ENVIRONMENTAL PRODUCT DECLARATION

ALUMINUM EXTRUSIONS

ANODIZED AND PAINTED FINISH

Kawneer products are comprised of extrusions made from one of the earth's most plentiful recyclables — aluminum. Durable and lasting the extruded products also boast aesthetically appealing design features that can help contribute to energy efficiency and long-term sustainability.

KAWNEER
AN ARCONIC COMPANY

Kawneer Company, Inc., part of Arconic's global Building and Construction Systems (BCS) business, has provided the commercial construction industry with best-in-class architectural aluminum products and service for more than 100 years. Its extensive range of solutions — from curtain walls and windows, to entrances and framing systems — help build infinite possibilities for thermal performance, hurricane resistance, blast mitigation and sun control.

Kawneer's commitment to social and environmental responsibility is rooted in high performing, sustainable solutions that extend beyond energy efficiency to elements like daylighting, acoustical efficiency, recyclability, occupant security and occupant comfort. In fact, sustainability is at the heart of Kawneer's product line, which is comprised of one of the earth's most plentiful recyclables — aluminum.

Kawneer offers architects a new way to look at the building façade, placing endless design and sustainability options at their fingertips.

For more information visit www.kawneer.com

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

KAWNEER

Anodized and Painted Aluminum Extrusions

Products of Aluminum and Aluminum Alloys

According to ISO 14025, EN 15804, and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL ENVIRONMENT 333 PFINGSTEN ROAD NORTHBROOK, IL 60611 HTTPS://WWW.UL.COM HTTPS://SPOT.UL.COM
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.5 March 2020
ASSOCIATION NAME AND ADDRESS	Kawneer North America 555 Guthridge Ct. Technology Park/Atlanta Norcross, GA 30092
DECLARATION NUMBER	4789733794.102.1
DECLARED PRODUCT & DECLARED UNIT	Extruded Aluminum, 1 kg
REFERENCE PCR AND VERSION NUMBER	Part A: Calculation Rules for the LCA and Requirements Project Report, (IBU/UL Environment, V3.2, 12.12.2018) and Part B: Requirements on the EPD for Products of aluminum and aluminum alloy (IBU/ V1.6, 11.30.2017) (IBU, PCR Guidance-Texts for Building-Related Products and Services: Part B: Requirements on the EPD for Products of aluminium and aluminium alloys (IBU / v1.6 11.30.2017), 2014).
DESCRIPTION OF PRODUCT APPLICATION/USE	Extruded Aluminum, anodized or painted
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	October 1, 2021
PERIOD OF VALIDITY	5 years
EPD TYPE	Industry specific
EPD SCOPE	Cradle to gate with options
YEAR(S) OF REPORTED PRIMARY DATA	2019-2020
LCA SOFTWARE & VERSION NUMBER	GaBi v10
LCI DATABASE(S) & VERSION NUMBER	GaBi 2021 (CUP 2021.1)
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR5 (GWP), CML-IA v4.8, TRACI 2.1

The sub-category PCR review was conducted by:	Institut Bauen und Umwelt e.V. The Independent Expert Committee (SRV) info@ibu-epd.com
This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report,", v3.2 (December 2018), in conformance with ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017) ☐ INTERNAL ☒ EXTERNAL	James Mellentine, Thrive ESG
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	James Mellentine, Thrive ESG

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible”. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

Product Definition and Information

Description of Organization

Kawneer Company, Inc., part of Arconic's global Building and Construction Systems (BCS) business, has led the façade industry with innovative, high-performing building envelope solutions for more than a century. With locations across North America and Europe, Kawneer manufactures a broad range of architectural aluminum systems from curtain walls and entrances to framing systems and windows. Kawneer's technical expertise and product capability enhance building performance, protection and productivity to deliver inspiring buildings around the world. Part of Arconic Corporation's global Building and Construction Systems business, Kawneer innovation is advancing the frontiers of building and architectural design.

Product Description

Kawneer extruded aluminum is used in a variety of commercial building and construction applications, including: high rise curtain wall, commercial and architectural windows, storefront framing systems, sun control and shading devices, entrances/doors, skylights, interior framing and impact resistance.

Product Average

This EPD covers the production of extruded aluminum with the following finishing options: anodized and painted. The results for each product type are calculated for the production-weighted average from all Kawneer production sites across North America.

Technical Specification

Technical data for the studied product can be found in the table below.

