# LCA report –Aluminium profiles produced by Fujian Nanping Aluminium Co., LTD.

As the basis for the publication of EPD within the International EPD system

Version 1.1.0

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**Author:** Shuhan Huang

**Commissioned by:** Fujian Nanping Aluminium Co., LTD.

**Photo:** Fujian Nanping Aluminium Co., LTD.

**Examiner:** Yanjing Zhu
**Approver:** Juanjuan Yao

**Third-party verifier:** Matt Fishwick

*LCA, EPD, Construction*

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# 1 Introduction

To communicate the environmental performance of mill finished, anodized, fluorocarbon coated, powder coated, and thermal barrier aluminium profiles produced by Fujian Nanping Aluminium Co., LTD. (hereafter short Nanping Aluminium), IVL Swedish Environmental Research Institute (hereafter IVL) has calculated the environmental performance using Life Cycle Assessment (LCA) which will form the basis of **five upcoming Environmental Product Declarations (EPDs)** for external communication. This report provides details about the methodology and data used to produce the LCA results. Nanping Aluminium has provided data based on the production in the calendar year 2023.

## 1.1 About this report

While the EPDs are for external communication, this LCA report is for internal use only. The report consists of a goal and scope section, a section describing the data used in the Life Cycle Inventory (LCI), and a section with results. The LCA report should be used together with “Masterbook of NP liquid aluminium”, “Masterbook of NP alloy ingot”, “Masterbook of NP Aluminium Profile”, and “Masterbook of NP Thermal barrier aluminium profile”.

The methodology applied in this study follows the requirements of ISO14025:2006, ISO 14044:2006/Amd 2:2020, ISO 14040:2006, and the PCR 2019:14 Construction products Version 1.3.4 [valid until: 2025-06-20], which is based on the standard EN 15804:2012+A2:2019/AC:2021 (based on EF 3.1).

The EPDs are to be certified through the International EPD® system and this report is therefore in line with their requirements in the general programme instructions (GPI) of the International EPD® system and in the PCR for construction products.

This LCA-report is not public. Nanping Aluminium can however decide to communicate the report externally, for example, to their downstream clients.

## 1.2 About Nanping Aluminium

Fujian Nanping Aluminium Co., LTD., founded in 1958, now is one of the national top ten aluminium production enterprise, is the present domestic only with "enterprise technology centers recognized by the state", "national torch plan key high-tech enterprise", "national innovative enterprises" honour aluminium of large state-owned enterprises, listed by the national ministry of "two fusion to promote energy conservation and emissions reduction of pilot demonstration enterprise", "industrial brand cultivation demonstration enterprise", for "the second session of Fujian provincial government quality prize", list the national "quality" benchmarking enterprises. The registered capital of Nanping Aluminium is 1028.7 million yuan, with 5,200 employees (including subordinate enterprises) and annual sales revenue of over 10 billion yuan.

Nanping Aluminium practices the business philosophy of "people first, integrity as foundation, innovation driven and collaborative growth" and strives for change. Now has yearly produces 150,000 tons of aluminium industry chain (pre-baked anode aluminium electrolytic aluminium casting < cast-rolling > - aluminium processing mould, aluminium, aluminium strip - aluminium deep processing), including aluminium casting, aluminium processing capacity of more than 200,000 tons/year, leading products for aluminium. With more than 350 patents for invention, appearance and utility models approved by the state intellectual property office, Nanping Aluminium has the largest number of patents in the aluminium profile industry. There are 4 national key new products and 13 provincial or ministerial science and technology and new products awards. It is one of the main drafting units of GB5237 "aluminium alloy building profiles" test and development base and national standard of aluminium alloy building profiles.

Nanping Aluminium boasts several advanced technology innovation platforms, including a national-level enterprise technology centre, a nationally recognised laboratory, and a demonstration base for the development of the GB/T5237 national standard for aluminium alloy building profiles. Nanping Aluminium also host the Fujian Provincial Engineering Research Centre for Aluminium Alloy Profiles. Nanping Aluminium commitment to quality, safety, environmental protection, and high-end certifications spans various sectors, including automotive, railways, shipbuilding, military, and green building materials.

Nanping Aluminium has achieved comprehensive certification for ISO 9001:2015 Quality Management System Certification, ISO 14001:2015 Environmental Management Systems, ISO 45001:2018 Occupational Health and Safety

Management Systems, ISO 16949:2016 automotive profile quality systems, ISO 22163:2023 Railway industry quality management system - Quality management system requirements for organizations in the railway sector, ASI Certification Performance Standard and ASI Certification Chain of Custody Standard. It has received numerous accolades, including the China Famous Brand, China Well-Known Trademark, Fujian Provincial Government Quality Award, and the Influential Contribution Brand Award for 30 Years of Reform and Opening Up in Fujian. For 18 consecutive years, we have been honoured with the "Golden Cup Award" for the physical quality of non-ferrous metal products and recognised by the Ministry of Industry and Information Technology as a "Demonstration Enterprise for Industrial Brand Cultivation" (see Appendix D: Certificates of Nanping Aluminium:).

Nanping Aluminium is dedicated to implementing a new development philosophy. Nanping Aluminium will adhere to an innovation-driven strategy, concentrate on the green and low-carbon new materials industry, strengthen and expand consumer electronics and new energy sectors, enhance our aluminium alloy materials division, and refine our construction and engineering segments. Nanping Aluminium are committed to driving the transformation and upgrading of Nanping Aluminium for high-quality development, contributing to the comprehensive construction of a modern socialist country and achieving new successes in Fujian."

## 1.3 Brief introduction of the studied product

This LCA serves five EPDs, and all of them are EPDs of multiple products based on average results. The products corresponding to these five EPDs are mill finished, anodized, fluorocarbon coated, powder coated and thermal barrier aluminium profiles.

### 1.3.1 Mill finished aluminium profile

Mill finished aluminium profile is the ideal choice for the construction industry due to its low density, high strength, and excellent machinability. Its non-toxic and recyclable nature makes it environmentally friendly and sustainable, while its outstanding corrosion resistance ensures long-term durability. Widely used in building materials, transportation, and home decor, mill finished aluminium profile is an indispensable material in modern engineering.

Nanping Aluminium's mill finished aluminium profiles adhere to the national standard GB/T 5237.1-2017," Aluminium alloy extruded profiles for architecture - Part 1: Mill finish profiles". The quality parameters of the products and the standards for testing are shown in Table 1(see appendix G).

*Table 1 The product quality parameters and the standards for testing*

| Quality parameters | unit | value | Test standard |
|---|---|---|---|
| Si | % | 0.30~0.6 | GB/T7999-2015 |
| Fe | % | 0.10~0.30 | GB/T7999-2015 |
| Cu | % | ≤0.10 | GB/T7999-2015 |
| Mn | % | ≤0.10 | GB/T7999-2015 |
| Mg | % | 0.35~0.6 | GB/T7999-2015 |
| Cr | % | ≤0.05 | GB/T7999-2015 |
| Zn | % | ≤0.15 | GB/T7999-2015 |
| Ti | % | ≤0.10 | GB/T7999-2015 |
| Tensile Strength $R_m$※ | N/mm² | ≥215 | GB/T16865-2023 |
| Specified Non-Proportional Yield Strength $R_{p0.2}$※ | N/mm² | ≥160 | GB/T16865-2023 |
| Elongation after Fracture $A_{50mm}$※ | % | ≥6 | GB/T16865-2023 |
| Vickers Hardness HV5 | / | 77.0 | GB/T4340.1-2009 |
| Wall Thickness (A) | mm | 1.50±0.13 | GB/T5237.1-2017 |

The LCA study of mill finished aluminium profiles is based on the average results, and the product family are all produced from Nanping Aluminium's plant, located in No. 65, industrial road, Nanping city, Fujian province, China.

The UNCPC code of this products is 4153 Semi-finished products of aluminium or aluminium alloys.

The photo of the products could be found in Figure 1 below. Details will be addressed in the rest of the report.

*Figure 1. Picture of mill finished aluminium profile*

### 1.3.2 Anodized aluminium profile

Anodized aluminium profiles feature excellent weather resistance, corrosion resistance, and outstanding oxidation resistance on its surfaces, effectively protecting against environmental factors such as UV rays, moisture, and salt spray. These properties make it widely applicable in various fields, including building curtain walls, aluminium windows and doors, and interior decorative materials, especially in environments that demand long-lasting durability and aesthetic appeal. With these advantages, anodized aluminium profile has become an indispensable material in modern construction and decoration industries.

Nanping Aluminium's anodized aluminium profiles adhere to the national standard GB/T 5237.2-2017, "Wrought Aluminium Alloy Extruded Profiles for Architecture - Part 2: Anodized Profiles" and meets the requirements of CNCA-CGP-13:2020 "Guidelines for the Implementation of Green Building Materials Product Classification Certification", CQM31-3262-01-2013 "Certification Rules for Aluminum Alloy Building Profiles", and CQM64-CGP130205-2021 "Detailed Implementation Rules for Green Building Materials Product Classification Certification for Profiles Used in Doors, Windows, and Curtain Walls" with a three-star rating (see Appendix E: Certificates of products). The quality parameters of the products and the standards for testing are shown in Table 2(see appendix G)..

*Table 2 The product quality parameters and the standards for testing*

| Quality parameters | unit | value | Test standard |
|---|---|---|---|
| Si | % | 0.20-0.6 | GB/T7999-2015 |
| Fe | % | ≤0.35 | GB/T7999-2015 |
| Cu | % | ≤0.10 | GB/T7999-2015 |

| | | | |
|---|---|---|---|
| Mn | % | ≤0.10 | GB/T7999-2015 |
| Mg | % | 0.45-0.9 | GB/T7999-2015 |
| Cr | % | ≤0.10 | GB/T7999-2015 |
| Zn | % | ≤0.10 | GB/T7999-2015 |
| Ti | % | ≤0.10 | GB/T7999-2015 |
| Tensile Strength $R_m$※ | N/mm² | ≥160 | GB/T16865-2023 |
| Specified Non-Proportional Yield Strength $R_{p0.2}$※ | N/mm² | ≥110 | GB/T16865-2023 |
| Elongation after Fracture $A_{50mm}$※ | % | ≥8 | GB/T16865-2023 |
| Wall Thickness (B) | mm | 1.90±0.23 | GB/T5237.1-2017 |
| Coating Thickness average and local thickness requirements | μm | ≥25<br>≥20 | GB/T 4957-2003 |
| Sealing Quality | mg/dm² | ≤30 | GB/T 8753.1-2017 |

The LCA study of anodized aluminium profiles is based on the average results, and the product family are all produced from Nanping Aluminium's plant, located in No. 65, industrial road, Nanping city, Fujian province, China.

The UNCPC code of this product is 4153 Semi-finished products of aluminium or aluminium alloys.

The photo of the products could be found in Figure 2 below. Details will be addressed in the rest of the report.

*Figure 2. Picture of anodized aluminium profile*

### 1.3.3 Fluorocarbon coated aluminium profile

Fluorocarbon coated profiles are widely utilized in the construction and decoration industries due to its outstanding properties. Fluorocarbon coated profiles offer excellent weather resistance, ensuring it can withstand harsh environmental conditions without fading or deteriorating over time. Its impact resistance adds durability, allowing it to endure physical impacts without sustaining damage. This strength is crucial for applications where safety and longevity are paramount. Additionally, the high decorative quality of fluorocarbon paint enhances the aesthetic appeal of buildings and structures, offering a wide range of colour options and finishes to suit various design visions. The combination of these properties makes fluorocarbon coated profile an optimal choice for modern architectural and decorative applications.

Nanping Aluminium's fluorocarbon paint coated aluminium profiles adhere to the national standard GB/T 5237.5-2017, "Wrought Aluminium Alloy Extruded Profiles for Architecture - Part 5. Paint coating profiles" and meets the requirements of CNCA-CGP-13:2020 "Guidelines for the Implementation of Green Building Materials Product Classification Certification", CQM31-3262-01-2013 "Certification Rules for Aluminum Alloy Building Profiles", and CQM64-CGP130205-2021 "Detailed Implementation Rules for Green Building Materials Product Classification Certification for Profiles Used in Doors, Windows, and Curtain Walls" with a three-star rating (see Appendix E: Certificates of products). The quality parameters of the products and the standards for testing are shown in Table 3(see appendix G)..

*Table 3 The product quality parameters and the standards for testing*

| Quality parameters | unit | value | Test standard |
|---|---|---|---|
| Si | % | 0.20-0.6 | GB/T7999-2015 |
| Fe | % | ≤0.35 | GB/T7999-2015 |
| Cu | % | ≤0.10 | GB/T7999-2015 |
| Mn | % | ≤0.10 | GB/T7999-2015 |
| Mg | % | 0.45-0.9 | GB/T7999-2015 |
| Cr | % | ≤0.10 | GB/T7999-2015 |
| Zn | % | ≤0.10 | GB/T7999-2015 |
| Ti | % | ≤0.10 | GB/T7999-2015 |
| Tensile Strength $R_m$※ | N/mm² | ≥160 | GB/T16865-2023 |
| Specified Non-Proportional Yield Strength $R_{p0.2}$※ | N/mm² | ≥110 | GB/T16865-2023 |
| Elongation after Fracture $A_{50mm}$※ | % | ≥8 | GB/T16865-2023 |

| | | | |
|---|---|---|---|
| Wall Thickness (B) | mm | 1.40±0.23 | GB/T5237.1-2017 |
| Coating Thickness average and local thickness requirements | μm | ≥40<br>≥34 | GB/T 4957-2003 |
| Color Difference ($\Delta E^{*}_{ab}$) | / | ≤1.5 | GB/T11186.2-1989 |
| Hardness | / | ≥1H | GB/T6739-2022 |
| Boiling Water Resistance | / | After the high-pressure water immersion test, the coating surface should not exhibit peeling, wrinkling, bubbling, loss of gloss, discoloration, or other defects, and adhesion should reach Level 0 | GB/T5237.5-2017 |
| Impact Resistance | / | After the impact resistance test, minor cracks in the coating are allowed, but no coating should peel off on the adhesive tape. | GB/T1732-2020 |
| Hydrochloric Acid Resistance | / | After the hydrochloric acid resistance test, the coating surface should show no bubbles or other obvious change | GB/T5237.5-2017 |
| Dry Adhesion | / | Level 0 | GB/T5237.5-2017 |
| Wet Adhesion | / | Level 0 | GB/T5237.5-2017 |
| Boiling Water Adhesion | / | Level 0 | GB/T5237.5-2017 |
| Mortar Resistance | / | After the mortar resistance test, the coating surface should show no peeling or other obvious changes | GB/T5237.5-2017 |
| Volatile Organic Compounds | g/L | <2 | GB/T 23986-2009 |

The LCA study of fluorocarbon coated aluminium profiles is based on the average results, and the product family are all produced from Nanping Aluminium’s plant, located in No. 65, industrial road, Nanping city, Fujian province, China.

The UNCPC code of this product is 4153 Semi-finished products of aluminium or aluminium alloys.

The photo of the product could be found in Figure 3 below. Details will be addressed in the rest of the report.

*Figure 3. Picture of fluorocarbon coated aluminium profiles*

### 1.3.4 Powder coated aluminium profile

Powder coated aluminium profiles are widely used in architectural curtain walls, aluminium windows and doors, and interior decorative materials due to their rich colours, strong texture, enhanced corrosion resistance, excellent weather resistance, and environmentally friendly properties. Additionally, the effective powder coating significantly improves the corrosion resistance of the profiles, ensuring it can withstand harsh weather conditions and pollutants, thus extending its service life. Most importantly, it meets environmental standards, containing no harmful substances, making it a safe and healthy choice that aligns with sustainable development goals.

Nanping Aluminium's powder coated aluminium profiles adhere to the national standard GB/T 5237.4-2017, "Wrought Aluminium Alloy Extruded Profiles for Architecture - Part 4.Powder coating profiles" and meets the requirements of CNCA-CGP-13:2020 "Guidelines for the Implementation of Green Building Materials Product Classification Certification", CQM31-3262-01-2013 "Certification Rules for Aluminum Alloy Building Profiles", and CQM64-CGP130205-2021 "Detailed Implementation Rules for Green Building Materials Product Classification Certification for Profiles Used in Doors, Windows, and Curtain Walls" with a three-star rating (see Appendix E: Certificates of products). The quality parameters of the products and the standards for testing are shown in Table 4 (see appendix G).

*Table 4 The product quality parameters and the standards for testing*

| Quality parameters | unit | value | Test standard |
|---|---|---|---|
| Si | % | 0.20-0.6 | GB/T7999-2015 |
| Fe | % | ≤0.35 | GB/T7999-2015 |

| | | | |
|---|---|---|---|
| Cu | % | ≤0.10 | GB/T7999-2015 |
| Mn | % | ≤0.10 | GB/T7999-2015 |
| Mg | % | 0.45-0.9 | GB/T7999-2015 |
| Cr | % | ≤0.10 | GB/T7999-2015 |
| Zn | % | ≤0.10 | GB/T7999-2015 |
| Ti | % | ≤0.10 | GB/T7999-2015 |
| Tensile Strength $R_m$※ | N/mm² | ≥160 | GB/T16865-2023 |
| Specified Non-Proportional Yield Strength $R_{p0.2}$※ | N/mm² | ≥110 | GB/T16865-2023 |
| Elongation after Fracture $A_{50mm}$※ | % | ≥8 | GB/T16865-2023 |
| Wall Thickness (B) | mm | 1.40±0.23 | GB/T5237.1-2017 |
| Local Coating Thickness | μm | ≥40 | GB/T 4957-2003 |
| Color Difference ($\Delta E^*_{ab}$) | / | ≤1.5 | GB/T11186.2-1989 |
| Hardness (Indentation) | / | ≥80 | GB/T 9275-2008 |
| Dry Adhesion | | Level 0 | GB/T 5237.4-2017 |
| Wet Adhesion | | Level 0 | GB/T 5237.4-2017 |
| Boiling Water Adhesion | | Level 0 | GB/T 5237.4-2017 |
| Boiling Water Resistance | / | After the high-pressure water immersion test, the coating surface should not exhibit peeling, wrinkling, or other defects, but very small, highly dispersed bubbles may be visually observed, and adhesion should reach Level 0 | GB/T 5237.4-2017 |
| Impact Resistance | / | After the impact test on the Type III coating test panel, minor cracking in the coating is allowed; however, when further tested with adhesive tape with an adhesion strength greater than 10N/25mm, the coating surface should show no peeling. | GB/T1732-2020 |
| Hydrochloric Acid Resistance | / | After the hydrochloric acid resistance test, the coating surface should show no bubbles or other obvious change | GB/T5237.4-2017 |
| Mortar Resistance | / | After the mortar resistance test, the coating surface should show no peeling or other obvious changes | GB/T5237.4-2017 |
| Volatile Organic Compounds | g/L | <2 | GB/T 23986-2009 |

The LCA study of powder coated aluminium profiles is based on the average results, and the product family are all produced from Nanping Aluminium's plant, located in No. 65, industrial road, Nanping city, Fujian province, China.

The UNCPC code of this products is 4153 Semi-finished products of aluminium or aluminium alloys.

The photos of powder coated aluminium profiles could be found in Figure 4 below. Details will be addressed in the rest of the report.

*Figure 4 Picture of powder coated aluminium profiles*

### 1.3.5 Thermal barrier aluminium profile

Thermal barrier aluminium profiles provide numerous benefits, including energy efficiency, noise reduction, excellent waterproofing, high wind pressure resistance, fire resistance, and superior strength. Its reduce heat loss, improve energy efficiency, and lower heating and cooling costs. Additionally, it significantly cuts noise transmission for a more comfortable indoor environment. With strong waterproofing, it performs well in rain and humidity, extending its lifespan. Its high strength and wind pressure resistance ensure stability in extreme weather, while fire resistance adds an extra layer of safety. Thermal barrier aluminium profile is ideal for use in high-end residential, commercial, and public building door and window systems.

