Environmental Product Declaration

Insulated Metal Panels

WALL AND ROOF PANEL SYSTEMS

METAL CONSTRUCTION ASSOCIATION

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.

Insulated Metal Panels are a major product category developed by MCA members. These factory fabricated metal panels have a continuous insulating core that together with the metal skins act as an air, water vapor, and thermal barrier.

This Environmental Product Declaration for Insulated Metal Panels is one of several different product EPDs offered by MCA.

For more information visit
www.metalconstruction.org

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

Insulated Metal Panels
Industry-Wide EPD

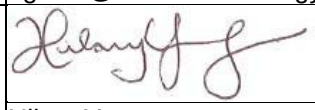
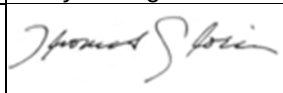
According to ISO 14025

This declaration is an environmental product declaration in accordance with ISO 14025. This EPD does not guarantee that any performance benchmarks, including environmental performance benchmarks, are met. EPDs are intended to compliment Type I environmental performance labels. EPDs provide LCA-based information and additional information on the environmental aspects of products and assist purchasers and users to make informed comparisons between products. EPDs are not comparative assertions. EPDs encourage improvement of environmental performance and provide information for assessing the environmental impacts of products over their life cycle. EPDs not based on an LCA covering all life cycle stages, or based on a different PCR, are examples of declarations that have limited comparability. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Metal Construction Association (MCA)
DECLARATION NUMBER	13CA27321.101.1
DECLARED PRODUCT	Insulated Metal Panels
REFERENCE PCR	Insulated Metal Panels & Metal Composite Panels, and Metal Cladding: Roof and Wall Panels (UL, October 2012)

DATE OF ISSUE	27 August 2013
PERIOD OF VALIDITY	5 Years

CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	UL Environment Review Panel Thomas Gloria (Chairperson) 35 Bracebridge Road Newton, MA 02459-1728 t.gloria@industrial-ecology.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	 Hilary Young
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	 Thomas Gloria, Life-Cycle Services, LLC

Insulated Metal Panels
Industry-Wide EPD

According to ISO 14025

Description of organization and product

Organization Description

The Metal Construction Association (MCA), Chicago, IL, is an organization of manufacturers and suppliers whose metal products are used in structures throughout the world. 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 Insulated Metal Panels Council who are volunteers representing the leading manufacturers of IMPs. The product configurations offered herein use ranges representative of all types of IMPs based on specific products from the three manufacturing facilities of the following MCA-member manufacturers:

CENTRIA Architectural Systems, Moon Township, PA, offers factory foamed insulated wall and roof panel systems for architectural and industrial applications along with field assembled metal panels, and architectural and engineering support services. For 100 years, the continuous pursuit of innovation and excellence has been synonymous to CENTRIA and its predecessor companies H.H. Robertson, E.G. Smith and Steelite. CENTRIA strives to offer sustainable, eco-friendly metal wall and roof systems. Its Recycle, Reuse and Reclaim initiatives have generated impressive results that demonstrate the company's commitment to sustainable practices in the built environment. Learn more at http://eco.CENTRIA.com

Kingspan Insulated Panels North America is part of Kingspan Group PLC. The world's largest manufacturer of insulated metal panels with global operations, Kingspan was founded in 1972 as a small family business in Ireland, and entered the North American market in 2007. Headquartered in Deland, FL, Kingspan Insulated Panels North America has five manufacturing facilities: Deland, FL; Columbus, Ohio; Modesto, CA; Caledon, Ontario; and Langley, British Columbia. Kingspan is committed to reducing the impact of its business operations, products and services on the environment. The company has a commitment to reach Net Zero in its facilities by the year 2020 and is on track to be halfway there by 2015. For more details visit http://www.pathtonetzero.com.

Metl-Span, Lewisville, TX, is part of NCI Group, Inc., the single largest producer of metal building components in North America. For over 40 years, Metl-Span® has been the leader in insulated metal panels for a variety of building applications. Since its inception, the company has been dedicated to a cleaner, safer environment. It produces panels that meet or exceed the U.S. Green Building Council's criteria for sustainability, reusability, recyclability and other attributes that enable customers to qualify their building projects for credits in the Leadership in Energy and Environmental Design (LEED) Rating System. To learn more visit www.environmentallyconnected.com.

Insulated Metal Panels
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MBCI, an NCI company, is an industry leading manufacturer of metal roof and wall systems. Its metal product solutions include single skin metal panels for roof and wall applications as well as the insulated metal panel systems covered by this EPD. In 2013, MBCI's IMP manufacturing operations were consolidated with those of Metl-Span, allowing MBCI to supply insulated metal roof and metal wall panels to the architectural, industrial, commercial and institutional markets across North America. With facilities strategically located across the United States and Canada, coupled with an accredited Quality Control program, MBCI has the capabilities of meeting insulated metal panel needs wherever they may be. For more information, visit www.mbci.com.

Insulated Metal Panels
Industry-Wide EPD

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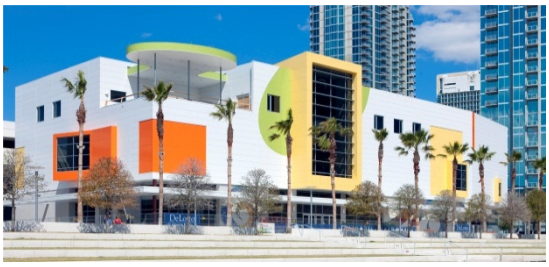
Product Benefits

For schools such as this, Insulated Metal Panels help reduce operating costs and improve protection from the elements.

Since the 1960s cold storage facilities have used insulated metal panels for their excellent thermal efficiency.

