ENVIRONMENTAL PRODUCT DECLARATION

EXTRUDED ALUMINUM

INDUSTRY-AVERAGE EXTRUDED ALUMINUM MANUFACTURED IN NORTH AMERICA

The Aluminum Association

The Aluminum Association and the aluminum industry are committed to responsible environmental stewardship. Aluminum is one of the most sustainable materials in use today:

- Strong and lightweight: Aluminum's favorable strength-to-weight ratio means it can be substituted for heavier materials, driving energy efficiency.
- Infinitely recyclable: Aluminum can be recycled over and over again without losing any of its fundamental properties.
- Efficiency improvements: Through voluntary industry efforts, the North American aluminum industry has reduced the carbon footprint of primary aluminum production by 49 percent since 1991.
- Corrosion-resistant: Durable aluminum lasts longer than many competing materials, limiting the need for replacement.
- Highly recycled: Aluminum is one of the most recycled materials on the market today. And production recycled aluminum takes just 7 percent of the energy needed to make primary aluminum.

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

The Aluminum Association

Extruded Aluminum
Aluminum Construction Product

According to ISO 14025 and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfingsten Road Northbrook, IL 60611 WWW.UL.COM www.spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Program Operator Rules v2.7 2022
MANUFACTURER NAME AND ADDRESS	The Aluminum Association 1400 Crystal Drive, Suite 430, Arlington, VA 22202
DECLARATION NUMBER	4790545973.104.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Extruded aluminum, one metric ton (1000 kg)
REFERENCE PCR AND VERSION NUMBER	ULE PCR Part A – Product Category Rules for Building-Related Products and Services v4 ULE PCR Part B – Aluminum Construction Products v1.0
DESCRIPTION OF PRODUCT'S INTENDED APPLICATION AND USE	Extruded aluminum for use in building applications
PRODUCT RSL DESCRIPTION (IF APPL.)	n/a
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	September 27, 2022
PERIOD OF VALIDITY	5 Years
EPD TYPE	Industry-average
RANGE OF DATASET VARIABILITY	Industry-average only
EPD SCOPE	Cradle to gate with end-of-life options (C1-C4 and D)
YEAR(S) OF REPORTED PRIMARY DATA	2015-2019
LCA SOFTWARE & VERSION NUMBER	GaBi 10.6.1.35
LCI DATABASE(S) & VERSION NUMBER	GaBi 2020.1 (CUP 2020.1)
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR5 (GWP), TRACI 2.1 and CML v4.2

The PCR review was conducted by:	UL Environment PCR Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Environment
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability
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

The Aluminum Association represents aluminum production and jobs in the United States, ranging from primary production to value added products to recycling, as well as suppliers to the industry. The association is the industry's leading voice, representing companies that make 70% of the aluminum and aluminum products shipped in North America.

Based in the Washington, D.C. area, the association is the U.S. industry's leading voice — developing global standards, business intelligence, sustainability research and industry expertise for member companies, policymakers and the general public (AA, 2022).

Product Description

Product Identification

This EPD covers the production of semi-fabricated and surface-finished aluminum extrusion products. The results represent an average across all extruded aluminum products manufactured in North America (United States and Canada). Averages are obtained thorugh aggregating production-weighted data from the participating member companies.

Product Specification

Name	Value	Unit
Density	2.66-2.84	$(kg/m^3) \times 10^3$
Melting point (Typical)	475-655	°C
Electrical conductivity (Typical) at 20°C/at 68˚F	Equal Volume:16-36	MS/m (0.58*%IACS)
Thermal conductivity (Typical) at 25˚c/at 77˚F	113-234	W/(m.K)
Average Coefficient of thermal expansion (Typical) 20˚ to 100˚c /68° to 212°F	22.3-23.9	per ˚C
Modulus of elasticity (Typical)	69-73	$MPa * 10^3$

Product Average

This EPD covers the production of extruded aluminum from Aluminum Association participating companies. The list of participating members is available in the full report produced by the Aluminum Association in January 2022 (AA, 2022).

Application

Extruded aluminum is used in a variety of market sectors, including the following:

- Transportation: automobile structures and components, truck and trailer structures and components, train structure and components, aircraft structure and components, etc.
- Building, construction and infrastructure: building windows, doors, curtain walls, facades, skylights, green houses, roof structures, furniture and decorations, solar device frames and structures, structure and components of

bridges and stadiums, etc.

