ENVIRONMENTAL PRODUCT DECLARATION

ROLL- FORMED CLADDING

ALUMINUM PANELS
STEEL PANELS

PAC-CLAD
PETERSEN
A CARLISLE COMPANY

Since 1965, Petersen, a Carlisle company, has manufactured PAC-CLAD architectural metal cladding products in multiple gauges of steel and aluminum. Based in Elk Grove Village, IL, Petersen operates facilities in Georgia, Texas, Maryland, Arizona and Minnesota. PAC-CLAD products add creative aesthetics, performance and sustainability to any project. Where possible, Petersen products include a high percentage of recycled material. Additionally, these products offer a long lifespan, and at the end of their extended service life are 100% recyclable. Most PAC-CLAD colors meet LEED® and ENERGY STAR® certification requirements and are rated by the Cool Roof Rating Council.

For more information visit www.pac-clad.com/sustainability for information on sustainable metal cladding..

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

Environmental Product Declaration

PAC-CLAD PETERSEN A CARLISLE COMPANY

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

Roll-Formed Steel and Aluminum Panels

According to ISO 14025, EN 15804, and ISO21930:2017

EPD Program and Program Operator Name, Address, Logo, and Website	UL Provided
General Program Instructions and Version Number	UL Provided
Manufacturer Name and Address	Petersen Aluminum Corp. 1005 Tonne Road, Elk Grove Village, IL 60007
Declaration Number	UL Provided
Declared Product & Functional Unit or Declared Unit	Roll formed aluminum and steel cladding; 100m^2
Reference PCR and Version Number	Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels [UL Environment]
Description of Product Application/Use	Aluminum and steel sheet roll-formed into a variety of profiles
Product RSL Description (if Appl.)	75 Years
Markets of Applicability	North America, Caribbean
Date of Issue	UL Provided
Period of Validity	UL Provided
EPD Type	Product specific
Range of Dataset Variability	-
EPD Scope	Cradle to gate, with options
Year(s) of Reported Primary Data	2016
LCA Software & Version Number	GaBi ts, 8.7
LCI Database(s) & Version Number	GaBi 2019 (service pack 39)
LCIA Methodology & Version Number	TRACI 2.1

The PCR review was conducted by:	UL Provided UL Provided UL Provided
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☐ EXTERNAL	UL Provided
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	UL Provided
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	UL Provided

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. Product Definition and Information

1.1. Description of Organization

The product configurations offered herein use ranges representative of all types of roll-formed metal panels based on specific products from Petersen.

Since 1965, Petersen, a Carlisle company, has manufactured PAC-CLAD architectural metal cladding products in multiple gauges of steel and aluminum Based in Elk Grove Village, IL, Petersen operates facilities in Georgia, Texas, Maryland, Arizona and Minnesota. PAC-CLAD products add creative 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 PAC- CLAD colors meet LEED® and ENERGY STAR® certification requirements and are rated by the Cool Roof Rating Council. For more information visit www.pac-clad.com/sustainability for information on sustainable metal cladding.

1.2. Product Description

Product Identification

Roll-formed metal panels are designed and produced for commercial and residential applications. This declaration is intended for business-to-business applications (B2B).

Panels are custom roll-formed from coils of steel or aluminum to fit a variety of roof and wall applications. The panels can be factory-formed (Figure 1) or formed on the job site using a mobile roll former (Figure 2) or a combination of both. The metal panels offer long-term durability and come in a broad palette of colors and finishes to maximize design options. A wide range of panel profiles is available to meet building code and aesthetic requirements, as illustrated in Figure 3Figure 3.

Product Specification

Technical specifications are provided in Section 1.6 and product characteristics in Section 1.7.

Flow Diagram

Metal panel products are manufactured from metal coil or sheet. A manufacturing flow diagram is detailed in Figure 4.

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Figure 1: Inline Roll Former (Photo courtesy The Bradbury Co.)

Figure 2: Mobile Roll Former (Photo courtesy Schlebach Machines)

Figure 3: Images representing the range of panel profiles

1.3. Product Benefits

For decades, roll-formed metal wall and roof panels have served building owners and architects as one of the best combinations of economy, service and design; the reasons for this are many. They offer a wide selection of profiles and a multitude of design options. Preformed metal wall panels are manufactured from a variety of metals, including steel, aluminum, copper and zinc. Ongoing development of coating technology continues to provide longer life spans for the metal panels, making them a particularly important part of mainstream commercial building design.