IMPs offer cost-competitive construction advantages and long-term high performance to help lower operating costs for building owners in any construction market, including healthcare facilities, commercial, amusement and industrial buildings.



IMPs speed construction and offer environmental and aesthetic benefits for large public facilities such as the Glazer Children's Museum in Florida.

Insulated Metal Panels
Industry-Wide EPD

According to ISO 14025

Product Description

Insulated metal panels in their simplest form are rigid foam sandwiched between two sheets of coated metal as shown in Figure 1. The panels are molded in a variety of styles and sizes depending on application. Steel or aluminum panel facings create a vapor, air and moisture barrier and provide long-term thermal stability. The metal skins offer long-term durability and come in a multitude of colors and finishes.

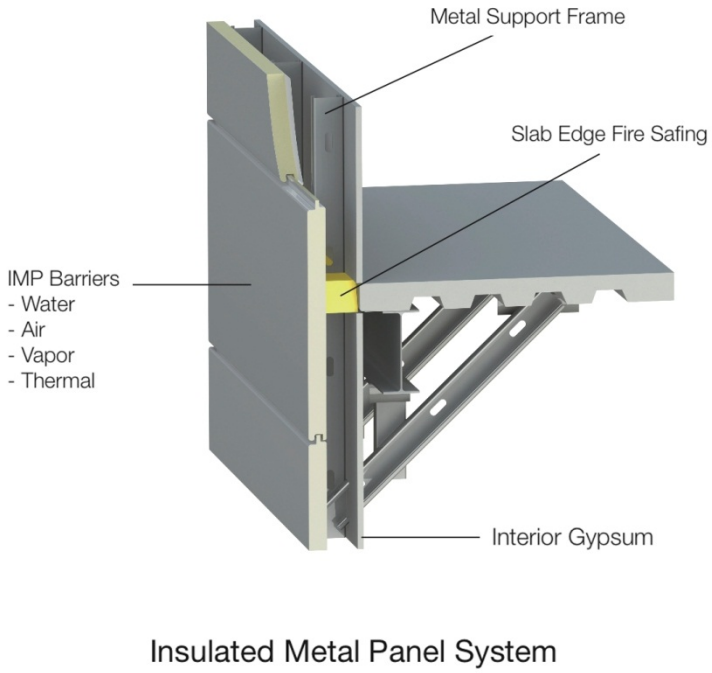


Figure 1: Cross Section of a 3-inch insulated metal panel.

Materials

Panel edges are roll formed to create interlocking side joints, which accommodate the concealed fastener and clip system and achieve the panel-to-panel seals. A variety of modules, profiles and side joints are available for insulated metal roof systems. For example, side joints can be standing seam, or overlapping. The width of the panel is referred to as the module and can typically range from 24 inches to 42 inches. The panel thickness can vary from 2 inches to 6 inches with R-values generally ranging from 7 to 48 depending on the manufacturer.

Raw materials/primary products

Component	Material	Availability	Origin	Mass (%)
Galvanized coil	Steel coil, hot-dipped galvanized	Fossil resource, limited	North America	79%
Polyurethane foam	Polyester polyol	Fossil resource, limited	US	7%
	MDI	Fossil resource, limited	US	12%
	Blowing Agent	Fossil resource, limited	US	2%

Table 1: Base material mass by percentage, MCA Industry-average

Auxiliary substances/Additives

In addition to the main components declared above, adhesives are used in the manufacturing process.

Raw Material Extraction and Origin

Steel coil represents steel that has been rolled out into 22, 24, or 26 gauge sheet and hot-dipped galvanized. The coated steel coil is assumed to be 100% produced in North America. Hot-dipped galvanized steel used by manufacturers is first coated for aesthetics and to provide weather protection before its use in insulated metal panels. Other substrates are stainless steel, aluminum-zinc coated steel, and aluminum. To stiffen the panel faces an embossed surface texture is commonly applied and various profiles are roll formed into them. Profiles are usually in the form of light striations or planking, deep ribbing or stiffening beads. Smooth or un-embossed surfaces are available from some manufacturers.

The three primary chemicals used to produce polyurethane foam—namely polyester polyol, MDI, and blowing agents—are all produced and sourced within the United States:

Polyester polyol is one of the primary components of polyurethane and is typically produced by polymerizing propylene oxide and ethylene oxide.

Methylene diphenyl diisocyanate (MDI) is another primary component of polyurethane foam.

The panel core is a polyisocyanurate or polyurethane foam. The chemistry is usually proprietary to each manufacturer. The formulation contains the additives necessary to meet the fire performance of the given product geometry and to satisfy the needs of the manufacturing process. The density is typically between 2 and 3 pcf. The panel weight will vary depending on thickness and gauge of the skins. A 2-inch panel with 26 gauge skins will weigh about 2.3 psf. The same panel with 22 gauge skins may weigh as much as 3.65 psf depending on the panel profile.

Pentane is a hydrocarbon used as a blowing agent to produce foam.

1,1,1,2-tetrafluoroethane (R-134a) is an inert hydrofluorocarbon gas also used as a blowing agent to produce foam.

Availability of Raw Materials

All raw materials are produced from fossil resources and thus of limited availability. Galvanized steel coil production, however, consumes around 0.1 kg of scrap steel per kilogram of output.

Manufacturing

The process of manufacturing insulated metal panels requires a marriage of customized mechanical equipment and foam chemistry. The most involved method is the continuous process as shown in Figure 2. Greatly simplified, it entails forming the continuous metal facers while at the same time (at another point on the continuous line) injecting the foam mixture into the panel assembly. The foam then expands and fills the cavity between the metal skins as they enter a platen conveyor. Panels are then cut to length with an in-line cross cut saw. Post fabrication work, available through some manufacturers, can be performed on the product to treat the cut ends of the panels.