Nanping Aluminium's thermal barrier aluminium profiles adhere to the national standard GB/T 5237.66-2017, "Wrought Aluminium Alloy Extruded Profiles for Architecture - Part 6. Thermal barrier profiles for insertion methodology" and meets the requirements of CNCA-CGP-13:2020 "Guidelines for the Implementation of Green Building Materials Product Classification Certification", CQM31-3262-01-2013 "Certification Rules for Aluminum Alloy Building Profiles", and CQM64-CGP130205-2021 "Detailed Implementation Rules for Green Building Materials Product Classification Certification for Profiles Used in Doors, Windows, and Curtain Walls" with a three-star rating (see Appendix E: Certificates of products). The quality parameters of the products and the standards for testing are shown in Table 5 (see appendix G).

*Table 5 The product quality parameters and the standards for testing*

| Quality parameters | unit | value | Test standard |
|---|---|---|---|
| Si | % | 0.20-0.6 | GB/T7999-2015 |
| Fe | % | ≤0.35 | GB/T7999-2015 |
| Cu | % | ≤0.10 | GB/T7999-2015 |
| Mn | % | ≤0.10 | GB/T7999-2015 |
| Mg | % | 0.45-0.9 | GB/T7999-2015 |
| Cr | % | ≤0.10 | GB/T7999-2015 |
| Zn | % | ≤0.10 | GB/T7999-2015 |
| Ti | % | ≤0.10 | GB/T7999-2015 |
| Tensile Strength $R_m$※ | N/mm² | ≥160 | GB/T16865-2023 |
| Specified Non-Proportional Yield Strength $R_{p0.2}$※ | N/mm² | ≥110 | GB/T16865-2023 |
| Elongation after Fracture $A_{50mm}$※ | % | ≥8 | GB/T16865-2023 |
| Wall Thickness (B) | mm | 2.50±0.25 | GB/T5237.1-2017 |
| Local Coating Thickness | μm | ≥40 | GB/T 4957-2003 |
| Color Difference ($\Delta E^*_{ab}$) | / | ≤1.5 | GB/T11186.2-1989 |
| Hardness (Indentation) | / | ≥80 | GB/T 9275-2008 |
| Dry Adhesion | | Level 0 | GB/T 5237.4-2017 |
| Wet Adhesion | | Level 0 | GB/T 5237.4-2017 |
| Boiling Water Adhesion | | Level 0 | GB/T 5237.4-2017 |
| Boiling Water Resistance | / | After the high-pressure water immersion test, the coating surface should not exhibit peeling, wrinkling, or other defects, but very small, highly dispersed bubbles may be visually observed, and adhesion should reach Level 0 | GB/T 5237.4-2017 |
| Impact Resistance | / | After the impact test on the Type III coating test panel, minor cracking in the coating is allowed; however, when further tested with adhesive | GB/T1732-2020 |

| | | | |
|---|---|---|---|
| | | tape with an adhesion strength greater than 10N/25mm, the coating surface should show no peeling. | |
| Hydrochloric Acid Resistance | / | After the hydrochloric acid resistance test, the coating surface should show no bubbles or other obvious change | GB/T5237.4-2017 |
| Mortar Resistance | / | After the mortar resistance test, the coating surface should show no peeling or other obvious changes | GB/T5237.4-2017 |
| High-Temperature Longitudinal Shear Strength Characteristic Value | N/mm | ≥24 | GB/T 28289-2012 |

The LCA study of thermal barrier aluminium profiles is based on the average results, and the product family are all produced from Nanping Aluminium's plant, located in No. 65, industrial road, Nanping city, Fujian province, China.

The UNCPC code of this product is 4153 Semi-finished products of aluminium or aluminium alloys.

The photos of thermal barrier aluminium profile could be found in Figure 5 below. Details will be addressed in the rest of the report.

*Figure 5 Picture of thermal barrier aluminium profile*

## 1.4 About life cycle assessment

Life cycle assessments (LCA) investigate the environmental impacts related to a product or a system during its whole life cycle. This includes evaluating energy and resource consumption as well as emissions, from all life cycle stages including material production, manufacturing, use and maintenance, and end-of-life. LCA is a widely-used and accepted method for studies of environmental performance of various products and systems. The LCA in this report is performed in accordance with ISO 14040:2006 and ISO 14044:2006 standards. More information about life cycle assessment could be found in Appendix B: Brief introduction to LCA.

# 2 Goal and Scope

The goal of the study is to individually calculate and present the environmental performance of mill finished, anodized, fluorocarbon coated, powder coated and thermal barrier aluminium profiles, with the results to be published in EPDs for business-to-business communication. The LCA report may only be communicated to the third-party verifier and to Nanping Aluminium, which shall not be publicly available.

## 2.1 Declared unit

The declared unit is the unit that the results in the study are related to. **The declared unit for the EPD reports for these five product families is 1,000 kg of the studied products based on the average results**. The total inputs and outputs required for the studied product family were calculated. Based on a physical method, the energy consumption, auxiliary materials consumption, and waste data were distributed to each declared unit according to the total production mass of 2023. By using this weighted average method, a result based on the average product was obtained.

## 2.2 Studied product system

The scope of the EPDs generated corresponds to “Cradle to gate with options” which servers type (b) EPD, assessing the potential environmental impacts associated with the studied product. The information module included in the study is A1-A3, A5, C1-C4, and D, no processes are omitted or excluded in this study. To be noted, A4 and B1-B7 modules are not included in this study since they are not needed for Nanping Aluminium. An overview of the life cycle stages included in the LCA study are presented in Table 6.

*Table 6. Life cycle stages included in this study*

| Life-cycle stages | Information modules | Cradle to gate with modules C1-C4 and module D | Included in this study? (2) |
|---|---|---|---|
| A1-A3 Product stage | A1 Raw material supply | Mandatory | X |
| | A2 Transport | | |
| | A3 Manufacturing | | |
| A4 and A5 Construction process stage | A4 Transport | Optional(1) | ND |
| | A5 Construction installation | Optional(1) | X |
| B Use stage | B1 Use | Optional(1) | ND |
| | B2 Maintenance | | |
| | B3 Repair | | |
| | B4 Replacement | | |
| | B5 Refurbishment | | |
| | B6 Operational energy use | | |
| | B7 Operational water use | | |
| C End of life stage | C1 Deconstruction, demolition | Mandatory | X |
| | C2 Transport | | |
| | C3 Waste processing | | |
| | C4 Disposal | | |
| D Benefits and loads beyond the system boundary | D Reuse, recovery, recycling, potential | Mandatory | X |

(1) Module A4, A5, and B1-B7 are optional in the for this EPD applied PCR, which is based on version PCR 2019:14 Construction products Version 1.3.4 [valid until: 2025-06-20], which is based on the standard EN 15804:2012+A2:2019/AC:2021 (based on EF 3.1)

(2) Modules included in the EPD (X) and the modules not declared (ND).

An overview of the studied system for the products is presented in Figure 6. The system is related to the life cycle stages included in the assessment and is further described in the Life Cycle Inventory Analysis (LCI) chapter. It should be noted that not all processes are featured in detail in the figure, which is only schematic.

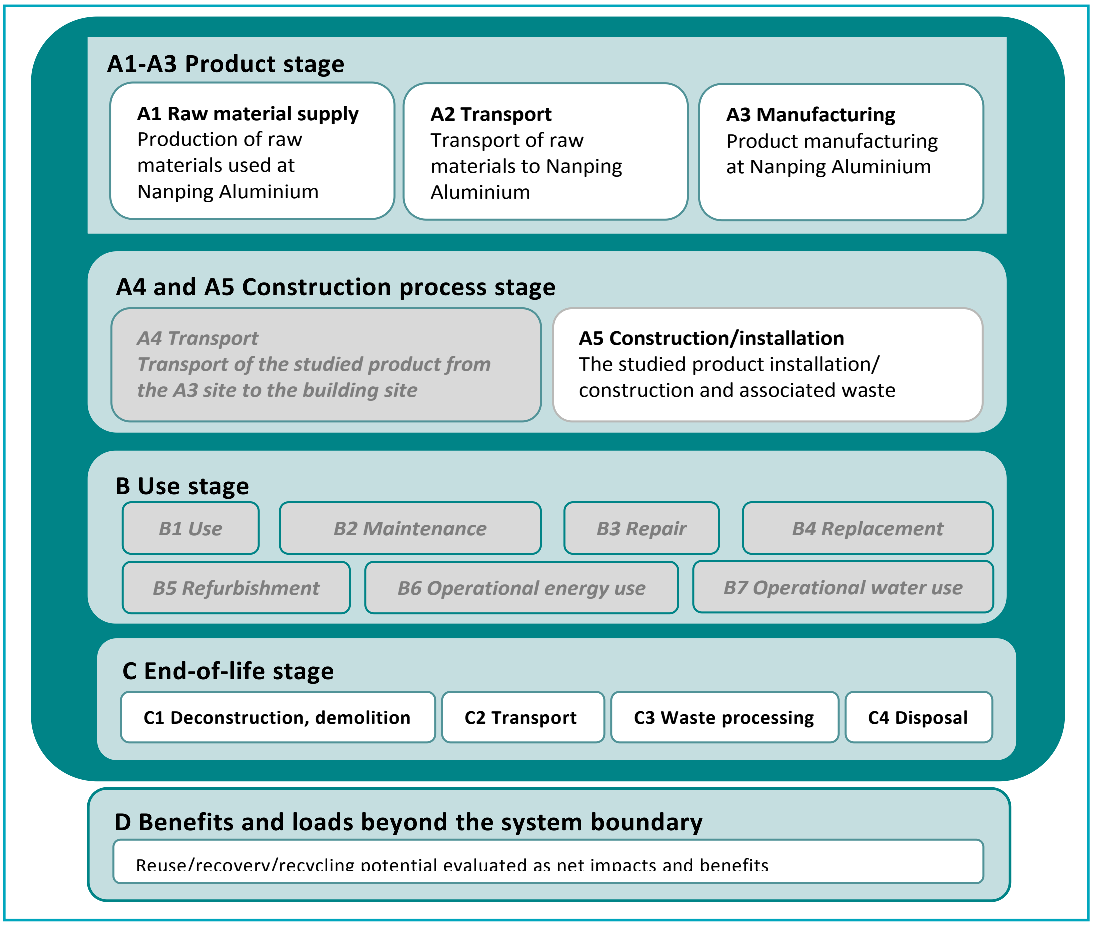


*Figure 6. Overview of the studied system in the study*

To be noted, since this study does not cover A4 and B1-B7 stages, so those stages are grey in Figure 6.

The end-of-life stage (module C) and the benefits associated with recycling (module D) are hypothetically modelled, since the studied product produced by Nanping Aluminium ends up in many different end user applications. For further details, see sections 3.5 to 3.9.

### 2.2.1 Information on the products

The products covered by the report could be divided into the following five product groups (Figure 7 and Table 7).

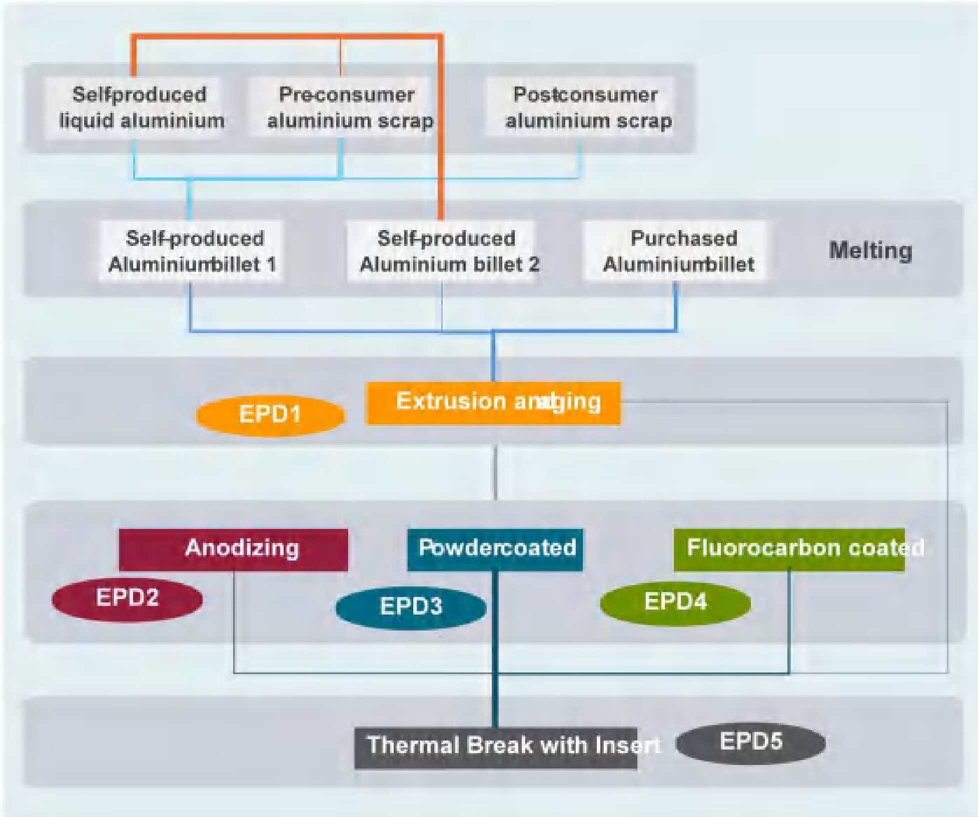


*Figure 7 Product groups*

*Table 7. Product groups*

| EPD group | EPD |
|---|---|
| Mill finished aluminium profiles. | 1 |
| Anodized aluminium profiles. | 2 |
| Fluorocarbon coated aluminium profiles. | 3 |
| Powder coated aluminium profiles. | 4 |
| Thermal barrier aluminium profiles | 5 |

## 2.2.2 Content declaration

### 2.2.2.1 Mill finished aluminium profile

This LCA servers for the EPD of multiple products, based on average results. The content of 1 000 kg mill finished aluminium profiles with its package is shown in Table 8.

*Table 8 Average content declaration of the products in the study.*

| Product components | Weight, kg/declared unit | Post-consumer material, weight-% of declared unit | Biogenic material, kg CO2 eq. declared unit |
|---|---|---|---|
| Aluminium billet | 1000.00 | 2.65% | 0.00 |
| TOTAL | 1000.00 | 2.65% | 0.00 |
| **Packaging materials** | **Weight, kg/declared unit** | **Weight-% (versus the declared unit)** | **Weight biogenic carbon, kg CO2 eq. declared unit** |
| Kraft paper | 3.50 | 0.35% | 5.65 |
| TOTAL | 3.50 | 0.35% | 5.65 |

For construction product EPD compliant with EN 15804, the content declaration shall at least declare the substances contained in the product that are listed in the "Candidate List of Substances of Very High Concern for Authorization", in case their content exceeds the limits for registration with the European Chemicals Agency (0.1% of the weight of the product). Nanping Aluminium declares that their products covered by the study do not contain substances of very high concern (SVHC) as defined and listed in the European Chemicals Agency (ECHA) Candidate List of substances of very high concern for Authorization, in levels above 0.01% by weight for the products that concern this LCA report.

#### 2.2.2.2 Anodized aluminium profile

This LCA servers for the EPD of multiple products, based on average results. The content of 1 000 kg anodized aluminium profile with its package is shown in Table 9.

*Table 9 Average content declaration of the products in the study.*

| Product components | Weight, kg/declared unit | Post-consumer material, weight-% of declared unit | Biogenic material, kg CO2 eq. per declared unit |
|---|---|---|---|
| Aluminium billet | 1000.00 | 2.91% | 0.00 |
| TOTAL | 1000.00 | 2.91% | 0.00 |
| **Packaging materials** | **Weight, kg/declared unit** | **Weight-% (versus the declared unit)** | **Weight biogenic carbon, kg CO2 eq. per declared unit.** |
| Kraft paper | 6.58 | 0.66% | 10.63 |
| PE film | 1.30 | 0.13% | 0.00 |
| PP film | 0.23 | 0.02% | 0.00 |
| PET film | 3.48 | 0.35% | 0.00 |
| PVC film | 2.28 | 0.23% | 0.00 |
| TOTAL | 13.90 | 1.39% | 10.63 |

For construction product EPD compliant with EN 15804, the content declaration shall at least declare the substances contained in the product that are listed in the "Candidate List of Substances of Very High Concern for Authorization", in case their content exceeds the limits for registration with the European Chemicals Agency (0.1% of the weight of the product). Nanping Aluminium declares that their products covered by the study do not contain substances of very high concern (SVHC) as defined and listed in the European Chemicals Agency (ECHA) Candidate List of substances of very high concern for Authorization, in levels above 0.01% by weight for the products that concern this LCA report.

#### 2.2.2.3 Fluorocarbon coated aluminium profiles

This LCA servers for the EPD of multiple products, based on average results. The content of 1 000 kg fluorocarbon coated aluminium profile with its package is shown in Table 10.

*Table 10 Average content declaration of the products in the study.*

| Product components | Weight, kg/declared unit | Post-consumer material, weight-% of declared unit | Biogenic material, kg CO2 eq. per declared unit |
|---|---|---|---|
| Aluminium billet | 924.36 | 2.45% | 0.00 |
| Fluorocarbon Paint | 46.86 | 0.00% | 0.00 |
| Organic Solvents | 28.78 | 0.00% | 0.00 |
| TOTAL | 1000.00 | 2.45% | 0.00 |
| **Packaging materials** | **Weight, kg/declared unit** | **Weight-% (versus the declared unit)** | **Weight biogenic carbon, kg CO2 eq. per declared unit.** |
| Kraft paper | 20.10 | 2.01% | 32.41 |
| PE film | 0.00 | 0.00% | 0.00 |
| TOTAL | 20.10 | 2.01% | 32.41 |

For construction product EPD compliant with EN 15804, the content declaration shall at least declare the substances contained in the product that are listed in the "Candidate List of Substances of Very High Concern for Authorization", in case their content exceeds the limits for registration with the European Chemicals Agency (0.1% of the weight of the product). Nanping Aluminium declares that their products covered by the study do not contain substances of very high concern (SVHC) as defined and listed in the European Chemicals Agency (ECHA) Candidate List of substances of very high concern for Authorization, in levels above 0.01% by weight for the products that concern this LCA report.

#### 2.2.2.4 Powder coated aluminium profile

This LCA servers for the EPD of multiple products, based on average results. The content of 1 000 kg powder coated aluminium profile with its package is shown in Table 11.

*Table 11 Post-and pre- consumer material declaration of powder coated aluminium profile*

| Product components | Weight, kg/declared unit | Post-consumer material, weight-% of declared unit | Biogenic material, kg CO2 eq. per declared unit |
|---|---|---|---|
| Aluminium billet | 963.26 | 2.55% | 0.00 |

| | | | |
|---|---|---|---|
| polyester resin | 36.74 | 0.00% | 0.00 |
| TOTAL | 1000.00 | 2.55% | 0.00 |
| **Packaging materials** | **Weight, kg/declared unit** | **Weight-% (versus the declared unit)** | **Weight biogenic carbon, kg CO2 eq. per declared unit.** |
| Kraft paper | 47.70 | 4.77% | 77.09 |
| PE film | 0.06 | 0.01% | 0.00 |
| Adhesive tape | 0.46 | 0.05% | 0.00 |
| PET film | 1.64 | 0.16% | 0.00 |
| PVC film | 18.10 | 1.81% | 0.00 |
| TOTAL | 68.00 | 6.80% | 77.09 |

For construction product EPD compliant with EN 15804, the content declaration shall at least declare the substances contained in the product that are listed in the "Candidate List of Substances of Very High Concern for Authorization", in case their content exceeds the limits for registration with the European Chemicals Agency (0.1% of the weight of the product). Nanping Aluminium declares that their products covered by the study do not contain substances of very high concern (SVHC) as defined and listed in the European Chemicals Agency (ECHA) Candidate List of substances of very high concern for Authorization, in levels above 0.01% by weight for the products that concern this LCA report.

