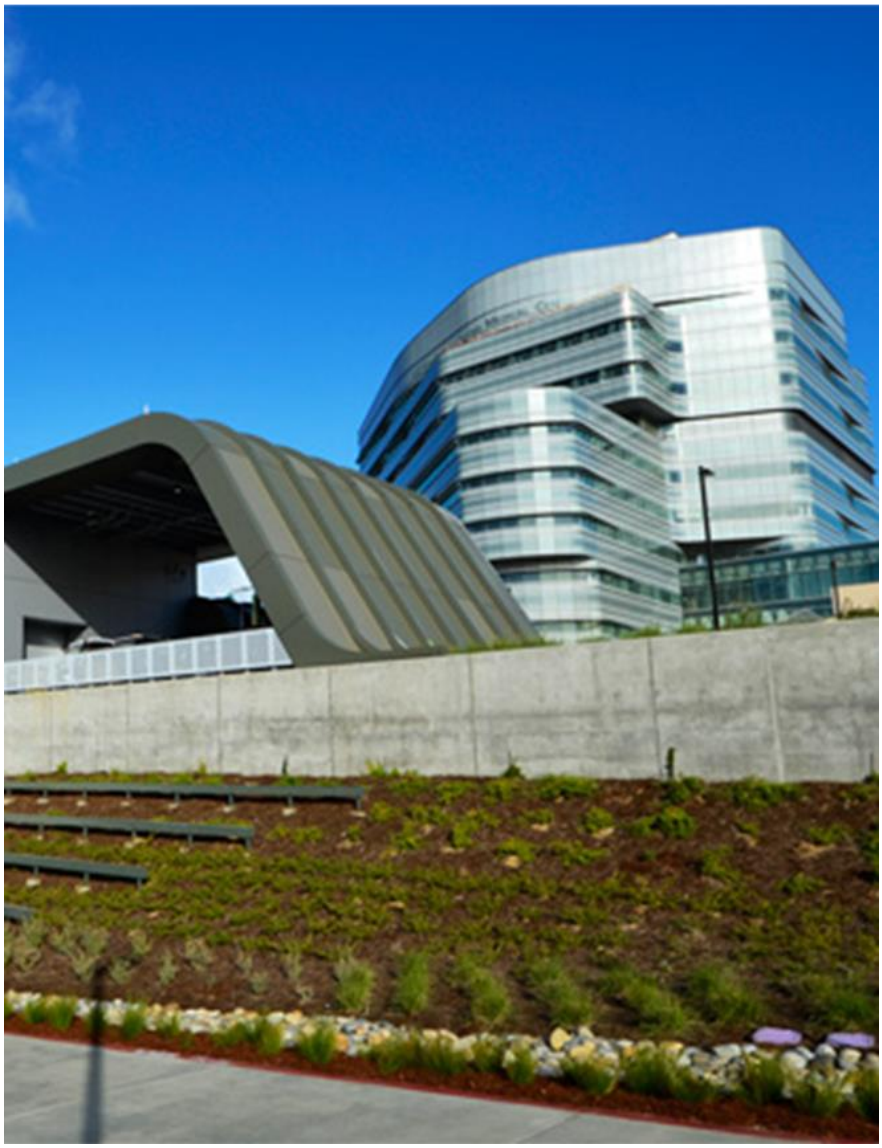
ENVIRONMENTAL PRODUCT DECLARATION

INSULATED METAL PANELS

WALL AND ROOF PANEL 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.

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

ENVIRONMENTAL PRODUCT DECLARATION

Insulated Metal Panels
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	4789289084.101.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Insulated Metal Panels; 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	Comprised of a polyurethane core sandwiched between two pre-finished steel sheets which form a single, all-in-one insulated metal panel used as exterior wall and roof cladding systems, interior ceiling, and partition walls.
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. Organization Description

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 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 following four primary MCA-member manufacturers:

AWIP ALL WEATHER INSULATED PANELS	All Weather Insulated Panels (AWIP) is an innovator in the design, construction, and advancement of foam composite insulated metal panels. We are strategically positioned to meet the growing energy, environmental and economic challenges facing the North American building industry with two state-of-the-art continuous line manufacturing facilities: Vacaville, CA and Little Rock, AR.
Kingspan® Insulated Panels	Kingspan offers aesthetic flexibility with a vast range of insulated panel profiles supported by state-of-the-art specialty fabrications. Their commercial insulated metal roof and wall panel systems combine design flexibility, efficiency and performance to create the ultimate building envelope solution. Their wide range of insulated metal wall panel systems meets the needs of a variety of market sectors. Their wall systems offer superior quality and high R-values, while providing a modern look.
GREEN SPAN INSULATED METAL PANELS	Green Span Profiles started manufacturing insulated metal panels in 2011, just outside of Houston, in Waller, Texas. We pride ourselves on manufacturing the highest-quality insulated panels in America. Utilizing state-of-the-art equipment, our panels are built by a continuously poured-in-place process binding interior and exterior corrosion-reistant steel facings to a polyisocyanurate insulating foam core. Our quality control is second to none and our on-time delivery rate is beyond compare. Our products are rigorously tested by Factory Mutual, Underwriters Laboratories and Miami-Dade County. More importantly, they are tested, in-place, every day by our most valued customers and end-users who depend on our panels to protect their most valuable assets.

CORNERSTONE BUILDING BRANDS	At Cornerstone Building Brands we provide our residential and commercial customers with a comprehensive portfolio of products and solutions, when and where they need it. As the largest manufacturer of exterior building products, with an expansive national footprint, we are dedicated to efficiently and effectively meeting the needs of customers and communities. The Cornerstone Building Brands' relentless focus on excellence combined with our ongoing commitment to innovation and R&D has driven us to become the #1 manufacturer of windows, vinyl siding, insulated metal panels, metal roofing and wall systems and metal accessories. We believe every building we create, and every part of that building, positively contributes to communities where people live, work and play.

1.2. 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 panel facings create a vapor, air, and moisture barrier and provide long-term thermal stability.

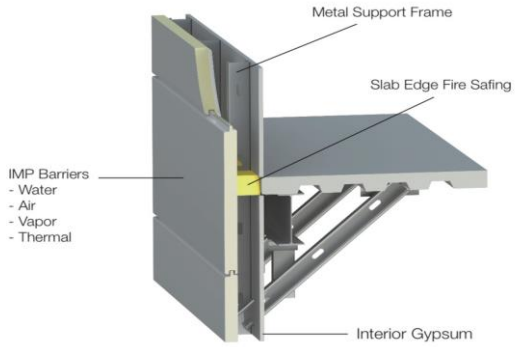


Figure 1: Cross Section of a 3-inch Insulated Metal Panel

MCA IMP 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.

Table 1: Panel products under study

PRODUCT	DESCRIPTION	PRIMARY PROCESSES
Insulated metal panel (IMP)	Coil gauge: 22 – 26 Gauge Foam thickness: 2 – 6 inches Primary product: 2" Insulated metal panel (IMP) with polyurethane/polyisocyanurate foam core and 24 gauge steel coil	• Continuous coil coating • IMP continuous foaming

1.3. Application

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. Insulated metal panels are used in a variety of applications because of their excellent performance characteristics and competitive in-place costs. Successful applications include: manufacturing facilities, healthcare facilities, cold-storage and food-processing plants, aircraft hangars and service facilities, schools and universities, warehousing and distribution centers, sports complexes, and convention 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. IMP lightweight wall and roof panels are available in a wide range of long lasting finishes and colors. Additionally, 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.

Declared unit of this product system is coverage of 100 square meters (1076.4 square feet) of building area.

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. Product Specification

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*

1.6. Properties of Declared Product as Delivered

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 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	0.6 – 1	m
Thickness	40 – 150	mm
Density	90 – 400	kg / m^3
Tensile strength	350 – 550	MPa
Modulus of elasticity	200,000	MPa
U-value	0.014 – 0.72	W / m^2-K
R-value	1.6 – 8.5	m^2-K / W
Water permeance	0	Metric perms
Airborne sound reduction	15 – 25	dB
Noise reduction coefficient	10 – 25	%

1.7. Material Composition

Steel coil represents steel that has been rolled out into 22, 24, or 26 gauge sheet and hot-dipped galvanized.