Table 1 Technical Specification

Name	Value	Unit
Density	2700	kg/m3
Melting point	616-654	°C
Electrical conductivity at 20°C	31.25	m/Ωmm^2
Thermal conductivity	200	W/(mK)
Coefficient of thermal expansion	24	$10^{-6}K^{-1}$
Modulus of elasticity	68.9 x 10^3	N/mm^2
Shear modulus	25.8 x 10^3	N/mm^2
Specific heat capacity	0.90	kJ/kgK
Hardness	73	HB
Yield strength	214	N/mm^2
Ultimate tensile strength	241	N/mm^2
Breaking elongation	12	%
Chemical composition	Aluminum - 97.5 Alloy – 2.5	% by mass

Delivery Status

Extruded Aluminum profiles are sold to external and internal customers and used to manufacture different building products.

Extrusions vary in size and thickness depending on the part and application.

Industry **Standards**

ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes. This specification includes guidelines regarding chemical compositions, manufacturing practices, mechanical properties and end product testing procedures.

ASTM B807/B807M - Standard Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys. This specification establishes the controls required for extrusion press solution heat treatment of the 6xxx and 7xxx series aluminum alloys.

AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum. This specification describes test procedures and requirements for architectural quality aluminum oxide coatings applied to aluminum extrusions and panels for architectural products.

AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Pigmented Organic Coatings on Aluminum Extrusions and Panels. This specification covers high performance organic coatings which are used on products produced by the Kawneer Company and other manufacturers of high quality products.

AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Pigmented

Organic Coatings on Aluminum Extrusions and Panels. This specification covers superior organic coatings which are used on products produced by the Kawneer Company and other manufactures of high quality products.

Base And Ancillary Materials

Extruded aluminum products produced by Kawneer contained a considerable proportion of metal recycled content from aluminum scrap. The average metal composition based on metal feedstock information collected from the client in this EPD, is as follows:

Table 2 Base and ancillary materials

Category of metal source	Percentage (by mass)
Primary metal (including alloying agents)	30%
Scrap supply (recycled content)	70%

Manufacturing

The Kawneer aluminum extrusions covered by this EPD are produced in three US plants (Bloomsburg, PA; Cranberry, PA; Springdale, AR;) and one Canadian plant (Lethbridge, AB). Kawneer's Visalia, CA plant purchases extruded aluminum.

The manufacturing process comprises the following production stages:

- Extrusion: Aluminum billet (rods approximately 24 feet in length and 8-9 inch in diameter) are heated and pressed through various die shapes to create an aluminum extrusion.
- Surface treatment:
    - Pre-treatment: The aluminum extrusions are cleaned in preparation for finishing.
    - Anodizing: Cleaned extrusions are placed in chemicals baths with an electric current to etch and color the surface, then the extrusions are sealed to harden the surface.
    - Painting: Primer is added to the cleaned extrusions, then they are sprayed with a color coating and baked to set the color. Painted coatings were liquid.

The manufacturing process is illustrated in the diagram below.

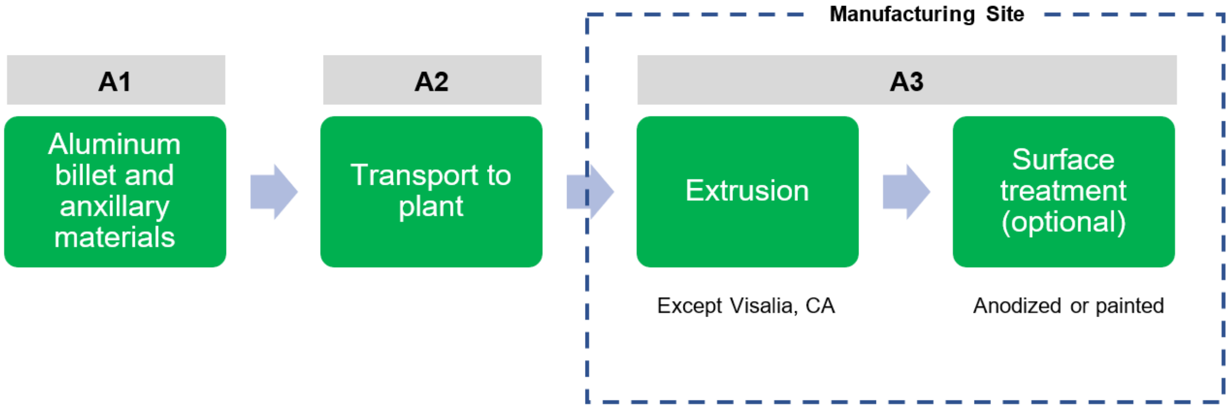


Figure 1: Breakdown of life cycle stages for aluminum extrusion

Product Processing / Installation

Installation is outside of the scope of this EPD.