#### 2.2.2.5 Thermal barrier aluminium profile

This LCA servers for the EPD of multiple products, based on average results. The content of 1 000 kg thermal barrier aluminium profile with its package is shown in Table 12.

*Table 12 Post-and pre- consumer material declaration of thermal barrier aluminium profile*

| Product components | Weight, kg/declared unit | Post-consumer material, weight-% of declared unit | Biogenic material, kg CO2 eq. per declared unit |
|---|---|---|---|
| Aluminium billet | 941.71 | 2.40% | 0.00 |
| Thermal insulation strip | 58.29 | 0.00% | 0.00 |
| TOTAL | 1000.00 | 2.40% | 0.00 |
| **Packaging materials** | **Weight, kg/declared unit** | **Weight-% (versus the declared unit)** | **Weight biogenic carbon, kg CO2 eq. per declared unit.** |
| Kraft paper | 35.24 | 3.52% | 56.92 |
| TOTAL | 35.24 | 3.52% | 56.92 |

### 2.2.3 Introduction for the manufacturing process

As the manufacturing process is important to understand the whole studied system, the description of the main manufacturing processes for producing the studied product is explained as below. A flow chart of product manufacturing is shown in Figure 8.

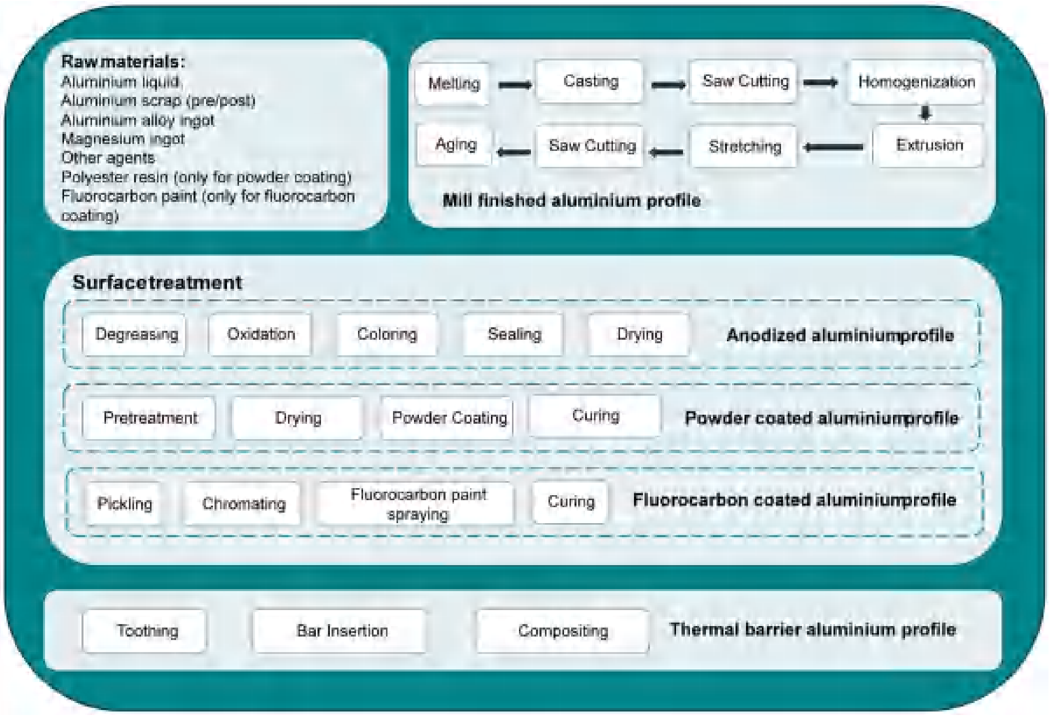


*Figure 8. The flow chart of main manufacturing processes of the studied product*

The production process at Nanping Aluminium begins with electrolytic aluminium. The produced molten aluminium, along with other aluminium scrap and self-produced alloy ingots, are charged into a melting furnace for re-melting. Through processes such as casting, sawing, and homogenization, aluminium billets are produced. Nanping Aluminium produces two kinds of aluminium billet, one of which contains 61% pre-consumer aluminium scrap and 4% post-consumer aluminium scrap, while the other type ( called electrolytic aluminium billet) is primarily made from electrolytic aluminium liquid. Nanping Aluminium also purchases aluminium billets for production. Next, the self-produced and purchased aluminium billets are extruded into profiles using moulds. After undergoing processes like stretching, straightening, and sawing, the aluminium profiles enter the aging furnace for treatment. Finally, after inspection, the finished aluminium products are either packaged as **mill finished aluminium** or sent to the next production stage. In the above production process, electricity and natural gas are primarily consumed. Wastewater and exhaust gases generated during production are treated before being discharged, while hazardous waste is either landfilled or incinerated, with the remaining waste being recycled. All industrial solid waste is fully recycled. For more details, please refer to 3.3.

For anodized aluminium profile, the mill finished aluminium is first placed into a process tank, where it undergoes a series of pre-treatment steps, including degreasing and alkaline cleaning. The material is then anodized, creating a dense aluminium oxide layer. Next, the profile enters a dyeing tank for colouring, giving the profile the desired hue. Afterward, the profile undergoes sealing to enhance the durability and strength of the oxide layer, preventing fading or contamination. Finally, the profiles are dried, packaged, and prepared for delivery to customers. During the anodizing process, electricity is consumed. The wastewater generated is treated within the factory before being discharged into the municipal pipeline system. Both hazardous waste and industrial solid waste are recycled.

For powder coated aluminium profile, mill finished aluminium first undergoes a series of pre-treatment processes, to ensure the surface is clean and free from contaminants, allowing the coating to adhere properly. The material is then dried to remove any residual moisture. Next, the profiles are sprayed with powder coating using electrostatic spraying technology, creating an even layer of powder on the surface. After coating, the profiles enter a curing oven, where the powder is heated and fused to the aluminium, forming a durable and protective layer. Finally, after a quality inspection, the profiles are packaged and stored, ready for shipment to customers. The above production process primarily consumes electricity. Wastewater and exhaust gases generated during production are treated before being discharged. Hazardous waste is incinerated, with the remaining waste being recycled. All general industrial solid waste is fully recycled. For more details, please refer to 3.3.

For fluorocarbon coated aluminium profiles, mill finished aluminium first undergoes a series of pre-treatment processes to ensure the surface is optimally prepared for coating. This includes acid cleaning, water washing, and chromating, followed by another water wash to remove any remaining impurities. The material is then dried thoroughly to ensure a clean, dry surface. Next, the aluminium profiles are coated with fluorocarbon paint and then cured to ensure the paint adheres firmly and forms a strong, protective layer. After curing, the profiles undergo quality inspection to ensure the coating is even and free from defects. Finally, after passing inspection, the aluminium profiles are packaged, stored, and prepared for shipment to customers. In the above production process, electricity and natural gas are primarily consumed. Wastewater and exhaust gases generated during production are treated before being discharged, while hazardous waste is either landfilled or incinerated, with the remaining waste being recycled. All industrial solid waste is fully recycled. For more details, please refer to 3.3.

For thermal barrier aluminium profile, a toothing process is used to create precise slots on the internal or external surfaces of the aluminium profile. Next, the insulating strips are inserted into the grooves through the inserting bar process. Finally, a rolling process is employed to firmly bond the aluminium profile and the insulating strip together, ensuring that the insulating material remains securely in place within the profile without shifting or coming loose. Through this series of precision processes, a strong physical interlock is formed between the aluminium profile and the insulating strip, ensuring that the insulation is evenly distributed throughout the profile, effectively blocking heat transfer and enhancing the thermal insulation performance of the aluminium profile. The above production process primarily consumes electricity, with no wastewater, exhaust gases, or hazardous waste generated. The waste plastic packaging from raw materials is recycled, and the waste insulating strips are incinerated.

## 2.3 Overall LCA methodology

Methodology aspects considered in this LCA, such as allocation procedures, cut-off criteria and other key assumptions, are described in this section.

### 2.3.1 System boundaries

#### 2.3.1.1 Boundaries towards nature

This LCA is a cradle-to-gate study (A1-A3 modules) with optional declared modules (A5), also covering end-of-life treatment (C1-C4 modules) and potential benefits from recycling (D module), severing for type (b) EPD. For inputs of fuels, electricity and raw materials, the cradle of the life cycle is nature. The boundary between nature and the product life cycle is crossed when the natural resources (e.g., crude oil or uranium) are extracted from the ground. The “grave” of the life cycle is:

- Soil (after human activity has ceased, and landfill gas emissions and leakage production are minimal),
- Air (e.g., emissions from combustion of fuels) or
- Water (e.g., water emissions from wastewater treatment).

#### 2.3.1.2 Boundaries within the life cycle

The production, maintenance, and after-use treatment of capital goods, such as machines, factories, etc., “overhead” activities, such as heating of buildings and lighting, and the activities of the employees are not included in the life cycle. Depending on the PCR, in general, the production and end-of-life processes of infrastructure or capital goods used in the product system should be excluded, unless there is evidence that they are relevant in terms of their environmental impact, or when a generic LCI dataset includes infrastructure/capital goods, and it is not possible, within reasonable effort, to subtract the data on infrastructure/capital goods from this dataset (directly citation from section 4.3.2 of PCR 1.3.4). In this study, the infrastructure and capital goods are not included in the LCA analysis since they are used plenty of times for several years for the product manufacturing. According to the PCR, it should be excluded.

This study assesses the production of raw materials, the production process of the products, as well as treatment of products and treatment of package at end-of-life. These processes have been modelled based on client's production technology and rules in the PCR.

Electricity production and the conversion of energy resources into fuels are included in the life cycle system. This means that emissions and natural resources demand from electricity and fuel production are included. Here, the inflows to the system are, instead of electricity, the energy resources including crude oil, coal, hydropower, and uranium etc., used for the electricity production.

#### 2.3.1.3 Temporal coverage

The reference year for this study is the calendar year 2023 (from Jan to Dec).

#### 2.3.1.4 Geographical boundaries

The study reflects production (modules A1-A3) of the studied products in Nanping city, Fujian province, China, then module A5 (disposal of package), module C, and module D are considered as the global condition.

### 2.3.2 Allocation

#### 2.3.2.1 Co-product allocation

There are 4 types of aluminium scraps used as input, in-house generated pre-consumer scrap (same production line), in-house generated pre-consumer scrap (different production line), purchased pre-consumer scrap and purchased post-consumed scrap.

For in-house generated pre-consumer scrap (same production line), as they are produced in the same production line with the products and then reintroduced into the smelter. So, this scrap can be defined as internal scrap for closed-loop recycling. According to the PCR, scrap produced and used internally in the same product system is a case of closed-loop recycling; thereby no co-products leave the product system, and no allocation shall be done (directly citation from section 4.5.5 of PCR 1.3.4).

For in-house generated pre-consumer scrap (different production line) and purchased pre-consumer scrap, since aluminium profile production is a long process, these scraps are generated at multiple production stages, making them difficult to allocate environmental impacts based on actual production conditions and prices. we used a generic dataset < Aluminium, wrought alloy {RoW}| treatment of aluminium scrap, new, at remelter | Cut-off, U> to calculate its environmental impact, with a GWP-GHG of 0.55 kg CO2eq/kg, which accounts for 33% of the environmental impact of mill finished aluminium profiles.

For post-consumer scrap, scrap directly entering the melting stage (e.g., secondary aluminium rod) has no environmental impact. For remelted liquid aluminium and recycled ingots (produced from post-consumer scrap), it is assumed that they carry the environmental impact from the remelting stage when they enter the A1-A3 stages.

#### 2.3.2.2 Allocation of waste treatment processes

Followed the PCR and EN 15804, the polluter pays principle was applied to the waste treatment processes allocation. It means that the generator of the waste carries the full environmental impact until the point in the product life cycle in which the end-of-waste criteria are fulfilled. As the data for the waste generation is collected at the workshop level, mass allocation was applied to the waste treatment process.

Details will be described in the following sections and the detailed allocation calculation is described in section 3.3.1.

#### 2.3.2.3 Thermal efficiency of incineration/combustion

This section is not applicable as 90% of the products at the end-of-life stage are recycled, and 10% are sent to landfill (C stage, see 3.7).

#### 2.3.2.4 Recycling, reuse and recovery — Module D

In this study, $M_{MR\ IN}$ including post-consumer and internal and external pre-consumer scrap. As "recycling rate" applied is assumed to be 90%, $M_{MR\ out}$ equal to 900 kg. The net flow is equal to $M_{MR\ out}$ minus $M_{MR\ IN}$, so the four types of scrap invested in the A1 stage are not accounted for in the recovery benefits at the D stageAs "Y" applied is assumed to be 1, the net flow is as Table 13. See section 3.7 for more information. Meanwhile, this study does not consider the co-product allocation in this project, so there is no co-product allocation issue for the module D calculation. Besides, the mass loss during module D is assumed to be zero.

*Table 13 Net flow calculated in module D*

| Module D | Mill finished | Anodized | Powder coated | Fluorocarbon coated | Thermal barrier |
|---|---|---|---|---|---|
| Recycled content (%) | 17.59% | 15.40% | 16.94% | 16.26% | 15.91% |
| Net flow (kg) | 741.68 | 761.42 | 747.50 | 753.66 | 756.78 |

### 2.3.3 Cut-off criteria

The cut-off criteria established by the PCR is that data for elementary flows to and from the product system contributing to a minimum of 95% of the declared environmental impacts shall be included (not including processes that are explicitly outside the system boundary). No cut-off for the studied product has been applied in the study.

## 2.4 Data quality and representativeness

The type of data used to model the system may affect the relevance, reliability and accessibility of any LCA study. Relevance of the data is how the data represents what it is supposed to represent. The different aspects of relevance can be for instance temporal, geographical and technological representativeness, as well as completeness of the data. Reliability deals with the precision of the data, while accessibility deals with the ability to review and reuse the data. Depending on the PRC and EN15804, as a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice as a basis for calculating an EPD. This LCA analysis fully meets the requirement in section 6.3.8 of EN15804.

Concerning the relevance of the data in the study, most data used in A1-A3 modules were collected from Nanping Aluminium. The specific data (also refered to as primary data) has been sourced through close cooperation with relevant functions at Nanping Aluminium within their manufacturing processes, taken from material statement. Data relevant to the production are average values for the prodction situation in year 2023 (from Jan. to Dec.). Nanping Aluminium treats air emission to meet the requirements of dischareging after treatment. Nanping Aluminium also has wastewater generation during the manufacturing processes. The unpolluted waste water such as water used for cooling is directly discharged into the sewage pipe network. The polluted wastewater is treated in Nanping Aluminium's factory wastewater treatment plant and that is included in the study.

For hazardous wastes, most of them were sent to third parties for treatment, except for hydraulic oil from the extrusion process, which was recycled by Nanping Aluminium itself. Specifically, aluminium dross and dust residues from melting were landfilled, and waste air filter was incinerated. Alkali slag from the extrusion process and coloured precipitation slag from the anodizing process were recycled. Waste polyester resin and waste slag from the powder coating process were incinerated. For the fluorocarbon coating process, surface treatment waste residues and chrome slag were landfilled, paint sludge and waste activated carbon were incinerated, and waste iron barrels and plastic barrels were sent for recycling.

All industrial wastes were sent to third parties for recycling. So, the waste treatment of the waste generated during the manufacturing process was included in the system boundary. The amount of air emissions, wastewater, and solid waste data were sourced from the yearly environmental evaluation report, third party evaluation report, and Nanping's monthly waste report.

With regard to the A5 stage, since the application of the product is varied, often requiring manual installation, and Nanping Aluminium can not provide supporting information for consumed energy and materials, it is assumed that installation is performed manually. Thus, there is no input of energy or materials required during the construction stage. However, since the packaging contains biogenic carbon, depending on the recommendation of the PCR, it is assumed that the packagings become to waste in this stage and is treated to end-of-life stage. In this case, the packagings, including kraft paper, PE plastic film, PP plastic film, adhesive tape, PET plastic film and PVC plastic film, are assumed to be incinerated by third party, with a transportation of 100 km by truck. Also, the balance of biogenic carbon dioxide is considered in this stage.

The modelling of the C1 module is assumed that the consumption of additional materials and energy used in the deconstruction stage for installation is zero since the aluminium profiles feature a wide range of applications. After C1, it is assumed that 10% of the product would be sent to C4 for disposal, and 90% of aluminium for recycling according to the International Aluminium Institute's data (the supporting material is listed in Appendix F:). For the C2 module, the assumption has been made that all waste products would be transported for 100 km by truck. For the waste processing C3 module, disposal C4 module, and D module (benefits and loads beyond the system boundary), the generic data has been applied. In detail, none of the waste product are assumed to be lost during the processing in C3 and D. To to noted, for the end-of-waste, the scenario is set based on the relevant research and expert experience of the client and IVL, which could be represented for the studied product. Details are shown in section 3.5 to section 3.9.

It should be noted that for all other life cycle stages beyond A3, the scenarios included are currently in use and are representative for one of the most probable alternatives.

Most of the generic data (sometimes refered to as "secondary data") are extracted from Ecoinvent 3.9.1 and are valid until 2022, which means the time representative of the datasets is very good.

Examples where specific data has been used in this study are:

- A2 Transportation data (e.g., distance and vehicle type) of raw material to manufacture and packaging to the client's factory.
- A3 Manufacturing process for producing products, e.g., energy use, material use, environmental emissions, and waste disposal.

Examples where generic data have been used in this study are:

- Datasets used for calculating the environmental impacts of upstream raw materials, and auxiliary materials for manufacturing, from ecoinvent database.
- Energy production data, such as power grid mix information and diesel production data.
- Transport processes of the waste package and waste product.
- End-of-waste processes for packaging materials and waste product.

An overview of the data collection and the data sources information are presented in Table 14.

*Table 15. Overview of the data collection activity and data source information*

| Modules | Data collection activity of the main sections | Data source information |
|---|---|---|

| | | |
|---|---|---|
| A1 | Extraction and transportation of resource; Material and energy input to produce raw materials, parts, semi-products, and auxiliaries of the product | Ecoinvent 3.9.1 database, Nanping Aluminium |
| A2 | Transportation (distance and type of transportation) of main parts and components to Nanping Aluminium | Nanping Aluminium |
| A3 | Material and energy input for the product assemble; waste generation through the manufacturing | Nanping Aluminium |
| A4 | Transportation from the manufacturing factory to clients (distance and type of transportation) | Not declared |
| A5 | The input of material and energy during construction and associated waste | Assumption |
| B1-B7 | The inputs of materials and energy for installation, maintenance, repair, replacement, refurbishment. | Not declared |
| C1 | The input of material and energy during deconstruction of the product | Assumption |
| C2 | Transport of the deconstruction waste comprising the end-of-life construction product to waste processing facility or to final disposal | Assumption |
| C3 | Waste processing operations for reuse, recovery or recycling | Assumption |
| C4 | Final disposal of end-of-life construction product | Assumption |

As for the reliability of the data, it is always uncertain but as the data for the manufacturing processes and transportation have been collected from the production sites, the data have been measured and verified internally. The data are assumed to be the most relevant according to current conditions and production practices. Finally, the study is sufficiently accessible and reproducible since all the data used, assumptions made, and datasets applied can be found in this report and in the SimaPro LCA models for the third-party verifier to review.