- Consumer durables: components of consumer durable goods, such as computers, home appliances, and recreation devices and utilities.

Technical Requirements

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 B345/B345M-11 Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems

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

Properties of Declared Product as Delivered

The output of the extrusion process is a semi-fabricated and surface finished extrusion product transported to a component or final product manufacturer.

Material Composition

Extruded aluminum products made in North America contain a considerable proportion of metal recycled from aluminum scrap. The metal composition of products, based on metal feedstock information collected at the melting furnaces for extrusion billet making, is shown below. Products shipped to different market sectors may vary significantly on its metal compositions.

Recovered aluminum from internal process (run-around) scrap is considered as a repeated closed-loop manufacturing process and therefore is excluded from metal composition declaration. Definitions of Internal Process (Run-Around) Scrap, Post-Industrial Scrap and Post-Consumer Scrap are consistent with ISO 14021/25 (2006) on environmental labels and declarations, and the related interpretations by UL Environment.

Extruded aluminum products may include various types of coatings, including anodized, painted, and laquered finishes. All coating materials are included in inventory, based on averages across the industry.

Table 1 A6063 Aluminum Alloy Chemical Composition (% by mass) as per Teal Sheet

	Si	Cu	Mn	Mg	Cr	Zn	Ti	Others (each)	Others (total)	Aluminum
Minimum	-	-	-	0.45	-	-	-	-	-	remainder
Maximum	0.35	0.10	0.10	0.90	0.10	0.10	0.10	0.05	0.15	remainder

Category of Metal Source	Percentage (by mass)
Primary Aluminum (including alloy agents)	40%
Recovered Aluminum from Other Post-Industrial Scrap	31%
Recovered Metal from Post-Consumer Scrap	29%

Table 2 Primary and Recycled Material Composition

Manufacturing

The extrusion process takes cast extrusion billet (round bar stock produced from direct chill molds) and produces extruded shapes. The process begins with an inline preheat that takes the temperature of the billet to a predetermined level depending on the alloy. The billet is then sheared if not already cut to length and deposited into a hydraulic press. The press squeezes the semi-plastic billet through a heated steel die that forms the shape. The shape is extruded into lengths defined by the take-off tables and is either water quenched or air cooled. The shape is then clamped and stretched to form a solid straightened length. The straighten lengths are cut to final length multiples and may be placed in an aging furnace to achieve a desired temper. Lengths are then finished (drilled and shaped) and placed into a coating process. The types of coatings include anodized, painted, and lacquered finishes.

The overall manufacturing process is illustrated in the below diagram.

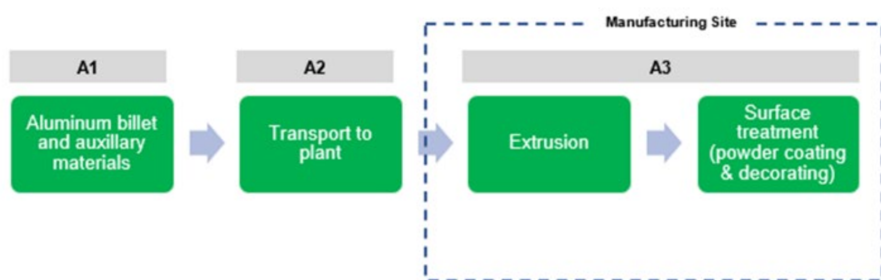


Figure 1 Manufacturing process for semi-fabricated aluminum products

Packaging

Product delivery packaging includes wood, steel, paper board, and sometimes plastic wraps. Packaging is incuded in the scope of this EPD.

Transportation

Supply chain material transporation is included in the varies stages of raw material production and scrap collection processes. In addition a transportation distance of 100 km (62 miles) by truck has been added for the transportation of the semi-fabricated products and for the transportation of waste to end-of-life.

Product Installation

Installation is outside of the scope of this EPD.

Use

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

Reference Service Life and Estimated Building Service Life

Service lifes for aluminum extrusions vary based on the application. This EPD does not cover the product use phase and therefore makes no specific claim as to a typical reference service life.

Recycling and Disposal

Aluminum is a highly recyclable material. During manufacturing, most process and new scrap are fed back into the production process. At the end of life, aluminum scrap is collected and sold to both secondary smelting and semi-fabrication companies. The recycling rate for aluminum scrap is assumed to be 95%. Recycling over 95% is typical for aluminum products in high volume automotive and construction market sectors (IAI, 2013).

