the declared unit (i.e. reference flow).

To increase comparability between EPDs based on a declared unit, it is important to specify technical properties of relevance for the application/use of the product. Since the PCR may be used for aluminium components providing different functions in the vehicle, the EPD shall include a description of the aluminium component object of the study, its geometry, function in the vehicle, weight, and production process. A picture/scheme shall be included.

3.2.2. System boundary

To be consistent with EN 15804:2012+A2:2019, and to garantee modularity, the stage phases have been split and described as Module A (production) Module B (use phase) and Module C (End of Life Stage). Additionally, as in EN 15804:2012, Module D on additional benefits which results from the recycling at the end of life outside the system, is considered.

The project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101003785

Following this logic, this PCR allows the development of EPDs according to three catgories based on different LCA scopes:

1. a "cradle-to-gate" EPD; based on LCA information of the production life cycle stage including data from UPSTREAM and CORE processes (Module A)
2. a cradle to gate EPD plus end of life stage including additional environmental aspect resulting from this EoL stage, (Modules A+ C+ D)
3. a "cradle-to-grave" EPD; covering all life-cycle stages, (Module A + B+ C+ D)

In a "cradle-to-grave" EPD (3rd category), all life cycle stages are mandatory. Hence, a "cradle-to-grave" EPD requires the development of detailed information that defines the function of the product and scenarios for handling the usage in order to meet consistency and comparability within the specific application of the product group (Module A). If there are many scenario possibilities for the use phase of one single product, the most relevant use phase scenario (relevant in terms of the percentage of type of use given to that specific product) should be taken.

The same principle should be applied to the selection of the End of life stage scenario used for the 2nd & 3rd categories (Module C) . In the both categories, the Module D scenario results from the other Modules, especially Modules A & C, as explained in section 3.5.3 and Annex 1.

3.2.3. Production stage (Module A)

For the purpose of different data quality rules and for the presentation of results, the production life cycle of the product is divided into two processing types:

- Upstream processes (from cradle-to-gate)
- Core processes (from gate-to-gate)

In the EPD, the environmental performance associated with each of the two processing types shall be reported separately and in aggregated form. The processes included in the scope of the PCR and belonging to each life cycle stage are described in Sections below.

Upstream Process

The following unit processes are part of the product system and shall be classified as upstream processes

- Extraction and processing of raw materials. Some indications are:
  - Bauxite ore: the source of the bauxite used should be specified as well as its production process (e.g., mining operations) and included in the LCA study.
  - Alumina production: the conversion of Bauxite into alumina should be modelled based on specific data or generic data considering properly the origin of the bauxite.
  - Petroleum coke and pitch (coal): mining operations and production of anodes and cathodes should be taken into account. If specific data are not available, a global average source of coal mix can be used, i.e. data from LCA databases or recognized literature.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

- Aluminium smelting (electrolysis) should be modelled considering the origin of the aluminium with a special focus on the electricity model used for its production since it plays a key role in the environmental results of aluminium products.
- Scrap: the origin and type of scrap used in aluminium production shall be described, whether it is external or internal scrap. Any kind of scrap pre-treatment (e.g., sorting, grinding, compacting), if (externally or internally) carried out, should be assessed and included in LCA calculations.

- Production of alloying elements, chemicals and auxiliary and their transportation to the production plant
- Manufacturing of aluminium alloys semi-finished products (e.g., ingots, bars, sheets, extrusions, billets …)
- Treatment of manufacturing by-products and waste (e.g., slags, sludge, dust), even if carried out by third parties, including transportation,
- Generation of electricity and production of fuels, steam and other energy carriers used in the upstream processes,
- Production of packaging, if relevant
- Transportation of the materials (from bauxite to the Al component) through the different production steps, based on average distance and mode

The above list is not exhaustive. Hence, other relevant upstream processes not listed above may be included. All elementary flows at resource extraction shall be included, except for the flows that fall under the general cut-off rule in Section **Error! Reference source not found.**.