Besides, a data quality assessment is included in the study (details is shown in the section 6.3), based on EN15804 Annex E Table E-1 (Data quality level and criteria of the UN Environment Global Guidance on LCA database development).

## 2.5 Life cycle impact assessment

This LCA used the EN15804+A2:2019/AC:2021 as the calculation method (EF package 3.1). The environmental indicators describing environmental impacts according to EN15804+A2:2019/AC:2021 and the requirement of the international system is listed in the Appendix C: Life cycle impact assessment indicators. The result of the study covers all environmental impacts according to EN15804+A2:2019/AC:2021 as well as the resource use, waste, output flows and additional mandatory impact category indicators of the PCR.

SimaPro (version 9.6.0.1) supports for the environmental impacts' calculation. The results were categorised according to the PCR rules, which state in separate different life cycle modules.

## 2.6 Main assumptions and exclusions

All assumptions involved in this study are listed below:

- A5: Since only the waste package treatment is considered, in another word, it is assumed that the consumption of additional materials and energy use in construction stage for installation is zero. Also, the assumption has been made that all waste packages would be transported for 100 km by truck. Besides, all waste packages are assumed to be incinerated for final disposal without any reuse nor recycle as the conservative consideration.
- C1: The consumption of additional materials and energy use in deconstruction stage for installation is zero. The 10% of the rest of the waste product would be sent to C4 for disposal, and 90% of aluminium to recycling depending on the International Aluminium Institute's data.
- C2: The waste product would be transported for 100 km by truck.
- C3: The waste processing for C3 have no mass loss.
- C4: The waste product is assumed landfilled.
- D: None of the waste product entered in module D is assumed to be lost during the processing.

The scenarios for A5, C and D modules are currently in use and are representative for one of the most probable alternatives.

The main exclusion of the study is outbound transportation stage (A4) and the whole use stage (B1-B7) are excluded from the analysis.

## 2.7 Critical review procedure

Matt Fishwick has performed an independent external critical review of this report in order to ensure that the following criteria are met:

- The methods used to carry out the LCA are consistent with the ISO 14044:2006 standard and in line with the PCR.
- The methods used to carry out the LCA are scientifically and technically valid.

- The data used are appropriate and reasonable in relation to the goal of the study.
- The interpretations reflect the limitations identified and the goal of the study.
- The study report is transparent and consistent.

The critical review statement is presented in Appendix A: Critical review statement.

# 3 Life cycle inventory analysis (LCIA)

This LCA study follows an attributional approach. The life cycle inventories generated for the studied product are compiled from the inputs and outputs of the component processes. All environmentally relevant flows of energy and materials crossing the system boundaries have been accounted for (e.g., energy, material resources, wastes and emissions). These flows are recorded for each unit process and summarised across the entire product life cycle.

The life cycle inventory analysis describes the data collection in terms of material composition of the primary components, site specific data, database data used as well as other information such as statistics on which the study is based.

Each of the data collection activities is briefly described in the data collection part of Chapter 2.4 and more details can be found in the background files. There is therefore a reference to each of these files and folders in the description below.

A summary of most of the data can also be found in the files: "Masterbook of NP Aluminium Profile" and "Masterbook of NP Thermal barrier aluminium profile". This files were used to aggregate all data information for Simapro modelling in terms of all life cycle stages of the studied products' lifetime.

## 3.1 A1 Raw material production

The main raw materials used in the production are liquid aluminium, pre-consumer and post-consumer aluminium scrap, magnesium ingots, outsourced aluminium billets, and other alloy additives. For fluorocarbon coated aluminium profile, toluene and fluorocarbon paint and other organic solutions are also required. For powder coated aluminium profile, polyester resin is needed. For barrier aluminium profile, thermal insulation strip is needed. Nanping Aluminium produced liquid aluminium and aluminium alloys to manufacture aluminium billets. Additionally, Nanping Aluminium also purchases billets to produce further aluminium profiles. In principle, all datasets used in this study are from ecoinvent 3.9.1 database to keep the consistency. Datasets information for the raw material input of the studied product can be found in "Masterbook of NP Aluminium Profile", "Masterbook of NP liquid aluminium", "Masterbook of NP alloy ingot" and "Masterbook of NP Thermal barrier aluminium profile".

The basic dataset selection for aluminium billet is < Aluminium, primary, cast alloy slab from continuous casting {ROW}| aluminium production, primary, cast alloy slab from continuous casting | Cut-off, U >. Since the aluminium electrolytic billet produced is also produced in Nanping city, Fujian province and the outsource aluminium billet is from Xinjiang city, northwest district of China, the datasets of them electricity were replaced by Fujian electricity and Xinjiang electricity respectively. Additionally, since the raw materials for remelted aluminium liquid and recycled aluminium ingots were post-consumer aluminium scrap from Nanping city, the dataset was made by excluding the aluminium ingot data from the < Aluminium production, primary, ingot {CN}|aluminium production, primary, ingot |Cut-off, U> and the dataset for electricity has been replaced by Fujian electricity.

Overall, the dataset selection for raw material has a certain technical representativeness.

## 3.2 A2 Raw material transport

The transporation data (e.g., type of transportation, distance, load capacity, etc. ) of product's raw materials and packaging is collected according to the information provided by Nanping Aluminium. Details can be found in "Masterbook of NP Aluminium Profile", "Masterbook of NP liquid aluminium", "Masterbook of NP alloy ingot" and "Masterbook of NP Thermal barrier aluminium profile".

## 3.3 A3 manufactruing

### 3.3.1 Specific data on process yields

Raw material inputs, energy consumption, auxiliary material usage, and waste generation are all collected directly from the factory. The material and energy flows and other detailed data information can be found in the Masterbooks. To be note, the data for the auxiliary material consumption, energy use, and the waste generation is collected at the workshop level. In this case, the consumption and emission of one declare unit is calculated based on the production ratios. For example, the annual yield rate of the anodized aluminium profile (average) is 100% of the workshop, the electricity consumption per declared unit is calculated by dividing the total electricity usage by the total output of anodized aluminium profiles. The allocation on auxiliary materials and waste generation is considered as the same logic.

The dataset of electricity represents region-specific electricity supply for final consumers, including electricity own consumption, transmission/distribution losses of electricity supply and electricity imports from neighbouring provinces.

China is relatively large, and the electricity generation structure varies from province to province, so the electricity data for China requires the use of a sub-national electricity mix according to the PCR requirements. Therefore, the electricity datasets used is from the ecoinvent (3.9.1) Databases based on sub-national electricity grid composition from the *China electric power yearbook 2022*. To be noted, in China, all kinds of electricity are collected into the gird and then sent to the user side, thus, residual mix of electricity is not appliable in China. There is no trade of electricity, thus, the residual mix in China is identical to the consumption mix.

Since the studied product were produced in Fujian province, the power structure of Fujian from the *China electric power yearbook 2022* is used. The composition of the electricity consumption mix of Fujian is shown in Table 15. And based on this ratio, the various types of electricity generation sources in China in the database has been combined to simulate the electricity mix of the province. The GWP-GHG of electricity mix for Fujian province in this study is 0.622 kg $CO_2$ eq./kWh. Detailed information can be found in " Masterbook of NP Aluminium Profile" and "Masterbook of NP Thermal barrier aluminium profile".

*Table 15 Electricity structure of Fujian province*

| Electricity generation sources | Percentage |
|---|---|
| CN, hard coal[1] | 58.1% |
| CN-FJ, hydro | 9.3% |
| CN-FJ, nuclear | 26.5% |
| CN-FJ, wind | 5.2% |
| CN-FJ, photovoltaic | 0.9% |

(1) In the 2022 China Electricity Yearbook, the percentage of electricity from fossil fuel for each province is not specified. A brief description of electricity from fossil fuel for the whole country is given in the yearbook, i.e. it covers coal, gas, oil, biomass, and a small amount of unidentified sources for generating electricity. Based on the information in the yearbook, i.e., electricity from hard coal accounts for more than 80% of the thermal power generation types, and considering that China is a country where coal-fired power generation is the main source of thermal power generation, the LCA practitioner (IVL) decide to use electricity from hard coal as 100% of the dataset selection for electricity from fossil fuel in this study for modelling.

### 3.3.2 Packaging materials

The packaging materials consists of kraft paper, PE plastic film, PP plastic film, PET plastic film, PVC plastic film and adhesive tape. The amount and the datasets of packaging materials for these aluminium profiles can be found in "Masterbook of NP Aluminium Profile", and "Masterbook of NP Thermal barrier aluminium profile". When assembling the packaging and use it to pack the final product, there is no energy consumption nor emission generation

### 3.3.3 End-of-life treatment of waste from the manufacturing processes

As described in section 2.4, the studied products have some waste generation during the manufacturing processes. The values for gas emission and wastewater in the factory are those that have been treated in the factory, and the materials used for the gas and wastewater treatment have been counted and calculated as auxiliary materials. After the treatment, the gases are emitted directly to the atmosphere. The wastewater is discharged into the municipal pipeline system after internal treatment within the plant. Most of hazardous waste are sent for treatment and all industrial waste are sent to third parties for recycling.

According to the requirements of PCR, the scope of this study on the treatment of waste generated from manufacturing process covers the treatment of wastewater after entering the wastewater treatment plant, as well as the transportation of hazardous waste and general industrial solid waste and the subsequent incineration and/or landfill and does not take into account the benefit brought by incineration or landfill. For waste sent to third party companies for reuse or recycle, this study only covers the environmental impacts of transport from the manufacturing plant to the third-party company and does not consider the environmental burden of the recycle process since it is out of the system boundary.

Some of the waste is recycled and used in the factory, so there is no consideration of transport and the environmental burden.

The transport information for sending the wastes to the third-party companies and the waste treatment process dataset selection can be found in "Masterbook of NP Aluminium Profile", and "Masterbook of NP Thermal barrier aluminium profile".

## 3.4 A5 Construction

As mentioned in section 2.4, A5 is included in the study is to calculate the environmental burden from the waste packaging and balance the biogenic carbon of the package. The waste treatment of those waste package is seen to be conducted locally, i.e., in the country and/or city constructing the product. All waste package is seen to be incinerated. Since the application of the product is varied, often requiring manual installation, and Nanping Aluminium cannot provide supporting information, it is assumed that there are no consumables or energy consumption for constructing the product and no mass loss of the product during the construction stage. Besides Waste transportation of the waste is considered in this LCA analysis. However, because the client producer lacks detailed information of this stage, the distance is assumed as 100 km for transporting the waste. Details can be found in "Masterbook of NP Aluminium Profile", and "Masterbook of NP Thermal barrier aluminium profile".

## 3.5 C1 Deconstruction

During the deconstruction phase, according to Nanping Aluminium, most of the construction aluminium profiles are dismantled manually and the majority of the construction waste aluminium is recycled. Thus, it is assumed no consumables or energy consumption during deconstruction, see section 2.4, so the environmental impact of the deconstruction stage is deemed to be zero.

## 3.6 C2 Transportation for the waste product

Waste transportation of all waste product is considered in this LCA analysis. However, because the Nanping Aluminium lacks detailed information of this stage, the distance is assumed as 100 km for transporting all waste products. Relevant data can be found in "Masterbook of NP Aluminium Profile", and "Masterbook of NP Thermal barrier aluminium profile".

## 3.7 C3 Waste processing

A recycling rate of 90% has been assumed for the aluminium product. That is to be seen as the proportion of the material in the product that will be recycled (or re-used) in a subsequent system. The recycling rate referring to the output of the recycling plant and all the material losses through the lifecycle have been taken into account, including material losses in the collection, sorting and recycling (or re-use) processes up to the point of final substitution. The scenario results in 10% material losses in total, considered as landfilled aluminium scrap.

According to the EN 15804 the modelling will be done like this: The "recycling rate" applied is assumed to be 90% and is considered after module C i.e. the amount of aluminium going from module C to module D is 0.9 kg. Due to no loss in the waste processing (C3) the amount of aluminium entering this process is 0.9 kg. The total amount to disposal (C4) is 0.1 kg, directly from deconstruction. According to the PCR, only the net flow leaving the product system should be considered, meaning that the recycled content input in product production must be deducted. Therefore, although the rest of waste product which is recycled could have the benefits, the recycled content in the aluminium profiles—comprising both pre- and post-consumer aluminium(see Table 16)—should not be counted towards these benefits. After excluding the recycled content from aluminium scrap, the final mass for aluminium profiles that can be credited in module D can be found in Table 16. This is also illustrated in Figure 9.

*Table 16 Module D Calculation*

| Module D | Mill finished | Anodized | Powder coated | Fluorocarbon coated | Thermal barrier |
|---|---|---|---|---|---|
| Recycled content (%) | 17.59% | 15.40% | 16.94% | 16.26% | 15.91% |
| Final mass(kg) | 741.68 | 761.42 | 747.50 | 753.66 | 756.78 |

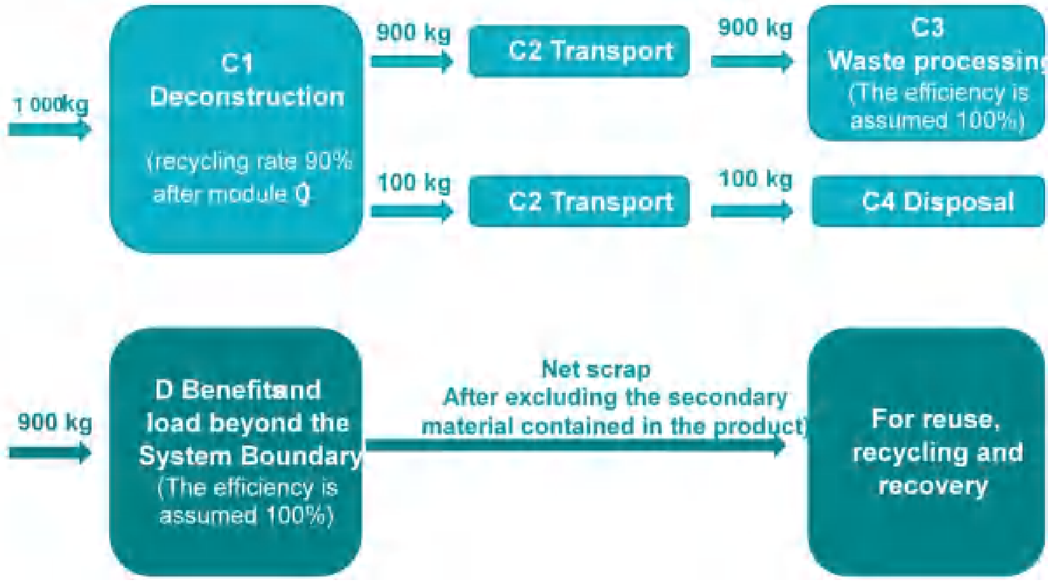


*Figure 9 End-of-life illustration for the studied products*

## 3.8 C4 Disposal

The recyclable aluminium profile waste is out of system boundary when it is transported to the recycling centre. However, the left 100 kg of waste product needed to be handled until it gets the end-of-life stage. In the study, landfill is the final disposal of these 10% of waste product and corresponding impact were calculated. Relevant data can be found in "Masterbook of NP Aluminium Profile", and "Masterbook of NP Thermal barrier aluminium profile".

## 3.9 D Benefits beyond the System Boundary

Module D corresponds to future, reuse, recycling or energy recovery potentials, which are quantified benefits and loads beyond the system boundary. This means that the potential benefits associated with the recycling of the aluminium used in a aluminium application is quantified. In this study, the result of module D already considered to remove the benefits from this part of the recycled content to follow the requirement of the PCR and EN15804.

As mentioned in the previous section, 90% of the aluminium application is assumed to be recycled after the deconstruction. This part of the product could be considered in module D depending on the PCR. The assumption of the recycling rate done in this study is considered reasonable depending on the International Aluminium Institute's statistic. The benefit (credit) could be generated through applying the waste produce to replace the new one. For the studied product, it could be seen as the aluminium scrap after deconstruction. After sorting and cleaning, it can be added to the production of new aluminium products, replacing the raw aluminium ingots. The final mass for mill finished, anodized, powder coated, fluorocarbon coated, and thermal barrier aluminium profiles that can be credited in module D is 741.68 kg, 761.42 kg, 747.50 kg, 753.66 kg, and 756.78 kg respectively.

# 4 LCA Modelling

## 4.1 Overview of the model

Modelling of the product was corresponding with the PCR and EN15804 and this study covers A1-A3, A5, C1-C4, and D. The screenshots of the model of anodized, fluorocarbon coated, or powder coated aluminium profiles in the software are shown in Figure 10, Figure 11, Figure 12, Figure 13 ,and Figure 14, separately.

