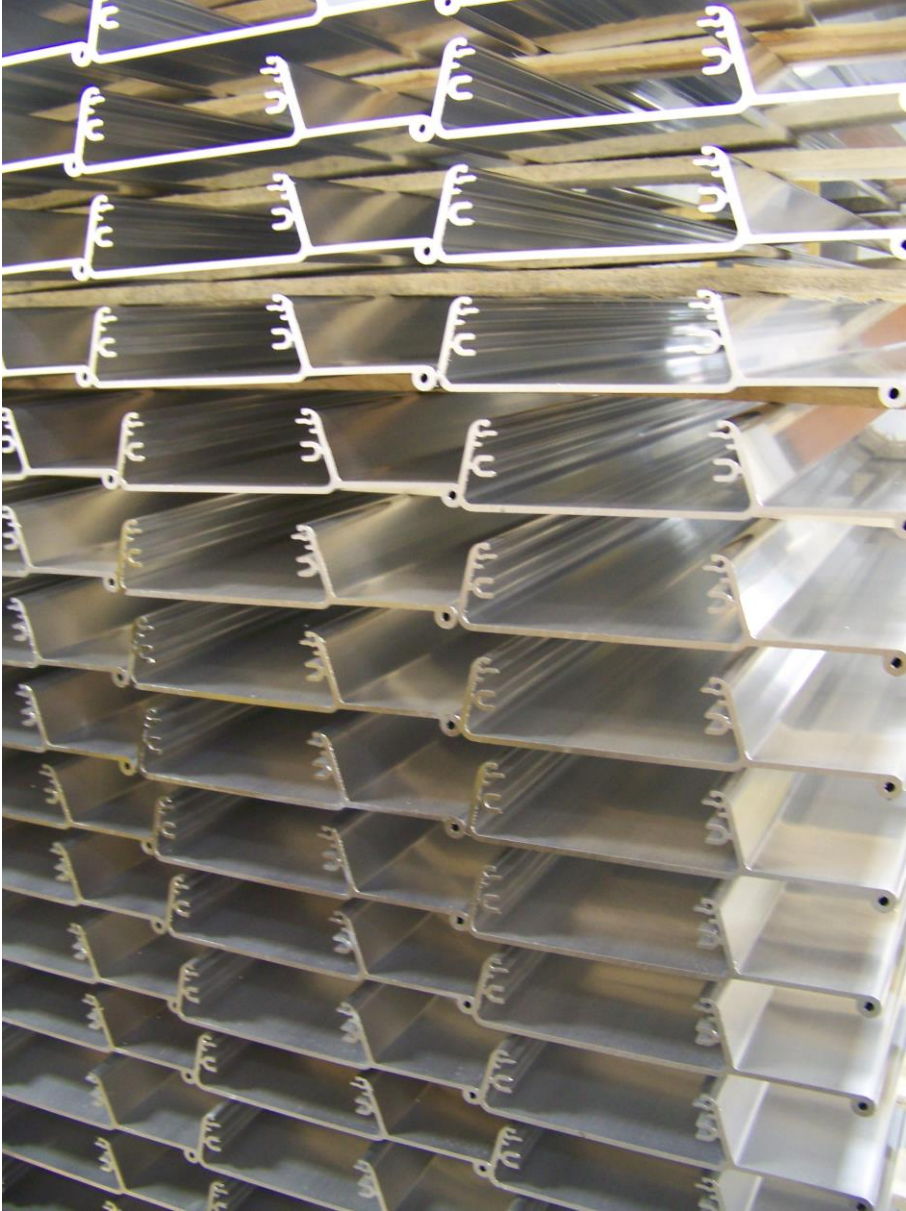


## ENVIRONMENTAL PRODUCT DECLARATION

# ALUMINUM EXTRUSIONS

MILL FINISHED, PAINTED, AND ANODIZED



Extrusions of aluminum, either mill finished, painted, or anodized, that can be used in a variety of applications and produced for a variety of cross-sections.



ALUMINUM  
EXTRUDERS  
COUNCIL

Aluminum extrusions offer engineers, architects and product designers a unique combination of attributes that can lead to outstanding product solutions. Strong, light weight, corrosion resistant, capable of complex shapes with tight tolerances and engineered performance ... and infinitely recyclable, extrusions are ideally suited to today's world.

As the trade association for the North American aluminum extrusion industry, the Aluminum Extruders Council is committed to advancing extrusion technology, promoting the effective use of extrusions, and ensuring fair trade.

In producing this first AEC industry EPD, the Council and its members demonstrate their commitment to sustainability and transparency.

Visit [www.aec.org](http://www.aec.org) for more information



# ENVIRONMENTAL PRODUCT DECLARATION





Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. 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, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.