The following processes shall not be included:

- Manufacturing of production equipment, buildings and other capital goods
- Maintenance of machinery and other appliances more frequent than 1 year for processes modelled with primary data
- Packaging of raw materials
- Travels to and from work of personnel
- Business travel of personnel
- Research and development activities

Core processes

The following unit processes are part of the product system and shall be classified as core processes:

- Transportation of materials and components to the aluminium automotive component manufacturing site,
- Manufacturing of the aluminium component (e.g., HPDC, extrusion, stamping…) including thermal treatment when relevant Packaging if relevant

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

- Surface treatments such as conversion coating, application of e-coating, paint application
- Fastening methods, cleaning procedures and assembly on the car
- End-of-life treatment of manufacturing waste even if carried out by third parties, including transportation,
- Generation of electricity and production of fuels, steam and other energy carriers used in core processes.

This list is not exhaustive and other core processes not listed may also be included.

The following processes shall not be included:

- Manufacturing of production equipment, buildings and other capital goods,
- Business travel of personnel,
- Travel to and from work by personnel, and
- Research and development activities.

3.2.4. Other life cycle stages and related processes

The following unit processes are part of the product system and shall be classified as downstream processes:

- Use stage (Module B)
  - Transportation of the product to retailer/consumer,
  - Use of the component in the vehicle (including fuel consumption)
- End-of-Life stage (Module C)
  - Collection and processing, including transportation, dismantling, shredding, and separation,
  - Transportation of waste to disposal,
  - Disposal, including landfilling, waste incineration, composting, and conversion to energy,
  - Transportation of scrap to the recycling facility; and
  - Generation of electricity and production of fuels, steam and other energy carriers used in downstream processes.

The following processes shall not be included:

- Manufacturing of production equipment, buildings and other capital goods,
- Business travel of personnel,
- Travel to and from work by personnel, and
- Research and development activities.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Additionally the modelling guidance for Module D, which accounts for the additional potential benefits of avoided future use of primary materials associated with recycling and recovery beyond the system boundary, can be found in Section 3.5.3.

3.2.5. Other boundary setting

Boundary towards nature

Boundaries to nature are defined as where the flows of material and energy resources leaves nature and enters the technical system (i.e. the product system). Emissions cross the system boundary to nature when they are emitted to air, soil or water.

Boundary towards other technical systems

Boundaries towards other technical systems define the flow of materials and components to/from the product system under study and from/to other product systems. If there is an inflow of secondary material to the product system in the production/manufacturing stage, the transport from the scrapyard/collection site to the recycling plant, the recycling process, and the transportation from the recycling plant to the site where the material is being used shall be included. If there is an outflow of material or component to recycling, the transportation of the material to the scrapyard/collection site shall be included. The material or component going to recycling is then an outflow from the product system.

Temporal boundary

The temporal boundary defines the time period for which the life cycle inventory data is recorded, e.g., for how long emissions from waste deposits are accounted. As default, the time period over which inputs to and outputs from the product system is accounted for shall be 100 years from the year that the LCA model best represents, considering the representativeness of the inventory data. This year shall, as far as possible, represent the year of the publication of the EPD.

Geographical boundary

The geographical boundary defines the geographical coverage of the LCA. This shall reflect the physical reality of the product under study, accounting for the representativeness of technology, input materials and input energy.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

