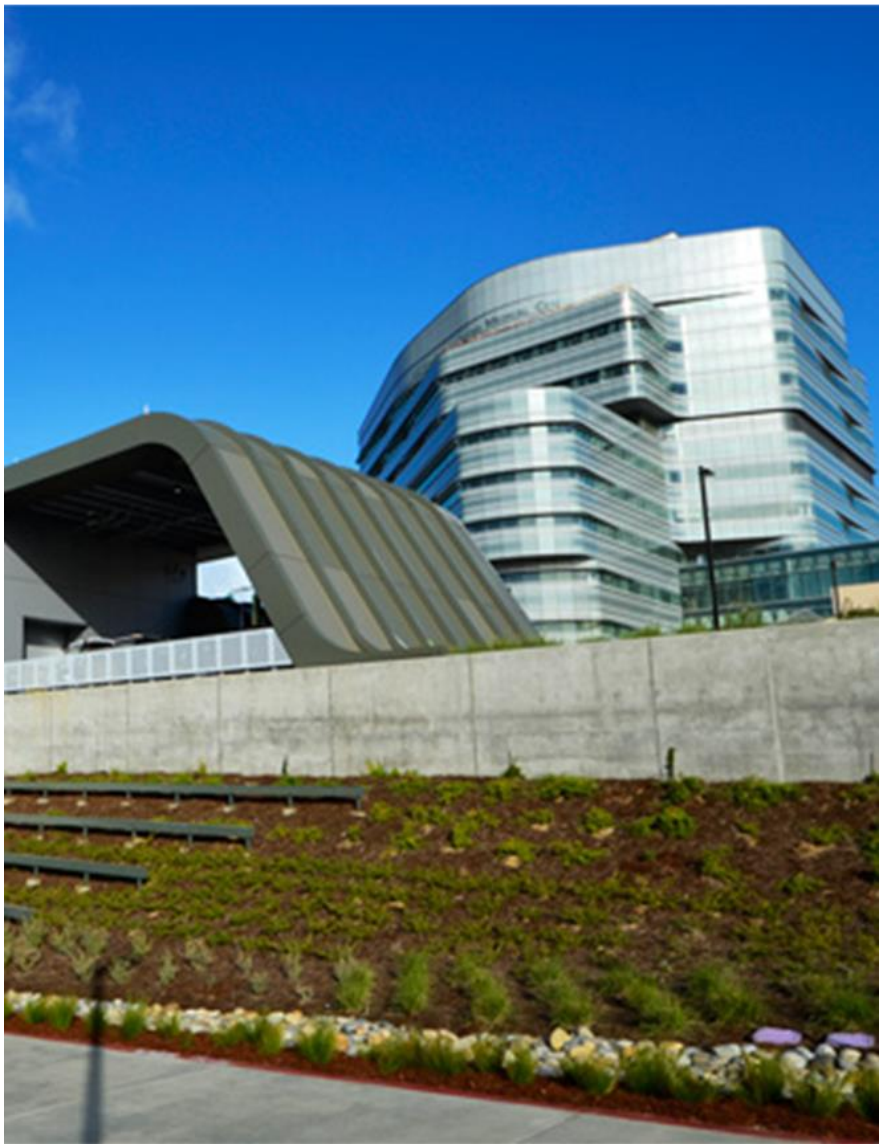
ENVIRONMENTAL PRODUCT DECLARATION

ROLL FORMED CLADDING

WALL AND ROOF CLADDING SYSTEMS



The Metal Construction Association (MCA) is a non-profit organization formed in 1983 with the primary purpose of expanding the use of metal in construction. MCA unites diverse industry segments for the purpose of informing decision makers about the benefits of metal through awareness and education programs. MCA also supports third-party metal product research and testing. MCA and its members are committed to creating a cleaner, safer environment evidenced by the association's LCA program and support of similar initiatives.

Roll formed aluminium and steel cladding products are a major product category developed by MCA members. Metal cladding products are also an environmentally responsible and sustainable design choice that features high recycled content, low maintenance and long service life. The metal used in the panels is also 100% recyclable at the end of its useful life.