PROGRAM OPERATOR	UL Environment	
DECLARATION HOLDER	Aluminum Extruders Council (AEC)	
DECLARATION NUMBER	11240237.101.1	
DECLARED PRODUCT	Aluminum Extrusion Products	
REFERENCE PCR	Part A: Calculation Rules for the LCA and Requirements Project Report, (IBU/UL E, V1.3, 06.19.2014), Part B: Requirements on the EPD for windows and doors (IBU, V1.7, 06.11.2014), Part B Addendum: IBU PCR for Windows and Doors (UL E, V1.0 Oct. 2015). Berlin: Institut Bauen, Umwelt.	
DATE OF ISSUE	October 4, 2016	
PERIOD OF VALIDITY	5 Years	
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications	
The PCR review was conducted by:	IBU	
	The Independent Expert Committee	
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL		
	Wade Stout, UL Environment	
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:		
	Thomas Gloria, Industrial Ecology Consultants	

# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## The Aluminum Extruders Council

The Aluminum Extruders Council (AEC), formed over 60 years ago, is the trade association for the North American aluminum extrusion industry. With approximately 60 U.S. and Canadian extruder members, and a like number of aluminum producers and other industry suppliers, the Council represents an estimated 75% of North American aluminum extrusion production.

Today the Council focuses on three distinct missions:

- Promoting the effective application of aluminum extrusions to solve product challenges in a wide range of industries. Whether helping create more energy efficient buildings, improving automotive performance, facilitating the transition to LED lighting, or advancing products in a wide range of other industries, extrusions are playing a major role.
- Advancing extrusion technology, via member training, networking, benchmarking, best-practice sharing and research & development projects and conferences.
- Ensuring fair trade.

The information in this document is based on information supplied by 11 AEC member companies in the U.S. and Canada who have joined together to produce the first comprehensive industry-wide environmental product declaration (EPD) for aluminum extrusion. The data comes from 30 separate production facilities, with a total of over 85 extrusion presses, 12 anodizing facilities, 10 paint facilities (liquid and powder), 4 thermal management operations and 12 cast houses that produce scrap-based extrusion billet. In aggregate, the facilities in the data base produced 1.7 billion pounds of extrusion in 2015 (the subject year), about 1/3 of total North American production for the year.

## Participating Companies



Aerolite Extrusion  
Company  
aeroext.com



Jordan Aluminum Extrusions  
jordanextrusion.com



Pennex Aluminum Company, LLC  
pennexaluminum.com



Alexandria Industries  
alexandriaindustries.com



Sapa Extrusions North America  
sapagroup.com/na



Almag Aluminum, Inc.  
almag.com



Sierra Aluminum  
sierraaluminum.com



Apel Extrusions Limited  
apeextrusions.com



Tri-City Extrusion  
tricityextrusion.com



Bonnell Aluminum  
bonnalum.com



Western Extrusions Corp.  
westernextrusions.com



# ENVIRONMENTAL PRODUCT DECLARATION



ALUMINUM  
EXTRUDERS  
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Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## Product

### Product Description

This EPD covers the production of non-thermally enhanced aluminum extrusions, including mill finished, painted (liquid and powder paint), and anodized. It excludes downstream fabrication operations such as tight-tolerance cutting, machining, and assembly due to the wide diversity of such operations.

The results are a production-weighted average that is representative of all extruded aluminum products produced in North America (U.S. and Canada).

### Applications

Aluminum extrusions are utilized in a wide variety of market sectors, including:

- *Building and construction:* windows, doors, curtain walls, façade systems, skylights, canopies, louvers, light shelves, interior partitions, bridges, etc.
- *Transportation:* automotive structural and chassis components, crash management systems, auto body and trim components, truck and trailer components, rail passenger and freight car components, etc.
- *Electrical and energy:* electronics housings and heat sinks, LED lighting components, solar energy mounting and racking systems, cable raceways, conduit, etc.
- *Medical and consumer durables:* components of recreation products, home & garden tools, appliances, ambulatory care products, medical diagnostic equipment, etc.

### Technical Data

Technical data is representative of 6000 series alloy (6xxx alloy, tempers T1-T6), which is the predominant production of the participants.

Name	Value	Unit
Density	2.66 – 2.84	(kg/m <sup>3</sup> ) x 10 <sup>3</sup>
Melting point (typical)	475 – 655	°C
Electrical conductivity (typical) at 20°C / 68°F	Equal volume: 16 – 36	Ms/m (0.58 x %IACS)
Thermal conductivity (typical) at 25°C / 77°F	170 – 210	W/m·K
Average coefficient of thermal expansion (typical) 20°C to 100°C / 68°F to 212°F	22.3 – 23.9	per °C
Modulus of elasticity (typical)	69 – 73	MPa x 10 <sup>3</sup>
Hardness (typical)	40 – 95 (47 – 96)	HB (Rockwell E)
Yield strength (min)	60 – 330	MPa
Ultimate tensile strength (min)	120 – 370	MPa
Breaking elongation (min) (50mm & 4D)	>4	%
Chemical composition	Varying by alloy, Al 96.2 – 98.6	% by mass