3.3. System diagram

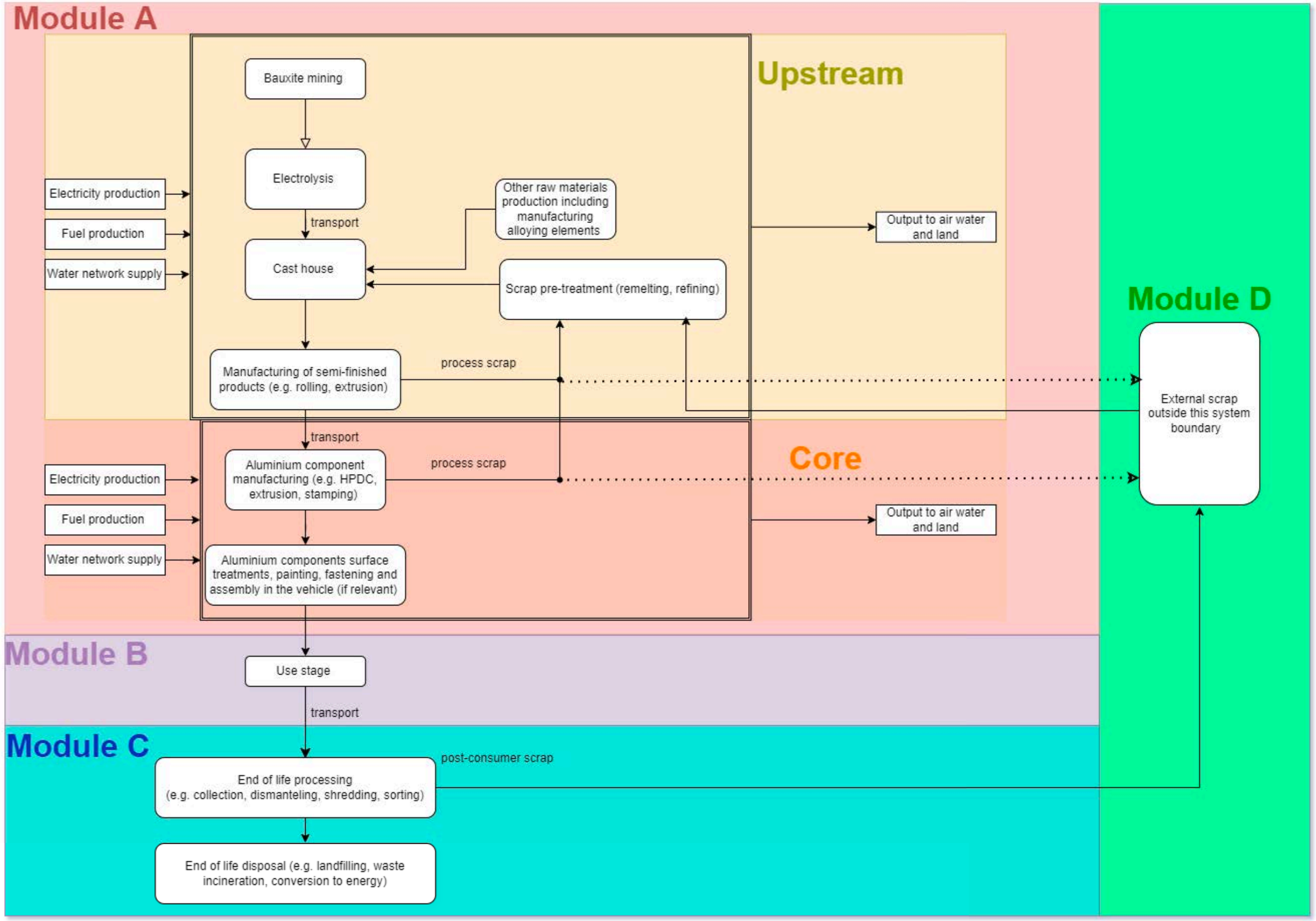


Figure 2 System diagram illustrating the processes that shall be included in the product system, divided into upstream, core and downstream processes. The illustration of processes is not exhaustive

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

3.4. Cut-off rules

In cases of insufficient input data or data gaps for a unit or system process, the cut-off criteria shall be 1% of total energy usage and 1% of the total mass input of that process. For each alloying element, the cut off rule applies for elements that are added in less than per thousand.

The total of neglected input and output flows of the cradle-to-grave auto part product system shall not exceed a maximum of 5% of energy usage, mass or environmental impact category indicator covered by this LCA Guideline.

All hazardous and toxic materials and substances shall be included in the inventory, and the cut-off rules do not apply.

The cut-off of inventory data, based on the above cut-off rule, should be the result of a sensitivity analysis, alone or in combination with expert judgment based on experience of similar product systems. Further, the exclusion of inventory data based on the cut-off rule shall be documented in the LCA report, and the EPD developer shall provide the information the verifier considers necessary to verify the cut-off.

3.5. Allocation methodological aspects

3.5.1. Co-product allocation

The following hierarchy of allocation methods shall be followed for co-product allocation:

1. Allocation shall be avoided, if possible, by dividing the process to be allocated into sub-processes and collecting the inventory data for each sub-process.
2. If allocation cannot be avoided, the inventory data should be partitioned between the different co-products in a way that reflects the underlying physical relationships between them, i.e. allocation should reflect the way in which the inventory data changes if the quantities of delivered co-products change.

   For key processes in the product system, Table 2 provides specific allocation guidance.