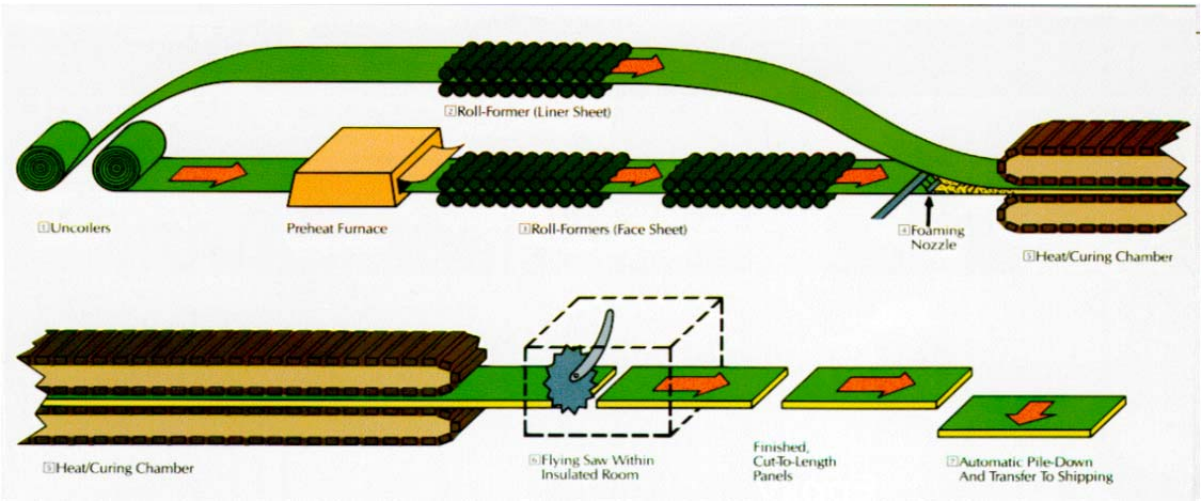


Figure 2: Schematic of continuous manufacturing process for insulated metal panels.

Insulated metal panels can also be manufactured by a laminating process as shown in *Figure 3.* In this method, procured foam board stock in an appropriate thickness is adhered to preformed metal facers with structural adhesives and placed under pressure in a platen press operation.

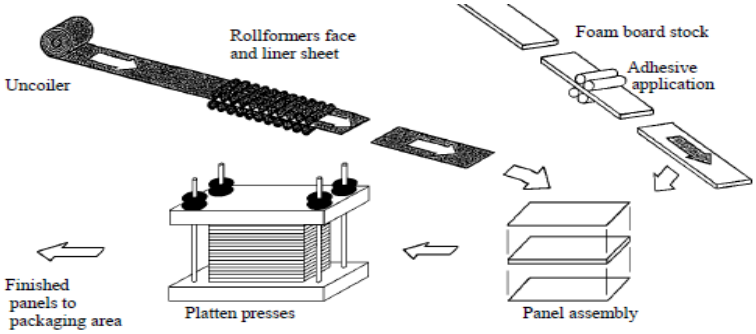


Figure 3: Schematic of laminating process for manufacturing insulated metal panels.

Range of Applications

Since the 1960s, contractors, designers and owners of commercial, industrial and refrigerated buildings have relied on insulated metal panels for excellent thermal efficiency, ease of installation and overall structural integrity. Insulated metal panels offer benefits for the entire building team. The owner achieves a thermally efficient, high performance product that has superior life cycle cost. The designer works with a product that offers many design and performance options. The erector works with a product that is easy and quick to install in almost any weather condition, in response to the common tight building schedules of today's market.

Insulated metal panels are used in a variety of applications because of their excellent performance characteristics and competitive in-place costs. Examples of buildings using IMPs:

- Aircraft hangars and service facilities
- Banks, corporate offices and municipal buildings

- Churches
- Cold-storage and food-processing plants
- Healthcare facilities
- Manufacturing facilities
- Retailers, including auto dealerships
- Schools and universities
- Sports complexes, museums and convention centers
- Warehousing and distribution centers

Insulated metal panel systems provide many of the same benefits and features found with other metal wall and roof systems as well as some unique benefits:

- Insulated metal panels are installed as a single monolithic element allowing for faster building completion in almost any kind of weather without risk to system integrity, as opposed to multiple installation steps for other insulated wall and roof systems.
- The lightweight wall and roof panels are available in a wide range of long lasting finishes and colors.
- When combined with the inherent benefits of metal facings, insulated metal panels require less maintenance than other exterior systems and meet the most demanding performance requirements.

Product Performance Data

All major insulated panel manufacturers meet the performance requirements listed below.

Structural **-** ASTM E-72 or ASTM E330 for walls and roofs. The maximum deflection criteria for the insulated panels is typically L/180 for walls and L/240 for roofs

Thermal Transmittance **-** ASTM C-1363 at 75 degrees F mean test temperature per ASHRAE 90.1 requirements. A 40 degree F mean test temperature is commonly used for refrigerated buildings or to simulate heating of a commercial building in cold climate zones. Insulated metal panels are available with thermal resistance values generally ranging from R7 to R48.

Core Physical Properties **-** The polyurethane or polyisocyanurate core tests include:

- Density per ASTM D1622
- Shear strength per ASTM C273
- Tensile strength per ASTM D1623
- Compressive strength per ASTM D1621

The core is also tested for:

- Humidity aging per ASTM D 2126
- Heat aging per ASTM D 2126
- Cold aging per ASTM D 2126

The core properties of insulated metal panels vary slightly with the type of foam that each manufacturer uses. The most critical factor in panel production is formulating a foam system with the right balance of these properties that will ensure structural integrity and adhesion of the foam to the metal faces.