Bright blue wall panels with horizontal ribs make a bold statement on this school in Nevada.

This health care facility in Illinois features three butterfly-like roof systems using standing seam architectural metal roof panels.

Metal roofs can be curved to add drama to a roof, such as the custom green roof panels seen on this aquatic center on a college campus in Florida.

Commuters waiting to board trains in Illinois are protected by this multi-tiered curved metal roof system.

The architect chose the Copper Penny color to make this restaurant in Pennsylvania a beacon for locals and tourists looking for an enjoyable meal on the riverfront.

Metal wall panels in multiple colors create visual interest to multi-story structures like this office building.

Three colors of wall panels create the mosaic pattern seen on this fine arts facility in Texas.

Three shades of red were chosen to create this bright mosaic pattern on the corner of this vo-tech high school in Texas.

This Cabela's store features a standing seam metal roof system in custom green color to complete the log cabin aesthetic architects envisioned.

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1.4. Application

The steel and aluminum panels are selected for 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 with solar roof and wall systems, and rainscreen applications. Metal panels require less maintenance than other exterior systems and meet demanding performance requirements including wind-load ratings. Many designers and building owners also choose metal panels for the environmental value derived from being made with recycled content and being recyclable or reusable at the end of a building's useful life.

1.5. Material Composition

The standing seam roof panels and some wall-cladding panels are roll-formed to create interlocking joints which accommodate the fastener and concealed clip system to achieve panel-to-panel engagement. Roll-formed exposed-fastener roof and wall panels feature overlapping edges, which are mechanically fastened to the substrate. A variety of profiles in various widths are available for metal roof systems. Profile depth range is 2 inches or less. Table 1 represents the material composition, specified by mass percentage.

Table 1. Industry-weighted, average material composition

COMPONENT DESCRIPTION	MATERIAL	MASS %
Metal	Steel coil, hot dip coated/cold-rolled aluminum	>99%
Anti-corrosive	Spray applied thermoplastic	<1%
Metal	Cold-rolled aluminum	>99%
Anti-corrosive	Spray applied thermoplastic	<1%
Packaging		
	Wood	96%
	HDPE	3%
	Cardboard	1%

Steel coil represents 18 to 29-gauge steel that has been hot-dip coated (e.g. zinc, aluminum-zinc coated) and rolled. The hot-dip coating provides corrosion protection and improved aesthetics before and after the roll- forming process is applied. For aesthetic reasons, steel coil may be pre-painted using a continuous coil coating process whereby durable exterior primers and finish coats are applied to the metal surface. Light striations, pencil ribs (also known as stiffening beads) may be applied to reduce oil-canning.

Aluminum coils in thicknesses from 20 to 14-gauge (0.032" to 0.063") are rolled and undergo the same intermediate processes before undergoing the roll-forming process.

Aluminum coil production and coating are known to be performed in the same facility. For steel coils, there is a very short haul, 1 mile, from the site of coil production to the site of coil coating. Following the coil coating process, the average inbound transportation to the Petersen roll forming facility in Elk Grove, Illinois is 87 miles for steel coil and 565 miles for aluminum.

No substances required to be reported as hazardous are associated with the production of this product. Furthermore, the products do not release dangerous or regulated substances that affect health or environment.

1.6. Technical Requirements

Typical standards to which metal panel products conform are listed below.

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

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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

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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

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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]

1.7. Properties of Declared Product as Delivered

The delivery conditions can vary highly depending on the needs of the building structure and design. Panel width can range from approximately 10 inches to 36 inches (0.25 meters to 1 meter, approximately). As characteristic of continuous production methods, panels can be sheared to the required length, but can range from 4 feet to 64 feet (1 meters to 20 meters, approximately) depending on panel profile.

Roll-formed metal panels can be produced with different skin metals such as zinc and copper. Steel and aluminum, however, remains the dominant material.

Panel thickness can range from 29 gauge to 18 gauge. Thickness of the panels themselves can vary due to different corrugated profile designs.

Petersen warehouse and production personnel utilize the basic PPE (personal protective equipment). This includes but is not limited to: gloves for handling metal; protective eyewear, especially when cutting of metal is involved; ear protection for use near machines, and also steel-toe boots. In addition, a hazard communication program is in effect for chemicals primarily used for maintenance of machines.