Table 2 allocation method for key processes in the product system

PROCESS	MAIN PRODUCT AND CO-PRODUCTS	ALLOCATION METHOD
Manufacturing process	Aluminium components and PROCESS SCRAP GENERATED DURING THE MANUFACTURING Aluminium (main product) and all other sub-products generated by the same process (e.g. process scrap…)	Scrap generated at production stage should be treated, first and foremost as closed loop recycling, provided that the quality of the scrap entering and exiting the system are of similar quality and that it reflects adequately, the reality of the product system. Hence, this scrap stream should not be considered as secondary material input coming from outside the system boundary or as material output exiting the system boundary. For the net fraction of scrap exiting or entering the product system, a cut-off approach should be used by default (section 3.2.3), no burdens are allocated to these scrap flows. Alternatively, a co-product allocation can be applied to this net flow of process scrap entering or exiting the product system provided a tracking system is in place and it is documented and demonstrated, e.g. through an EPD, that the burdens

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

		allocated to this net flow of process scrap are indeed considered, using these process scrap as a co-product and not as a secondary material. In such a case, the choice of the co-product allocation rule should be justified and documented.
Co-product treatment	Other products containing aluminium or not	Mass allocation

3. If a physical relationship between the inventory data and the delivery of co-products cannot be established, the inventory data should be allocated between the co-products in a way that reflects other relationships between them. For example, inventory data might be allocated between co-products in proportion to their economic values. If economic allocation is used, a sensitivity analysis exploring the influence of the choice of the economic value shall be included in the LCA report.

3.5.2. Treatment of waste flows

The polluter pays principle and its interpretation in EN 15804: "processes of waste processing shall be assigned to the product system that generates the waste until the end-of-waste state is reached." The end-of-waste state is reached when all the following criteria for the end-of-waste state are fulfilled (adapted from EN 15804):

- the recovered material, component or product is commonly used for specific purposes;
- a market or demand, identified e.g., by a positive economic value, exists for such a recovered material, component or product;
- the recovered material, component or product fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
- the use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.

The above outlined principle means that the generator of the waste shall carry the full environmental impact until the point in the product life cycle in which the end-of-waste criteria are fulfilled. Waste may have a negative economic market value, and then the end-of-waste stage is typically reached after (part of) the waste processing and further refinement, at the point at which the waste no longer has a negative market value. This allocation method is (in most cases) in line with a waste generator's juridical and financial responsibilities.

For waste being recycled or reused, processes after the end-of-waste state, if any, shall be directed to Module D for calculating the associated environmental aspect (see paragraph 3.2.4). This is valid both for scrap (using the cut-off rule) in input in the upstream phase (i.e. carrying the environmental impacts of transport and pre-treatment, not the impacts generated in the earlier lifecycle) and waste produced in the core phase (i.e. carrying the environmental impacts of waste treatment).

3.5.3. Module D calculation principle

Benefits and loads of reuse, recycling or recovery outside the system boundary are calculated in Module D through substitution method where quantitative environmental information (burdens and

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

benefits) related to the net flow of recovered secondary material/energy are declared separately as additional environmental information. For aluminium products, Module D (see Figure 2) calculates, the environmental aspects of the net flow of aluminium scrap resulting from the product life cycle directed from/to the scrap pool. Typically, if the product life cycle consumes scrap (less scrap generated at EoL than scrap consumed at production stage), Module D will reflect burdens, if it generates scrap on its life cycles (more scrap generated at EoL than scrap consumed at production stage), Module D will calculate environmental benefits. If the product life cycle consumes and produces the same scrap quantity on its life cycle, Module D will be empty. In other word, Module D reflects the environmental aspects of the circularity discrepancy between the production stage and the EoL stage regarding the scrap flow. The calculation methodology is explained in Annex 1.

3.6. Data quality requirements and selection of data

Life cycle inventory data are classified into specific data and generic data, where the latter can be selected generic data or proxy data. The data categories are defined as follows:

- specific data (also referred to as "primary data" or "site-specific data"):
  - plant-specific data gathered through measurement or modelling current product-specific processes directly where they are carried out;
  - actual data from other parts of the life cycle traced to the product under study, for example site-specific data on the production of materials or generation of electricity provided by contracted suppliers, and transportation data on distances, means of transportation, load factor, fuel consumption, etc., of contracted transportation providers; and
  - LCI data from databases on transportation and energyware that is combined with actual transportation and energy parameters
- generic data (sometimes referred to as "secondary data"), divided into:
  - selected generic data: data (e.g. commercial databases and free databases) that fulfil prescribed data quality requirements for precision, completeness, and representativeness (see below Section **Error! Reference source not found.**),
  - proxy data: data (e.g. commercial databases and free databases) that do not fulfil all of the data quality requirements of "selected generic data".