Quality Control

Insulated metal panels are manufactured to meet the performance and testing requirements of the model building codes and insurance listing agencies. Insulated metal panels carry ratings for fire, structural, thermal transmittance, foam core properties, water leakage and air infiltration. In some cases, an additional fire barrier may be used on the inside of these panels for certain fire ratings.

When compared to other mutli-component field assembled systems, insulated metal panels minimize installation impact on system performance. This results in better inplace quality, weather integrity, and appearance. Having many of the components combined into one product assembly offers the best in-place quality, less construction trades and faster construction times.

All IMP manufacturers provide testing documentation and calculations verifying that all factors affecting positive and negative wind loads along with the load carrying capacity of the panels meet specified project requirements.

Individual quality control procedures will vary by individual manufacturer.

Delivery Conditions and Properties

Manufacturers supply IMPs 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 previously identified manufacturers that participated in the Metal Construction Association LCA project.

Wall panel configurations have a range as follows:

- Thickness: from 2 inches to 6 inches
- Width: from 24 inches to 42 inches
- Length: from 1 foot to 53 feet.

Joint configurations: Double tongue and groove interlocking rainscreen joint; offset double tongue and groove with extended metal shelf for positive face fastening; mechanically closed single lock standing seam at the exterior side joint with interior side joint being a single tongue-and-groove interlock.

Facings: Material:

Aluminum, Galvalume/Zincalume®, G-90 HDG steel, stucco embossed steel, aluminum and zinc

Gauge ranges:

22 to 24 gauge steel; 22, 24 and 26 gauge coated steel

Roof panel configurations:

- Thickness: 2 inches to 6 inches
- Width: 42 inches
- Length: 8 feet to 52 feet
- Joint configuration: standing seam 2 inches high minimum
- Panel facings: Galvalume, Zincalume, pre-painted steel
- Gauges 24 to 22 for exterior; 22, 24 or 26 for interior

Galvalume® is an internationally recognized trademark of BIEC International, Inc.

Packaging

Foam sheets are layered between insulated metal panels before the panels are stacked on (OSB) oriented strand board and (EPS) expanded polystyrene underlayment and wrapped in polyethylene film. Depending on the manufacturer, chipboard and/or oriented strand board are also used in packaging.

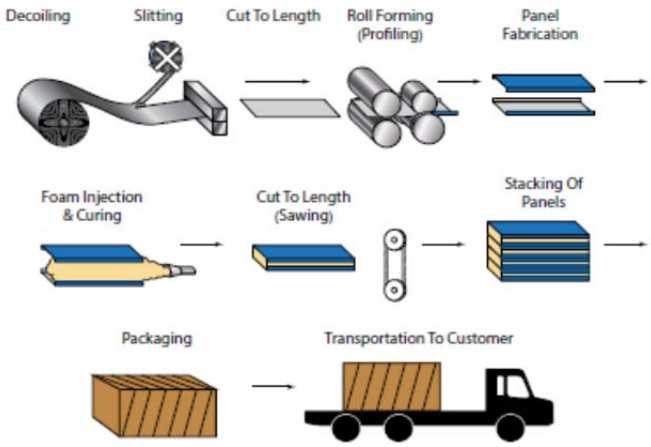


Figure 4: Schematic of packaging process for insulated metal panels

Singular Effects

Key Product Standards

Not all standards are applicable to all products. Consult specific manufacturer's information for standards compliance.

Material Standards

ASTM A 240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*
ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*
ASTM A 755	Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products*
ASTM A 792	Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process*
ASTM A 924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process*

Performance Standards - Acoustical

ASTM E 413	Classification for Rating Sound Insulation

ASTM E 90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*

Performance Standards - Air Tightness

ASTM E 1680	Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems*
ASTM E 283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen*

Performance Standards - Fire

ASTM D 1929	Standard Test Method for Determining Ignition Temperature of Plastics*
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials*
CAN/ULC S101	Standard Methods of Fire Endurance Tests of Building Construction Materials**
CAN/ULC S102	Standard Method of Test for Surface Burning Characteristics of Building Materials**
CAN/ULC S126	Standard Method of Test for Fire Spread Under Roof Deck Assemblies**
CAN/ULC S127	Standard Corner Wall Method of Test for Flammability Characteristics of Non-Melting Building Materials
CAN/ULC S134	Fire Test of Exterior Wall Assemblies**
CAN/ULC S138	Standard Method of Test for Fire Growth of Insulated Building Panels in a Full-Scale Room Configuration**
FM 4880	Approval Standard for Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall Systems*
NFPA 259	Standard Test Method for Potential Heat of Building Materials*
NFPA 268	Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source*
NFPA 285	Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*
NFPA 286	Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*

Performance Standards - Structural

ASTM D 2126	Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM C 273	Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM D 1621	Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D 1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D 1623	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D 3359	Standard Test Methods for Measuring Adhesion by Tape Test
ASTM D 6226	Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E 1592	Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference*

ASTM E 1886	Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E 1996	Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes*
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*
ASTM E 72	Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
FM 4470	Approval Standard for Class 1 Roof Covers*
FM 4471	Approval Standard for Class 1 Panel Roofs
FM 4881	Approval Standard for Class 1 Exterior Wall Systems
UL 580	Tests for Uplift Resistance of Roof Assemblies*

Performance Standards - Thermal

ASTM C 1363	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus*
ASTM C 518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*

Performance Standards - Water Resistance

AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
AAMA 501.2	Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
ASTM E 1646	Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference
ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*

Performance Standards - Coatings

ASTM B 117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D 1014	Standard Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates
ASTM D 1654	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 1729	Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
ASTM D 2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 4145	Standard Test Method for Coating Flexibility of Prepainted Sheet
ASTM D 4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