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## Application Rules

**ASTM B221-13/B221M-13** Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

**ASTM B241/B241M-12e1** Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

**ASTM B317/B317M-07** Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)

**ASTM B429/B429M-10e1** Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

**ASTM B491/B491M-06** Standard Specification for Aluminum and Aluminum-Alloy Extruded Round Tubes for General-Purpose Applications

**AAMA 611-12** Specification for test Procedures and Requirements for Class I and Class II architectural quality aluminum oxide coatings applied to aluminum extrusions and panels

**AAMA 603.6-72** Performance Requirement and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum (includes AAMA 2603, AAMA 2604 and AAMA 2605)

**AAMA 603.6-67** Specification for Organic Coatings for Aluminum Extruded Products

## Delivery Status

The output of the extrusion process is a semi-fabricated and surface finished extrusion product, ready for additional fabrication or transportation to a component or final product manufacturer. Most North American extrusions are custom designs for specific end-use applications; they do not have standard dimensions except as specified by the consumer.

## Base and Ancillary Materials

Extruded aluminum products produced in North America typically contain a considerable proportion of metal recycled from aluminum scrap. The average metal composition of North American products, based on metal feedstock information collected from the companies participating in this EPD, is as follows:

Table 1: Metal composition

Category of Metal Source	Percentage (by mass)
Primary Metal (including alloying agents)	45.8%
Recovered Aluminum from Post-Industrial (Pre-Consumer) Scrap	40.6%
Recovered Aluminum from Post-Consumer Scrap	13.6%

The definitions for post-industrial and post-consumer aluminum scrap are consistent with ISO 14021/25 and the related interpretations by UL Environment. Post-industrial scrap typically includes extrusion drop-offs from cutting, off-spec material, and scrap generated during subsequent processing by extruders or customers. Post-consumer scrap is scrap that has been used for an intended application as part of a previous product life cycle. It often includes aluminum wheels, wire, and reclaimed material from building demolition or renovation.

Extruded aluminum products produced for different customers, applications, and market sectors may vary substantially in metal composition, ranging from 100% primary aluminum to nearly 100% aluminum scrap. There is no relevant chemical composition difference between primary and scrap-based product if both are governed by the same alloy designation and chemical composition limit standards.



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

Extruded aluminum products may also include various coatings, including anodized and painted finishes; extruded products with those coatings are shown separately in this inventory.

## Manufacture

### Extrusion

The production stage starts with extraction and processing of aluminum ingot, billet, and ancillary materials, followed by the transportation of these materials to the plant.

The extrusion manufacturing process, as shown in Figure 1, takes cast extrusion billet (round bar stock, produced from direct chill molds and typically ranging in diameter from 6 to 14 inches, depending on the extrusion press on which it will be processed) and produces extruded profiles. The process begins with an inline preheat furnace that elevates the temperature of the billet to a predetermined level, depending on the alloy. If not already cut to length, the billet is then sheared and placed into a hydraulic press, which then forces the semi-plastic billet through a heated steel die to form the desired shape. The length of the resulting extrusion is dictated by the take-off tables. The extrusions are air cooled or water quenched, with specific quench parameters dependent on alloy and desired properties. The extrusion is then clamped and stretched to straighten the profile.

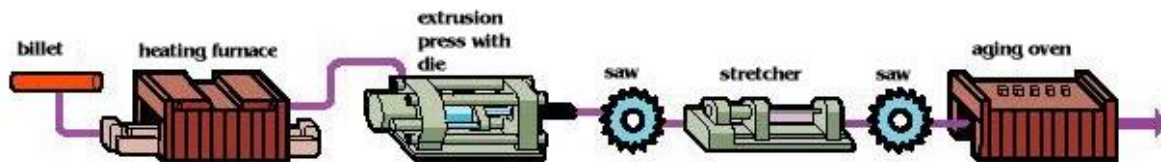


Figure 1: Extrusion process schematic

The straightened lengths are cut to intermediate or final length multiples and then typically aged in an aging oven to achieve the desired temper. Subsequently, the profile lengths are packed for shipment, finished with anodized, painted, or mechanical finishes, and/or further fabricated (e.g. cut to smaller, precise lengths, thermally enhanced, machined, bent, punched, etc.) The extent and sequence of these subsequent operations will be dependent on specific customer specifications. Any further fabrication as noted above is outside the scope of this EPD, as is any finishing (painting or anodizing) performed by a remote, third-party service provider.

Any production scrap generated during the extrusion and surface-treatment processes is collected and sent either to the company's own cast house or to recycling facilities; in the LCA model, a credit is applied for recycled scrap which is equivalent to primary aluminum less recycling operations (e.g., cleaning, re-melting, and casting).

### Painting

Extrusions to be painted are typically cleaned and then treated with a pre-coat in either a vertical or horizontal paint booth. Depending on the ultimate paint performance desired, a variety of pre-coats and primers may be employed. After pre-treatment, the extrusions will be coated with a liquid or powder paint and baked. Various paint formulations may be used depending on the desired performance.