Quality control is a major emphasis for Petersen. Petersen has both internal and third-party programs that validate the consistency of the processes involved in manufacturing these high-quality metal products. Petersen works under the following guidelines:

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Table 2. Allowable fabrication tolerances

DESCRIPTION	TOLERANCE
Panel Length	+/- 1/4 inches
Panel End Squareness	+/- 1/4 inches
Viewed from Panel Front (Measured across sheet)	0.5% of width and no more than 1/8 inch at one end
Viewed from Panel Side (Measured across sheet)	2% of panel depth and no more than 1/16 inch
Camber (Lateral bow of panel viewed from panel front)	3/16 inch per 10 feet length Accumulation allowed (e.g., 40 ft panel) Length maximum camber = 3/4 inch

2. Life Cycle Assessment Background Information

A “cradle-to-grave” life cycle assessment (LCA) was conducted for this EPD. The analysis was done according to UL’s product category rule (PCR) (UL Environment, Dec 2018). The analysis follows LCA principles, requirements, and guidelines laid out in the ISO 14040/14044 standards (ISO, 2009) (ISO, 2006). EPDs of construction products may not be comparable if they do not comply with the same PCR or if they are from different programs.

While the intent of the PCR is to increase comparability, there may still be differences among EPDs that comply with the same PCR (e.g., due to differences in system boundaries, background data, etc.).

2.1. Declared Unit

The declared unit for this study is defined as “coverage of 100 square meters (1,076 square feet) with metal product.” The coverage area refers to the projected flat area covered by the product as output by the final step in the manufacturing process and does not account for losses due to overlap and scrap during installation.

To achieve the functional unit of 100 square meters (1,076 square feet) coverage, a reference flow of 467 kg (1029 lbs) for steel or 207 kg (456 lbs) for aluminum is required for an industry-average roll-formed metal cladding.Table 3 summarizes the key Petersen primary products, substrates and processes for which primary life cycle inventory (LCI) data were collected.

Table 3. Petersen products

PRIMARY PRODUCT	METAL SUBSTRATE OF INTEREST	PETERSEN PRIMARY PROCESSES
Roll formed steel cladding	High performance coated 0.028” (24 gauge) steel coil	Roll forming
Roll formed aluminum cladding	Aluminum coated (20 gauge) coil	Roll forming Roll forming

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2.2. System Boundary

A cradle-to-gate with options system boundary was used for the analysis. Within these boundaries the following stages were included:

- Product stage: modules A1 to A3
- Construction stage: modules A4 and A5
- Panel maintenance (re-painting): module B2
- End-of-life stage: module C4
- Benefits and loads beyond system boundaries: module D

Each module includes provision of all relevant materials, products and energy. Impacts and aspects related to wastage (i.e. production, transport and waste processing and end-of-life stage of lost waste products and materials) are considered in the module in which the wastage occurs. Consequently, there are no direct emissions associated with this module.

Per the PCR, capital goods and infrastructure flows are assumed to not significantly affect LCA results or conclusions and thus excluded from the analysis.

2.3. Reference Service Life and Estimated Building Service Life

The reference service life (RSL) is declared as 75 years, equivalent to the building itself.

2.4. Allocation

The net scrap approach was used for modeling manufacturing wastes and end-of-life. Metal scrap produced during the production module (A3) is accounted for as materials for recycling. To calculate results for module D, the net amount of scrap leaving the product system (i.e., outputs from manufacturing and end-of-life, minus inputs into raw material production) is first calculated. All relevant recycling operations, such as remelting of scrap, are accounted for within the model.

The energy recovered from the disposal of manufacturing waste (A3) and packaging waste (A5) are accounted for in exported energy.

2.5. Cut-off Criteria

All known mass and energy flows were included where possible. If matching life cycle inventories were not available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts. Capital equipment production and maintenance were excluded under the assumption that the impacts associated with these aspects are small enough to become irrelevant when scaled down to the declared unit.

2.6. Data Sources

The LCA model was created using the GaBi ts software system (v.8.7) for life cycle engineering, developed by Sphera. The GaBi 2019 databases provided the life cycle inventory data for upstream and downstream processes of the background system. Proxy data used in the LCA model were limited to background data for raw material production and coil coating. Background data specific to the manufacturer's location were used whenever possible, with other locations substituted as proxies when necessary.