ASTM D 523	Standard Test Method for Specular Gloss
ASTM D 7091	Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
ASTM D 968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM E 18	Standard Test Methods for Rockwell Hardness of Metallic Materials

* Referenced in IBC 2012 or IECC 2012
** Referenced in National Building Code of Canada, 2010

Thermal Effects

Thermal expansion is accommodated by a combination of thermal bow and thermal stress. Because insulated metal panels are a composite sandwich with both the interior and exterior faces bonded to the core, there is no significant differential expansion between the interior and exterior faces. The insulated panels are positively fastened to the structure and the expansion of the panel is distributed among the individual spans as thermal bow rather than linear expansion. The overall panel does not significantly elongate or contract so there is no need to install an insulated metal roof panel with slotted clips. Thermal bow does not adversely affect the performance of the panels used in a properly designed roof system, since all panel analysis calculations must make allowance for it.

The ability of the insulated panel to accommodate this flexing is substantiated by Cyclic Load Tests, which subject a panel specimen to alternate cycles of positive and negative loads at a deflection limit of L/180. A typical test might use a 10-foot long panel. A cycle load of +/- 20 psf is applied.

Requirements for the Underlying Life Cycle Assessment

The LCA study and analysis were conducted according to the Product Category Rule (PCR) created by UL Environment for insulated metal panels, metal composite panels, and metal cladding.

Functional Unit/Reference Flow

The functional unit for this study is defined as **"coverage of 1,000 square feet with metal product"**. 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.

To achieve the functional unit of 1,000 ft2 coverage, a reference flow of 1371 kg is required for an industry-average insulated metal panel (IMP). Table 2 summarizes the key MCA primary products, substrates, and processes for which LCI data was collected from MCA member facilities.

Primary Product	Metal Substrate of Interest	MCA Primary Processes
2" Insulated Metal Panel (IMP) with polyurethane/ polyisocyanurate foam core	High performance coated 0.028" (24 gauge) steel coil	• Continuous Coil Coating • IMP Continuous Foaming

Table 2: Insulated Metal Panels, Key Metal Substrates and Processing

System Boundaries

The defined system boundary is a 'cradle-to-gate' LCA, which correlates to the Product Stage modules A1 – A3 as defined by EN 15804:[1]

- A1 - Raw material supply
- A2 - Inbound transport of raw materials to manufacturing facility and transportation between steel coil coating and IMP manufacturing facilities
- A3 - Energy and water input at steel coating and IMP manufacturing facilities

A cradle-to-gate assessment excludes all impacts beyond the factory; thus, the reference service life (RSL) is not stated in the document. Figure below illustrates the system boundary for the IMP product system.

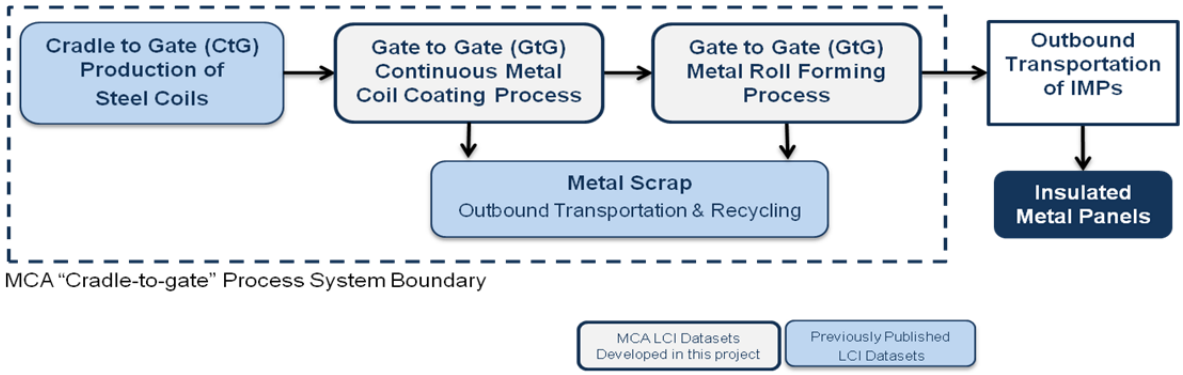


Figure 5: Cradle-to-Gate System Boundaries of IMP Products

Scope

The scoping stage considers all elements identified as contributing to the production of IMPs and then evaluated for their inclusion or exclusion from the LCA study. Table 3 summarizes the elements included and excluded from the cradle-to-gate system boundary for this study.

[1] EN 15804:2012 – Sustainability of construction works—Environmental Product Declarations—core rules for the product category of construction products. European Committee for Standardization, Brussels.

Included	Excluded
✓ Extraction of input raw materials, transportation and production of the metal sheet used in the product ✓ Energy supply ✓ Overhead (heating, lighting) of manufacturing facilities ✓ In-bound transportation of all materials, intermediate products and fuels ✓ Operation of primary production equipment ✓ Operation of mobile support equipment ✓ Input water (for process and cooling) ✓ Waste and on-site waste water treatment ✓ Manufacture and transport of product packaging ✓ Process ancillary materials (e.g. fasteners) ✓ Waste & emissions ✓ Transportation & recycling of metal sheet scrap	× Maintenance and manufacture of fixed capital equipment × Maintenance of mobile support equipment × Outbound transportation of the main product/process output × Hygiene related water use × Employee commuting × Human labor × Installation and disposal of product

Table 3: System Boundaries Description for Cradle-to-Gate process

Temporal Scope

Primary data collected from the previously identified MCA member companies for their operational activities are representative for the year 2010. Additional data necessary to model base material production and energy use, etc. was adopted from the GaBi 2011 databases.