### Anodization

If extrusions are to be anodized, they are cleaned and etched (with either caustic or acid etch) in a series of baths. Subsequently, they are immersed in an acid electrolyte bath and an electrical current is passed through the solution. A cathode is mounted to the inside of the anodizing tank, while the aluminum extrusions act as an anode. Oxygen ions are released from the electrolyte and combine with aluminum atoms at the surface of the extrusion being anodized, thereby creating a durable aluminum oxide layer fully integrated with the underlying aluminum. Organic or inorganic



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

colorants can subsequently be added. The final step is a sealing stage to enhance durability.

## Manufacturing Locations

The members who participated in this study produce aluminum extrusions across the United States and Canada, as shown in Figure 2.

## Environmental and Health during Manufacturing

**Air:** Hazardous air emission releases from the extrusion and finishing processes comply with regulatory thresholds.

**Water/Soil:** Pollutants in wastewater discharge comply with regulatory thresholds.

**Noise:** Due to adequate acoustical absorption and mitigation devices, measurements of sound levels have shown all values inside and outside the production plant comply with regulatory thresholds.



Figure 2: Locations of production

## Product Processing and Installation

Any fabrication, further processing (other than anodizing or painting), assembly and/or installation of extruded aluminum products is dependent on application and customer specification, and is outside the scope of this EPD.

## Packaging

Aluminum extrusions are packaged for delivery using:

- Wood or plastic pallets
- Plastic film (polyethylene)
- Foam (polyurethane)
- Linerboard
- Steel or plastic strapping
- Lumber
- Reusable totes

Packaging is often per customer specification. All packaging materials are recyclable and/or reusable following delivery to the customer. Packaging materials are included in the scope of this EPD; packaging disposal, however, is outside the scope.

## Condition of Use

No special conditions of use are relevant under the scope of this EPD

## Environment and Health During Use

The environmental and health effects during use are dependent on the ultimate processing and use of the extruded aluminum, and consequently are outside the scope of this EPD.



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## Reference Service Life

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Service lives for aluminum extrusions will vary depending on the application, but is typically long due to aluminum's high corrosion resistance. This EPD does not cover the product use stage and therefore makes no specific claims regarding typical service lives.

## Extraordinary Effects

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**Fire:** Aluminum extrusions comply with all local and federal laws with respect to fire hazards and control.

**Water:** There is no evidence to suggest water runoff or exposure under normal and intended operation will violate general water quality standards.

**Mechanical destruction:** Not relevant for aluminum extrusions

## Recycling and Disposal

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Aluminum extrusions are highly recyclable. During extrusion manufacturing, most process and new scrap is fed back into the billet production process. At the end of life, aluminum scrap is collected and sold—via a well-established infrastructure—to secondary smelting operations for billet production. Numerous extruders operate their own secondary smelting facilities in addition to purchasing billet from independent secondary smelters.

The recycling rate for aluminum products has proven to be quite high, with recycling rates of 90-95% documented in high volume automotive and construction sectors.

## Life Cycle Assessment

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### Declared Unit

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The declared unit is *one metric ton (1,000 kg) of extruded aluminum*, including the optional surface treatments, painting and anodization.

### System boundary

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This cradle-to-gate with options analysis provides information on the Product Stage of the aluminum product life cycle, including modules A1-A3, plus disposal at end-of-life module C4 along with a credit for recycling in future product systems module D.





# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

Production			Installation		Use stage							End-of-Life				Next product system	
Raw material supply (extraction, processing)	Transport to manufacturer	Manufacturing	Transport to building site	Installation into building	Use / application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to EoL	Waste processing for reuse, recovery or recycling	Disposal	Reuse, recovery or 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	MND	X	X

X = declared module; MND = module not declared

Table 2: Life cycle modules included in EPD

## Estimates and assumptions

Anodization chemicals were modeled based on the masses available in technical data sheets (TDS) and safety data sheets (SDS). In cases where these masses were incomplete, missing data were estimated based on best available data and expert judgement.

Because thousands of different paints are used in the production of painted aluminum extrusions, paints were modeled based on a representative paint product for the three major paint families: polyvinylidene fluoride (PVDF), acrylic, and polyester.

It was not always possible to distinguish intermediate flows between extrusion and the finishing steps. One example of this is packaging. In order to avoid double counting of packaging impacts, total packaging inputs for extrusion, anodization, and painting processes were aggregated in the extrusion process.

Transport for ancillary materials was not included.

Data was only available for primary and secondary aluminum ingot. To ensure that the correct recycled content of purchased aluminum billet was modeled, an approach as shown in Figure 3 was taken. All scrap was modeled as burden free when entering the system. When a company provided data for their own cast house, primary and secondary ingot and aluminum scrap were entered into the cast house model in the amounts provided. When companies did not provide data for their own billet production, primary ingot was modeled with the Aluminum Association North American dataset (or the International Aluminum Institute “Rest of World” dataset for non-domestic sources), and secondary billet was modeled with a ratio of primary ingot and aluminum scrap corresponding to the recycled content of the billet. Both primary ingot and aluminum scrap went through a remelting process. When companies were not able to provide the recycled content of their purchased secondary billet, an assumption was made based on the industry average.