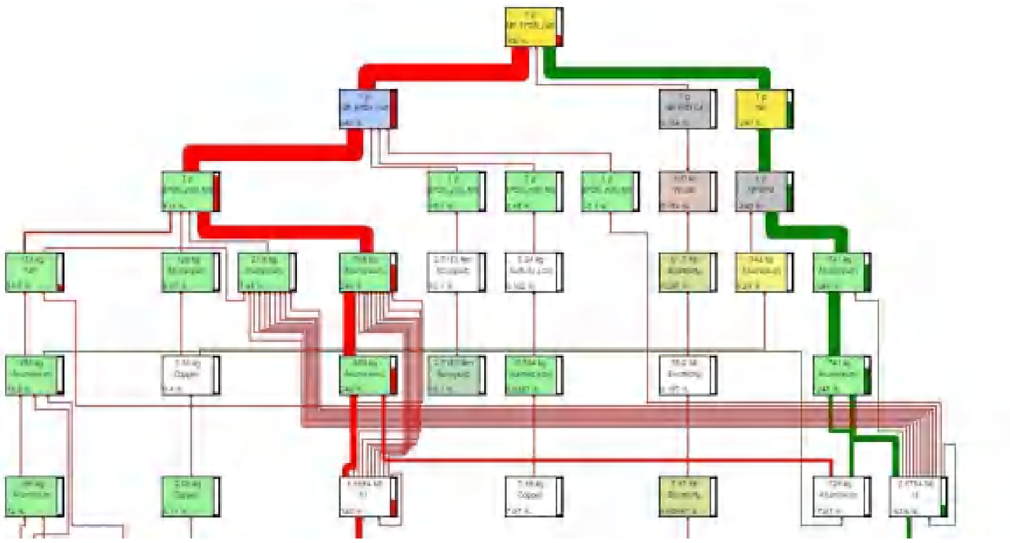

*Figure 10 The main plan of overall modelling of the mill finished aluminium profile product*

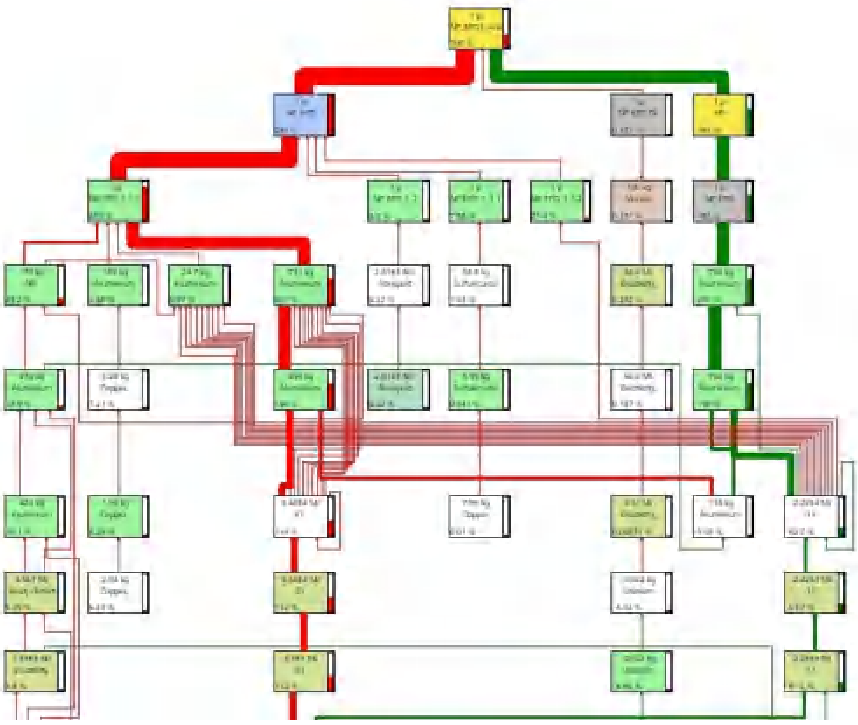

*Figure 11 The main plan of overall modelling of the anodize aluminium profile product*

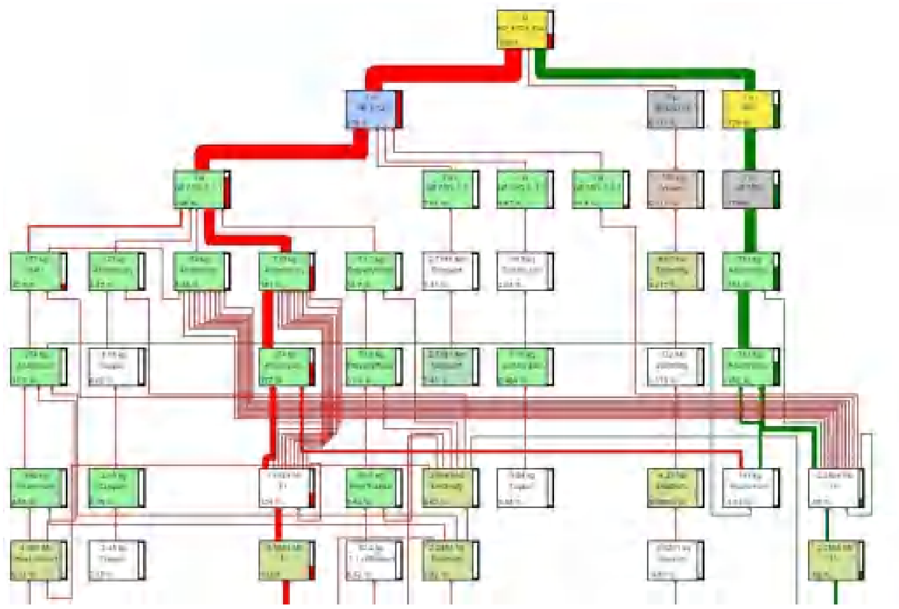

*Figure 12 The main plan of overall modelling of the fluorocarbon coated aluminium profile product*

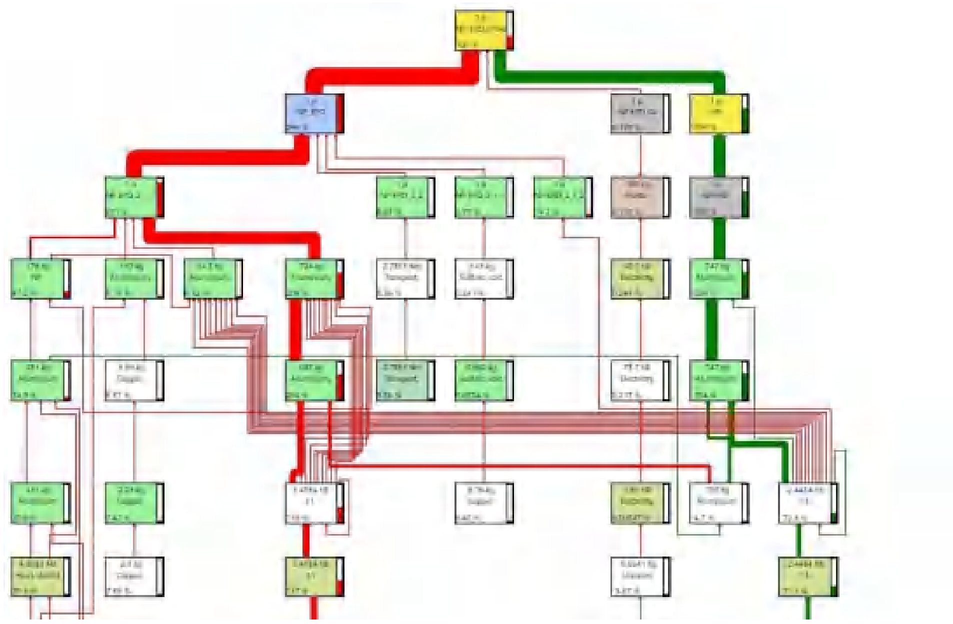

*Figure 13 The main plan of overall modelling of powder coated aluminium profile product*

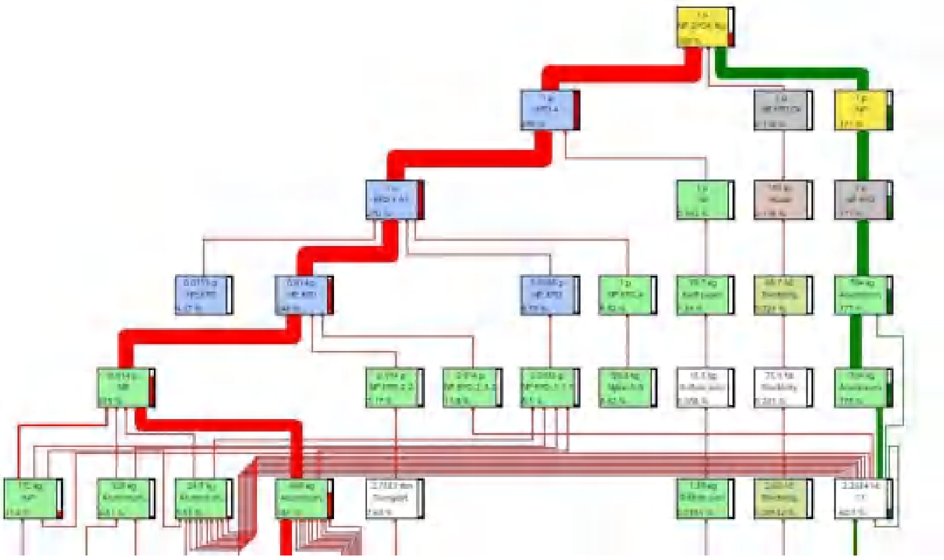

*Figure 14 The main plan of overall modelling of thermal barrier aluminium profile product*

## 4.2 Adjusting the GWP-biogenic for the model

According to the PCR and EN 15804, the GWP-biogenic result needs to be balanced for the construction product during the whole LCA. The suggested method is listed in the Table 17. This study fully considered the GWP-biogenic of the studied product and applied the GWP-biogenic correction when building the LCA model. This section will describe the GWP-biogenic correction method used in the LCA model. Here are two categories for adjusting the GWP-biogenic $CO_2$.

***Table 17 Example for illustrating the calculation of GWP-biogenic results (unit is CO2 equivalents), directly cited from the PCR (page 43).***

| | | A1-A2 | A3 | C1-C2 | C3 | Sum A-C | Comment |
|---|---|---|---|---|---|---|---|
| Row 1 | GWP-biogenic (CO, $CH_4$ etc.) | 2 | 1 | 0.5 | 2 | 5.5 | Result from LCA tool |
| Row 2 | GWP-biogenic ($CO_2$ for non-product/packaging content) | 0 | 0 ~~200~~ | 0 ~~5~~ | 0 | 0 ~~206~~ | Result from LCA tool |
| Row 3 | GWP-biogenic (product or packaging content as $CO_2$) | -715 | | | 715 | | Manually added |
| Row 4 | **GWP-biogenic (as reported in the EPD)[38]** | **-713** | **1** | **0.5** | **717** | **5.5** | Calculated |

(1) Adjusting the GWP-biogenic $CO_2$ for the product and package

The raw materials of the product do not contain biogenic content, so no carbon intake in A1 and then no needs for the correction in C4.

In the packaging of aluminium profiles, each kg of kraft paper stores 0.44 kg of biogenic carbon. These packaging materials have the negative values of GWP-biogenic $CO_2$. The amount of kraft paper used for one declared aluminium profile and corresponding biogenic CO2 emission in the A5 module is shown in Table 18.

***Table 18 Adjusting the GWP-biogenic CO2 for package***

| Aluminium porfile | Mill finished | Anodized | Powder coated | Fluorocarbon coated | Thermal barrier |
|---|---|---|---|---|---|
| kraft paper used for one declared unit (kg) | 3.50 | 6.58 | 47.72 | 20.07 | 35.24 |
| biogenic CO2 emission in the A5 module | 5.65 | 10.63 | 77.09 | 32.41 | 56.92 |

(2) Adjusting the GWP-biogenic $CO_2$ for the non-product/packaging content

Depending on the PCR, the GWP-biogenic carbon dioxide for the non-product/packaging content should be adjusted to zero. Therefore, in the model, the emission factor of GWP-biogenic for A2, A3, A4, A5, and C2 stages are set to zero. The negative values of GWP-biogenic mainly comes from the energy use since many energy resources is mixed with some bioenergy, which may be extracted from plants with the negative values of GWP-biogenic. For example, diesel used for the transportation has the negative values of GWP-biogenic.

After all those bio-carbon adjustments, the bio-carbon is balanced in the model and have the more reasonable value which is corresponded to the PCR and EN15804.

# 5 Results

This LCA analysis applied the EN 15084 as the calculation method. The EN 15804 is the EPD standard for the sustainability of construction works and services. This standard harmonizes the structure for EPDs in the construction sector, making the information transparent and comparable. First published in 2012, it is formally known as the EN 15804+A1 "Sustainability of construction works - Environmental product declarations – Core rules for the product category of construction products". In 2019, a second version of the standard was updated, called EN 15804+A2, which is currently in use more general. According to the General Programme Instructions of the International EPD System, one of the fundamental methodologies of the PCR development is EN15804. Thus, this LCA analysis applied the EN 15804 as the calculation methodology. All results in this LCA analysis are calculated by the EN 15804+A2. The "EN 15804 reference package" is calculated based on EF 3.1.

The results for each impact category assessed in this LCA study are described in detail in the following sections. The product's environment-influential categories are listed as the requirement of the International EPD system. In addition, a supplementary indicator for climate impact (GWP-GHG) is reported. This indicator includes all greenhouse gases excluding biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product as defined by IPCC AR 6 (IPCC 2021). 38 categories are mentioned in the result table of whole stages.

The results are categorised into the following modules: "A1-A3 Manufacturing (A1-A3), including raw materials, auxiliaries as well as the product packaging production, transportation and the manufacturing of the product"; "A5 Construction/installation (A5)", "C1 Deconstruction (C1)", "C2 Transportation

(C2)", "C3 Waste processing (C3)", "C4 Disposal (C4)", "D Benefits beyond the System Boundary (D)".

In addition, depending on the requirement of the PCR, benefits and loads beyond the system boundary of the studied product is analysed in the study, reported as module D (namely "D Benefits") in the following the result table.

The detailed results are shown in: "Result Analysis". The table of main results and figures of main environmental indicators are shown in the following pages. The result is calculated by SimaPro mainly.

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

In the result tables below, results of the environmental impact indicators including Abiotic depletion potential for non-fossil resources (ADP-minerals & metals), Abiotic depletion potential for fossil resources (ADP-fossil), Water (user) deprivation potential, deprivation-weighted, water consumption (WDP) shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

## 5.1 Mill finished aluminium profile

### 5.1.1 Average results

*Table 20 The overall result of the mill finished aluminium profile per declared unit.*

| [illegible] | A1-A3 | [illegible] | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| 1. Environmental impact indicators | | | | | | | |
| 00 Global warming potential (GWP-GHG) [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 01 EN15804+A2 Climate Change - total [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Climate Change, fossil [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Climate Change, biogenic [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Climate Change, land use and land use change [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Ozone depletion [kg CFC-11 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Acidification [Mole of H+ eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Eutrophication, freshwater [kg P eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Eutrophication, marine [kg N eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 09 EN15804+A2 Eutrophication, terrestrial [Mole of N eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 10 EN15804+A2 Photochemical ozone formation, human health [kg NMVOC eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 11 EN15804+A2 Resource use, mineral and metals [kg Sb eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 12 EN15804+A2 Resource use, fossils [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 13 EN15804+A2 Water use [m³ world equiv.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2. Resource use indicators | | | | | | | |
| 01 EN15804+A2 Use of renewable primary energy (PERE) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Primary energy resources used as raw materials (PERM) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Total use of renewable primary energy resources (PERT) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Use of non-renewable primary energy (PENRE) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Non-renewable primary energy resources used as raw materials (PENRM) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Total use of non-renewable primary energy resources (PENRT) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Input of secondary material (SM) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Use of renewable secondary fuels (RSF) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 09 EN15804+A2 Use of non renewable secondary fuels (NRSF) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 10 EN15804+A2 Use of net fresh water (FW) [m3] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 3. Output flows and waste categories | | | | | | | |
| 01 EN15804+A2 Hazardous waste disposed (HWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Non-hazardous waste disposed (NHWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Radioactive waste disposed (RWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Components for re-use (CRU) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Materials for Recycling (MFR) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Material for Energy Recovery (MER) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Exported electrical energy (EEE) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Exported thermal energy (EET) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 4. Optional indicators | | | | | | | |
| A1b_01 EN15804+A2 Respiratory inorganics [Disease incidence] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A1b_02 EN15804+A2 Ionising radiation - human health [kBq U235 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A1b_03 EN15804+A2 Ecotoxicity (freshwater) [CTUe] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A1b_[illegible] 04 EN15804+A2 Cancer human health effects [CTUh] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A1b_05 EN15804+A2 Non-cancer human health effects [CTUh] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A1b_06 EN15804+A2 Land Use [Pt] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

To be noted, option A from annex 3 of the PCR is chosen to separate the use of primary energy into energy used as raw material and energy used as energy carrier.

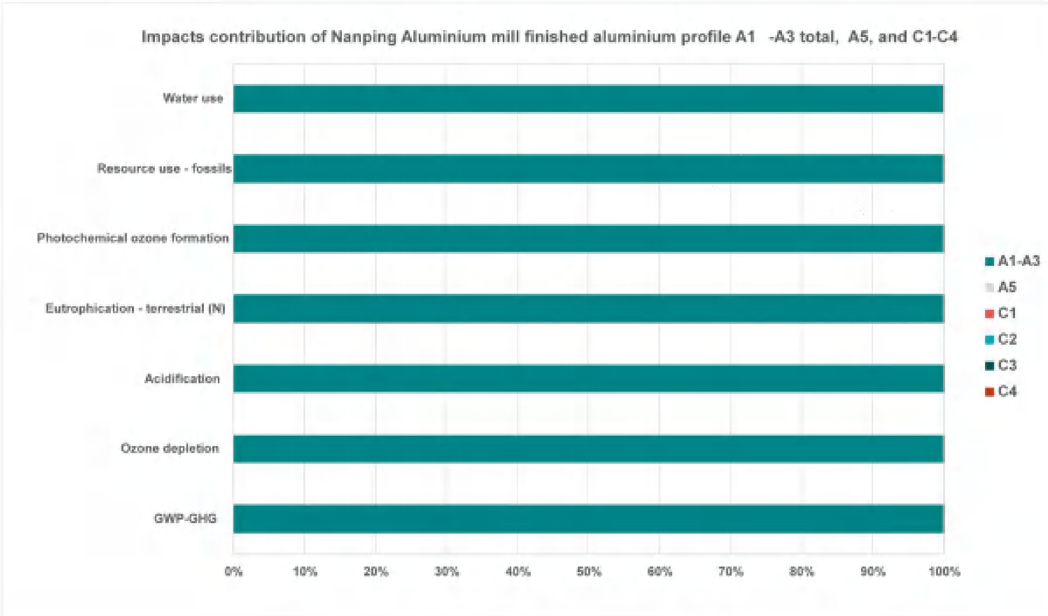


*Figure 15 The environmental impacts distribution of mill finished aluminium profile every module in the relevant life cycle. Results are shown the proportion of impacts at different life modules per declared unit*

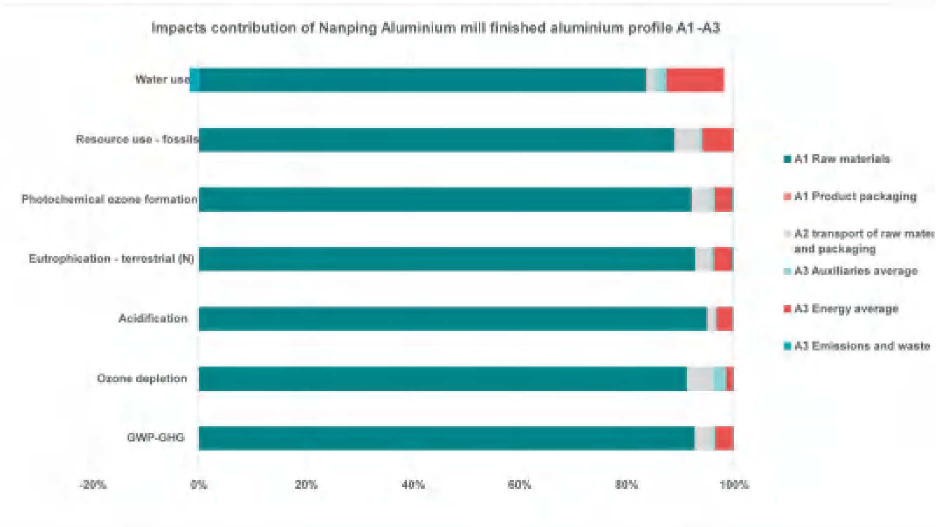


*Figure 16 The environmental impacts distribution of mill finished aluminium profile in A1 to A3. Results are shown the proportion of impacts at different life modules per declared unit.*

## 5.1.2 Information table for EPD

*Table 21. Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results)*

| | Product stage | | | Construction process stage | | Use stage | | | | | | | End of life stage | | | | Resource recovery stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Waste processing | Disposal | Reuse-Recovery-Recycling-potential |
| **Module** | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** |
| Modules declared | X | X | X | ND | X | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | CN | CN | CN | - | GLO | - | - | - | - | - | - | - | GLO | GLO | GLO | GLO | GLO |
| Specific data used | 21.92% | | | | | | | | | | | | | | | | |
| Variation – products | <10% | | | | | | | | | | | | | | | | |
| Variation – sites | 0% | | | | | | | | | | | | | | | | |

(1) Modules included in the EPD (X) and the modules not declared (ND).