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2.7. Data Quality

Data quality and representativeness are considered to be good. Foreground data were collected from Petersen manufacturing facilities. The LCI data sets from the GaBi 2019 databases are widely distributed and used with the GaBi ts software. The datasets have been used in LCA models worldwide in industrial and scientific applications in internal as well as in many critically reviewed and published studies. In the process of providing these datasets, they are cross-checked with other databases and values from industry and science. All background data used in this model have reference years between 2010 and 2018 and are considered sufficiently representative of current activities.

2.8. Period under Review

Primary data from Petersen represents 12 continuous months of production during the 2016 calendar year.

2.9. Comparability and Benchmarking

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. Comparisons of EPDs need to meet the requirements of ISO 21930, section 5.5.

3. Life Cycle Assessment Scenarios

Scenario assumptions for modules A4 through D are provided in this section (see Table 4 to Table 8). Items that are excluded from these tables (c.f., PCR Part B: Metal Ceiling and Interior Wall Panel Systems EPD Requirements (UL Environment, Oct 2018)) are assumed to be zero. Furthermore, the use stage (modules B2) is also considered.

3.1. Manufacturing

Roll forming is a continuous bending operation in which a strip of metal (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 (i.e. press brake). A variety of cross-section profiles can be produced, but each profile requires a carefully crafted set of roll tools. Roll forming can be performed in factories with permanently positioned machines, or in the field will mobile roll formers.

Producing the panels is a five-stage process, as follows: (1) The metal coils are introduced from an uncoiler. (2) A flattener ensures an even, consistent surface for shaping. (3) Any punching is done by presses prior to forming. (4) The coil then enters a series of rolls designed to incrementally shape the steel or aluminum sheet into the desired profile. (5) Finally, the roll-formed panel is sheared to the required length and stacked for inspection and final packaging. Scrap metal generated are sent to external recyclers.

3.2. Packaging

Packaging materials are considered as part of this declaration. For Petersen, this included cardboard, wooden pallets, and plastic film. The packaging materials are assumed to be disposed according to PCR guidelines. The impacts of

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this disposal are reported in the installation module (A5); credits from recycling and energy recovery are included in module D.

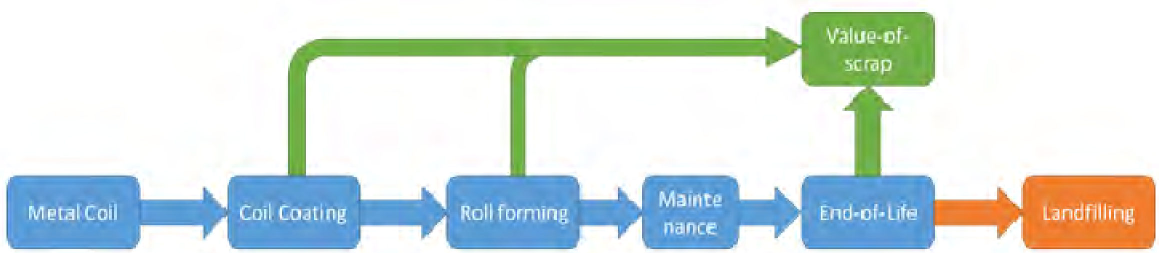

Figure 4: Process flow diagram overview of Petersen panels

3.3. Transportation

Average transportation distances via truck and rail are included for the transport of the raw materials to production facilities. Transport of the finished product 644 km via truck within North America to the construction site is accounted for. If products are manufactured outside North America, additional transportation via ship is included. Construction wastes and the deconstructed product at end-of-life are modeled as transported 100 km via truck to disposal facilities. Additional information on module A4 is provided in Table 4.

Table 4. Transport to the building site (A4)

NAME	VALUE	UNIT
Fuel type	Diesel	
Liters of fuel	35	l/100km
Vehicle type	Truck (trailer)	
Transport distance	644	km
Capacity utilization (including empty runs, mass based)	78	%
Gross density of products transported	NA	kg/m^3
Capacity utilization volume factor	NA	-

3.4. Product Installation

Products are assumed to be manually installed. The installation stage includes the disposal of packaging. Depending on the application of the panels, installation hardware varies. For standing seam roof panels, a clip is used for every 0.9 m (36 in) of panel with two fasteners. For the wall panels, only fasteners are used every 0.45 m to 0.6 m (18” to 24”).