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

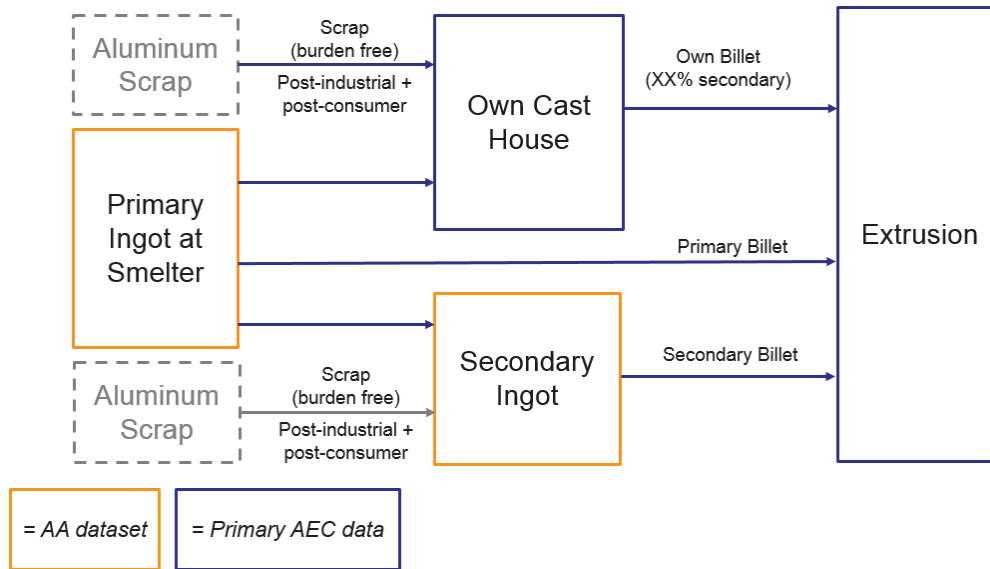


Figure 3: Secondary billet modeling approach

## Cut-off criteria

As required by EN 15804, in case of insufficient input data or data gaps for a unit process, the cut-off criteria were 1% of renewable and non-renewable primary energy usage, and 1% of the total mass input of that unit process. The total of neglected input flows per module was a maximum of 5% of energy usage and mass.

In practice, all inputs and outputs, for which data are available, have been included in the calculation. Data gaps have been filled by conservative assumptions with average or generic data.

## Background Data

In order to model the life cycle for the production and recycling of the extruded aluminum, the GaBi Professional software system developed by thinkstep AG was used. All relevant background data necessary for the production of extruded aluminum were taken from the GaBi 2016 databases.

## 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 2016 databases. The data for aluminum billet, as well as externally sourced aluminum extrusions, are based on 2010 Aluminum Association studies and are the best available. Other life cycle inventory (LCI) datasets were sourced from the GaBi 2016 databases and are representative of years 2007-2015.

LCI datasets from the GaBi 2016 databases are widely distributed and used with the GaBi Professional Software. The datasets have been used in LCA models worldwide, in industrial and scientific applications, and in internal as well as in

# ENVIRONMENTAL PRODUCT DECLARATION



## Aluminum Extrusions

Products of Aluminum and Aluminum Alloys

According to ISO 14025

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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.

### Period under review

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Primary data were collected on production within calendar year 2015. Background data for upstream and downstream processes (i.e., raw materials, energy resources, transportation, and ancillary materials) were obtained from the GaBi 2016 databases.

### Allocation

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The recycling potential was calculated according to the requirement of the German Institute Construction and Environment (IBU) e.V. PCR document "Construction Metals". The methodology quantifies the environmental burden avoided in relation to production of the virgin material (here, the avoidance of primary aluminum production). An estimated 100% of aluminum extrusions are recycled at the end of life. However, at this point 95% represents a defensible recycling rate for aluminum extrusion products in the building and transportation sectors, so this rate was used and it was assumed that the remaining 5% goes to landfill. No co-products are generated from the production process.

### Comparability

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A comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to EN 15804 and the building context, and if the product-specific characteristics of performance are taken into account.



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## Life Cycle Assessment: Results

### Mill finished aluminum extrusion

Results given per one metric ton of product.

#### ENVIRONMENTAL IMPACTS

CML 2001 (v4.1)

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
GWP	kg CO <sub>2</sub> eq	7,510	2.24	-4,910
ODP	kg CFC-11 eq	8.27E-07	4.29E-11	-2.08E-07
AP	kg SO <sub>2</sub> eq	49.2	0.00970	-35.1
EP	kg PO <sub>4</sub> <sup>3</sup> eq	2.74	0.00124	-1.45
POCP	kg C <sub>2</sub> H <sub>4</sub> eq	2.71	9.84E-04	-1.76
ADPE	kg Sb eq	0.00494	8.59E-07	-0.00263
ADPF	MJ	78,400	33.9	-45,200