Packaging

Packaging is excluded for Aluminum extrusions in this study.

Recycling and Disposal

Aluminum extrusions are a highly efficient, sustainable building material. Aluminum is 100% recycleable and can be recycled repeatedly. Recycled aluminum is identical to smelted aluminum but requires a fraction of energy to manufacture. In building and construction, aluminum scrap has a recycling rate of 95% (UNEP, 2011) (AEC, 2021).The remaining 5% is sent to landfill.

Environment and Health

Product manufacturing: Plant emissions to air/soil/water are monitored (if applicable) and comply with local laws.

Product use: Kawneer products are not expected to create exposure conditions that exceed safe thresholds for health impacts to humans or flora/fauna under normal operating conditions.

Life Cycle Assessment – Background Information

A "cradle-to-gate with options" analysis using life cycle assessment (LCA) techniques was conducted for this EPD. The analysis was done according to the product category rule (PCR) for Products of Aluminum and Aluminum Alloys and followed LCA principles, requirements and guidelines laid out in the ISO 14040/14044/21930 and EN 15804 standards. As such, EPDs of aluminum products may not be comparable if they do not comply with the same PCR. While the intent of the PCR is to increase comparability, there may still be differences among EPDs that comply with the same PCR (e.g., due to differences in system boundaries, background data, etc.).

Declared Unit

The declared unit is 1 kg of aluminum extrusion as produced at the factory.

System Boundary

Per the PCR, this cradle-to-gate with options analysis provides information on the Product Stage of the aluminum product life cycle, including modules A1–A3, C4 and D:

- A1 The provision of resources, additives and energy
- A2 Transport of resources and additives to the production site
- A3 Production process on site, including energy, production of additives, disposal of production residues, consideration of related emissions and recycling of production scrap ("closed loop")
- C4 Disposal at the end of the life cycle, i.e., during building deconstruction
- D Net benefits resulting from reuse, recycling and energy recovery that take place beyond the system boundary.

The table below represents the system boundary and scope.

Table 3 : System boundary modules included and excluded from the study, in accordance with EN 15804

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)				
PRODUCT STAGE	CONSTRUCTION PROCESS STAGE	USE STAGE	END OF LIFE STAGE	BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES

Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement[1]	Refurbishment[1]	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X

* X = module included, MND = module not declared

Time coverage: Kawneer primary data represent production within calendar year 2019. Background data for upstream and downstream processes (i.e., raw materials, energy resources, transportation, and ancillary materials) were obtained from the GaBi 10 (CUP 2021.1) databases.

Technology coverage: Data were collected for the production of anodized, painted and mill-finish aluminum extrusions at Kawneer's facilities in the United States and Canada.

Geographical coverage: Kawneer manufactures aluminum extrusion products at four US facilities and one Canadian facility. As such, the geographical coverage for this study is based on North American system boundaries for all processes and products. Whenever US/Canadian background data were not readily available, European data or global data were used as proxies.

Estimations and Assumptions

The manufacturing process and end product is essentially the same in all manufacturing sites. A1-A3 impacts and inventories for each product – mill finished extrusions, painted extrusions, and anodized extrusions – are calculated with a mass-based production-weighted average of each manufacturer's impacts and inventories.

No significant assumptions have been made beyond the aforementioned. All of the raw materials and energy inputs have been modeled using processes and flows that closely follow actual production raw materials and processes. All of the material and energy flows have been accounted.

Cut-off Criteria

In the case of data gaps for unit processes, the cut-off criteria as defined by ISO 21930 were applied. All available energy and material flow data have been included in the model. In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts.

Data Sources

To ensure reliable results, first-hand industry data were used in combination with consistent background LCA information from the GaBi database (CUP 2021.1). The data for aluminum billet, as well as externally sourced aluminum extrusions, are based on Aluminum Association studies and are the best available. Other LCI datasets were sourced from the GaBi databases and are representative of the years 2018-2020.

Data Quality

Inventory data quality is judged by its precision (measured, calculated or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied on a study serving as a data source) and representativeness (geographical, temporal, and technological).

To cover these requirements and to ensure reliable results, first-hand industry data were used in combination with consistent background LCA information from the GaBi LCI database. The data for aluminum billet, as well as externally sourced aluminum extrusions, are based on Aluminum Association studies for primary and secondary aluminum and are the best available.

LCI datasets from the GaBi LCI database are widely distributed and used with the GaBi Professional Software. The datasets have been used in LCA models worldwide in industrial and scientific applications in internal as well as in many critically reviewed and published studies. In the process of providing these datasets they are cross-checked with other databases and values from industry and science.