Table 5. Installation into the building (A5)

NAME	VALUE	UNIT
Product loss per functional unit	-	kg
Waste materials at the construction site before waste processing, generated by product installation	121.62	kg
Wood packaging	117	kg
Plastic packaging	3.34	kg
Paper packaging	1.28	kg
Biogenic carbon contained in packaging	42.12	kg CO_2

3.5. Use

Due to the wide range of applications for metal panels products, only the use stage (B2) is considered for this declaration. Therefore, no conditions of use, environmental and health effects during use, and reference service life considerations have been made.

Table 6. Maintenance cycle (B2)

NAME	UNIT	VALUE
Maintenance cycle	3	# per RSL
Ancillary materials for maintenance	15	kg/cycle
Wastage material during maintenance	0	kg
Net freshwater consumption during maintenance	0	m3
Energy input during maintenance	0	kWh
Direct emissions to ambient air, soil, and water	0	kg

3.6. Disposal

Table 7. End of life (C1-C4)

NAME		VALUE		UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)		Aluminum	Steel	
Collection process (specified by type)	Collected separately	207	467	kg
	Collected with mixed construction waste	0	0	kg
Recovery (specified by type)	Reuse	0	0	kg
	Recycling	176	397	kg
	Landfill	31	70	kg
	Incineration	0	0	kg

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	Incineration with energy recovery	0	0	kg
	Energy conversion efficiency rate	n/a	n/a	
Disposal (specified by type)	Product or material for final deposition	207	467	kg
Removals of biogenic carbon (excluding packaging)		0	0	kg CO_2

3.7. Re-use Phase

Metal panels products are mostly metal and can be recycled once they reach the end of their useful lifetime.

Table 8. Reuse, recovery and/or recycling potentials (D), relevant scenario information

NAME	VALUE	UNIT
Net energy benefit from energy recovery from waste treatment declared as exported energy in C3 (R>0.6)	0	MJ
Net energy benefit from thermal energy due to treatment of waste declared as exported energy in C4 (R<0.6)	0	MJ
Net energy benefit from material flow declared in C3 for energy recovery	0	MJ
Process and conversion efficiencies	n/a	
Further assumptions for scenario development (e.g. further processing technologies, assumptions on correction factors)	Recovery of metal	

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4. Life Cycle Assessment Results

Table 9. Description of the system boundary modules. X = included in EPD scope; MND = module not declared (i.e., excluded from EPD scope)

	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	X	X	MND	X	MND	MND	MND	MND	MND	MND	MND	MND	X	X

Life cycle impact assessment and other results for 100 sqm of metal panel product are presented in Table 10 to Table 17. Per the PCR, impact assessment results are based upon the US EPA TRACI 2.1 Tool for the Reduction and Assessment of Chemical and other environmental Impacts. Results are shown for a cradle-to-gate with options system boundary.

Biogenic carbon is not reported in global warming potential (GWP) as metal panel products do not typically contain bio-based materials. As such, biogenic carbon dioxide emissions and removals are not declared.

4.1. Life Cycle Impact Assessment Results

Table 10. North American Impact Assessment Results (Steel)

TRACI v2.1	A1-A3	A4	A5	B2	C4	D
Global warming potential, GWP 100 [kg CO_2 eq]	1.58E+03	2.13E+01	4.81E+01	8.37E+01	3.13E+00	-7.37E+02
Ozone depletion potential, ODP [kg CFC-11 eq]	3.32E-05	-1.16E-13	-1.92E-11	-8.01E-12	-1.62E-13	-5.70E-08
Acidification potential, AP [kg SO_2 eq]	3.89E+00	1.14E-01	1.89E-01	3.68E-01	1.71E-02	-1.41E+00
Eutrophication potential, EP [kg N eq]	1.84E-01	9.35E-03	1.81E-02	1.65E-02	1.92E-03	-5.86E-02
Photochemical ozone creation potential, POCP [kg O_3 eq]	6.00E+01	2.62E+00	9.56E-01	1.02E+01	2.83E-01	-1.90E+01
Abiotic depletion potential (fossil), ADP_{fossil} [MJ, surplus]	7.30E+02	4.21E+01	6.42E+00	1.93E+02	6.17E+00	9.06E+01

Table 11. North American Impact Assessment Results (Aluminum)