When available and relevant, specific data are preferred to generic data. In particular, specific data should be used for the core processes. If generic data are used for the core processes, it shall be clearly stated and justified in the EPD.

For primary data collection through measurement, the data should represent and reflect the selected representative year of development of the EPD.

3.6.1. Rules for using generic data

For generic data to be classified as "selected generic data", the following requirements apply:

- datasets shall be based on attributional LCA modelling

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

- the reference year shall be as current as possible and should be representative for the validity period of the EPD,
- the 1% cut-off rule (as described in Section A.3.3) shall be met on the level of the product system,
- data should be geographically relevant, following the defined geographical coverage of the EPD and succinctly documented in case of clear deviation from the scope of the EPD,
- technological representativeness should be declared

If selected generic data that meets the above data quality requirements are not available, proxy data may be used. The environmental impacts associated with proxy data shall not exceed 10% of the overall environmental impact of the product system.

The EPD may include a data quality declaration to demonstrate the share of specific data, selected generic data and proxy data contributing to the results of the environmental impact indicators.

3.6.2. Examples of databases for generic data

Table 3 lists examples of databases and datasets to be used for generic data. Please note that a data quality assessment shall be performed also for data listed in the table, and that other data that fulfil the data quality requirements may also be used.

Table 3 Example of databases to use for generic data

PROCESS		GEOGRAPHICAL SCOPE	DATASET	DATABASE
Aluminium		European	-	European Aluminium Association www.european-aluminium.eu/ Direct link
Chemicals		Global	-	Life Cycle Data Network https://eplca.jrc.ec.europa.eu/LCDN/
Plastics		European	-	Plastics Europe http://plasticseurope.lca-data.com/ILCD
	Some reference databases for LCA are the following below: • Ecoinvent database: contains international industrial life cycle inventory data on energy supply, resource extraction, material supply, chemicals, metals, agriculture, waste management services, and transport services. http://www.ecoinvent.ch/ • The Greenhouse Gas Protocol Initiative. http://www.ghgprotocol.org/			

3.6.1. Data quality requirements and other modelling guidance per life-cycle stage

Below are further data quality requirement per life-cycle stage. Exceptions to the requirements may be accepted, if justified in the EPD; such exceptions are subject to the approval by the verifier on a case-to-case basis.

3.6.1.1. Production stage (Module A)

Upstream Process

Data referring to processes and activities upstream in a supply chain over which the EPD owner direct management control shall be specific and collected on site.

Data referring to contractors that supply main parts, packaging, or main auxiliaries should be requested from the contractor as specific data, as well as infrastructure, where relevant.

Data on transport of main parts and components along the supply chain to a distribution point (e.g. a stockroom or warehouse) where the final delivery to the manufacturer can take place, should be specific and based on the actual transportation mode, distance from the supplier, and vehicle load.

In case specific data is lacking, selected generic data may be used. If this is also lacking, proxy data may be used (see Section 4.7).

For upstream processes modelled with specific data, generation of electricity used shall be accounted for in this priority:

1. Specific electricity mix as generated, or purchased from an electricity supplier, demonstrated by a Guarantee of Origin or similar as provided by the electricity supplier.
2. Residual electricity mix of the electricity supplier on the market.
3. Residual electricity mix on the market.
4. Electricity consumption mix on the market.

The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total consumption mix.

“The market” in the above hierarchy may correspond a national electricity market, if this can be justified.

The mix of electricity used in upstream processes shall be documented in the EPD, where relevant.

Packaging: specific data shall be used for the consumer packaging production if it is under the direct control of the organization or if the environmental impact related to the consumer packaging production is more than 10% of the total product environmental indicators. In other cases, generic data may be used. When consumer packaging shows the organization's logo, the LCA report should report the exerted/non-exerted direct control on the production of consumer packaging by the organization.