Allocation

No multi-output (i.e., co-product) allocation was performed in the foreground system of this study. Allocation of background data (energy and materials) taken from the GaBi 2021 databases is documented online at: https://sphera.com/wp-content/uploads/2020/04/Modeling-Principles-GaBi-Databases-2021.pdf.

End-of-Life allocation generally follows the requirements of ISO 14044, section 4.3.4.3 and EN15804, section 6.4.3.3. For this study, allocation was performed using the avoided burden approach.

Material recycling (avoided burden approach): Open scrap inputs from the production stage are subtracted from scrap to be recycled at end of life to give the net scrap output from the product life cycle. This remaining net scrap is then sent to material recycling. The original burden of the primary material input is then allocated between the current and subsequent life cycle using the mass of recovered secondary material to scale the substituted primary material, i.e., applying a credit for the substitution of primary material so as to distribute burdens appropriately among the different product life cycles. These subsequent process steps are modeled using industry average inventories. The associated impacts and credits are reported in module D.

Life Cycle Assessment – Results

Extruded Aluminum (painted finish)

Results given per one kilogram of product.

Table 4 Environmental impact results for painted finish aluminum extrusions

Impact Category	Unit	A1 - A3	C4*	D
LIFE CYCLE IMPACTS ASSESSMENT (LCIA) RESULTS				
IPCC, AR5 (IPCC, 2013)				
Global Warming Potential	kg CO_2 eq.	8.94E+00	2.17E-03	-4.03E+00
CML-IA v4.8				
Abiotic Depletion (ADP elements)	kg Sb eq.	5.02E-06	9.50E-10	-2.17E-06
Abiotic Depletion (ADP fossil)	MJ LHV	1.08E+02	3.29E-02	-3.72E+01
Acidification Potential (AP)	kg SO_2 eq.	4.65E-02	8.63E-06	-2.88E-02
Eutrophication Potential (EP)	kg $(PO_4)_3^-$ eq.	3.74E-03	1.16E-06	-1.20E-03
Ozone Layer Depletion Potential (ODP, steady state)	kg R11 eq.	3.37E-10	7.35E-18	-1.71E-10
Photochemical Ozone Creation Potential (POCP)	kg C_2H_4 eq.	5.05E-03	8.21E-08	-1.40E-03
TRACI 2.1				
Acidification Potential (AP)	kg SO_2 eq.	4.67E-02	9.37E-06	-2.66E-02
Eutrophication Potential (EP)	kg N eq.	1.44E-03	5.22E-07	-4.27E-04
Ozone Layer Depletion Potential (ODP, steady state)	kg CFC 11 eq.	3.58E-10	7.35E-18	-1.82E-10
Resources, Fossil fuels (FF)	MJ LHV surplus energy	1.10E+01	4.28E-03	-2.46E+00
Smog Formation Potential (SFP)	kg O_3 eq.	6.99E-01	1.66E-04	-2.06E-01
RESOURCE USE INDICATORS				
Renewable primary resources used as energy carrier (fuel) (RPRE)	MJ LHV	3.45E+01	2.80E-03	-2.39E+01
Renewable primary resources with energy content used as material (RPRM)	MJ LHV	6.41E-01	0.00E+00	0.00E+00
Non-renewable primary resources used as an energy carrier (fuel) (NRPRE)	MJ LHV	1.12E+02	3.36E-02	-3.82E+01
Non-renewable primary resources with energy content used as material (NRPRM)	MJ LHV	1.58E+00	0.00E+00	0.00E+00
Renewable secondary fuels (RSF)	MJ LHV	--	--	--
Non-renewable secondary fuels (NRSF)	MJ LHV	--	--	--
Recovered energy (RE)	MJ LHV	--	--	--

Impact Category	Unit	A1 - A3	C4*	D
Secondary material (SM)	kg	9.78E-01	0.00E+00	0.00E+00
Use of net fresh water resources (FW)	m^3	1.48E-01	4.62E-06	-1.11E-01
OUTPUT FLOWS & WASTE FLOWS				
Hazardous waste disposed (HWD)	kg	2.67E-02	3.18E-12	-3.82E-04
Non-hazardous waste disposed (NHWD)	kg	2.25E-02	5.92E-02	6.17E-04
High-level radioactive waste, conditioned, to final repository (HLRW)	kg	2.95E-06	3.24E-10	-5.04E-07
Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW)	kg	2.44E-03	2.80E-07	-4.01E-04
Components for reuse (CRU)	kg	--	--	--
Materials for Recycling (MFR)	kg	5.00E-01	--	9.50E-01

*C3 (waste processing) is not within the scope of the study, hence the results are reported for C4

Extruded Aluminum (anodized finish)

Results given per one kilogram of product.