Geographic Scope

The geographical coverage for this study is based on North American system boundaries for all processes and products. Whenever North American background data was not readily available, European data was used as a proxy.

Background Data

The LCA model was created using the GaBi 4.4 Software system for life cycle engineering, developed by PE INTERNATIONAL AG. The GaBi 2011 LCI database provides the life cycle inventory data for several of the raw and process materials obtained from the background system. North American background data were used whenever possible; if such data were not available, European data were used as a proxy. The worldsteel North American average data were used for galvanized steel coil background data, with coil coating data obtained from the Metal Construction Association (MCA).

Life Cycle Assessment Results and Analysis

Cradle-to-gate life cycle impact assessment results are shown for both TRACI 2.0 and CML (November 2009) characterization factors. Due to the relative approach of LCA, which is based on a functional unit, these results are relative expressions only 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, 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 life-time of plant-derived packaging materials is shorter than the 100 year time horizon of this impact category (GWP 100), biogenic carbon was excluded from the global warming potential calculations.

Total Environmental Impacts

TRACI 2.0 Impact Categories	Units	MCA Industry-average
Global warming potential (GWP100)	kg CO_2-eq.	6,520
Ozone depletion potential (ODP)	kg CFC11-eq.	1.37E-04
Acidification potential (AP)	kg H^+ mol-eq.	1,090
Eutrophication potential (EP)	kg N-eq.	0.858
Smog formation potential (SFP)	kg O_3-eq.	354
CML 2001 – November 2009		
Global warming potential (GWP100)	kg CO_2-eq.	6,520
Ozone depletion potential (ODP)	kg R11-eq.	7.40E-04
Acidification potential (AP)	kg SO_2-eq.	19.4
Eutrophication potential (EP)	kg PO_4^{3-}-eq.	2.01
Photochemical oxidation potential (POCP)	kg C_2H_4-eq.	2.55
Abiotic depletion potential (ADP) – elements	kg Sb-eq.	2.86E-02
Abiotic depletion potential (ADP) – fossil fuels	MJ	59,500

Table 4: Total life cycle impacts of 1,000 sq ft of IMP, TRACI 2.0 and CML 2001 (Nov 2009)

The chart below shows TRACI 2.0 impact categories by product stages A1 – A3. Two additional inventory metrics of primary energy demand, non-renewable (PED, non-ren.) and primary energy demand, renewable (PED, ren.) are included.

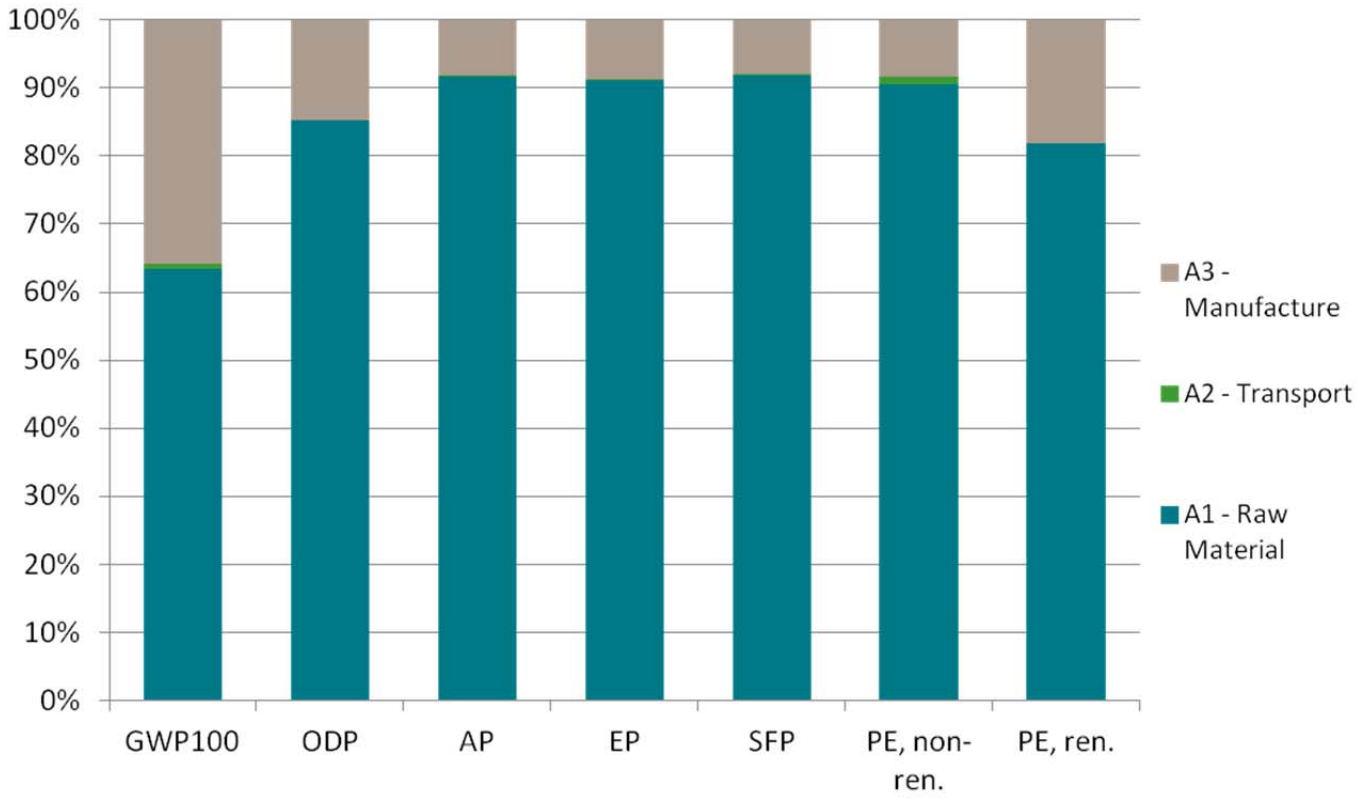


Figure 6: Total life cycle impacts of 1,000 sq ft of IMP, TRACI 2.0 impacts and primary energy inventory

As described in the product description, steel coil and foam can vary in thickness. Steel coil is assumed to be gauge 24 by default, however can be either 22 gauge or 26 gauge. Similarly, polyurethane foam can be significantly thicker than the default of 2 inches depending on the application. Roofing panels in particular can require foam thickness up to 6 inches. The effect of these thickness variations on the environmental indicators are shown below.