ALLOYING ELEMENTS

The project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101003785

Elements, others than aluminium, which are already present in the primary aluminium (i.e. not intentionally added to the melt) shall not be considered in the calculation of the alloying elements . All other alloying elements that are added to the melt shall be considered in the calculations, with the exception of alloying elements that are added in less than per thousandth (i.e. <0.1%), that may be disregarded in the calculation and the same amount of primary aluminium should be considered instead and shall be calculated when estimating the cut off.

In cradle to gate EPD (Module A), input flows of aluminium post-consumer scrap are considered as burdens free. When alloyed aluminium scrap are used, the alloying elements already included in the scrap should be considered as contributing to the composition of the aluminium alloy. Hence, only the net addition of alloying elements (i.e. via master alloys) to the melt to reach the final composition shall be considered as the raw material input. Such addition of alloying elements to the melt will be assumed to be issued only from primary production.

For example: the melt already includes 2% in weight of Silicon. To reach the specific composition of 5% of silicon, 3% in weight is added to the melt. The LCA calculation for module A should include only the 3% in weight of silicon added to the melt to reach the desired composition of 5%.

Core Process

Transport from the final delivery point of raw materials, chemicals, main parts, and components (see above regarding upstream processes) to the manufacturing plant/place of service provision should be based on the actual transportation mode, distance from the supplier, and vehicle load, if available.

- Goods: Specific data shall be used for the assembly of the product and for the manufacture of main parts as well as for on-site generation of steam, heat, electricity, etc., where relevant.
- Services: Specific data shall be used for the consumption of materials, chemicals, steam, heat, electricity, etc., necessary for execution of the service
- For electricity used in the core processes, generation of electricity used shall be accounted for in this priority:
  1. Specific electricity mix as generated, or purchased from an electricity supplier, demonstrated by a Guarantee of Origin or similar as provided by the electricity supplier.
  2. Residual electricity mix of the electricity supplier on the market.
  3. Residual electricity mix on the market.
  4. Electricity consumption mix on the market. This option shall not be used for electricity used in processes over which the manufacturer (EPD owner) has direct control[2].

The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total consumption mix.

"The market" in the above hierarchy may correspond a national electricity market, if this can be justified.

[2] For electricity markets without trade of Guarantees of Origin (or similar), the residual mix will, however, be identical to the consumption mix.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

The mix of electricity used in the core processes shall be documented in the EPD, where relevant.

Waste treatment processes of manufacturing waste should be based on specific data, if available

3.6.1.2. Use stage (Module B)

Data and GHG emissions for the use stage shall be reported separately in Module B and are usually based on scenarios, nevertheless, specific data should be used when available and relevant.

Data on the emissions from the use stage should be based on documented tests, verified studies in conjunction with average or typical product use, or recommendations concerning suitable product use. Whenever applicable, test methods shall be internationally recognised.

The use of electricity in the region/country where the product is used (as specified in the geographical scope of the EPD) shall be accounted for in the following priority:

1. Residual electricity mix on the market.

2. Electricity consumption mix on the market.

The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total production mix.

“The market” in the above hierarchy may correspond a national electricity market, if this can be justified.

The mix of electricity used in the downstream processes shall be documented in the EPD, where relevant.

The transport of the product to the customer shall be described in the EPD, where relevant, and be accounted for in this priority:

1. Precise transportation modes and distances to specific a customer or market, representing the geographical scope of the EPD.

2. A weighted average of transportation modes and distances, based on transportation to several customers or markets, representing the geographical scope of the EPD.

3.6.1.3. End of Life stage (Module C)

Data & GHG emissions for the End-of-life stage shall be reported separately in Module C. The End-of-life stage shall be modelled based on current practice scenarios and data. The typical End of-life scenario for aluminium components is recycling. Scenarios for the end-of-life stage should be technically and economically representative and as far as possible compliant with current regulations in the relevant geographical region based on the geographical scope of the EPD. Key assumptions regarding the end-of-life stage scenario shall be documented in the LCA report.

3.6.1.4. Scrap flow modelling and Module D calculation

In cradle to gate EPD, post-consumer aluminium scrap used as input to the process are modelled though cut-off, i.e. no environmental burden from the previous life cycle is attributed to them. Post-consumer aluminium scrap however bears the burden of the following processes:

The project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101003785

- Transportation from the plant where the scrap is prepared and sorted to the plan in which the scrap is used.

In cradle to gate EPD, applying this cut-off rule while focussing on production stage corresponds to the so-called recycled content approach.