It is assumed that 5% of the extruded aluminum products are sent to the landfill for disposal at the end of life. The European Waste Code for aluminum is 17 04 02.

Table 3 Recycling and disposal

Name	Unit
Deconstruction	--
Transportation to the disposal site	100 km by truck
Waste processing	--
Disposal to landfill	5%
Recycling rate of the product	95%
Removals of biogenic carbon	N/A

Life Cycle Assessment Background Information

Declared Unit

The declared unit is the production and end-of-life treatment of one metric ton of extruded aluminum product. The results can be converted to one kilogram by dividing by 1000.

Table 4 Declared Unit

Name	Value	Unit
Declared unit	1	metric ton
Density (typical)	2700	kg/m^3

System Boundary

Per the PCR (UL Environment, 2022), this cradle-to-gate with options analysis provides information on the Product Stage of the aluminum product life cycle, including modules A1–A3, C1-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")
- C1 Deconstruction
- C2 Transport to the disposal site
- C3 Waste processing
- 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.

Table 5 below represents the system boundary and scope.

Table 5 System boundary modules included and excluded from the study

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

* X = module included, MND = module not declared

It should be noted here that, C1 and C3 are to be reported as zero as they are assumed to fall below the cut-off criteria defined by ISO 21930. C2 is assumed as 100 km by truck. Materials for recycling (95%) for aluminum is reported in C4 module.

Time coverage: Aluminum Association primary data represent production within calendar year 2016. Refer to the 2022 Semi-fab LCA report for more information on temporal coverage (AA, 2022). Background data for upstream and downstream processes (i.e., raw materials, energy resources, transportation, and ancillary materials) were obtained from the GaBi 10 (CUP 2020.1) databases.

Technology coverage: Data were collected for the production of aluminum extrusions at several Aluminum Association members facilities located in Canada and the United States.

Geographical coverage: Aluminum Association members manufacture aluminum extrusion products throughout North America. As such, the geographical coverage for this study is based on North American system boundaries for all processes and products. Whenever Canadian or U.S. background data were not readily available, European data or global data were used as proxies.

Interpreting the Results in Module D

The values in Module D include a recognition of the benefits or impacts related to aluminum recycling which occur at the end of the product's service life. The rate of aluminum recycling and related processes will evolve over time. The results included in Module D attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.

A net scrap approach was taken to capture the benefits and impacts related to aluminum recycling reported in Module D. The following datasets in Table 6 were used to calculate the associated net recycling credit:

Table 6 Background datasets used for Module D

Background datasets (Sphera, 2021)	**Reference year**
RNA: Secondary aluminum ingot (95% recycled content) AA	2016
RNA: Primary aluminum ingot AA	2016

Estimates and Assumptions

The LCA required only limited use of estimates and assumptions. The most relevant estimation/assumption is the end-of-life recycling rate of 95%, which is discussed in the Recycling Phase section. All of the raw materials and energy inputs have been modeled using processes and flows that closely follow actual production data on raw materials and processes. All reported material and energy flows have been accounted for. Proxy data were applied to some materials where no matching life cycle inventories were available, as documented in the background report. Other estimates and assumptions are discussed in detail in the LCA background report.

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

In order to model the life cycle for the production of aluminum extrusion, the GaBi 10 software system developed by Sphera was used. All relevant background data necessary for the production of aluminum extrusion were taken from the GaBi 2020 databases or were made available by the Aluminum Association through industry survey results. Companies participating in the project, either with AA or IAI, are provided in the Participating Companies section.

Primary aluminum used in North America is sourced domestically and from other geographic regions, for which carbon intensity information is shared in the below Table 7:

Table 7 Data sources, origin and carbon intensity for primary aluminum

Dataset	Geographic origin	Electricity sources (IAI, 2017)	Carbon intensity (kg CO_2 eq/kWh)
RNA: Primary aluminum ingot	Domestic (North America)	Hydro (80%), lignite (17%), natural gas (3%), nuclear and fuel oil: <1%	0.214
RLA: Aluminum ingot mix IAI 2015	Argentina	Hydro (64%), natural gas (35%), coal <1%	0.393
RME: Aluminum ingot mix IAI 2015	Bahrain	Natural gas (100%)	0.45
RLA: Aluminum ingot mix IAI 2015	Brazil	Hydro (64%), natural gas (35%), coal <1%	0.393
RU: Aluminum ingot mix IAI 2015	Russia	Hydro (98%), coal (2%)	0.0421
RME: Aluminum ingot mix IAI 2015	United Arab Emirates	Natural gas (100%)	0.45
RLA: Aluminum ingot mix IAI 2015	Venezuela	Hydro (64%), natural gas (35%), coal <1%	0.393
GLO: Aluminum ingot mix IAI 2015	Rest of the World	Hydro (25%), coal (64%), natural gas (10%), nuclear (1%), oil <1%	0.778

Data Quality

The data is considered of high 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 in combination with consistent background life cycle inventories from the GaBi 2021 database were used.