TRACI v2.1	A1-A3	A4	A5	B2	C4	D
Global warming potential, GWP 100 [kg CO_2 eq]	3.84E+02	9.46E+00	2.13E+01	8.37E+01	1.39E+00	-1.63E+02
Ozone depletion potential, ODP [kg CFC-11 eq]	1.47E-05	-5.13E-14	-8.53E-12	-8.01E-12	-7.16E-14	-3.23E-08
Acidification potential, AP [kg SO_2 eq]	1.89E+00	5.07E-02	8.36E-02	3.68E-01	7.60E-03	-1.04E+00
Eutrophication potential, EP [kg N eq]	5.28E-02	4.14E-03	8.00E-03	1.65E-02	8.53E-04	-1.72E-02
Photochemical ozone creation potential, POCP [kg O_3 eq]	1.98E+01	1.16E+00	4.24E-01	1.02E+01	1.26E-01	-8.14E+00
Abiotic depletion potential (fossil), ADP_{fossil} [MJ, surplus]	4.46E+02	1.87E+01	2.85E+00	1.93E+02	2.74E+00	-1.06E+02

Table 12. CML Impact Assessment Results (Steel)

CML2001 - APR. 2013	A1-A3	A4	A5	B2	C4	D
Global warming potential, GWP 100 [kg CO_2 eq]	1.58E+03	2.13E+01	4.81E+01	8.37E+01	3.13E+00	-7.37E+02
Ozone depletion potential, ODP [kg R-11 eq]	6.60E-05	1.77E-15	-1.79E-11	2.19E-12	1.12E-14	-5.23E-08
Acidification potential, AP [kg SO_2 eq]	3.80E+00	8.38E-02	1.47E-01	3.71E-01	1.31E-02	-1.43E+00
Eutrophication potential, EP [kg PO_4^{3-}-eq]	3.43E-01	2.32E-02	3.20E-02	2.81E-02	2.98E-03	-9.98E-02
Photochemical ozone creation potential, POCP [kg C_2H_4 eq]	5.64E-01	-3.19E-02	4.08E-02	3.44E-01	1.16E-03	-3.40E-01
Abiotic depletion potential (fossil), $ADP_{element}$ [kg Sb-eq]	4.05E-02	4.27E-06	1.58E-06	5.15E-04	1.27E-06	-1.22E-02
Abiotic depletion potential (fossil), ADP_{fossil} [MJ, surplus]	1.71E+04	3.14E+02	5.11E+01	1.63E+03	4.79E+01	-6.98E+03

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Table 13. CML Impact Assessment Results (Aluminum)

CML2001 - Apr. 2013	A1-A3	A4	A5	B2	C4	D
Global warming potential, GWP 100 [kg CO_2 eq]	3.84E+02	9.46E+00	2.13E+01	8.37E+01	1.39E+00	-1.63E+02
Ozone depletion potential, ODP [kg CFC-11 eq]	2.93E-05	7.87E-16	-7.93E-12	2.19E-12	4.98E-15	-2.98E-08
Acidification potential, AP [kg SO_2 eq]	1.96E+00	3.71E-02	6.53E-02	3.71E-01	5.80E-03	-1.13E+00
Eutrophication potential, EP [kg PO_4 ^{3}-eq]	1.24E-01	1.03E-02	1.42E-02	2.81E-02	1.32E-03	-4.74E-02
Photochemical ozone creation potential, POCP [kg C_2H_4 eq]	9.02E-02	-1.42E-02	1.81E-02	3.44E-01	5.14E-04	-5.52E-02
Abiotic depletion potential (element), $ADP_{element}$ [kg Sb-eq]	4.00E-04	1.89E-06	6.99E-07	5.15E-04	5.64E-07	-8.52E-05
Abiotic depletion potential (fossil), ADP_{fossil} [MJ, surplus]	4.58E+03	1.39E+02	2.26E+01	1.63E+03	2.12E+01	-1.54E+03

4.2. Life Cycle Inventory Results

Table 14. Resource Use (Steel)

Parameter	A1-A3	A4	A5	B2	C4	D
Renewable primary resources used as energy carrier (fuel) RPR_E [MJ, LHV]	1.91E+03	9.59E+00	4.83E+00	2.18E+02	3.75E+00	4.81E+02
Renewable primary resources with energy content used as material, RPR_M [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable primary resources used as energy carrier (fuel), $NRPR_E$ [MJ, LHV]	1.77E+04	3.16E+02	5.36E+01	1.72E+03	4.91E+01	-6.77E+03
Non-renewable primary resources with energy content used as material, $NRPR_M$ [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials, SM [kg]	2.82E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels, RSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels, NRSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy, RE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fresh water, FW [m^3]	5.49E+00	3.75E-02	8.62E-02	3.96E-01	5.83E-03	-1.39E+00