In cradle to grave EPD, the recycled content approach alone cannot reflect the recycling performances on the whole product life cycle. Indeed, at end of life, aluminium components are collected and recycled with a high recycling rate which usually differs from the recycled content of the component. The recycled content metric alone does not reflect then the recycling aspects of the product on its full life cycle perspective. Hence, the discrepancy between the aluminium scrap used by the product system and the scrap generated by the product system is addressed in Module D where the environmental aspects of this net flow of scrap is calculated through substitution. The calculation of Module D is described in Annex 1.

3.6.2. Data quality declaration

EPDs may include a declaration of the quality of data used in the LCA calculations.

3.7. Environmental performance indicators

The EPD shall declare the default environmental performance indicators and their methods as described at the website of the International EPD system (www.environdec.com/indicators), which includes both inventory indicators and indicators of potential environmental impact. The source and version of the impact assessment methods and characterisations factors used shall be reported in the EPD. Alternative regional impact assessment methods and characterisation factors may be calculated and displayed in addition to the default list. If so, the EPD shall contain an explanation of the difference between the different sets of indicators, as they may appear to the reader to display duplicate information.

These indicators shall be reported for each module separately.

Apart from the required inventory indicators, other inventory data may also be declared in the EPD, if relevant and useful for EPD users. Such data shall not be declared in the main body of the EPD, but in an annex.

4. Conclusions and Outlook

The product category rule for Al components was developed, based on the ENVIRONDEC template, in this report to provide clear and transparent rules on the data collection and the assumptions to implement when calculating the environmental impact of primary aluminium and its alloys.

4.1. Next steps

10 LCAs based on this PCRs will be developed by the SALEMA's partner EURECAT with the support of European Aluminium.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

If considered necessary the PCR will be updated, in collaboration with EURECAT, to take in consideration challenges or opportunities highlighted during the LCA development.

If considered an added value, the following PCR can be submitted for approval to the ENVIRONDEC program.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Annex 1 - Modelling of the end-of-life stage and associated environmental aspects

The End-of-life stage shall be modelled based on current practice scenarios and data. The typical End of-life scenario for aluminium components is recycling.

In cradle to gate EPD, post-consumer aluminium scrap used as input to the process are modelled though cut-off, i.e. no environmental burden from the previous life cycle is attributed to them. Post-consumer aluminium scrap however bears the burden of the following processes:

- Transportation from the plant where the scrap is prepared and sorted to the plan in which the scrap is used

In cradle to gate EPD, applying this cut-off rule while focussing on production stage corresponds to the so-called recycled content approach.

In cradle to grave EPD, the recycled content approach alone cannot reflect the recycling performances on the whole product life cycle. Indeed, at end of life, aluminium components are collected and recycled with a high recycling rate which usually differs from the recycled content of the component. Hence, to consider and reflect this recycling discrepancy between both stages, the end-of-life stage shall be modelled in 2 parts:

- Part 1 – Module C: modelling all the process related to the collection and preparation of the aluminium scrap at end of life

- Part 2 – Module D modelling the additional environmental aspects resulting from the end-of-life stage which are calculated from the net flow of aluminium scrap (i.e. secondary materials) generated by the product system under study, i.e. the aluminium component.

The environmental aspects of Part 2 - Module D are assessed using the so-called "substitution methodology". In such methodology, the calculation considers on one side the environmental burdens to process the secondary material up to the point of functional equivalence and, on the other side, the environmental savings resulting of the primary aluminium which is effectively substituted. In the case of aluminium component, the point of equivalence is the aluminium ingot. If needed, a correction factor may be applied when full substitution cannot take place, i.e. when properties are not maintained through recycling.