# 5.2 Anodized aluminium profile

## 5.2.1 Average result

*Table 22. The overall result of the anodized aluminium profile per declared unit.*

| | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| 1. Environmental impact indicators | | | | | | | |
| 00 Global warming potential (GWP-GHG) [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | 6.94E+00 | [illegible] |
| 01 EN15804+A2 Climate Change - total [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 6.94E+00 | [illegible] |
| 02 EN15804+A2 Climate Change, fossil [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Climate Change, biogenic [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Climate Change, land use and land use change [kg CO2 eq.] | 4.21E-00 | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Ozone depletion [kg CFC-11 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | -1.30E-04 |
| 06 EN15804+A2 Acidification [Mole of H+ eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Eutrophication, freshwater [kg P eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Eutrophication, marine [kg N eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 09 EN15804+A2 Eutrophication, terrestrial [Mole of N eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 10 EN15804+A2 Photochemical ozone formation, human health [kg NMVOC eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 11 EN15804+A2 Resource use, mineral and metals [kg Sb eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 12 EN15804+A2 Resource use, fossils [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 13 EN15804+A2 Water use [m³ world equiv.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2. Resource use indicators | | | | | | | |
| 01 EN15804+A2 Use of renewable primary energy (PERE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Primary energy resources used as raw materials (PERM) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Total use of renewable primary energy resources (PERT) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Use of non-renewable primary energy (PENRE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Non-renewable primary energy resources used as raw materials (PENRM) [MJ] | [illegible] | [illegible] | 0.00E+00 | 0.00E+00 | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Total use of non-renewable primary energy resources (PENRT) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Input of secondary material (SM) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Use of renewable secondary fuels (RSF) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 09 EN15804+A2 Use of non renewable secondary fuels (NRSF) [MJ] | [illegible] | [illegible] | 0.00E+00 | 0.00E+00 | [illegible] | [illegible] | [illegible] |
| 10 EN15804+A2 Use of net fresh water (FW) [m3] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 3. Output flows and waste categories | | | | | | | |
| 01 EN15804+A2 Hazardous waste disposed (HWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Non-hazardous waste disposed (NHWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Radioactive waste disposed (RWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Components for re-use (CRU) [kg] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05 EN15804+A2 Materials for Recycling (MFR) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Materials for Energy Recovery (MER) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Exported electrical energy (EEE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Exported thermal energy (EET) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 4. Optional indicators | | | | | | | |
| A2b_01 EN15804+A2 Respiratory inorganics [Disease incidences] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_02 EN15804+A2 Ionising radiation - human health [kBq U235 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_03 EN15804+A2 Ecotoxicity freshwater [CTUe] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_04 EN15804+A2 Cancer human health effects [CTUh] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_05 EN15804+A2 Non-cancer human health effects [CTUh] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_06 EN15804+A2 Land Use [Pt] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

To be noted, option A from annex 3 of the PCR is chosen to separate the use of primary energy into energy used as raw material and energy used as energy carrier.

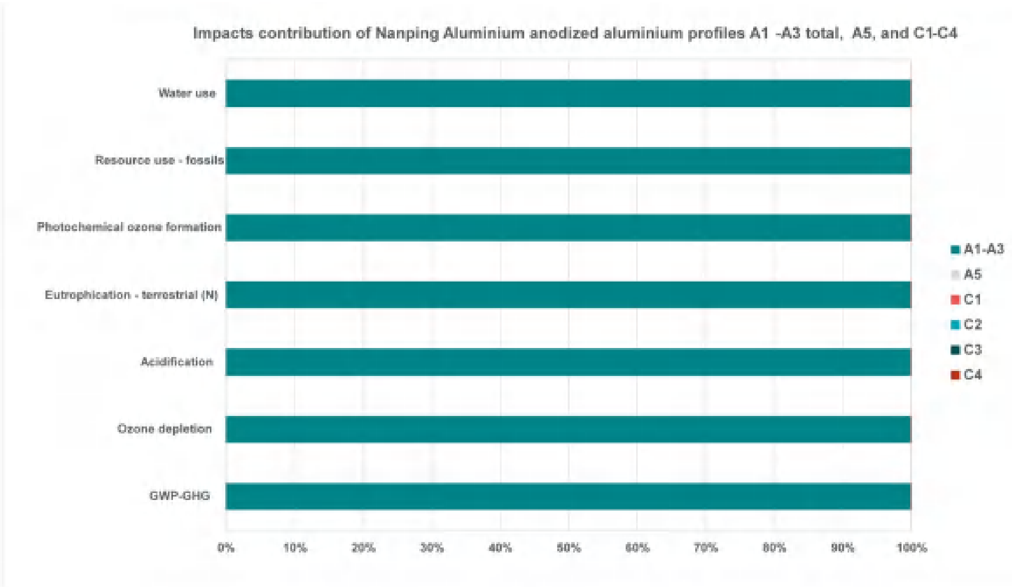


*Figure 17 The environmental impacts distribution of anodized aluminium profile every module in the relevant life cycle. Results are shown the proportion of impacts at different life modules per declared unit.*

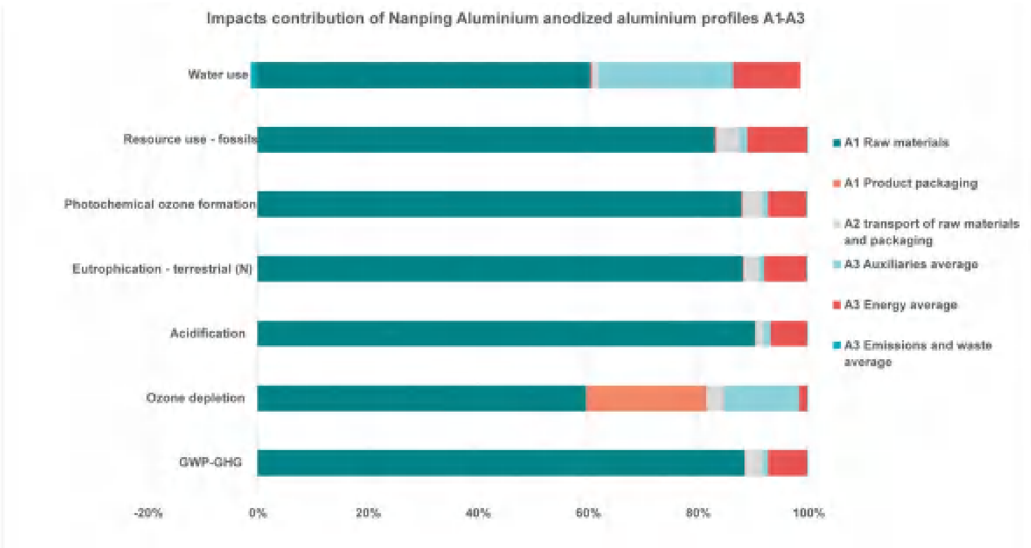


*Figure 18. The environmental impacts distribution of anodized aluminium profile in A1 to A3. Results are shown the proportion of impacts at different life modules per declared unit.*

## 5.2.2 Information table for EPD

*Table 23. Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results)*

| | Product stage | | | Construction process stage | | Use stage | | | | | | | End of life stage | | | | Resource recovery stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Waste processing | Disposal | Reuse-Recovery-Recycling-potential |
| **Module** | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** |
| Modules declared | X | X | X | ND | X | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | CN | CN | CN | - | GLO | - | - | - | - | - | - | - | GLO | GLO | GLO | GLO | GLO |
| Specific data used | 24.76% | | | | | | | | | | | | | | | | |
| Variation – products | <10% | | | | | | | | | | | | | | | | |
| Variation – sites | 0% | | | | | | | | | | | | | | | | |

(2) Modules included in the EPD (X) and the modules not declared (ND).

# 5.3 Fluorocarbon coated aluminium profile

## 5.3.1 Average result

*Table 24 The overall result of the fluorocarbon coated aluminium profile per declared unit.*

| [illegible] | A1-A3 | [illegible] | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| 1. Environmental impact indicators | | | | | | | |
| 00 Global warming potential (GWP-GHG) [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 01 EN15804+A2 Climate Change - total [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 02 EN15804+A2 Climate Change, fossil [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 03 EN15804+A2 Climate Change, biogenic [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 04 EN15804+A2 Climate Change, land use and land use change [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 05 EN15804+A2 Ozone depletion [kg CFC-11 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 06 EN15804+A2 Acidification [Mole of H+ eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 07 EN15804+A2 Eutrophication, freshwater [kg P eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 08 EN15804+A2 Eutrophication, marine [kg N eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 09 EN15804+A2 Eutrophication, terrestrial [Mole of N eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 10 EN15804+A2 Photochemical ozone formation, human health [kg NMVOC eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 11 EN15804+A2 Resource use, mineral and metals [kg Sb eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 12 EN15804+A2 Resource use, fossils [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 13 EN15804+A2 Water use [m3 world equiv.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 2. Resource use indicators | | | | | | | |
| 01 EN15804+A2 Use of renewable primary energy (PERE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 02 EN15804+A2 Primary energy resources used as raw materials (PERM) [MJ] | [illegible] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 03 EN15804+A2 Total use of renewable primary energy resources (PERT) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 04 EN15804+A2 Use of non-renewable primary energy (PENRE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Non-renewable primary energy resources used as raw materials (PENRM) [MJ] | [illegible] | [illegible] | 0.00E+00 | 0.00E+00 | [illegible] | [illegible] | 0.00E+00 |
| 06 EN15804+A2 Total use of non-renewable primary energy resources (PENRT) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 07 EN15804+A2 Input of secondary material (SM) [kg] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 08 EN15804+A2 Use of renewable secondary fuels (RSF) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 09 EN15804+A2 Use of non-renewable secondary fuels (NRSF) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 10 EN15804+A2 Use of net fresh water (FW) [m3] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 3. Output flows and waste categories | | | | | | | |
| 01 EN15804+A2 Hazardous waste disposed (HWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 02 EN15804+A2 Non-hazardous waste disposed (NHWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 03 EN15804+A2 Radioactive waste disposed (RWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 04 EN15804+A2 Components for re-use (CRU) [kg] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05 EN15804+A2 Materials for Recycling (MFR) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | [illegible] | 0.00E+00 | 0.00E+00 |
| 06 EN15804+A2 Materials for Energy Recovery (MER) [kg] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 07 EN15804+A2 Exported electrical energy (EEE) [MJ] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 08 EN15804+A2 Exported thermal energy (EET) [MJ] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 4. Optional indicators | | | | | | | |
| A2b_01 EN15804+A2 Respiratory inorganics [Disease incidence] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_02 EN15804+A2 Ionising radiation - human health [kBq U235 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_03 EN15804+A2 Ecotoxicity freshwater [CTUe] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_04 EN15804+A2 Cancer human health effects [CTUh] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_05 EN15804+A2 Non-cancer human health effects [CTUh] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_06 EN15804+A2 Land Use [Pt] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |

To be noted, option A from annex 3 of the PCR is chosen to separate the use of primary energy into energy used as raw material and energy used as energy carrier.

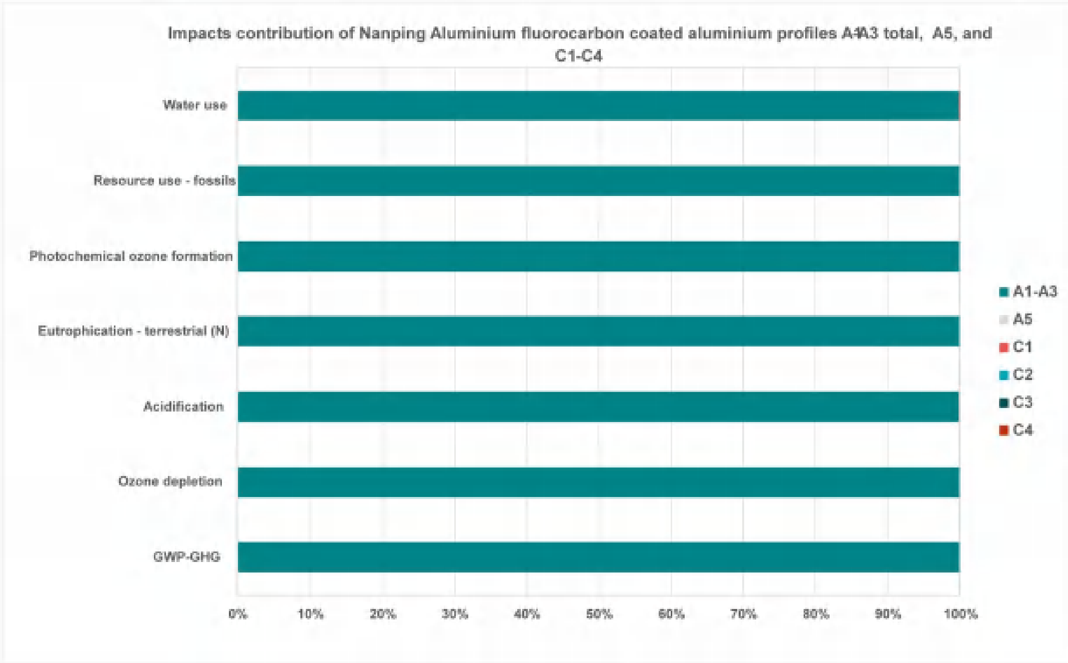


*Figure 19 The environmental impacts distribution of fluorocarbon coated aluminium profile every module in the relevant life cycle. Results are shown the proportion of impacts at different life modules per declared unit*

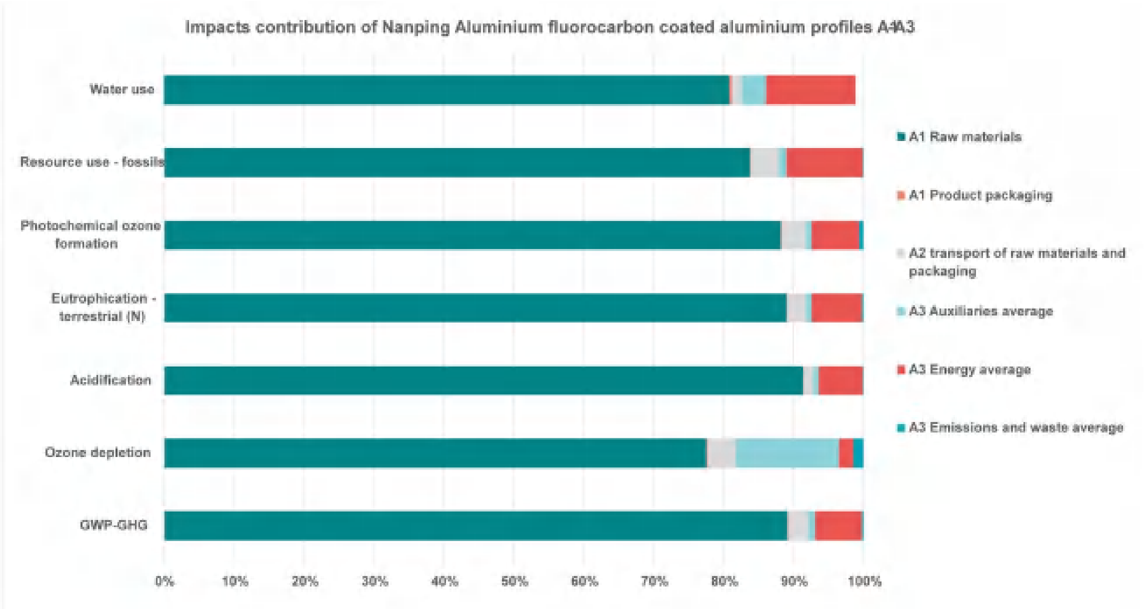


*Figure 20 The environmental impacts distribution of fluorocarbon coated aluminium profile in A1 to A3. Results are shown the proportion of impacts at different life modules per declared unit.*

## 5.3.2 Information table for EPD

*Table 25. Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results)*

| | Product stage | | | Construction process stage | | Use stage | | | | | | | End of life stage | | | | Resource recovery stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Waste processing | Disposal | Reuse-Recovery-Recycling-potential |
| **Module** | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** |
| Modules declared | X | X | X | ND | X | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | CN | CN | CN | - | GLO | - | - | - | - | - | - | - | GLO | GLO | GLO | GLO | GLO |
| Specific data used | 23.66% | | | | | | | | | | | | | | | | |
| Variation – products | < 10% | | | | | | | | | | | | | | | | |
| Variation – sites | 0% | | | | | | | | | | | | | | | | |

(1) Modules included in the EPD (X) and the modules not declared (ND).

# 5.4 Powder coated aluminium profile

## 5.4.1 Average result

*Table 26 The overall result of the powder coated aluminium profile per declared unit.*

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| 1. Environmental impact indicators | | | | | | | |
| 00 Global warming potential (GWP-GHG) [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 01 EN15804+A2 Climate Change - total [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Climate Change, fossil [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Climate Change, biogenic [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Climate Change, land use and land use change [kg CO2 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Ozone depletion [kg CFC 11 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Acidification [Mole of H+ eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Eutrophication, freshwater [kg P eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Eutrophication, marine [kg N eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 09 EN15804+A2 Eutrophication, terrestrial [Mole of N eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 10 EN15804+A2 Photochemical ozone formation, human health [kg NMVOC eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 11 EN15804+A2 Resource use, mineral and metals [kg Sb eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 12 EN15804+A2 Resource use, fossils [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 13 EN15804+A2 Water use [m³ world equiv.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2. Resource use indicators | | | | | | | |
| 01 EN15804+A2 Use of renewable primary energy (PERE) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Primary energy resources used as raw materials (PERM) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Total use of renewable primary energy resources (PERT) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Use of non-renewable primary energy (PENRE) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Non-renewable primary energy resources used as raw materials (PENRM) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Total use of non-renewable primary energy resources (PENRT) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Input of secondary material (SM) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Use of renewable secondary fuels (RSF) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 09 EN15804+A2 Use of non-renewable secondary fuels (NRSF) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 10 EN15804+A2 Use of net fresh water (FW) [m3] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 3. Output flows and waste categories | | | | | | | |
| 01 EN15804+A2 Hazardous waste disposed (HWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 02 EN15804+A2 Non-hazardous waste disposed (NHWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 03 EN15804+A2 Radioactive waste disposed (RWD) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 04 EN15804+A2 Components for re-use (CRU) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 05 EN15804+A2 Materials for Recycling (MFR) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 06 EN15804+A2 Material for Energy Recovery (MER) [kg] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 07 EN15804+A2 Exported electrical energy (EEE) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 08 EN15804+A2 Exported thermal energy (EET) [MJ] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 4. Optional indicators | | | | | | | |
| A2b_01 EN15804+A2 Respiratory inorganics [Disease incidences] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_02 EN15804+A2 Ionising radiation - human health [kBq U235 eq.] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_03 EN15804+A2 Ecotoxicity freshwater [CTUe] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_04 EN15804+A2 Cancer human health effects [CTUh] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_05 EN15804+A2 Non-cancer human health effects [CTUh] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| A2b_06 EN15804+A2 Land Use [Pt] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

To be noted, option A from annex 3 of the PCR is chosen to separate the use of primary energy into energy used as raw material and energy used as energy carrier.