The LCA model was created using the GaBi 10 software system for life cycle engineering, developed by Sphera (Sphera, 2021). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2020 database (CUP 2020.1). Primary manufacturing data were provided by the Aluminum Association.

Period under Review

Primary data were collected for bauxite mining, alumina refining, and primary aluminum production was collected by the International Aluminum Institute (IAI) and provided to the Aluminum Association (AA). Primary data for recycling, billet production and extrusion and finishing is collected by the Aluminum Association. Primary data collected from the participating companies and from their operational activities is representative for the year of 2016. This analysis is intended to represent production in 2016-2021.

Allocation

Internal recycling of by-products (e.g., salt cake, dross) is included within the system boundary. Note that co-product allocation may also be used in background data from the GaBi database (e.g., caustic acid).

The “net scrap” substitution approach is used to address recycled content, post-industrial scrap, and post-consumer scrap. Under this approach, the end-of-life scrap collected for recycling is first reduced by the scrap inputs into production. Only the remaining *net scrap* is then modeled as being sent to material recycling in order to avoid double-counting the benefits of using recycled content. If more scrap is recovered at product end-of-life than is required in the manufacturing stage, the product system receives a credit equal to the burden of primary material production minus the burden of recycling scrap into secondary material based on the mass of secondary material produced. If less scrap is recovered at product end-of-life than is required in the manufacturing stage, this net credit becomes a net burden.

Comparability (Optional)

A comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to ISO 21930 and the building context, respectively the product-specific characteristics of performance are taken into account.

Life Cycle Assessment Results

The results from the Aluminum Association extrusions are given below. While interpreting the Module D results one should consider that, the values in Module D include a recognition of the benefits or impacts related to aluminum recycling which occur at the end of the product's service life. The rate of aluminum recycling and related processes will evolve over time. The results included in Module D attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.

GWP excludes biogenic carbon as there are no relevant biogenic carbon removals or emissions in the life cycle. There is no calcination, carbonation and combustion of waste from non-renewable sources.

Life Cycle Impact Assessment Results

Table 8. North American Impact Assessment Results

TRACI v2.1	Unit	A1-A3	C1	C2	C3	C4	D
IPCC AR5 GWP	[kg CO_2 eq]	6.08E+03	-	9.90E+00	-	2.17E+00	-3.39E+03
ODP	[kg CFC-11 eq]	3.48E-07	-	1.05E-15	-	7.02E-15	2.55E-13
AP	[kg SO_2 eq]	2.31E+01	-	2.85E-02	-	9.49E-03	-1.60E+01
EP	[kg PO_4^{3-} eq]	6.36E-01	-	3.36E-03	-	5.35E-04	-3.56E-01
SFP	[kg O_3 eq]	2.22E+02	-	6.40E-01	-	1.67E-01	-1.32E+02
ADP_{fossil}	[MJ, LHV]	6.51E+03	-	1.86E+01	-	4.25E+00	-2.28E+03

Table 9. EU Impact Assessment Results

CML v4.2	Unit	A1-A3	C1	C2	C3	C4	D
GWP 100	[kg CO_2 eq]	6.06E+03	-	9.88E+00	-	2.16E+00	-3.38E+03
ODP	[kg CFC-11 eq]	3.01E-07	-	1.05E-15	-	7.02E-15	-1.15E-12
AP	[kg SO_2 eq]	2.43E+01	-	2.12E-02	-	8.75E-03	-1.73E+01
EP	[kg PO_4^{-3} eq]	1.67E+00	-	6.49E-03	-	1.17E-03	-1.04E+00
POCP	[kg ethene eq]	1.32E+00	-	-7.13E-03	-	7.64E-05	-8.55E-01
ADP_{fossil}	[MJ]	6.70E+04	-	1.39E+02	-	3.27E+01	-3.08E+04
$ADP_{element}$	[kg Sb eq]	2.41E-03	-	1.79E-06	-	8.18E-07	-1.27E-03