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Table 15.Resource Use (Aluminum)

PARAMETER	A1-A3	A4	A5	B2	C4	D
Renewable primary resources used as energy carrier (fuel) RPR_E [MJ, LHV]	2.07E+03	4.25E+00	2.14E+00	2.18E+02	1.66E+00	-9.33E+02
Renewable primary resources with energy content used as material, RPR_M [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable primary resources used as energy carrier (fuel), $NRPR_E$ [MJ, LHV]	4.97E+03	1.40E+02	2.38E+01	1.72E+03	2.18E+01	-1.59E+03
Non-renewable primary resources with energy content used as material, $NRPR_M$ [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials, SM [kg]	8.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels, RSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels, NRSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy, RE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fresh water, FW [m^3]	6.49E+00	1.66E-02	3.82E-02	3.96E-01	2.59E-03	-4.31E+00

Table 16: Output Flows and Waste Categories (Steel)

PARAMETER	A1-A3	A4	A5	B2	C4	D
Hazardous waste disposed, HWD [kg]	3.31E-02	2.57E-06	5.26E-04	1.57E-06	1.72E-07	-8.33E-04
Non-hazardous waste disposed, NHWD [kg]	5.83E+01	1.15E-02	4.29E+01	3.22E+01	7.02E+01	7.74E+01
Radioactive waste, [kg]	1.16E-01	5.62E-04	1.01E-03	3.66E-02	4.76E-04	-1.47E-02
Components for reuse, CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling, MR [kg]	0.00E+00	0.00E+00	1.29E+00	0.00E+00	0.00E+00	4.57E+02
Materials for energy recovery, MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E+02

Table 17. Output Flows and Waste Categories (Aluminum)

PARAMETER	A1-A3	A4	A5	B2	C4	D
Hazardous waste disposed, HWD [kg]	3.71E-02	1.14E-06	2.33E-04	1.57E-06	7.63E-08	-1.47E-02
Non-hazardous waste disposed, NHWD [kg]	8.10E+01	5.08E-03	1.90E+01	3.22E+01	3.11E+01	-4.97E+01
Radioactive waste, [kg]	1.47E-01	2.44E-04	4.37E-04	3.59E-02	2.07E-04	-2.16E-02
Components for reuse, CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling, MR [kg]	0.00E+00	0.00E+00	5.73E-01	0.00E+00	0.00E+00	8.95E+01
Materials for energy recovery, MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.70E+01

5. LCA Interpretation

The raw material module (A1) is associated with the largest potential impact relative to the other modules across all impact categories. The Global Warming Potential impact is dominated by stages A1 (materials) as well as moderate burdens at manufacturing (A3). The moderate impacts at manufacturing (A3) comes from energy use, primarily electricity. Inbound transportation (A2) is a minor contributor across all impact categories. Additionally, due to the estimation of re-painting two to three additional times after installation, the maintenance stage (B2) also has minor impact contributions to Global Warming Potential.

The installation module (A5) includes the disposal of packaging from installing 100 sqm of product. At end-of-life, 85% of the product is assumed to be recycled and the remainder landfilled. Credits associated with net scrap metal are presented in module D.

6. Additional Environmental Information

6.1. Environment and Health During Manufacturing

Petersen warehouse and production personnel utilize the basic PPE (personal protective equipment). This includes but is not limited to: gloves for handling metal; protective eyewear, especially when cutting of metal is involved; ear protection for use near machines, and also steel-toe boots. In addition, a hazard communication program is in effect for chemicals primarily used for maintenance of machines.

6.2. Environment and Health During Installation

There should be no release of harmful substances or emissions during the installation and use of metal panel products.

6.3. Extraordinary Effects

Fire

Fire performance for metal panel products is determined in accordance with UL 723, NFPA 255, ASTM E-84, or ICC's IBC 803.1.1 standards. Manufacturer-specific details are not provided here but can be obtained from manufacturers.

Water

There are no known effects on the environment in the event of flooding or other water damage to the product.

Mechanical Destruction

There are no known effects on the environment in mechanical destruction.

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