This Environmental Product Declaration for roll formed aluminium and steel cladding is one of several different product EPDs offered by MCA For more information visit www.metalconstruction.org

ENVIRONMENTAL PRODUCT DECLARATION

Roll Formed Aluminum and Steel Cladding
Industry-Wide EPD

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.2.4 July 2018
MANUFACTURER NAME AND ADDRESS	Metal Construction Association 8735 W. Higgins Rd., Suite 300 Chicago IL 60631
DECLARATION NUMBER	4789289084.103.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Roll Formed Aluminum and Steel Cladding; 100m^2
REFERENCE PCR AND VERSION NUMBER	UL Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels v.2.0 October 23, 2018
DESCRIPTION OF PRODUCT APPLICATION/USE	Aluminum and steel sheet formed by rolling into a variety of profiles
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	April 1, 2020
PERIOD OF VALIDITY	5 Years
EPD TYPE	Industry-average
RANGE OF DATASET VARIABILITY	Industry-average only
EPD SCOPE	Cradle to gate
YEAR(S) OF REPORTED PRIMARY DATA	2017
LCA SOFTWARE & VERSION NUMBER	GaBi ts, 9
LCI DATABASE(S) & VERSION NUMBER	GaBi 2019 (service pack 37)
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1

This PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria Thomas P. Gloria, Industrial Ecology Consultants

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.

1. EPD Content

1.1. Description of Company/Organization

The Metal Construction Association (MCA) is recognized as the leading advocate for the architectural metal products industry. Since it was formed in 1983, MCA has focused on promoting the use of metal in the building envelope through marketing, education, and action on public policies that affect metal's use. MCA is a volunteer-led organization that works to eliminate barriers to using metal in construction by supporting product performance testing, initiating research, and monitoring and responding to codes and regulations that affect metal. Visit www.metalconstruction.org for more details.

Information in this document has been prepared by MCA technical staff and members of MCA's Roofing Council and its Wall Panel Council who are volunteers representing the leading manufacturers of metal products used in roof and wall applications. The product configurations offered herein use ranges representative of all types of roll formed metal panels based on specific products from the following MCA member manufacturers:

ATAS International, Inc. Sustainable Building Envelope Technology	Founded in 1963, ATAS International, Inc. is a leading manufacturer of metal roofing, wall cladding, ceilings, perimeter edge metal, and accessories. The ATAS portfolio features an expansive selection of products available in aluminum, steel, zinc, stainless steel, and copper. Standard profiles include narrow and wide ribbed wall panels, corrugated styles, standing seam and batten seam roof systems, metal shingles, shakes, tiles, and more. With sustainability at the forefront of modern building design, ATAS proudly supports green building objectives with high performance solutions, such as solar-ready roof panels, insulated metal panels, cool roofing products, and solar air heating wall panels. ATAS has ISO 9001:2015 certified manufacturing locations located in Allentown, PA and Mesa, AZ. For more information at ATAS International, please visit www.atas.com.
DMI DIMENSIONAL METALS, INC.	Since 1988 Dimensional Metals, Inc. (DMI) has specialized in the manufacturing of architectural metal roof and wall panel systems as well as fabricated architectural sheet metal for the construction industry. We are backed by decades of proven metal envelope design, dependable Technical Field Services, and an Engineering Department delivering sustainable solutions. You are sure to find the product that will best enhance your design. Visit www.dmimetals.com for more information.