Life Cycle Inventory Results

Table 10. Resource Use

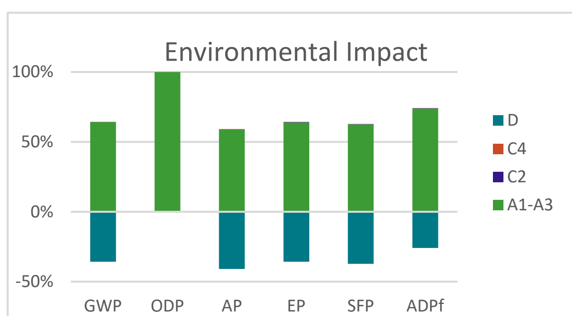
PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
RPR_E	[MJ, LHV]	3.04E+04	-	5.82E+00	-	2.71E+00	-2.22E+04
RPR_M	[MJ, LHV]	-	-	-	-	-	-
RPR_T	[MJ, LHV]	3.04E+04	-	5.82E+00	-	2.71E+00	-2.22E+04
$NRPR_E$	[MJ, LHV]	6.98E+04	-	1.40E+02	-	3.35E+01	-3.13E+04
$NRPR_M$	[MJ, LHV]	1.20E+02	-	-	-	-	-6.33E+01
$NRPR_T$	[MJ, LHV]	-	-	-	-	-	-
SM	[kg]	8.79E+02	-	-	-	-	4.26E+02
RSF	[MJ, LHV]	-	-	-	-	-	-
NRSF	[MJ, LHV]	-	-	-	-	-	-
RE	[MJ, LHV]	-	-	-	-	-	-
FW	[m^3]	6.95E+03	-	2.55E+01	-	4.43E+00	-3.04E+03

Table 11. Output Flows and Waste Categories

PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
HWD	[kg]	7.34E-04	-	2.40E-06	-	2.24E-07	-1.90E-05
NHWD	[kg]	1.34E+03	-	-	-	5.00E+01	-1.01E+03
HLRW	[kg]	1.39E-03	-	3.05E-07	-	3.30E-07	-2.68E-04
ILLRW	[kg]	3.75E-02	-	8.16E-06	-	8.70E-06	-6.79E-03
CRU	[kg]	-	-	-	-	-	-
MFR	[kg]	2.50E+02	-	-	9.50E+02	-	-2.32E+00
MER	[kg]	1.00E+01	-	-	-	-	-5.86E+00
EE	[MJ]	-	-	-	-	-	-

LCA Interpretation

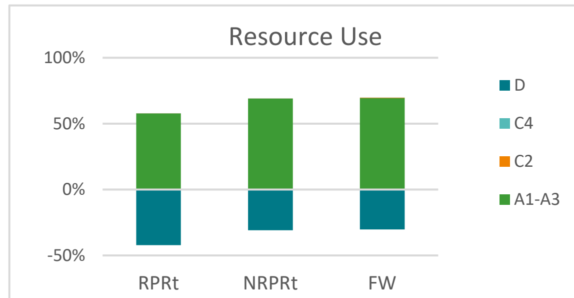
The results represent the cradle-to-gate and end-of-life environmental performance of a metric ton of extruded aluminum. The majority of the environmental impacts are from the production of the aluminum, however the credits from recycling the aluminum at end-of-life (module D) help to offset the initial burden.



Therefore, there is a strong push in the aluminum industry to maximize aluminum recycling rates and close material loops.

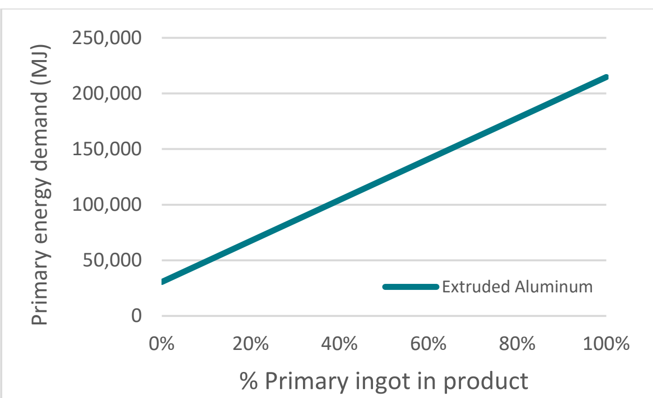
As with any metal, the recycling rate has a significant impact on the life cycle environmental performance of extruded aluminum. A 95% recycling rate is assumed. Aluminum is an ideal material for recycling because the metal can be recycled over and over again without any loss in quality (IAI, 2013).