Table 5 Environmental impact results for anodized finish aluminum extrusions

Impact Category	Unit	A1 - A3	C4*	D
Life Cycle Impacts Assessment (LCIA) Results				
IPCC, AR5 (IPCC, 2013)				
Global Warming Potential	kg CO_2 eq.	7.21E+00	2.17E-03	-3.68E+00
CML-IA v4.8				
Abiotic Depletion (ADP elements)	kg Sb eq.	8.54E-06	9.50E-10	-1.98E-06
Abiotic Depletion (ADP fossil)	MJ LHV	7.95E+01	3.29E-02	-3.39E+01
Acidification Potential (AP)	kg SO_2 eq.	3.89E-02	8.63E-06	-2.63E-02
Eutrophication Potential (EP)	kg $(PO_4)_3^-$ eq.	2.11E-03	1.16E-06	-1.09E-03
Ozone Layer Depletion Potential (ODP, steady state)	kg R11 eq.	3.24E-10	7.35E-18	-1.56E-10
Photochemical Ozone Creation Potential (POCP)	kg C_2H_4 eq.	1.94E-03	8.21E-08	-1.28E-03
TRACI 2.1				
Acidification Potential (AP)	kg SO_2 eq.	3.67E-02	9.37E-06	-2.43E-02

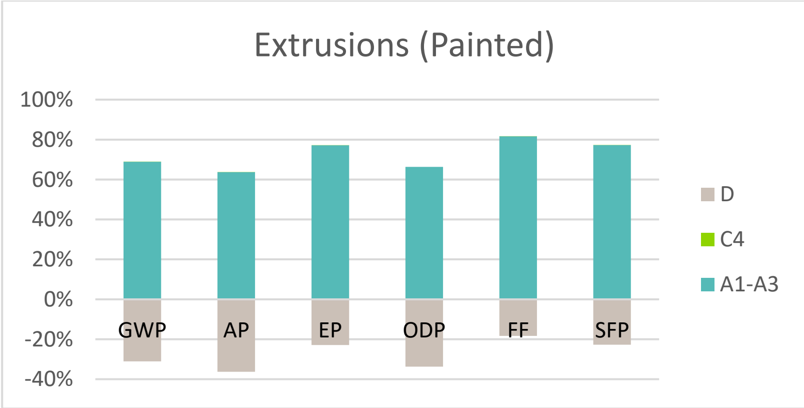
Impact Category	Unit	A1 - A3	C4*	D
Eutrophication Potential (EP)	kg N eq.	9.31E-04	5.22E-07	-3.90E-04
Ozone Layer Depletion Potential (ODP, steady state)	kg CFC 11 eq.	3.44E-10	7.35E-18	-1.66E-10
Resources, Fossil fuels (FF)	MJ LHV surplus energy	7.20E+00	4.28E-03	-2.24E+00
Smog Formation Potential (SFP)	kg O_3 eq.	3.33E-01	1.66E-04	-1.88E-01
Resource Use Indicators				
Renewable primary resources used as energy carrier (fuel) (RPRE)	MJ LHV	3.16E+01	2.80E-03	2.18E+01
Renewable primary resources with energy content used as material (RPRM)	MJ LHV	--	--	--
Non-renewable primary resources used as an energy carrier (fuel) (NRPRE)	MJ LHV	8.43E+01	3.36E-02	3.48E+01
Non-renewable primary resources with energy content used as material (NRPRM)	MJ LHV	9.50E-03	0.00E+00	0.00E+00
Renewable secondary fuels (RSF)	MJ LHV	--	--	--
Non-renewable secondary fuels (NRSF)	MJ LHV	--	--	--
Recovered energy (RE)	MJ LHV	--	--	--
Secondary material (SM)	kg	1.01E+00	0.00E+00	0.00E+00
Use of net fresh water resources (FW)	m^3	1.40E-01	4.62E-06	-1.01E-01
Output Flows & Waste Flows				
Hazardous waste disposed (HWD)	kg	2.18E-03	0.00E+00	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	5.33E-01	5.00E-02	0.00E+00
High-level radioactive waste, conditioned, to final repository (HLRW)	kg	2.32E-06	3.24E-10	-4.60E-07
Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW)	kg	1.91E-03	2.80E-07	-3.66E-04
Components for reuse (CRU)	kg	--	--	--
Materials for Recycling (MFR)	kg	5.00E-01	--	9.50E-01
Materials for Energy Recovery (MER)	kg	--	--	--
Exported Electrical Energy (EEE)	kg	--	--	--
Exported Thermal Energy (EET)	kg	--	--	--