ENGLERT™	For over 50 years Englert has offered an exceptionally broad range of standing seam metal roof and wall panel profiles, panel widths and finishes to meet any design objective. With one of the most technically advanced paint-lines in the world, all of our 26 ULTRA-Cool™ finishes are low-gloss, environmentally friendly, Energy Star® compliant and 20 of those finishes are LEED-compliant, and backed by widely recognized product testing, the best warranties in the industry, and engineering expertise.
FABRAL® METAL WALL AND ROOF SYSTEMS	Founded in 1967, Fabral is a widely recognized producer of metal roofing and wall panels for architectural, commercial, post frame, industrial, residential, transportation and agricultural applications. Fabral offers a wide variety of quality product offerings, advanced LEAN manufacturing processes and dedicated customer service values. In 1997, Fabral joined Euramax International, Inc., a producer of aluminum, steel, vinyl, copper and fiberglass products for original equipment manufacturers, distributors, contractors and home centers in North America and Western Europe. Visit www.fabral.com for more information.
McELROY METAL	When McElroy Metal was founded in 1963, it was built on three key traits: quality, service and performance. While we've certainly grown over the last 55 years, those traits are still the cornerstone of our business philosophy today. As a best-in-class metal roofing manufacturer with a complementary selection of metal wall panels and substructural components, we're here to meet any commercial, industrial, or residential need. With locations across the United States, our goal is to make your dream metal roof or wall a reality—no matter your location, project, or style preferences.
PAC-CLAD PETERSEN	For over 40 years, Petersen Aluminum Elk Grove Village, IL has been a leading provider of architectural metal products. PAC-CLAD products provide unmatched aesthetics, performance and sustainability to any project. Where possible, Petersen products include a high percentage of recycled material. Additionally, these products offer a long life span, and at the end of their extended service life, are 100% recyclable. Most of the PAC-CLAD colors meet LEED®, ENERGY STAR® and cool roof certification requirements. For more information visit www.pac-clad.com or www.pacgreeninfo.com for the most current information on sustainable cool metal roofing.

1.2. Product Description

Roll formed aluminum and steel products undergo the simplest production process of the evaluated products as no core is used. Aluminum coated coils are formed into the desired profile using a factory roller.

MCA products are used in a multitude of building coverage applications and offer a wide range of benefits, including aesthetics, durability, rain screening, fireproofing, and reduced energy costs, with each product type offering its own unique properties. This EPD focuses on panel products that are considered representative of common products manufactured by member companies, as seen in

Table 1. A flow diagram depicting the manufacturing process can be found in Figure 3. The EPD is intended to represent an industry average for roll formed cladding. The average is weighted based on on the area of product manufactured at each of the member's facilities (i.e., vertical averaging).

Table 1: Panel products under study

PRODUCT	DESCRIPTION	PRIMARY PROCESSES
Roll formed steel cladding	Steel gauge: 18 – 29 Gauge Primary product: 0.028 inches (24 Gauge) steel coil	• Continuous coil coating • Roll forming
Roll formed aluminum cladding	Aluminum gauge: 16 – 29 Gauge Primary product: 0.025 inches (22 Gauge) aluminum coil	• Continuous coil coating • Roll forming

1.3. Application

Roll formed aluminum and steel cladding products are selected for use in a variety of roof and wall applications because of their long-term durability, low maintenance, wide variety of color and finish options, and their ability to help improve energy efficiency, such as solar roof and wall systems, and rainscreen applications. Metal cladding products require less maintenance than other exterior systems and meet the most demanding performance requirements. Many designers and building owners also choose metal cladding for their environmental value of having recycled content and being recyclable or reusable at the end of a building's useful life.

Successful applications include: commercial facilities, healthcare facilities, industrial facilities, transportation, schools and universities, warehousing and distribution centers, sports complexes, and convention centers.

1.4. Declaration of Methodological Framework

The production stage (i.e., cradle-to-gate), including raw material extraction and processing, processing of secondary material, transport to the manufacturer, and manufacturing**,** is required by the PCR. The PCR considers installation, use, end-of-life, and recovery stages (modules A4 through D) as optional. As such, this study excludes the optional stages. Since this is a "cradle-to-gate" study, the products are not declared as fulfilling a building reference service life. This study also excludes construction of capital equipment, including tools used to produce, install and maintain the products; maintenance and operation of support equipment; human labor and commute; building energy consumption; and all other impacts associated with the use stage relative to energy use for the building in which the product is installed. The included and excluded life cycle stages are summarized in Table 2.