TRACI 2.1

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
GWP	kg CO <sub>2</sub> eq	7,510	2.26	-4,900
ODP	kg CFC-11 eq	8.90E-07	4.56E-11	-2.21E-07
AP	kg SO <sub>2</sub> eq	46.5	0.0104	-32.3
EP	kg N eq	1.03	5.81E-04	-0.519
SP	kg O <sub>3</sub> eq	457	0.203	-250
FF	MJ	6,970	4.35	-2,990

#### RESOURCE USE

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
PERE	[MJ]	32,200	2.20	-29,100
PERM	[MJ]	-	-	-
PERT	[MJ]	32,200	2.20	-29,100
PENRE	[MJ]	82,300	35.0	-46,400
PENRM	[MJ]	-	-	-
PENRT	[MJ]	82,300	35.0	-46,400
SM	[kg]	709	-	-
RSF	[MJ]	-	-	-
NRSF	[MJ]	-	-	-
FW	[m <sup>3</sup> ]	128	0.00535	-127

#### OUTPUT FLOWS AND WASTE CATEGORIES

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
HWD	[kg]	0.727	6.66E-08	-0.464
NHWD	[kg]	1,810	50.1	-1,570
RWD	[kg]	1.59	0.000354	-0.489
CRU	[kg]	-	-	-
MFR	[kg]	380	-	950
MER	[kg]	-	-	-
EE	[MJ]	-	-	-

#### Glossary

##### Environmental Impacts

GWP	Global warming potential
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential of land and water
EP	Eutrophication potential
POCP	Formation potential of tropospheric ozone photochemical oxidants
ADPE	Abiotic depletion potential for non fossil resources
ADPF	Abiotic depletion potential for fossil resources
FF	Fossil fuel consumption

##### Resource Use

PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PENRE	Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials
PENRM	Use of non renewable primary energy resources used as raw materials
PENRT	Total use of non renewable primary energy resources
SM	Use of secondary material
RSF	Use of renewable secondary fuels
NRSF	Use of non renewable secondary fuels
FW	Use of net fresh water

##### Output Flows and Waste Categories

HWD	Hazardous waste disposed
NHWD	Non hazardous waste disposed
RWD	Radioactive waste disposed
CRU	Components for re-use
MFR	Materials for recycling
MER	Materials for energy recovery
EE	Exported energy per energy carrier



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## Painted aluminum extrusion

Results given per one metric ton of product.

### ENVIRONMENTAL IMPACTS

CML 2001 (v4.1)

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
GWP	kg CO <sub>2</sub> eq	8,900	2.24	-5,310
ODP	kg CFC-11 eq	9.43E-05	4.29E-11	-2.25E-07
AP	kg SO <sub>2</sub> eq	54.6	0.00970	-37.9
EP	kg PO <sub>4</sub> <sup>3</sup> eq	3.18	0.00124	-1.57
POCP	kg C <sub>2</sub> H <sub>4</sub> eq	4.05	9.84E-04	-1.90
ADPE	kg Sb eq	0.00685	8.59E-07	-0.00285
ADPF	MJ	97,500	33.9	-48,900

TRACI 2.1

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
GWP	kg CO <sub>2</sub> eq	8,910	2.26	-5,300
ODP	kg CFC-11 eq	4.46E-05	4.56E-11	-2.39E-07
AP	kg SO <sub>2</sub> eq	51.9	0.0104	-34.9
EP	kg N eq	1.24	5.81E-04	-0.561
SP	kg O <sub>3</sub> eq	529	0.203	-270
FF	MJ	9,160	4.35	-3,230

### RESOURCE USE

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
PERE	[MJ]	35,200	2.20	-31,400
PERM	[MJ]	-	-	-
PERT	[MJ]	35,200	2.20	-31,400
PENRE	[MJ]	102,000	34.8	-50,200
PENRM	[MJ]	-	-	-
PENRT	[MJ]	102,000	34.8	-50,200
SM	[kg]	764	-	-
RSF	[MJ]	-	-	-
NRSF	[MJ]	-	-	-
FW	[m <sup>3</sup> ]	140	0.00535	-137

### OUTPUT FLOWS AND WASTE CATEGORIES

Parameter	Unit	Manufacturing	End-of-Life	Credits
		A1-A3	C4	D
HWD	[kg]	0.783	6.66E-08	-0.502
NHWD	[kg]	2,000	50.1	-1,690
RWD	[kg]	1.96	0.000354	-0.528
CRU	[kg]	-	-	-
MFR	[kg]	485	-	950
MER	[kg]	-	-	-
EE	[MJ]	-	-	-

### Glossary

#### Environmental Impacts

GWP	Global warming potential
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential of land and water
EP	Eutrophication potential
POCP	Formation potential of tropospheric ozone photochemical oxidants
ADPE	Abiotic depletion potential for non fossil resources
ADPF	Abiotic depletion potential for fossil resources
FF	Fossil fuel consumption

#### Resource Use

PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PENRE	Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials
PENRM	Use of non renewable primary energy resources used as raw materials
PENRT	Total use of non renewable primary energy resources
SM	Use of secondary material
RSF	Use of renewable secondary fuels
NRSF	Use of non renewable secondary fuels
FW	Use of net fresh water

#### Output Flows and Waste Categories

HWD	Hazardous waste disposed
NHWD	Non hazardous waste disposed
RWD	Radioactive waste disposed
CRU	Components for re-use
MFR	Materials for recycling
MER	Materials for energy recovery
EE	Exported energy per energy carrier



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

According to ISO 14025

## Anodized aluminum extrusion

Results given per one metric ton of product.