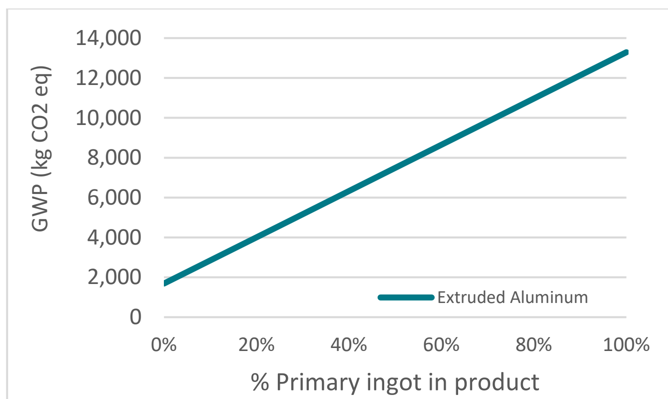
Finally, it is interesting to note that the landfilling of extruded aluminum in C4 has a negative use of net fresh water (FW). This is due to the landfill collecting rain water and introducing it into the watershed as landfill leachate, following the blue water calculation methodology.



Sensitivity Analysis

A sensitivity analysis has been conducted to examine the impact of increasing primary aluminum content in semi-finished products. Given the significant influence of primary aluminum on the cradle-to-gate footprint, one way to address it is to reduce the use of primary aluminum and increase the use of recycled metal. As shown below, a one percent increase in primary aluminum content in the products will increase the cradle-to-gate primary energy demand and global warming potential by as much as 1856 MJ and 117 kg CO2e, respectively, for 1,000 kg semi-finished products. This is equal to say that a one percentage point increase in recycled aluminum content will reduce the energy demand and carbon footprint by the same amount.



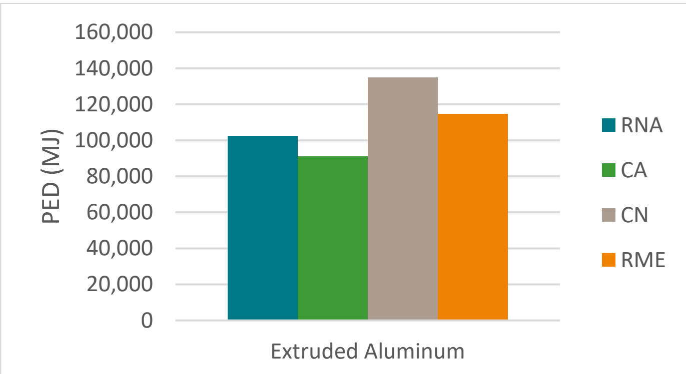


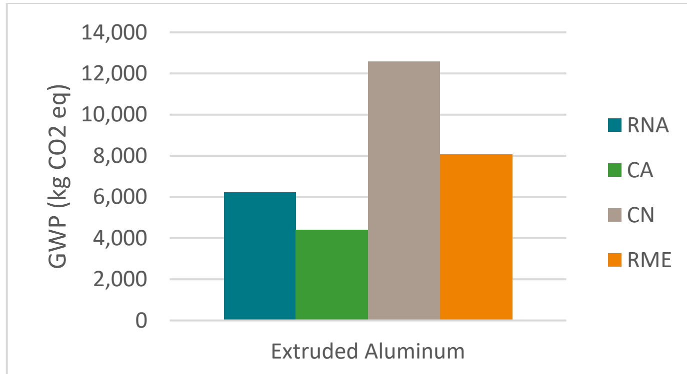
Scenario Analysis

To see the effect of primary aluminum sourcing, a scenario analysis was conducted to alternate the sourcing from different regions or countries other than the baseline case of the North American consumption mix. The metal compositions – shares of primary and recycled metal in the products, are kept unchanged for the scenario analysis. Both figures below show the effects of primary aluminum sourcing on cradle-to-gate primary energy demand and global warming potential, respectively. The regions and countries included in the scenario analysis are:

- RNA represents the weighted average of primary aluminum consumption mix in North America, which is the baseline case;
- CA represents Canada where primary aluminum is exclusively smelted with hydropower electricity;
- CN represents China where primary aluminum is mainly smelted with coal-fired electricity;
- RME represents the Middle East where primary aluminum is mainly smelted with natural gas fired electricity.