		Steel gauge (24 Gauge default)		
TRACI 2.0 Impact Categories	**Unit**	**22 Gauge**	**24 Gauge**	**26 Gauge**
Global warming potential	kg CO_2-eq.	7,200	6,520	5,850
Ozone depletion potential	kg CFC11-eq.	1.41E-04	1.37E-04	1.34E-04
Acidification potential	kg H^+ mol-eq.	1240	1090	936
Eutrophication potential	kg N-eq.	0.961	0.858	0.756
Smog formation potential	kg O_3-eq.	400	354	310
Total Resource Use and Waste Outputs				
Primary Energy, Renewable	MJ	3,900	3,720	3,530
Primary Energy, Non-renewable	MJ	74,300	66,100	58,100
Secondary Materials	kg	604	496	390
Water Use	m^3	291	284	277
Hazardous Waste	kg	35.6	31.0	26.6
Non-hazardous Waste	kg	14.8	12.4	10.0
Stockpile Goods	kg	9,020	7,650	6,290
Radioactive Waste	kg	1.40	1.31	1.21
Materials for Recovery	kg	51.5	43.0	34.7

Table 5: TRACI 2.0 impacts, resource use, and waste outputs of 1,000 sq ft of IMP for different steel coil gauges

		Polyurethane Foam Thickness in Inches (2 inches default)				
TRACI 2.0 Impact Categories	**Unit**	**2 in**	**3in**	**4in**	**5in**	**6in**
Global warming potential	kg CO_2-eq.	6,520	7,890	9,250	10,600	12,000
Ozone depletion potential	kg CFC11-eq.	1.37E-04	1.52E-04	1.66E-04	1.81E-04	1.95E-04
Acidification potential	kg H^+ mol-eq.	1,090	1,150	1,210	1,280	1,340
Eutrophication potential	kg N-eq.	0.858	0.936	1.01	1.09	1.18
Smog formation potential	kg O_3-eq.	354	370	385	400	415
Total Resource Use and Waste Outputs						
Primary Energy, Renewable	MJ	3,720	3,840	3,970	4,100	4,230
Primary Energy, Non-renewable	MJ	66,100	74,800	83,500	92,100	101,000
Secondary Material	kg	496	496	496	496	496
Water Use	m^3	284	298	312	326	339
Hazardous Waste	kg	31.0	35.6	40.1	44.6	49.2
Non-hazardous Waste	kg	12.4	12.9	13.3	13.7	14.2
Stockpile Goods	kg	7,650	7,958	8,270	8,580	8,890
Radioactive Waste	kg	1.31	1.47	1.64	1.80	1.96
Materials for Recovery	kg	43.0	44.6	46.1	47.7	49.2

Table 6: TRACI 2.0 impacts, resource use, and waste outputs of 1,000 sq ft of IMP for different polyurethane foam thickness

Energy and Material Resources

Primary energy resources, secondary material, and water use are presented below, subdivided by stages. Since no secondary fuels are associated with insulated metal panels, this category is not shown.

Product Stages	Primary Energy, Renewable [MJ]	Primary Energy, Non-renewable [MJ]	Secondary Material [kg]	Water use [m^3]
Total	3,720	66,100	496	284
A1 – Raw Material	3,040	59,900	496	57.9
A2 – Transport	1.10	759	0	2.09
A3 - Manufacture	674	5,530	0	224