*C3 (waste processing) is not within the scope of the study, hence the results are reported for C4

Life Cycle Assessment – Interpretation

The results represent the cradle-to-gate and end-of-life environmental performance of two types of aluminum extrusions: painted and anodized. As shown in the figures on the right, the results indicate that the impacts are dominated by the manufacturing stages (A1-A3). The primary impact is derived from aluminum production; the extrusion and finishing processes account for a relatively small part of the manufacturing impact in comparison. The painting process has 24% more impacts when compared with the anodizing process.

The credits at the end-of-life (Module D) do play a role in the life cycle; if a higher rate is used, the credit will increase, thus lowering the total life-cycle impacts. Similarly, a lower recycling rate would raise the total life cycle impacts. As new information becomes available (e.g., the Aluminum Association publishes regional-specific recycling rates), this report and EPD should be modified to reflect industry conditions.



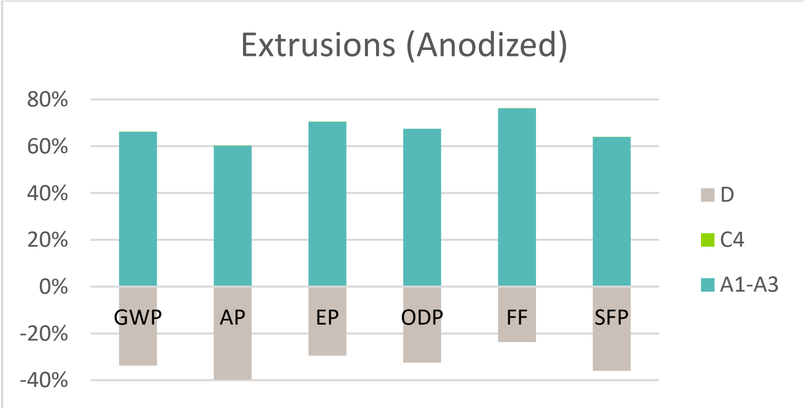


Figure 2 : Painted and anodized aluminum extrusion LCIA results (IPCC AR5 & TRACI 2.1)

(GWP = Global warming potential (IPCC); AP = Acidification potential; EP = Eutrophication potential; ODP = Stratospheric ozone layer depletion potential; FF = Resources, Fossil fuels; SFP = Smog formation potential)

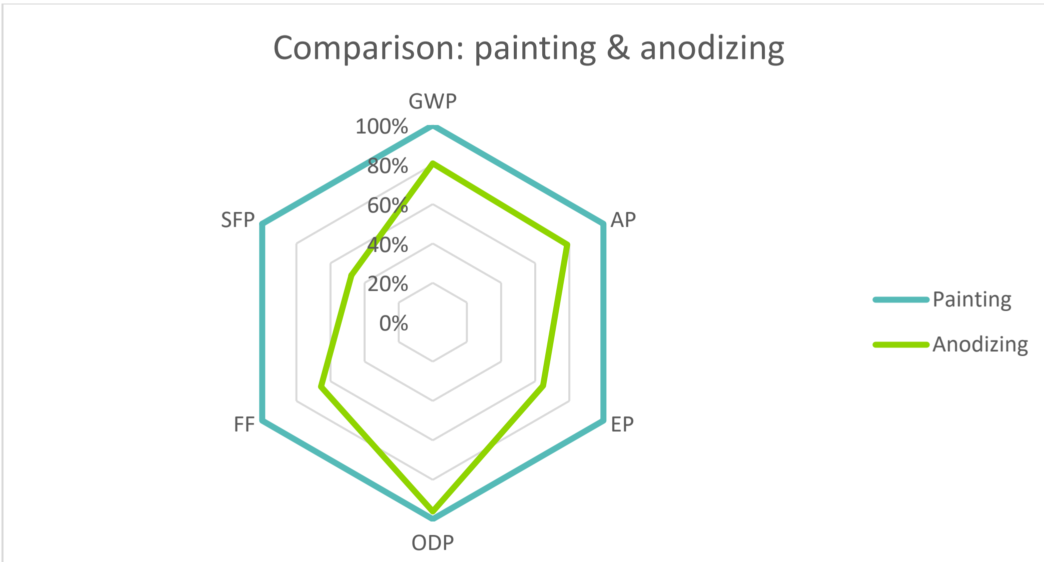


Figure 3: TRACI impacts (A1-A3) comparison between aluminum anodizing and painting processes

(GWP = Global warming potential (IPCC); AP = Acidification potential; EP = Eutrophication potential; ODP = Stratospheric ozone layer depletion potential; FF = Resources, Fossil fuels; SFP = Smog formation potential)

A comparison for between GWP and TRACI results are shown in Figure 4. For TRACI impact categories, all impacts are higher in the painting process than in the anodizing process. For CML impacts, the same trend was followed except for the abiotic depletion-ADP-elements category. The reason could be the chemicals used in the anodizing process have higher impacts than the chemicals and paints in the painting process.