The formula that can be applied is the equivalent of the formula used for Module D in the CEN standard EN15804 used in the building sector (EN15804:2012 +A2+2019 Annex D), for the calculation of the loads and benefits beyond the system boundary per unit of output calculated for each output flow leaving the system boundary. For the pure aluminium case, this formula can be restricted to the formula term 'e_{SMR}' which relates to secondary materials for recycling. For the aluminium component case, several metals may be considered as aluminium is alloyed with other elements.

$$e_{\mathrm{SMRi}} = (M_{\mathrm{MRi\ out}} - M_{\mathrm{MRi\ in}})\left(E_{\mathrm{MR\ after\ EoW\ out}} - E_{\mathrm{VMiSub\ out.}} \cdot \frac{Q_{\mathrm{Ri\ out}}}{Q_{\mathrm{iSub}}}\right) \quad \text{(F.7)}$$

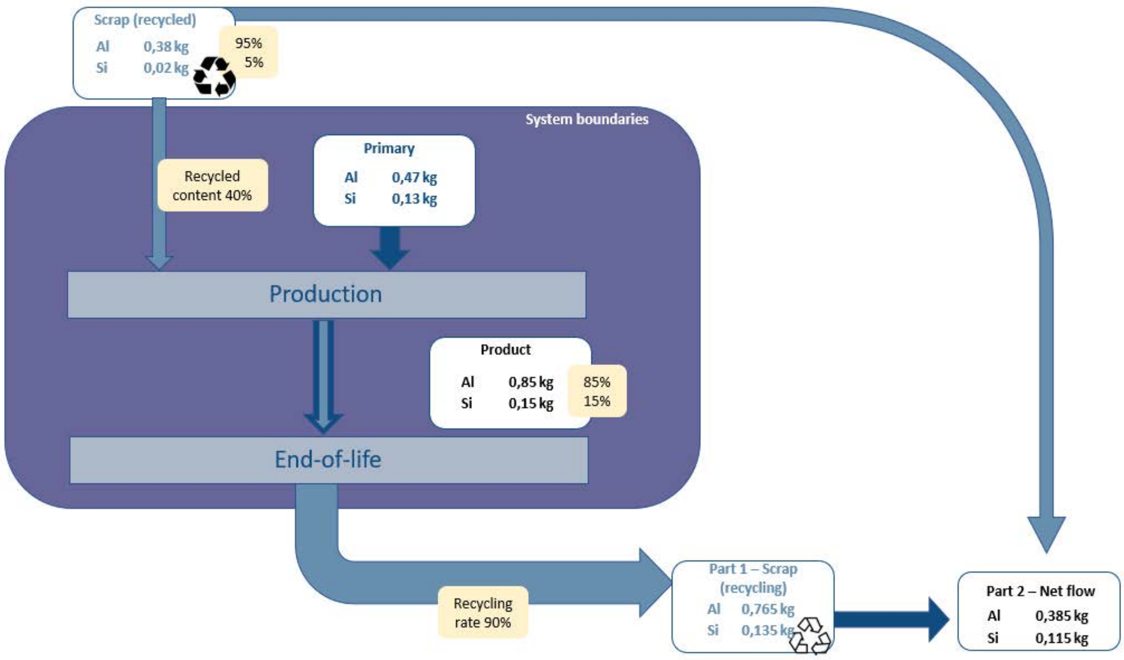
•Where:

- $M_{MRi\ out}$ is the quantity of Metal i in sorted scrap exiting the product system,
- $M_{\mathrm{MRi\ in}}$ is the quantity of Metal i in sorted scrap entering the product system
- $M_{MRi\ out} - M_{MRi\ in}$ represents the net quantity of Metal i in sorted scrap generated or consumed by the product system.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

- $E_{\text{MRafter EoW out}}$ corresponds to the specific emissions and resources arising from the recycling of the sorted scrap up to cast metal, at end of life. For the metal sheet case, it will be called $E_{RecyclingEoL}$. It should include all the processes reported
- $E_{\text{VMiSub out}}$ refers to specific emissions and resources consumed per unit of analysis arising from acquisition and pre-processing of the primary metal i from cradle to the cast metal.
- $\frac{Q_{\text{Ri out}}}{Q_{\text{iSub}}}$ is the quality factor between recycled metal i and primary metal i

As example, for a pure aluminium component of 1 kg made of 40% of recycled content and recycled at end of life with a recycling rate of 90%, the net flow of scrap generated from the product system is equal to 0.9 kg minus 0.4 kg = 0,5kg (50% of the mass). Hence, Part 2 (Module D) should calculate the benefits of substituting 0.5 kg of recycled metal. This logic should be applied per alloying element as illustrated in the next diagram for 1 kg of a component made of an alloy of 85% Al and 15% Si. In this case, Module D will calculate the environmental benefits of recycling 0.385kg of aluminium and 0.115 kg of Silicon.



The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785