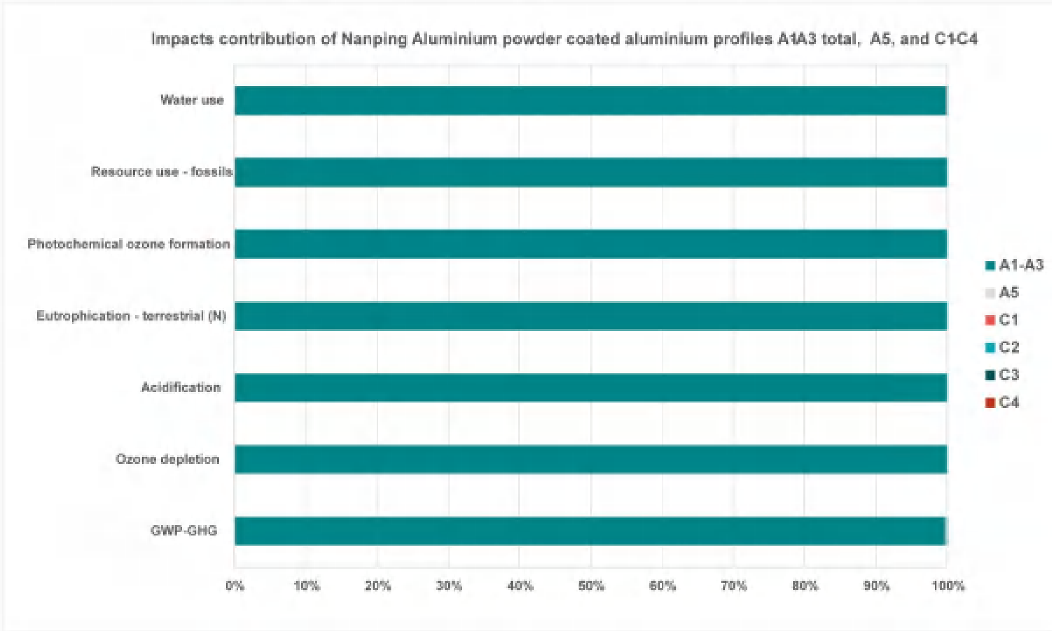


*Figure 21 The environmental impacts distribution of powder coated aluminium profile every module in the relevant life cycle. Results are shown the proportion of impacts at different life modules per declared unit*

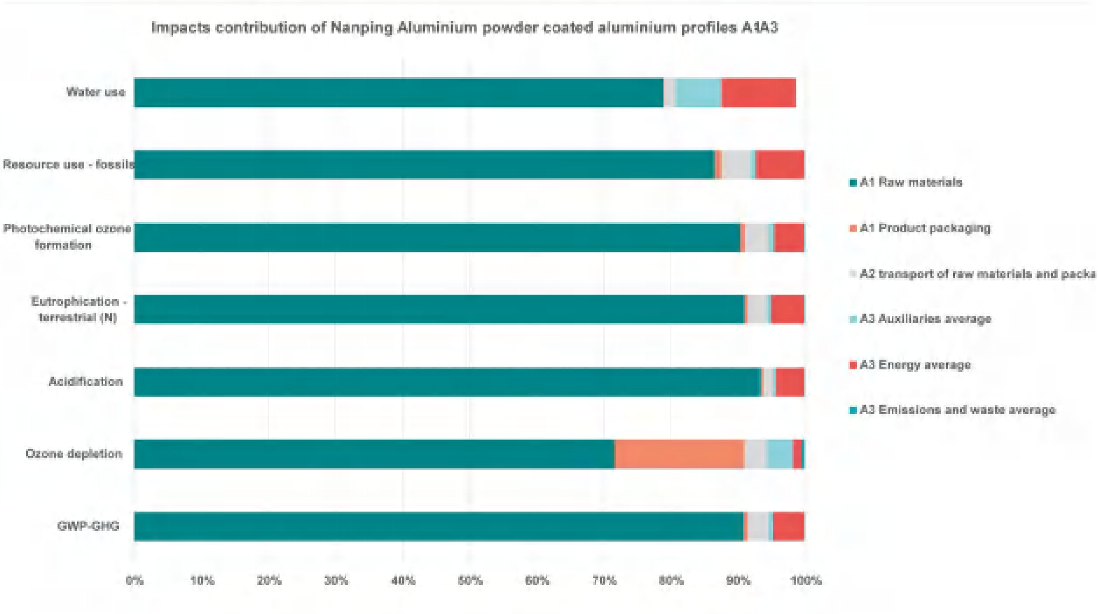


*Figure 22 The environmental impacts distribution of powder coated aluminium profile in A1 to A3. Results are shown the proportion of impacts at different life modules per declared unit.*

## 5.4.2 Information table for EPD

*Table 27. Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results)*

| | Product stage | | | Construction process stage | | Use stage | | | | | | | End of life stage | | | | Resource recovery stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Waste processing | Disposal | Reuse-Recovery-Recycling-potential |
| **Module** | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** |
| Modules declared | X | X | X | ND | X | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | CN | CN | CN | - | GLO | - | - | - | - | - | - | - | GLO | GLO | GLO | GLO | GLO |
| Specific data used | 22.68% | | | | | | | | | | | | | | | | |
| Variation – products | <10 % | | | | | | | | | | | | | | | | |
| Variation – sites | 0% | | | | | | | | | | | | | | | | |

(1) Modules included in the EPD (X) and the modules not declared (ND).

# 5.5 Thermal barrier aluminium profile

## 5.5.1 Average result

| [illegible] | A1-A3 | A4 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| 1. Environmental impact indicators | | | | | | | |
| 00 Global warming potential (GWP-GHG) [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 01 EN15804+A2 Climate Change - total [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 02 EN15804+A2 Climate Change, fossil [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 03 EN15804+A2 Climate Change, biogenic [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 04 EN15804+A2 Climate Change, land use and land use change [kg CO2 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 05 EN15804+A2 Ozone depletion [kg CFC-11 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 06 EN15804+A2 Acidification [Mole of H+ eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 07 EN15804+A2 Eutrophication, freshwater [kg P eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 08 EN15804+A2 Eutrophication, marine [kg N eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 09 EN15804+A2 Eutrophication, terrestrial [Mole of N eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 10 EN15804+A2 Photochemical ozone formation, human health [kg NMVOC eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 11 EN15804+A2 Resource use, mineral and metals [kg Sb eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 12 EN15804+A2 Resource use, fossils [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 13 EN15804+A2 Water use [m³ world equiv.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 2. Resource use indicators | | | | | | | |
| 01 EN15804+A2 Use of renewable primary energy (PERE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 02 EN15804+A2 Primary energy resources used as raw materials (PERM) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 03 EN15804+A2 Total use of renewable primary energy resources (PERT) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 04 EN15804+A2 Use of non-renewable primary energy (PENRE) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 05 EN15804+A2 Non-renewable primary energy resources used as raw materials (PENRM) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 06 EN15804+A2 Total use of non-renewable primary energy resources (PENRT) [MJ] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 07 EN15804+A2 Input of secondary material (SM) [kg] | [illegible] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 08 EN15804+A2 Use of renewable secondary fuels (RSF) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 09 EN15804+A2 Use of non-renewable secondary fuels (NRSF) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 10 EN15804+A2 Use of net fresh water (FW) [m3] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 3. Output flows and waste categories | | | | | | | |
| 01 EN15804+A2 Hazardous waste disposed (HWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 02 EN15804+A2 Non-hazardous waste disposed (NHWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 03 EN15804+A2 Radioactive waste disposed (RWD) [kg] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| 04 EN15804+A2 Components for re-use (CRU) [kg] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05 EN15804+A2 Materials for Recycling (MFR) [kg] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | [illegible] | 0.00E+00 | 0.00E+00 |
| 06 EN15804+A2 Material for Energy Recovery (MER) [kg] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 07 EN15804+A2 Exported electrical energy (EEE) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 08 EN15804+A2 Exported thermal energy (EET) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 4. Optional indicators | | | | | | | |
| A2b_01 EN15804+A2 Respiratory inorganics [Disease incidence] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_02 EN15804+A2 Ionising radiation, human health [kBq U235 eq.] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_03 EN15804+A2 Ecotoxicity freshwater [CTUe] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_04 EN15804+A2 Cancer human health effects [CTUh] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_05 EN15804+A2 Noncancer human health effects [CTUh] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |
| A2b_06 EN15804+A2 Land Use [Pt] | [illegible] | [illegible] | 0.00E+00 | [illegible] | 0.00E+00 | [illegible] | [illegible] |

To be noted, option A from annex 3 of the PCR is chosen to separate the use of primary energy into energy used as raw material and energy used as energy carrier.

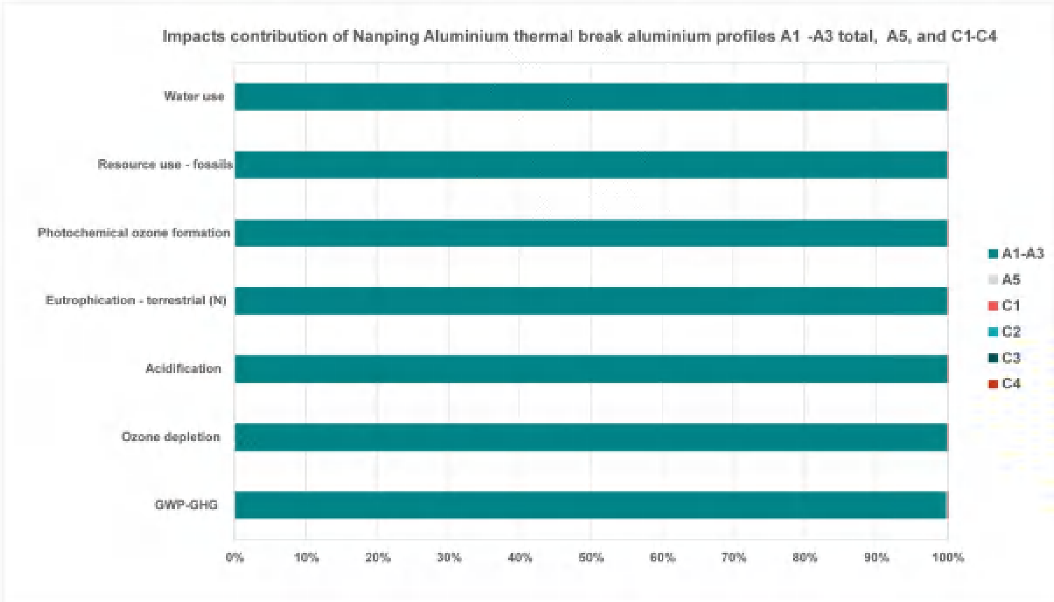


*Figure 23 The environmental impacts distribution of thermal barrier aluminium profile every module in the relevant life cycle. Results are shown the proportion of impacts at different life modules per declared unit*

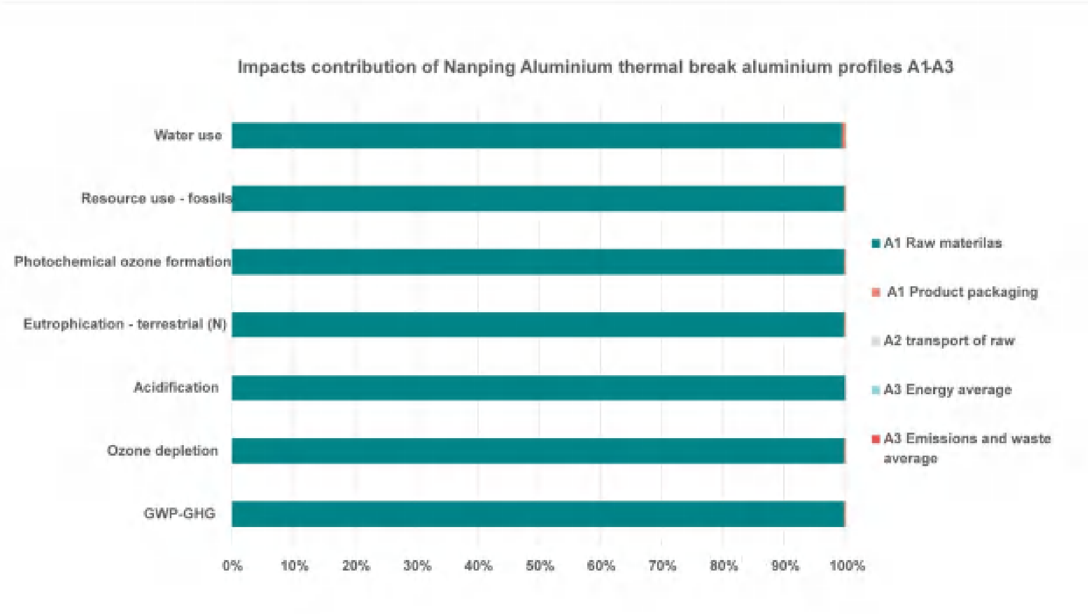


*Figure 24 The environmental impacts distribution of thermal barrier aluminium profile in A1 to A3. Results are shown the proportion of impacts at different life modules per declared unit.*

## 5.5.2 Information table for EPD

*Table 28. Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results)*

| | Product stage | | | Construction process stage | | Use stage | | | | | | | End of life stage | | | | Resource recovery stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Waste processing | Disposal | Reuse-Recovery-Recycling-potential |
| **Module** | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** |
| Modules declared | X | X | X | ND | X | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | CN | CN | CN | - | GLO | - | - | - | - | - | - | - | GLO | GLO | GLO | GLO | GLO |
| Specific data used | 21.65% | | | | | | | | | | | | | | | | |
| Variation – products | <10% | | | | | | | | | | | | | | | | |
| Variation – sites | 0% | | | | | | | | | | | | | | | | |

(1) Modules included in the EPD (X) and the modules not declared (ND).

# 6 Interpretation

## 6.1 Result analysis

This LCA study of the mill finished, anodized, fluorocarbon coated, powder coated and thermal barrier aluminium profiles gives insight into impacts from different life cycle phases (see as well as the underlying causes for the climate change. In this study, results are presented according to PCR regulated into A1-A3, A5, C1, C2, C3, C4, and D module.

When analysing the result of the study, A1-A3 is the main contributor for all indicators. According to the methodology described in this report and needed from the client, the focus among all impact categories is climate change. The climate change (total) of the **mill finished aluminium profiles** is 1.67E+04 kg $CO_2$ eq. per declared unit with the 1.67E+04 kg eq. for the climate change (fossil). The climate change (total) of the **anodized aluminium profiles** is 1.82E+04 kg $CO_2$ eq. per declared unit with the 1.81E+04 kg eq. for the climate change (fossil). The climate change (total) of the **fluorocarbon coated aluminium profiles** is 1.87E+04 kg $CO_2$ eq. per declared unit with the 1.86E+04 kg eq. for the climate change (fossil). The climate change (total) of **powder coated aluminium profiles** is 1.77E+04 kg $CO_2$ eq. per declared unit with the 1.77E+04 kg $CO_2$ eq. for the climate change (fossil). The climate change (total) of **thermal barrier aluminium profiles** is 1.77E+04 kg $CO_2$ eq. per declared unit with the 1.77E+04 kg $CO_2$ eq. for the climate change (fossil).

When analysing the distribution of total climate change of the product, above 99% of climate change influence is generated in the A1-A3 stage (see Figure 15, Figure 17, Figure 19, Figure 21and Figure 23). The reason for the high climate impact at the production stage (A1-A3) is the release of fossil $CO_2$ from A1 stage, especially the outsource aluminium billet. Among A1-A3, the outsource aluminium billet contributes above 60%. Besides raw materials, energy use, such as electricity, is the second largest contributor to fossil-related climate change, though it only accounts for up to 7.2% (anodized aluminium profile). And the transport of raw materials and packaging was the third factor for fossil-related climate change. For ozone depletion, auxiliaries were the secondary factor for fluorocarbon coated aluminium profile, product packages were  the secondary factor for anodized and powder coated aluminium profile.

This LCA study strictly follow the rules from LCA standards and PCR standard, such as allocation rules, cut-off rules, system boundary definition, data quality control, etc. The results stated in all declared modules to meet the EPD require format and more specifically stated life cycle stages to provide more detailed information to Nanping Aluminium. SimaPro (version 9.6.0.1) is the LCA software for modelling with the latest database.

## 6.2 Sensitivity analysis

Climate change is always the hotpot of LCA study. As shown above, raw material (especially outsource aluminium billet ) is the biggest factor of GWP in A1-A3 stage. Thus, a sensitivity analysis focus on the source of raw aluminium was done. First, we assumed that all the products are produced by the self-produced aluminium billet (with high pre-consumer aluminium scrap, from extrusion process). The results indicated that using self-produced billet could lead to a reduction from 42%-49% in the GWP-GHG for A1-A3 stages. Next, for mill finished, anodized, fluorocarbon coated, and powder coated profile, we assumed the aluminium profiles were 100% produced by pre-consumer aluminium materials (from melting process). The result show that the GWP-GHG for stage A1 has decreased by 92-94%. This demonstrates that the GWP result during the product's manufacturing stage is highly sensitive to the type of raw aluminium used.

Besides, as energy is the second factor of fossil-related climate change, a sensitivity analysis focus on the type of electricity was also done. We assumed that electricity was produced by photovoltaic. The result showed that impact on GWP-GHG for A1-A3 stages decreased 0.02%-6.18%. This result shows that the electricity has slight effect on the results.

*Table 29. Sensitivity analysis of raw materials*

| Stage/ GWP-GHG, kg $CO_2$ eq | Nanping Aluminium mill finished aluminium profile | | |
|---|---|---|---|
| | Basic Scenario | Sensitivity | Difference w. Basic (%) |
| Change all the billet into self-produced billet (with high pre-consumer aluminium scrap) | | | |
| A1-A3 | 1.67E+04 | 8.53E+03 | 48.79% |
| A1 raw materials | 1.55E+04 | 6.47E+03 | 58.18% |
| 100% pre-consumer aluminum | | | |

| | | | |
|---|---|---|---|
| A1 raw materials | 1.55E+04 | 9.10E+02 | 94.12% |
| aluminium raw materials | 1.53E+04 | 4.01E+02 | 97.37% |
| Change electricity to photovoltaic | | | |
| A1-A3 | 1.67E+04 | 1.63E+04 | 2.15% |
| A3 energy | 5.71E+02 | 2.12E+02 | 62.82% |
| Stage/ GWP-GHG, kg $CO_2$ eq | Nanping Aluminium anodized aluminium profiles | | |
| | Basic Scenario | Sensitivity | Difference w. Basic (%) |
| Change all the billet into self-produced billet (with high pre-consumer aluminium scrap) | | | |
| A1-A3 | 1.81E+04 | 9.64E+03 | 46.73% |
| A1 raw materials | 1.60E+04 | 6.67E+03 | 58.39% |
| 100% pre-consumer aluminum | | | |
| A1 raw materials | 1.60E+04 | 9.32E+02 | 94.18% |
| aluminium raw materials | 1.58E+04 | 4.05E+02 | 97.44% |
| Change electricity to photovoltaic | | | |
| A1-A3 | 1.81E+04 | 1.71E+04 | 5.43% |
| A3 energy | 1.30E+03 | 3.17E+02 | 75.63% |
| Stage/ GWP-GHG, kg $CO_2$ eq | Nanping Aluminium fluorocarbon coated aluminium profiles | | |
| | Basic Scenario | Sensitivity | Difference w. Basic (%) |
| Change all the billet into self-produced billet (with high pre-consumer aluminium scrap) | | | |
| A1-A3 | 1.87E+04 | 1.08E+04 | 42.16% |
| A1 raw materials | 1.66E+04 | 7.57E+03 | 54.45% |
| 100% pre-consumer aluminum | | | |
| A1 raw materials | 1.61E+04 | 9.26E+02 | 94.25% |
| aluminium raw materials | 1.54E+04 | 4.13E+02 | 97.32% |
| Change electricity to photovoltaic | | | |
| A1-A3 | 1.87E+04 | 1.75E+04 | 6.18% |
| A3 energy | 1.24E+03 | 8.99E+01 | 92.77% |
| Stage/ GWP-GHG, kg $CO_2$ eq | Nanping Aluminium powder coated aluminium profiles | | |
| | Basic Scenario | Sensitivity | Difference w. Basic (%) |
| Change all the billet into self-produced billet (with high pre-consumer aluminium scrap) | | | |

| | | | |
|---|---|---|---|
| A1-A3 | 1.77E+04 | 9.38E+03 | 47.05% |
| A1 raw materials | 1.61E+04 | 6.87E+03 | 57.34% |
| 100% pre-consumer aluminum | | | |
| A1 raw materials | 1.61E+04 | 1.14E+03 | 92.91% |
| aluminium raw materials | 1.57E+04 | 4.13E+02 | 97.37% |
| Change electricity to photovoltaic | | | |
| A1-A3 | 1.77E+04 | 1.70E+04 | 4.12% |
| A3 energy | 8.19E+02 | 8.99E+01 | 89.02% |

| Stage/ GWP-GHG, kg $CO_2$ eq | Nanping Aluminium thermal break aluminium profiles | | |
|---|---|---|---|
| | Basic Scenario | Sensitivity | Difference w. Basic (%) |
| Change all the billet into self-produced billet (with high pre-consumer aluminium scrap) | | | |
| A1-A3 | 1.77E+04 | 9.75E+03 | 44.92% |
| A1 raw materials | 1.76E+04 | 9.70E+03 | 45.03% |
| Change electricity to photovoltaic | | | |
| A1-A3 | 1.77E+04 | 1.77E+04 | 0.02% |
| A3 energy | 4.73E+00 | 6.46E-01 | 86.35% |

## 6.3 Data quality assessment

As generic data is adopted in this study, a data quality assessment was conducted according to EN ISO 14044:2006 and EN15804:2012+A2:2019/AC:2021. Detailed datasets information could be found in the Masterbook.