Table 2: Life cycle modules included in EPD

Production			Installation		Use stage							End-of-Life				Next product system
Raw material supply (extraction, processing, recycled material)	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	MND

X = declared module; MND = module not declared

1.5. Technical Data

Substrate Performance

AISI S100	North American Specification for the Design of Cold-Formed Steel Structural Members Specifications for Aluminum Structures, the Aluminum Association
ASTM A463	Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1063	Standard Specification for Steel Sheet, Twin-Roll Cast, Zinc-Coated (Galvanized) by the Hot Dip Process
ASTM A792	Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
Metal Roof Performance	
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1363	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM E90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials Specimen
ASTM E2140	Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head
ASTM E330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E413	Classification for Rating Sound Insulation
ASTM E795	Standard Practices for Mounting Test Specimens During Sound Absorption Tests
ASTM E1514	Specification for Structural Standing Seam Steel Roof Panel Systems
ASTM E1592	Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E1637	Specification for Structural Standing Seam Aluminum Roof Panel Systems
ASTM E1646	Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference
ASTM E1680	Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems
Metal Wall Performance	
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM C1363	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM D1494	Standard Test Method for Diffuse Light Transmission Factor of Reinforced Plastics Panels
ASTM E90	Standard Test Method for Laboratory Measurement of Airborne Sound
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM E119	Measurement Procedure for Noise Power Ratio
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the
ASTM E330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E413	Classification for Rating Sound Insulation
ASTM E795	Standard Practices for Mounting Test Specimens During Sound Absorption Tests
Paint Finish Performance	
ASTM D523	Standard Test Method for Specular Gloss
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

ASTM D2247	Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

Fire Performance

ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E631	Standard Terminology of Building Constructions

Model Codes or Standards

International Building Code
Local Building Code
ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures
UL-Building Materials Directory
UL- Fire Resistance Directory
ASHRAE, TIMA –[Handbook of Fundamentals & Insulation Requirements]
SMACNA, [Architectural Sheet Metal Manual – Gutter design and flashing details]
(FS HH-I-521)(FS HH-I-558b)-[Fiberglass Insulation]
FS HH-I-1972)-([Insulation Board Thermal Faced, Polyurethane or Polyisocyanurate])
FMRC-Approval Guide
FMRC-Specification Tested Products Guide
ANSI B18.6.4 –[Steel Self-Tapping Screw Standard]
SAE J78 Self Drilling Tapping Screws
MCA Technical Bulletin, Fastener Selection Guidelines, 2008
AAMA 501-[Method of Test for Metal Curtain Walls]

1.6. Properties of Declared Product as Delivered

Manufacturers supply roll formed steel products in a variety of sizes and configurations customized to each project's requirements. The data for this EPD is representative of panels offered by the participating manufacturers. Technical properties of panel products under study can be seen in Table 3.

Table 3: Product properties

PARAMETER	VALUE	UNIT
Length	1 – 15	m
Width	0.3 – 0.91	m
Thickness	0.38 – 0.76	mm
Density	7850	kg / m^3
Tensile strength	350 – 550	MPa
Modulus of elasticity	200,000	MPa
Airborne sound reduction	10 – 20	dB
Noise reduction coefficient	10 – 15	%

1.7. Material Composition

Steel cladding products are made of 100% steel and are roll formed into the desired profile from 18 – 29 gauge steel sheet. Aluminum cladding products are made of 100% aluminum and are roll formed into the desired profile from 16 – 29 gauge aluminum sheet.

1.8. Manufacturing

Roll forming is a continuous bending operation in which a strip of metal (typically coiled steel or aluminum) is passed through consecutive sets of rolls, or stands, each performing only an incremental part of the bend, until the desired cross-section profile is obtained. Roll forming is ideal for producing parts with long lengths or in large quantities with a minimum amount of handling as compared to other types of forming (e.g., press brake). A variety of cross-section profiles can be produced, but each profile requires a carefully crafted set of roll tools.

The panels can be factory-formed, as seen in Figure 1, or formed on the jobsite using a mobile roll former, as seen in Figure 2, or a combination of both.

Figure 1: Inline Roll Former

Figure 2: Mobile Roll Former

Figure 3 shows a detailed roll formed cladding manufacturing process.