The inventory indicators and waste flows are presented in the next 4 figures for painted and anodized aluminum extrusions.

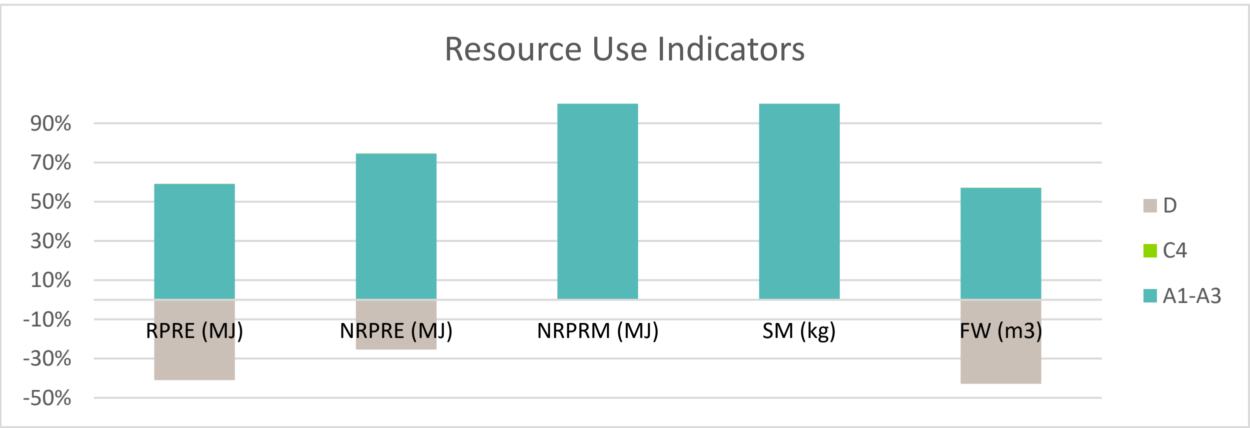


Figure 4: Painted aluminum resource use indicators (zero values are not shown in the graph)

(RPRE = Renewable primary resources used as energy carrier; NRPRE = Non-renewable primary resources used as an energy carrier; NRPRM = Non-renewable primary resources with energy content used as material; SM = Secondary material; FM = Use of net freshwater resources)

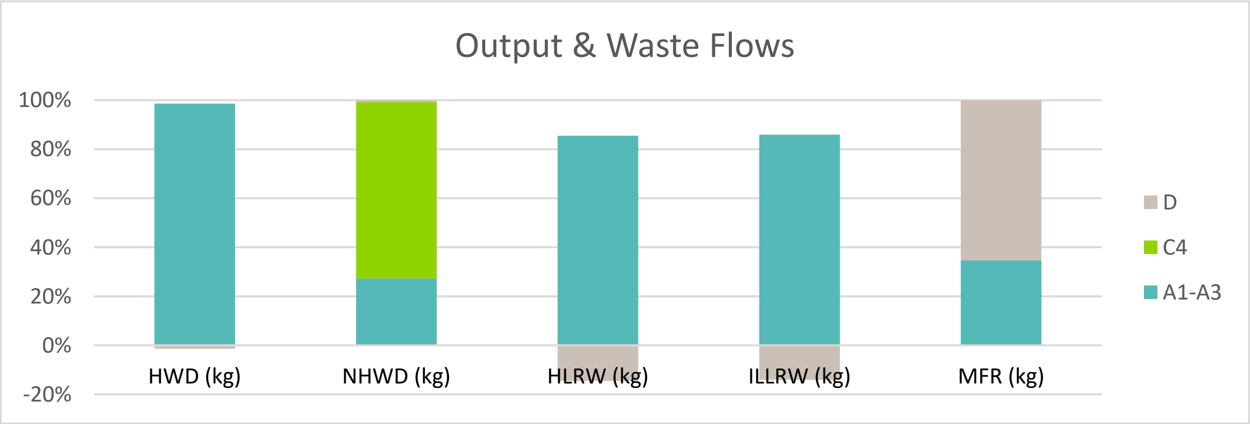


Figure 5: Painted aluminum output and waste flows (zero values are not shown in the graph)

(HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; HLRW = High-level radioactive waste; ILLRW = Intermediate- and low-level radioactive waste; MFR = Materials for Recycling)

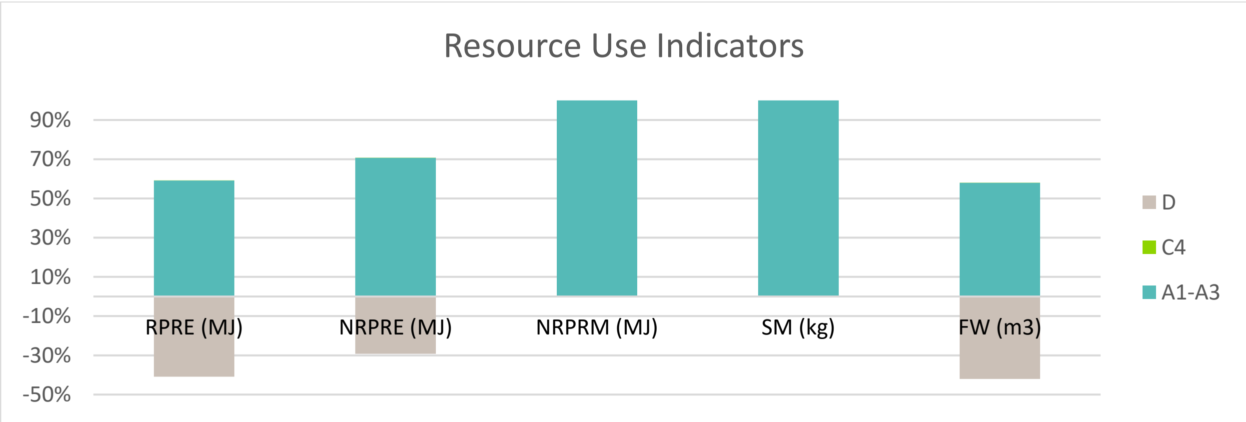


Figure 6: Anodized aluminum resource use indicators (zero values are not shown in the graph)

(RPRE = Renewable primary resources used as energy carrier; NRPRE = Non-renewable primary resources used as an energy carrier; NRPRM = Non-renewable primary resources with energy content used as material; SM = Secondary material; FM = Use of net freshwater resources)

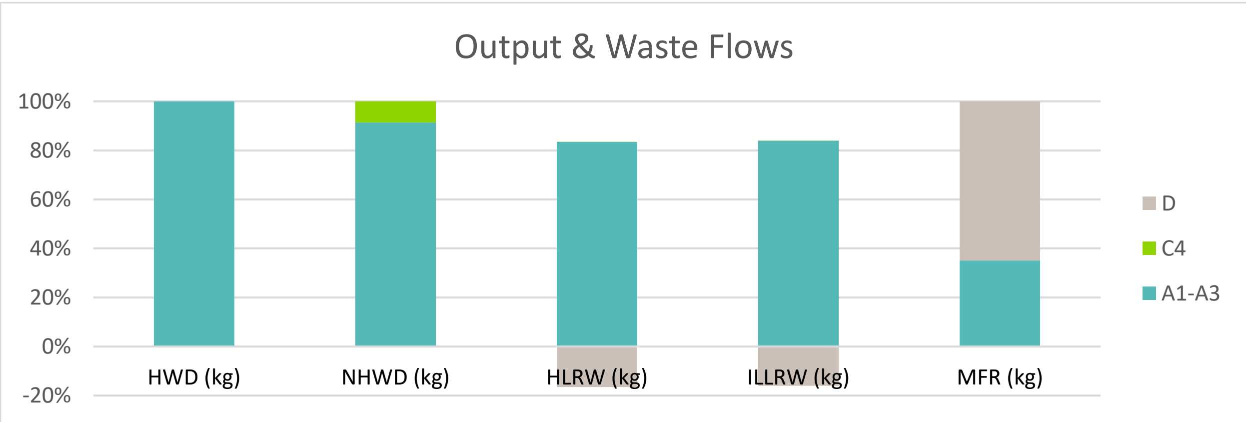


Figure 7: Anodized aluminum output and waste flows (zero values are not shown in the graph)

(HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; HLRW = High-level radioactive waste; ILLRW = Intermediate- and low-level radioactive waste; MFR = Materials for Recycling)

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