Table 7: Energy and materials resource use of 1,000 sq ft of IMPs

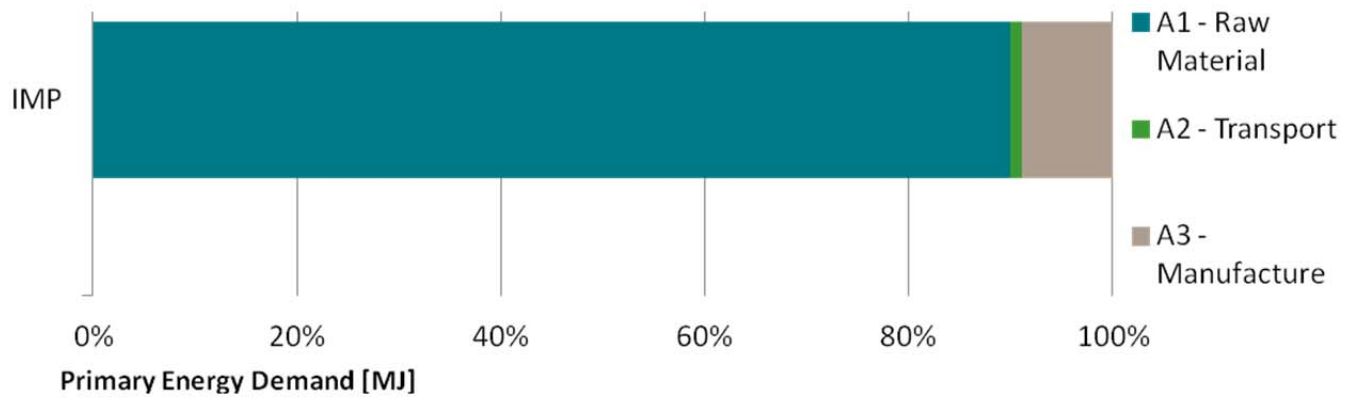


Figure 7: Primary energy demand by product stages A1 - A3

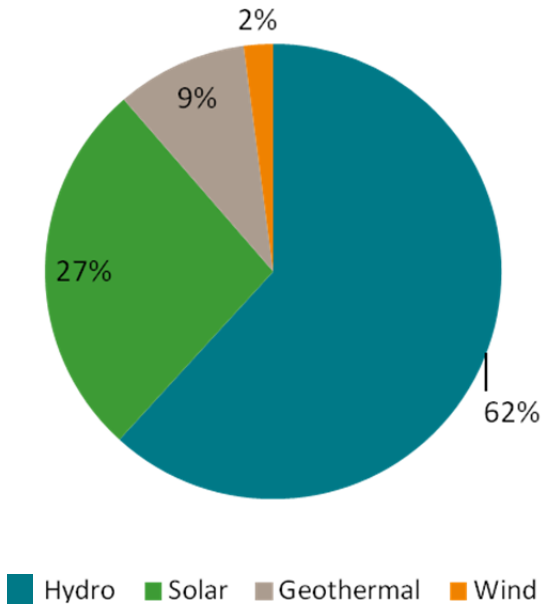


Figure 8: Renewable primary energy demand by fuel type

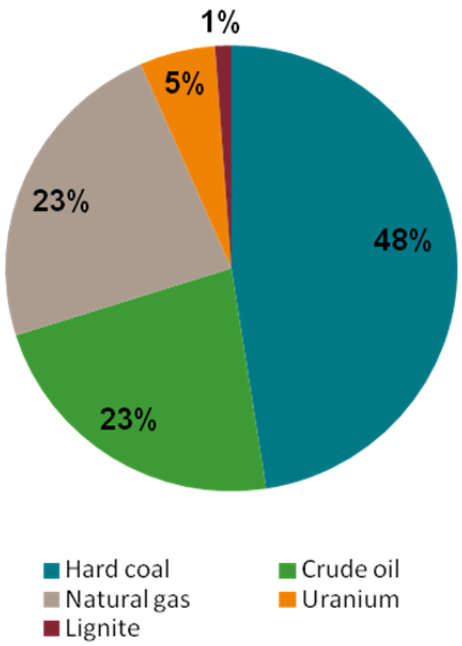


Figure 9: Non-renewable primary energy demand by fuel type

Renewable primary energy is also broken down into primary energy resources used as raw materials and primary energy resources excluding resources used as raw materials. Since consumption of renewable primary energy resources used as raw materials is exclusively due to packaging materials and takes place during raw materials supply, this category is not broken down by life cycle stage.

	Renewable primary energy used as raw materials [MJ]	Renewable primary energy, excluding those used as raw materials [MJ]	Renewable primary energy, total [MJ]
MCA Industry Average	1,870	1,850	3,720

Table 8: Total renewable energy used as raw material and as energy source

Waste and Output Flows

Additional environmental information, including hazardous, non-hazardous, and radioactive waste disposed; materials for recycling; and materials for energy recovery are shown below.

Since no reused components or exported energy are associated with an insulated metal panel's life cycle, these categories are excluded. Additionally, waste is assumed to be sent to landfill so no materials are available for energy recovery.

Waste and Output Flows	MCA Industry Average
Hazardous Waste [kg]	31.0
Non-Hazardous Waste [kg]	12.4
Stockpile Goods [kg]	7,650
Radioactive Waste [kg]	1.31
Materials for Recovery [kg]	43.0

Table 9: Waste and output flows per functional unit

Interpretation

The above results represent a cradle-to-gate assessment of an industry-average profile of insulated metal panel produced by Metal Construction Association (MCA) member companies. The study was conducted for the declared unit of *coverage of 1,000 square feet with insulated metal panel products.* Because of the cradle-to-gate system boundary (stages A1 – A3), impacts beyond manufacturing, such as delivery to construction site, installation, and disposal at the end of useful life, are not considered.

The global warming potential impact is dominated by stages A1 (materials) and A3 (manufacturing). In the raw material stage (A1), steel coil production is the major contributor at approximately 40% of the global warming impact of the cradle-to-gate system. Inputs for polyurethane foam, packaging, and other auxiliary chemical treatments contribute an additional 20% of the total global warming impacts. The transportation stage (A2) included all known inbound transportation as well as delivery of coated steel coil to IMP manufacturing facilities. Delivery to the construction site is excluded in this EPD. The contribution to global warming from stage A2 is marginal (<1%) and dominated by fuel combustion.

The manufacturing stage (A3) is also a major contributor to overall global warming impacts (36%). While electricity and heating energy are not insignificant, the majority of the impacts in manufacturing (A3) come from release of the blowing agent R134a (tetrafluoroethane). Those facilities that use pentane instead of R134a have a lesser global warming potential impact; however, they also exhibit a greater smog creation potential than R134a facilities.

With respect to the other environmental indicators, raw materials dominate over 90% in all categories except for ozone depletion. For ozone depletion, the manufacturing stage—specifically electricity generation—contributes approximately 15% to the total ozone depletion potential impact. Upstream emissions of halogenated compounds comprise the majority of ozone depletion impact contribution from raw materials. Specifically, fluororpolymer, used in the coil coating process, is a significant contributor of the halogenated compound 1,1,1-Trichloroethane. Upstream production of MDI, used in the polyurethane foaming process, leads to emissions of the halogenated compounds chloromethane and trichlorofluoromethane (CFC-11).

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Additional Information

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This EPD and corresponding LCA were prepared by PE International.

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