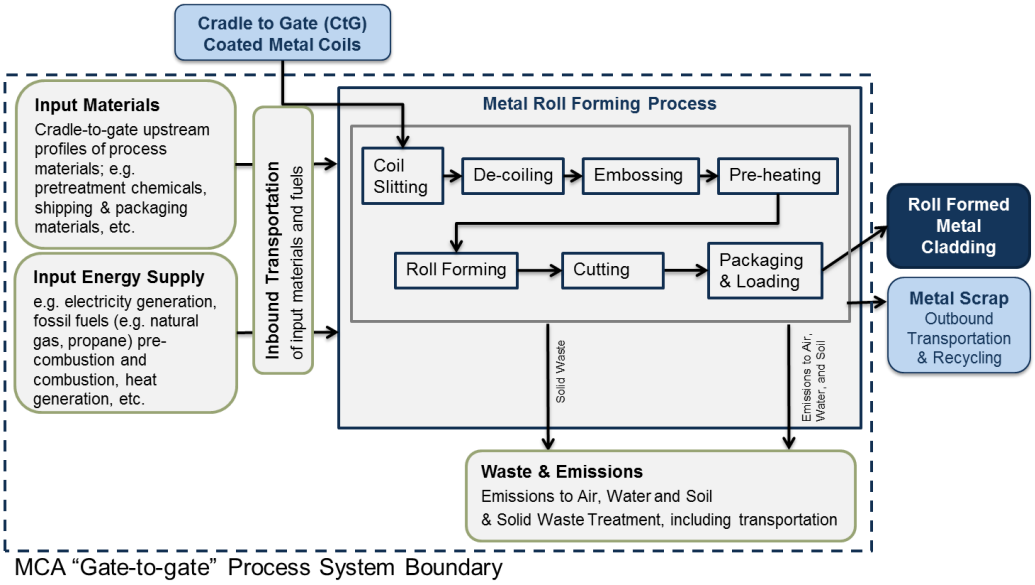


Figure 3: Roll formed cladding manufacturing process

Aluminum and steel coils can be formed into a variety of profiles and sizes depending on the need of the project, as seen in Figure 4.

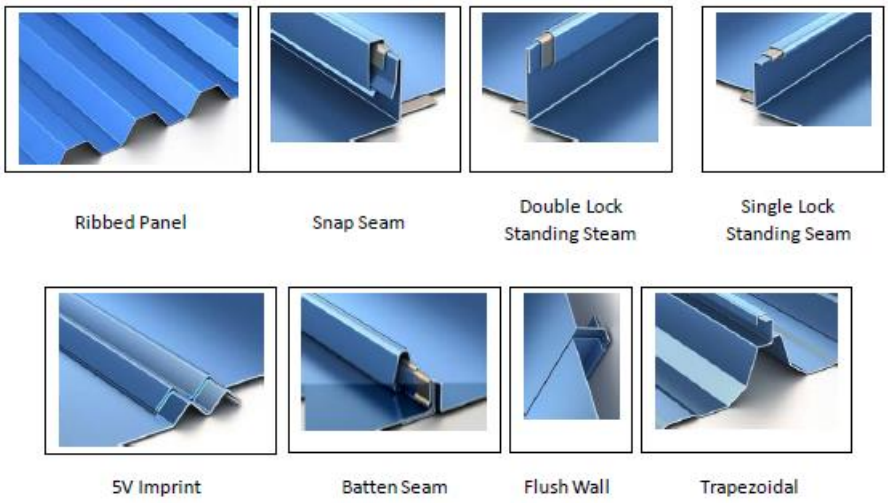


Figure 4: Types of roll forming profiles

1.9. Packaging

Foam sheets are layered between roll formed cladding before the products are stacked on wooden pallets and

expanded polystyrene underlayment and wrapped in polyethylene film. Figure 5 shows an example of packaged roll formed product.

Figure 5: Packaging process for roll formed product

1.10. Product Average

This declaration covers roll formed aluminum and steel cladding products manufactured by 6 different participating MCA member companies, representing a significant majority of annual production in the US and Canada, as seen in Table 4.

Table 4: Products by manufacturer

COMPANY	MANUFACTURING LOCATION	STEEL	ALUMINUM
ATAS International, Inc.	Morrisville, PA	X	X
Dimensional Metals, Inc.	Columbus, OH	X	X
Englert	Perth Amboy, NJ	X	X
Fabral	Jackson, GA	X	X
McElroy	Peachtree City, GA	X	
Petersen Aluminum Corporation	Elk Grove Village, IL	X	X

1.11. Transportation

Average transportation distances and modes of transport are included for the transport of the raw materials, operating materials, and auxiliary materials to production and assembly facilities.