### ENVIRONMENTAL IMPACTS

CML 2001 (v4.1)

Parameter	Unit	Manufacturing		End-of-Life	Credits
		A1-A3	C4	C4	D
GWP	kg CO <sub>2</sub> eq	9,060		2.24	-5,070
ODP	kg CFC-11 eq	1.10E-06		4.29E-11	-2.15E-07
AP	kg SO <sub>2</sub> eq	56.1		0.00970	-36.2
EP	kg PO <sub>4</sub> <sup>3</sup> eq	3.47		0.00124	-1.50
POCP	kg C <sub>2</sub> H <sub>4</sub> eq	3.18		9.84E-04	-1.81
ADPE	kg Sb eq	0.01180		8.59E-07	-0.00272
ADPF	MJ	99,600		33.9	-46,600

TRACI 2.1

Parameter	Unit	Manufacturing		End-of-Life	Credits
		A1-A3	C4	C4	D
GWP	kg CO <sub>2</sub> eq	9,070		2.26	-5,060
ODP	kg CFC-11 eq	1.18E-06		4.56E-11	-2.28E-07
AP	kg SO <sub>2</sub> eq	53.3		0.0104	-33.4
EP	kg N eq	1.56		5.81E-04	-0.536
SP	kg O <sub>3</sub> eq	515		0.203	-258
FF	MJ	9,200		4.35	-3,080

### RESOURCE USE

Parameter	Unit	Manufacturing		End-of-Life	Credits
		A1-A3	C4	C4	D
PERE	[MJ]	34,400		2.20	-30,000
PERM	[MJ]	-		-	-
PERT	[MJ]	34,400		2.20	-30,000
PENRE	[MJ]	106,000		35	-47,900
PENRM	[MJ]	-		-	-
PENRT	[MJ]	106,000		35	-47,900
SM	[kg]	729		-	-
RSF	[MJ]	-		-	-
NRSF	[MJ]	-		-	-
FW	[m <sup>3</sup> ]	140		0.00535	-131

### OUTPUT FLOWS AND WASTE CATEGORIES

Parameter	Unit	Manufacturing		End-of-Life	Credits
		A1-A3	C4	C4	D
HWD	[kg]	0.820		6.66E-08	-0.479
NHWD	[kg]	2,110		50.1	-1,620
RWD	[kg]	2.44		0.000354	-0.504
CRU	[kg]	-		-	-
MFR	[kg]	419		-	950
MER	[kg]	-		-	-
EE	[MJ]	-		-	-

### Glossary

#### Environmental Impacts

GWP	Global warming potential
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential of land and water
EP	Eutrophication potential
POCP	Formation potential of tropospheric ozone photochemical oxidants
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PENRM	Use of non renewable primary energy resources used as raw materials
PENRT	Total use of non renewable primary energy resources
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# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
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## Life cycle assessment: Interpretation

The results represent the cradle-to-gate and end-of-life environmental performance of aluminum extrusions with the three finishing options: mill finished, painted, and anodized. The primary drivers of the burden for all three products are the inputs of aluminum—specifically, primary and secondary billet purchases, as well as billet coming from companies’ own cast houses, which produce billets from a mix of primary and secondary ingot and scrap. The extrusion and processes account for a relatively small part of the manufacturing impact. The painting process represents up to 20% of the total burden, with the exception of ODP, for which it represents the majority of the impact due to the use of PVDF paint. Anodization contributes between 6% and 19% to total burdens and is driven by the electricity and thermal energy inputs.

The recycling rate of 95% represents a defensible rate for aluminum extrusion products. This is based on a conservative calculation for global aluminum recycling the building and transportation sectors. The credits at the end-of-life (Module D) are significant in the life cycle; if a higher rate is used, the credit will increase. 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.