Datasets from Ecoinvent 3.9.1 Databases were chosen all the time to keep the consistency. Datasets information for the raw material input of the studied product is listed in Chapter 3.

The data quality assessment is based on EN15804 Annex E Table E-1 (Data quality level and criteria of the Global Guidance Principles for Life Cycle Assessment Databases (UN Environment 2011). The data quality assessment results of the LCA study can be found in "Masterbook of NP liquid aluminium", "Masterbook of NP alloy ingot", "Masterbook of NP Aluminium Profile", and "Masterbook of NP Thermal barrier aluminium profile".

In general, time representation of the dataset's selection is very good for the studied product, the technical representation is good, the geographical representation is good. The reason is the ecoinvent has many datasets from global but limited datasets from China even Asia. In this study, the aluminium profiles were produced in China, so Chinese dataset (CN) is priority, then the Asia dataset (Asia) is second prioritized, followed by the global average (ROW then GLO) and European average (EU-28). Most of these data sets are from global average (ROW then GLO) to make sure the data quality. Technical representativeness still has some restriction because different countries may have different technical routes in some processes, such as in waste treatment processes. However, if Ecoinvent or other LCI databases could provide more datasets from Asia and China, the geographical and technical representativeness could be much better, meaning more accurate result in the future.

## 6.4 Uncertainty analysis

In the LCA study, the biggest uncertainty is lack of China and/or Asia datasets. Since the A1-A3 stages happened in China, it is better to choose datasets from China or Asia, which could give more accurate result. However, due to the lack of China and/or Asia datasets in databases, GLO, and Rest of World (expert for EU) have to be selected. As we mentioned in the above section, the selection for such datasets could lead to the underestimation of the environmental burden from the studied product. This could lead to the uncertainty of the whole result.

In addition, since the information provided by the producer is limited after A4 stage, we applied some secondary data in A5 and C modules. Those secondary data (or called default data) are mainly set for transportation processes. Since transportation processes do not influence the whole result very much, the use and the influence of the secondary data is acceptable while it still may cause some uncertainty for the analysis.

## 6.5 Recommendations

Depending on the result of the LCA analysis, the following recommendations are made to improve the environmental performance of the studied product, especially for lowing the carbon emission.

For Nanping Aluminium(A1-A3):

- Use alternatives which has lower carbon emission for the aluminium materials. Such as pre- consumer aluminium or post- consumer aluminium.
- Increase the working efficiency of manufacturing machines to save more electricity.
- Use more clean energy, such as installing solar panel in the factory and use electricity forklift.

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# Appendix

## Appendix A: Critical review statement

This appendix contains the signature page of the critical review statement.

# Appendix B: Brief introduction to LCA

Environmental life cycle assessment (LCA) is the calculation and evaluation of the environmentally relevant inputs and outputs and the potential environmental impacts of the life cycle of a product, material or service (ISO 14040:2006 and 14044:2006).

Environmental inputs and outputs refer to demand for natural resources and to emissions and solid waste. The life cycle consists of the technical system of processes and transports used at/needed for raw material extraction, production, use and after use (waste management or recycling). LCA is sometimes called a "cradle-to-grave" assessment.

An LCA is divided into four phases. In accordance with the current terminology of the International Organization for Standardization (ISO), the phases are called goal and scope definition, inventory analysis, impact assessment, and interpretation.

An LCA can be used in many different ways, depending on how the goal and scope are defined. Product development, decision making, indicator identification and marketing are examples of areas where the information retrieved from an LCA may be valuable.

**Goal and Scope**

In the first phase, the purpose of the study is described. This description includes the intended application and audience, and the reasons for carrying out the study. Furthermore, the scope of the study is described. This includes a description of the limitations of the study, the functions of the systems investigated, the functional unit, the systems investigated, the system boundaries, the allocation approaches, the data requirements and data quality requirements, the key assumptions, the impact assessment method, the interpretation method, and the type of reporting.

**Inventory analysis**

In the inventory analysis, data is collected and interpreted, calculations are made, and the inventory results are calculated and presented. Mass flows and environmental inputs and outputs are calculated and presented.

**Impact assessment**

In the life cycle impact assessment (LCIA), the production system is examined from an environmental perspective using category indicators. The LCIA also provides information for the interpretation phase.

For comparative assertions, there are four mandatory elements of LCIA:

- Selection of impact categories, category indicators and models,
- Assignment of the LCIA results (classification),
- Calculation of category indicator results (characterization) and
- Data quality analysis.

The following elements are optional:

- Calculating the magnitude of category indicator results relative to a reference value (normalization),
- Grouping and Weighting.

**Interpretation**

The interpretation is the phase where the results are analysed in relation to the goal and scope definition, where conclusions are reached, the limitations of the results are presented and where recommendations are provided based on the findings of the preceding phases of the LCA.

An LCA is generally an iterative process. The impact assessment helps increasing the knowledge about what environmental inputs and outputs are important. This knowledge can be used in the collection of better data for those inputs and outputs in order to improve the inventory analysis.

The conclusions of the LCA should be compatible with the goals and quality of the study.

## Part of selected environmental impact categories introduction

**Global Warming Potential (GWP)**

The mechanism of the greenhouse effect can be observed on a small scale, as the name suggests, in a greenhouse. These effects are also occurring on a global scale. The occur- ring short-wave radiation from the sun comes into contact with the earth‘s surface and is partly absorbed (leading to direct warming) and partly reflected as infrared radiation. The reflected part is absorbed by so-called greenhouse gases in the troposphere and is re- radiated in all directions, including back to earth. This results in a warming effect at the earth‘s surface.

In addition to the natural mechanism, the greenhouse effect is enhanced by human activities. Greenhouse gases that are considered to be caused, or increased, anthropogenically are, for example, carbon dioxide, methane and CFCs. The figure shows the main processes of the anthropogenic greenhouse effect. An analysis of the greenhouse effect should consider the possible long-term global effects.

The global warming potential is calculated in carbon dioxide equivalents (CO2-eq.). This means that the green- house potential of an emission is given in relation to CO2 Since the residence time of the gases in the atmosphere is incorporated into the calculation, a time range for the assessment must also be specified. A period of 100 years is customary.

**Acidification Potential (AP)**

The acidification of soils and waters occurs predominantly through the transformation of air pollutants into acids. This leads to a decrease in the pH-value of rainwater and fog from 5.6 to 4 and below. Sulphur dioxide and nitrogen oxide and their respective acids (H2SO4 und HNO3) produce relevant contributions. This damages ecosystems, whereby forest dieback is the most well-known impact.

Acidification has direct and indirect damaging effects (such as nutrients being washed out of soils or an increased solubility of metals into soils). But even buildings and building materials can be damaged. Examples include metals and natural stones which are corroded or disintegrated at an increased rate.

When analysing acidification, it should be considered that although it is a global problem, the regional effects of acidification can vary. The figure displays the primary impact pathways of acidification.

The acidification potential is given in sulphur dioxide equivalents (SO2-eq.). The acidification- ton potential is described as the ability of certain substances to build and release H+ - ions. Certain emissions can also be considered to have an acidification potential, if the given S-, N- and halogen atoms are set in proportion to the molecular mass of the emission. The reference substance is sulphur dioxide.

**Eutrophication Potential (EP)**

Eutrophication is the enrichment of nutrients in a certain place. Eutrophication can be aquatic or terrestrial. Air pollutants, wastewater and fertilization in agriculture all contribute to eutrophication.

The result in water is an accelerated algae growth, which in turn, prevents sunlight from reaching the lower depths. This leads to a decrease in photosynthesis and less oxygen production. In addition, oxygen is needed for the decomposition of dead algae. Both effects cause a decreased oxygen concentration in the water, which can eventually lead to fish dying and to anaerobic decomposition (decomposition without the presence of oxygen). Hydrogen sulphide and methane are thereby produced. This can lead, among others, to the destruction of the eco-system.

On eutrophicated soils, an increased susceptibility of plants to diseases and pests is often observed, as is a degradation of plant stability. If the nutrification level exceeds the amounts of nitrogen necessary for a maximum harvest, it can lead to an enrichment of nitrate. This can cause, by means of leaching, increased nitrate content in groundwater. Nitrate also ends up in drinking water.

Nitrate at low levels is harmless from a toxicological point of view. However, nitrite, a reaction product of nitrate, is toxic to humans. The causes of eutrophication are displayed in the figure. The eutrophication potential is calculated in phosphate equivalents (PO4-eq). As with acidification potential, it is important to remember that the effects of eutrophication potential differ regionally.

**Photochemical Ozone Creation Potential (POCP)**

Despite playing a protective role in the stratosphere, at ground-level ozone is classified as a damaging trace gas. Photochemical ozone production in the troposphere, also known as summer smog, is suspected to damage vegetation and material. High concentrations of ozone are toxic to humans.

Radiation from the sun and the presence of nitrogen oxides and hydrocarbons incur com- plex chemical reactions, producing aggressive reaction products, one of which is ozone. Nitrogen oxides alone do not cause high ozone concentration levels.

Hydrocarbon emissions occur from incomplete combustion, in conjunction with petrol (storage, turnover, refuelling etc.) or from solvents. High concentrations of ozone arise when the temperature is high, humidity is low, when air is relatively static and when there are high concentrations of hydrocarbons. Today it is assumed that the existence of NO and CO reduces the accumulated ozone to NO2, CO2 and O2. This means, that high concentrations of ozone do not often occur near hydrocarbon emission sources. Higher ozone concentrations more commonly arise in areas of clean air, such as forests, where there is less NO and CO.

**Ozone Depletion Potential (ODP)**

Ozone is created in the stratosphere by the disassociation of oxygen atoms that are ex- posed to short-wave UV-light. This leads to the formation of the so-called ozone layer in the stratosphere (15 - 50 km high). About 10 % of this ozone reaches the troposphere through mixing processes. In spite of its minimal concentration, the ozone layer is essential for life on earth. Ozone absorbs the short-wave UV-radiation and releases it in longer wavelengths. As a result, only a small part of the UV-radiation reaches the earth.

Anthropogenic emissions deplete ozone. This is well-known from reports on the hole in the ozone layer. The hole is currently confined to the region above Antarctica. However, another ozone depleted region can be identified, albeit not to the same extent, over the mid-latitudes (e.g. Europe). The substances which have a depleting effect on the ozone can essentially be divided into two groups; the fluorine-chlorine-hydrocarbons (CFCs) and the nitrogen oxides (NOX). The figure depicts the procedure of ozone depletion.

One effect of ozone depletion is the warming of the earth's surface. The sensitivity of hu- mans, animals and plants to UV-B and UV-A radiation is of particular importance. Possible effects are changes in growth or a decrease in harvest crops (disruption of photosynthesis), indications of tumours (skin cancer and eye diseases) and decrease of sea plankton, which would strongly affect the food chain. In calculating the ozone depletion potential, the anthropogenically released halogenated hydrocarbons, which can destroy many ozone molecules, are recorded first. The so-called Ozone Depletion Potential (ODP) results from the calculation of the potential of different ozone relevant substances.

This is done by calculating, first of all, a scenario for a fixed quantity of emissions of a CFC reference (CFC 11). This results in an equilibrium state of total ozone reduction. The same scenario is considered for each substance under study whereby CFC 11 is replaced by the quantity of the substance. This leads to the ozone depletion potential for each respective substance, which is given in CFC 11 equivalents. An evaluation of the ozone depletion potential should take into consideration the long term, global and partly irreversible effects.

# Appendix C: Life cycle impact assessment indicators

### *Environmental indicators describing environmental impacts according to EN15804+A2*

| Indicator | Unit | Method |
|---|---|---|
| **Environmental impacts** | | |
| Global warming potential total, GWP - total | kg $CO_2$ eq. | GWP 100, EN15804 (based on EF 3.1, 2023), according to IPCC baseline (2021) 100 years |
| Global warming potential fossil, GWP – fossil | kg $CO_2$ eq. | GWP 100, EN15804 (based on EF 3.1, 2023), according to IPCC baseline (2021) 100 years |
| Global warming potential biogenic, GWP – biogenic | kg $CO_2$ eq. | GWP 100, EN15804 (based on EF 3.1, 2023), according to IPCC baseline (2021) 100 years |
| Global warming potential land use and land use change, GWP – LULUC | kg $CO_2$ eq. | GWP 100, EN15804 (based on EF 3.1, 2023), according to IPCC baseline (2021) 100 years |
| Depletion potential of the stratospheric ozone layer, ODP | kg CFC-11 eq. | Steady-state ODPs, WMO 2014 |
| Acidification potential, Accumulated Exceedance, AP | Mol $H^+$ eq. | Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008 |
| Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-freshwater | kg P eq. | EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe |
| Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP - marine | kg N eq. | EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe |
| Eutrophication potential, Accumulated Exceedance, EP-terrestrial | mol N eq. | Accumulated Exceedance, Seppälä et al. 2006, Posch et al. 2008 |
| Photochemical ozone formation | kg NMVOC eq. | LOTOS-EUROS ,Van Zelm et al., 2008, as applied in ReCiPe |
| Abiotic depletion potential for non-fossil resources, ADP- minerals & metals | kg Sb eq. | CML 2002, Guinée et al., 2002, and van |
| Abiotic depletion potential for fossil resources, ADP-fossil fuels | MJ, net calorific value | CML 2002, Guinée et al., 2002, and van |
| Water (user) deprivation potential, deprivation weighted water consumption, WDP | $m^3$ world eq. deprived | Available WAter REmaining (AWARE), Boulay et al., 2016 |

The "EN 15804 reference package" is calculated based on EF 3.1.

### *Additional mandatory and voluntary impact category indicators*

| Indicator | Unit | Method |
|---|---|---|
| Global warming potential greenhouse gas, GWP-GHG [(1)] | kg $CO_2$ eq. | |
| Additional voluntary indicators e.g., the voluntary indicators from EN 15804 or the global indicators according to ISO 21930:2017 | | |

(1) This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO2 is set to zero.

### *Resource use, waste and output flows*

| Indicator | Unit | Method |
|---|---|---|
| **Use of resources** | | |
| Use of renewable primary energy excluding renewable primary energy resources used as raw materials (PERE) (2) | MJ, net calorific value | Based on LCI data |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | Based on LCI data |
| Total use of renewable primary energy resources (PERT) | MJ, net calorific value | Based on LCI data |
| Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials (PENRE) (1) | MJ, net calorific value | Based on LCI data |
| Use of non-renewable primary energy resources used as raw material (PENRM) | MJ, net calorific value | Based on LCI data |
| Total use of non-renewable primary energy resources (PENRT) | MJ, net calorific value | Based on LCI data |
| **Indicators describing the use of secondary materials, water and energy resources** | | |
| Use of secondary material (SM) | kg | Based on LCI data |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | Based on LCI data |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | Based on LCI data |
| Net use of fresh water (FW) | $m^3$ | Based on LCI data |
| **Waste** | | |
| Hazardous waste disposed (HWD) | kg | Based on LCI data |
| Non-hazardous waste disposed (NHWD) | kg | Based on LCI data |
| Radioactive waste disposed (RWD) | kg | Based on LCI data |
| **Output flows** | | |
| Components for re-use (CRU) | kg | Based on LCI data |
| Materials for Recycling (MFR) | kg | Based on LCI data |
| Material for Energy Recovery (MER) | kg | Based on LCI data |
| Exported electrical energy (EEE) | MJ | Based on LCI data |
| Exported thermal energy (EET) | MJ | Based on LCI data |
| **Other indicators** | | |
| Biogenic carbon content of the product, expressed in kg of C, | kg | |
| Biogenic carbon content of the associated packaging, expressed in kg of C | kg | |

(2) The impact category might provide a zero result since input data to the LCA-models (i.e. database data such as production of fuels, electricity, materials etc.) often does not distinguish between an energy carrier used as fuel and as material. Therefore, it is often not possible to present the results into these two categories (even though this is required).

### *Optional indicators describing environmental impacts*

| Indicator | Unit |
|---|---|
| **Additional indicators** | |
| Total use of primary energy during the life cycle | MJ |
| Emission of fine particles | incidence of diseases |
| Ionizing radiation, human health | kBq U235 eq. |
| Ecotoxicity, carcinogenic effect, | CTUe |
| Human toxicity, carcinogenic effect | CTUh |
| Human toxicity, non-carcinogenic effect | CTUh |
| Impact related to land use/solid quality, withoutdimension | |

# Appendix F: Building Aluminium Extrusion Recycling Rate (IAI)

Table 5-7 Comparison between Chinese and European buildings.

| Building Type | Location | Aluminium share (g/t) | Collection rate (%) |
|---|---|---|---|
| Residential building | Beijing: bungalow | 26 | 100 |
| | Beijing: five-story building | 52 | 100 |
| | Xiamen: three-story building | 753 | 100 |
| | France | 18 | 31 |
| | The Netherlands | 32 | 95 |
| | The Netherlands | 49 | 95 |
| Commercial building | Beijing: Tongzhou | 118 | 96 |
| | Beijing: Shunyi | 379 | 16 |
| | Xi'an: B1-21 | 94 | 100 |
| | Xi'an: B5-5 | 202 | 100 |
| | Xi'an: B8-30 | 238 | 100 |
| | Shanghai: Baoshan Hotel | 374 | 100 |
| | France | 640 | 92 |
| | Germany | 7500 | 98 |
| | Germany | 1750 | 98 |
| | Italy | 430 | 94 |
| | Spain | 4000 | 95 |
| | The United Kingdom | 6100 | 96 |

All the aluminium window and door frames in these surveys were collected during the removal of the accessory structure. However, aluminium-plastic boards were not collected during the demolition process. This is because aluminium-plastic boards have a low aluminium content; however, aluminium extrusion results in the highest proportion (approximately 86%) of total aluminium consumption in buildings. Thus, there is reason to believe that the recycling rate of waste aluminium in China should be above 90%.

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**STOCKHOLM**
Box 21060, 100 31 Stockholm

**GOTHENBURG**
Box 53021, 400 14 Gothenburg

**MALMÖ**
Nordenskiöldsgatan 24
211 19 Malmö

**KRISTINEBERG**
**(Center for Marine Research and Innovation)**
Kristineberg 566
451 78 Fiskebäckskil

**SKELLEFTEÅ**
Kanalgatan 59
931 32 Skellefteå

**BEJING, CHINA**
Unit 1112
ChinaTex Mansion
No. 19 Jianguomen Inner Street
Dongcheng District
Beijing 100005
China



*This report has been reviewed and approved in accordance with IVL's audit and approval management system.*