2. Life Cycle Assessment Background Information

2.1. Declared Unit

The main purpose of metal cladding and panels is to provide weather protection for building walls and roofs. The

panels create barriers that control noise, water, and air transmission between an external environment and interior building space. Accordingly, the PCR's functional unit for metal panels, metal composite panels, and metal cladding is the coverage of 100 square meters (1076.4 square feet) of building area. The coverage area refers to the projected flat area covered by the product as output by the final manufacturing process step and does not account for losses due to overlap and scrap during installation.

Table 5: Reference flows

NAME	ROLL FORM, STEEL	ROLL FORM, ALUMINUM
Declared unit [m^2]	100	100
Product mass [kg / 100 m^2]	277	491

2.2. System Boundary

A "cradle-to-gate" life cycle analysis was conducted. Within these boundaries, only the product stage (A1 – A3)—raw material supply, inbound transport of raw materials to manufacturing facility, manufacturing—is considered. The construction stage (A4 – A5), building use stage (B1 - B7), and end-of-life phase (C1 - C4) were not assessed, nor were the construction and maintenance of capital equipment (e.g., production equipment). Additionally, human labor and employee commute were not included in the analysis.

2.3. Estimates and Assumptions

This study was based on primary data collected at MCA member company facilities. Datasets selected to represent the production of raw materials by upstream suppliers are based on regional or global averages rather than on primary data collected directly from member company supply chains. When selecting these datasets, a conservative approach was applied in that datasets associated with higher impacts are used when there are multiple possible options.

Secondly, this study was conducted in accordance with a PCR. While this guidance document has been developed by industry experts to best represent this product system, real life environmental impacts of metal panel and cladding products may extend beyond those defined in this document.

2.4. Cut-off Criteria

Data were included whenever possible. If it was necessary to exclude materials in order to facilitate the analysis, only flows representing less than 1% of the cumulative mass of the product system were excluded, providing their environmental relevance was judged not to be a concern.

Packaging of incoming raw materials (e.g. pallets, totes, super-sacks) are excluded as they represent less than 1% of the product mass and are not environmentally relevant. Capital goods and infrastructure required to produce metal panel and cladding products are presumed to produce millions of units to over the course of their life, so impact of a single functional unit attributed to this equipment is negligible; therefore, capital goods and infrastructure were excluded from this study.

2.5. Data Sources

As a general rule, specific data derived from specific production processes or average data derived from specific

production processes shall be the first choice as a basis for calculating LCA results.

For life cycle modeling of the considered products, the GaBi Software System for Life Cycle Engineering, developed by thinkstep AG, was used to model the product systems considered in this assessment. All relevant background datasets were taken from the GaBi 2019 software database (service pack 37). The datasets from the GaBi database are documented in the online documentation (thinkstep, 2018). To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

The worldsteel global average data were used for galvanized steel coil background data, with coil coating data obtained from MCA.

2.6. Data Quality

A variety of tests and checks were performed throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of project-specific LCA models as well as the background data used.

Temporal Coverage

All of the primary data is taken from 12 months of continuous operation in the 2017 fiscal year. All secondary data were obtained from the GaBi 2019 databases and published EPDs. Data are representative of the years 2010 to 2018

Geographical Coverage

All primary and secondary data were collected specific to the countries or regions under study. Where country-specific or region-specific data were unavailable, proxy data were used.

Technological Coverage

All primary and secondary data were modeled to be specific to the technologies or technology mixes under study. Where technology-specific data were unavailable, proxy data were used.

2.7. Reference Period

Data providers were asked to provide annual data for 2017.

2.8. Allocation

Since only facility level data were available, input and output flows were allocated among each facility's co-products to determine the flows associated with the products analyzed. Allocation of materials was done on an area-basis as appropriate.

End-of-life allocation generally follows the requirements of ISO 14044, section 4.3.4.3 and the product category rule. (UL Environment, 2018) Under the PCR, the product life cycle is modeled using the cut-off approach. Scrap inputs to manufacturing are reported under the secondary materials metric. The system boundary at end-of-life is drawn after scrap collection to account for the collection rate. This generates a scrap output flow that is reported under the materials for recycling metric.