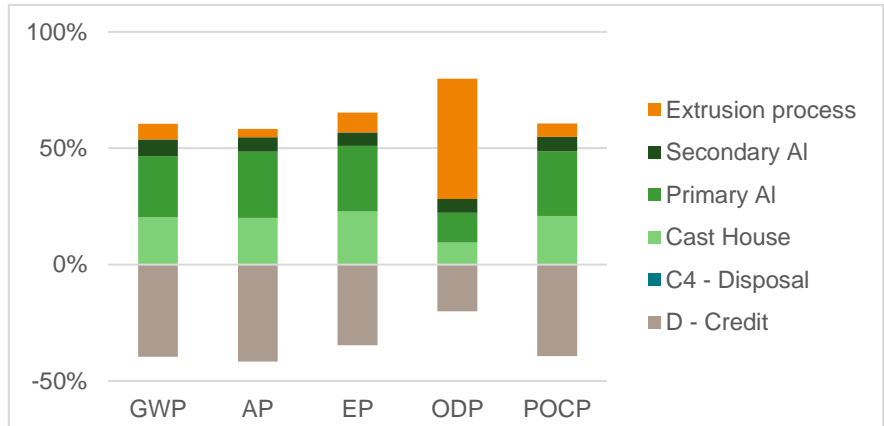


Figure 4: Mill finished extrusion, relative results

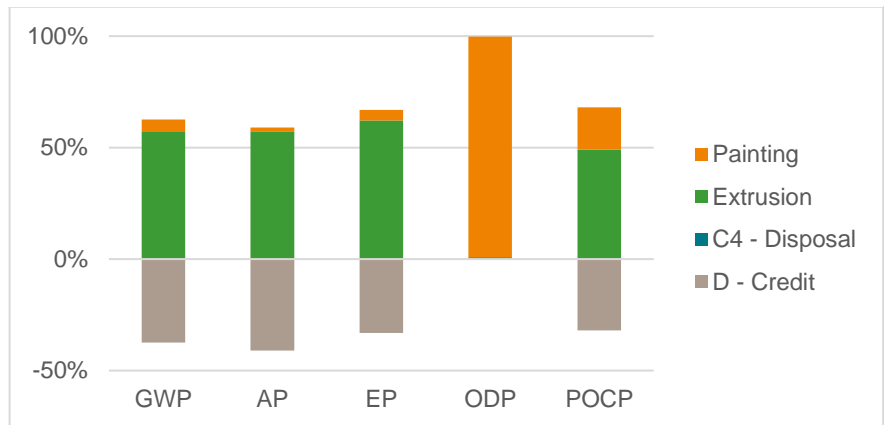


Figure 5: Painted extrusion, relative results

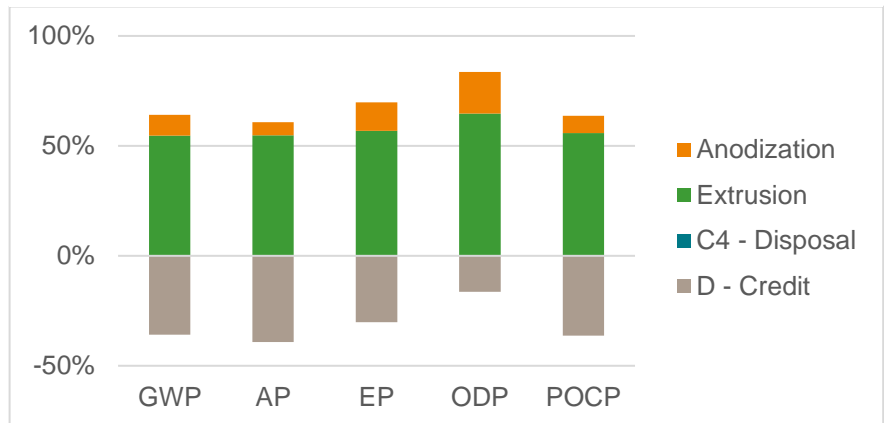


Figure 6: Anodized extrusion, relative results



# ENVIRONMENTAL PRODUCT DECLARATION



Aluminum Extrusions  
Products of Aluminum and Aluminum Alloys

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## References

- Aluminum Association. (2013). Environmental Product Declarations for Extruded Aluminum. ULE.
- IBU. (2014). Part B: Products of aluminium and aluminium alloys.
- ISO. (2006). ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines.
- ISO. (2009). ISO 14040: Environmental management - Life cycle assessment - principles and frameworks.
- ISO. (2011). ISO 14025: Environmental labels and declarations - Type III environmental declarations - principles and procedures.
- thinkstep. (2016). GaBi LCA Database Documentation. Retrieved from thinkstep AG: <http://www.gabi-software.com/international/databases/gabi-databases/>
- thinkstep. (2016). GaBi ts: Software system and database for life cycle engineering. Stuttgart, Echterdingen, Germany.
- UL Environment. (2014). Product Category Rules for Building-Related Products and Services. Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project report.
- UL Environment. (2015). PCR Addendum for IBU Part B: Products of aluminium and aluminium alloys.

## Contact Information

### Study Commissioner



Aluminum Extruders  
Council  
1000 N. Rand Rd.  
Suite 214  
Wauconda, IL 60084  
+1 (847) 526-2010  
[mail@aec.org](mailto:mail@aec.org)  
[www.aec.org](http://www.aec.org)

### LCA Practitioner



thinkstep

thinkstep, Inc.  
170 Milk St, 3rd floor  
Boston, MA 02109  
+1 (617) 247-4477  
[info@thinkstep.com](mailto:info@thinkstep.com)  
[www.thinkstep.com](http://www.thinkstep.com)