Clearly, the scale of difference is dependent both on impact category (e.g., PED or GWP) and on how much primary aluminum content is in the products. The more primary aluminum is in the product, the more striking the difference between hydropower smelted aluminum and coal-power smelted aluminum. The difference is more prominent for GWP than it is for PED. The cradle-to-gate carbon footprint of aluminum sheet made of Chinese primary aluminum would be 3.2 times higher than it is made of Canadian primary aluminum under the same share of primary and recycled content as the baseline case.





For additional sensitivity and scenario analysis information for the above products, please refer to the report (Aluminum Association, 2022).

Additional Environmental Information

Environment and Health During Manufacturing

Air: Hazardous air emission releases 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 that all values inside and outside the production plant comply with regulatory thresholds.

Environment and Health During Use

The environmental and health effects during use are dependent on the ultimate use of the extruded aluminum and are outside the scope of this EPD. The following general statements are relevant for all aluminum products:

- Aluminum products are often made from both primary and recycled ingots
- There is no relevant chemical composition difference between primary and secondary ingots if both are governed by the same alloy designation and chemical composition limit standards
- The service life of the final product depends on its application, but is typically long due to aluminum's excellent durability and corrosion resistance
- For that same reason, maintenance needs during use are usually low.

Extraordinary Effects

Fire: Aluminum products comply with ASTM E 136-11.

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.

References

AA. (2022, March). *About the Aluminum Association*. Retrieved from Aluminum Association: https://www.aluminum.org/about-aluminum-association

AA. (2022, January). *The Environmental Footprint of Semi-Fabricated Aluminum Products in North America.* Retrieved from https://www.aluminum.org/sites/default/files/2022-01/2022_Semi-Fab_LCA_Report.pdf

IAI. (2013). Global Life Cyle Inventory Data for the Primary Aluminum Industry. Longon, International Aluminum Institute.

IAI. (2017, June). Life Cycle Inventory Data and Environmental Metrics for the Primary Aluminium Industry. London, World Aluminium, 2015 Data.

ISO. (2006). *ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures.* Retrieved from https://www.iso.org/standard/38131.html

ISO. (2006). *ISO 14044:2006: Environmental management — Life cycle assessment - Requirements and guidelines.*

ISO. (2017). *ISO 21930:2017: Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.*

Sphera. (2021). *GaBi LCA Database Documentation*. Retrieved from Sphera Solutions, Inc.: http://www.gabi-software.com/america/support/gabi/

UL Environment. (2018). *Part A - Product Category Rules for Building-Related Products and Services.* UL Environment.

UL Environment. (2022, February 16). Part B: Aluminum Construction Product EPD Requirements, UL 10010-38.

Contact Information

Study Commissioner

The Aluminum Association
1400 Crystal Drive, Suite 430
Arlington, VA 22202
www.aluminum.org

LCA Practitioner

Sphera Solutions, Inc.
130 E Randolph St, #2900
Chicago, IL 60601
https://sphera.com/contact-us/
www.sphera.com

Participating Companies

No.	Company	Note
1	Alcoa Corporation	Primary aluminum
2	Arconic Corporation	Recycling, sheet, extrusion
3	Century Aluminum	Primary aluminum
4	Commonwealth Rolled Products	Formally Aleris International, recycling, sheet
5	Constellium	Recycling, sheet, extrusion
6	Howmet	Formally part of Arconic, recycling, sheet, extrusion
7	Hydro Extrusions North America	Recycling, extrusion
8	Hydro Metals North America	Recycling, extrusion billet
9	Jupiter Aluminum	Recycling, sheet
10	JW Aluminum	Recycling, sheet, foil
11	Kaiser Aluminum	Recycling, sheet, extrusion
12	Keymark	Recycling, extrusion
13	Novelis Inc.	Recycling, sheet, foil
14	Real Alloys	Recycling, RSI
15	Rio Tinto	Primary aluminum
16	Reynolds	Foil
17	Scepter Inc.	Recycling, RSI
18	Skana	Recycling, sheet
19	Smelter Service Corporation	Recycling, RSI
20	United Aluminum	Recycling, sheet