Processing and recycling of the net amount of scrap leaving the system (i.e., scrap outputs minus secondary material inputs) is not included in this study.

2.9. Comparability

No comparisons or benchmarking is included in this EPD. LCA results across EPDs can be calculated with different background databases, modeling assumptions, geographic scope and time periods, all of which are valid and acceptable according to the Product Category Rules (PCR) and ISO standards. Caution should be used when attempting to compare EPD results.

3. Scenarios and Additional Technical Information

This EPD represents a cradle-to-gate analysis; as such, no additional information is provided as the downstream modules are not declared.

4. Life Cycle Assessment Results

Cradle-to-gate life cycle impact assessment results are shown for TRACI 2.1 characterization factors. These results are relative expressions and do not predict impacts on category endpoints such as human health or ecosystem quality, the exceeding of thresholds, safety margins, or risks.

With respect to global warming potential, biogenic carbon is not considered as the declared products only use biogenic materials for packaging. For packaging, no credit was given for the sequestration of biogenic carbon during the growth of plants used in plant-derived packaging materials. Any carbon temporarily sequestered during the use of bio-based materials is assumed to be re-released to the atmosphere upon their decomposition. Since the lifetime of plant-derived packaging materials is shorter than the 100 year time horizon of this impact category (GWP 100), GWP including biogenic carbon is not reported.

4.1. Life Cycle Impact Assessment Results

Table 6: North American Impact Assessment Results – Aluminum roll formed cladding

PARAMETER	UNIT	TOTAL	A1	A2	A3
GWP	[kg CO_2 eq.]	**1.86E+03**	1.83E+03	3.91E+00	2.35E+01
ODP	[kg CFC-11 eq.]	**1.86E-05**	1.86E-05	0.00E+00	0.00E+00
AP	[kg SO_2 eq.]	**9.12E+00**	9.07E+00	1.44E-02	3.57E-02
EP	[kg N eq.]	**2.27E-01**	2.23E-01	1.29E-03	3.60E-03
SFP	[kg O_3 eq.]	**9.17E+01**	9.08E+01	3.24E-01	5.62E-01
ADPF	Surplus MJ	**2.10E+03**	2.06E+03	7.69E+00	2.82E+01

Table 7: North American Impact Assessment Results – Steel roll formed cladding

PARAMETER	UNIT	TOTAL	A1	A2	A3
GWP	[kg CO_2 eq.]	**1.53E+03**	1.51E+03	7.07E+00	1.93E+01
ODP	[kg CFC-11 eq.]	**1.88E-05**	1.88E-05	0.00E+00	0.00E+00
AP	[kg SO_2 eq.]	**4.00E+00**	3.95E+00	3.36E-02	2.60E-02
EP	[kg N eq.]	**1.80E-01**	1.75E-01	2.81E-03	2.43E-03
SFP	[kg O_3 eq.]	**6.49E+01**	6.37E+01	7.65E-01	4.27E-01
ADPF	Surplus MJ	**7.20E+02**	6.85E+02	1.39E+01	2.12E+01

4.2. Life Cycle Inventory Results – Steel roll formed cladding

Table 8: Resource Use – Aluminum roll formed cladding

PARAMETER	UNIT	TOTAL	A1	A2	A3
RPRE	[MJ, LHV]	**9.29E+03**	9.26E+03	1.79E+00	2.39E+01
RPRM	[MJ, LHV]	**9.09E+02**	9.09E+02	0.00E+00	0.00E+00
RPRT	[MJ, LHV]	**1.02E+04**	1.02E+04	1.79E+00	2.39E+01
NRPRE	[MJ, LHV]	**2.36E+04**	2.31E+04	5.78E+01	4.95E+02
NRPRM	[MJ, LHV]	**1.49E+02**	1.49E+02	0.00E+00	0.00E+00
NRPRT	[MJ, LHV]	**2.38E+04**	2.32E+04	5.78E+01	4.95E+02
SM	[kg]	**2.06E+02**	2.06E+02	0.00E+00	0.00E+00
RSF	[MJ, LHV]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ, LHV]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
RE	[MJ, LHV]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
FW	[m3]	**3.57E+01**	3.56E+01	6.93E-03	1.07E-01

Table 9: Resource Use – Steel roll formed cladding

PARAMETER	UNIT	TOTAL	A1	A2	A3
RPRE	[MJ, LHV]	**7.26E+02**	7.05E+02	3.23E+00	1.82E+01
RPRM	[MJ, LHV]	**7.92E+02**	7.92E+02	0.00E+00	0.00E+00
RPRT	[MJ, LHV]	**1.52E+03**	1.50E+03	3.23E+00	1.82E+01

NRPRE	[MJ, LHV]	**1.73E+04**	1.69E+04	1.04E+02	3.29E+02
NRPRM	[MJ, LHV]	**5.53E+01**	5.53E+01	0.00E+00	0.00E+00
NRPRT	[MJ, LHV]	**1.74E+04**	1.69E+04	1.04E+02	3.29E+02
SM	[kg]	**3.57E+01**	3.57E+01	0.00E+00	0.00E+00
RSF	[MJ, LHV]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ, LHV]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
RE	[MJ, LHV]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
FW	[m3]	**3.17E+00**	3.09E+00	1.25E-02	6.48E-02

Table 10: Output Flows and Waste Categories – Aluminum roll formed cladding

PARAMETER	UNIT	TOTAL	A1	A2	A3
HWD	[kg]	**7.52E-02**	7.52E-02	4.68E-07	1.65E-07
NHWD	[kg]	**4.89E+02**	4.88E+02	2.18E-03	2.20E-01
HLRW	[kg]	**1.76E-03**	1.67E-03	1.54E-07	8.80E-05
ILLRW	[kg]	**2.97E-02**	2.72E-02	4.16E-06	2.43E-03
CRU	[kg]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	**1.01E+01**	0.00E+00	0.00E+00	1.01E+01
MER	[kg]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
EE	[MJ]	**1.58E-03**	1.58E-03	0.00E+00	0.00E+00

Table 11: Output Flows and Waste Categories – Steel roll formed cladding

PARAMETER	UNIT	TOTAL	A1	A2	A3
HWD	[kg]	**1.62E-03**	1.61E-03	8.45E-07	1.40E-07
NHWD	[kg]	**6.68E+01**	6.67E+01	3.93E-03	1.01E-01
HLRW	[kg]	**1.20E-04**	8.25E-05	2.79E-07	3.73E-05
ILLRW	[kg]	**1.70E-03**	6.64E-04	7.52E-06	1.03E-03
CRU	[kg]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	**1.96E+01**	0.00E+00	0.00E+00	1.96E+01
MER	[kg]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
EE	[MJ]	**2.17E-03**	2.17E-03	0.00E+00	0.00E+00

5. LCA Interpretation

Nearly the entirety of burdens for all categories fall within module A1 (production of raw materials). Within raw materials production, the majority of impact categories are driven by the production of aluminum and steel.

Though some raw materials are transported vast distances, the inbound transportation module (A2) has a modest contribution to overall impact.

6. References

Bare, J. (2012). *Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) - Software Name and Version Number: TRACI version 2.1 - User's Manual.* Washington, D.C.: U.S. EPA.

EPA. (2012). *Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) – User's Manual.* Washington, D.C.: U.S. EPA.

IPCC. (2013). *Climate Change 2013: The Physical Science Basis.* Genf, Schweiz: IPCC.

ISO. (2006a). *ISO 14040: Environmental management – Life cycle assessment – Principles and framework.* Geneva: International Organization for Standardization.

ISO. (2006b). *ISO 14044: Environmental management – Life cycle assessment – Requirements and guidelines.* Geneva: International Organization for Standardization.

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

MCA. (2014). *Environmental Product Declaration: Metal Composite Material Panels, Industry-wide EPD.* UL Environment.

thinkstep. (2018). *GaBi LCA Database Documentation*. Retrieved from thinkstep AG: http://database-documentation.gabi-software.com

UL Environment. (2018). *Product Category Rules for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, UL 10010 (v3.2).*

UL Environment. (2018). *Product Category Rules for Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: UL 10010-5*. UL Environment.

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