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.

Blowing agent is an inert gas to facilitate the formation of foam. Hydrofluorocarbons (HFCs),

hydrofluoroolefins (HFOs), and hydrocarbons are utilized by MCA member companies.

Catalysts are used to balance the reaction between polyester polyol and MDI that produces polyurethane

Table 4: Base material mass by percentage, MCA Industry-average

MATERIAL	MASS (%)
Steel	79%
Polyurethane foam	21%

1.8. Manufacturing

The process of manufacturing IMPs requires a marriage of customized mechanical equipment and foam chemistry. IMPs are manufactured on a continuous production line, as depicted in Figure 2.

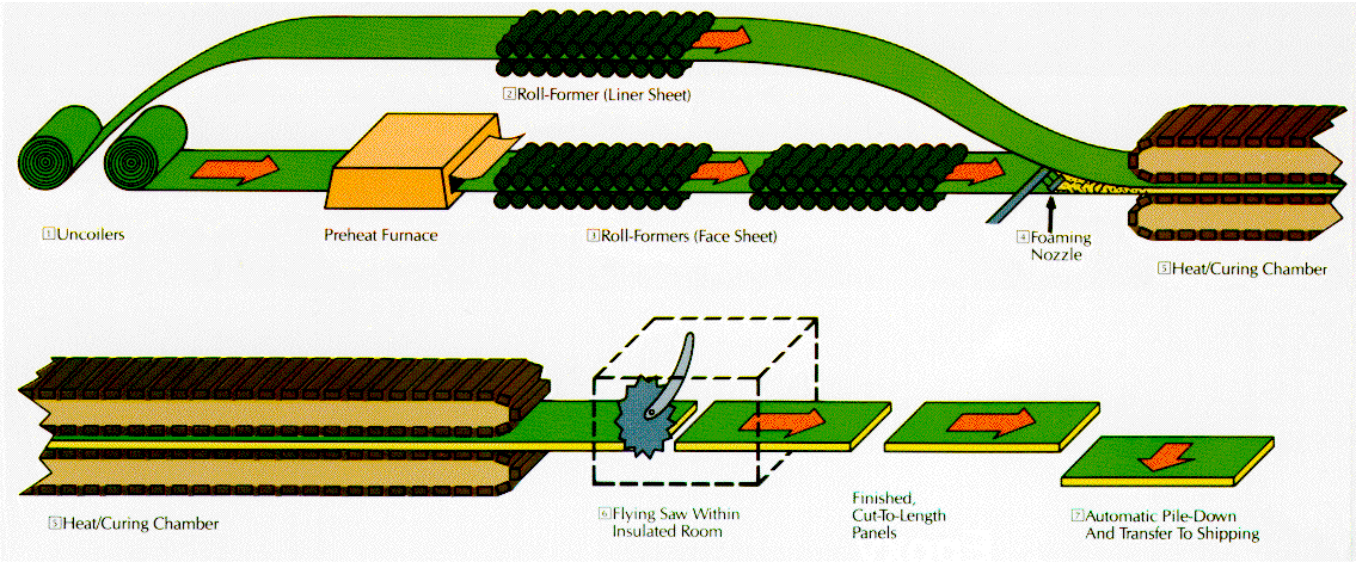


Figure 2: Schematic of continuous manufacturing process for insulated metal panels

In IMP production, foam chemicals are mixed and injected in-line between the two steel sheets. This process 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.

MCA member companies use a variety of blowing agents, including HFCs, HFOs, and hydrocarbons. Emissions mainly occur during foam injection between metal sheets. Blowing agent loss rate during manufacturing ranges from 5 – 27% and is based on experiments performed by member companies. If no primary data on loss rate was provided by a company, then the most conservative value (27%) was applied. Once the foam has cured, panels are 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. IMPs are then packaged and distributed to construction sites. Figure 3 shows a detailed IMP manufacturing process.

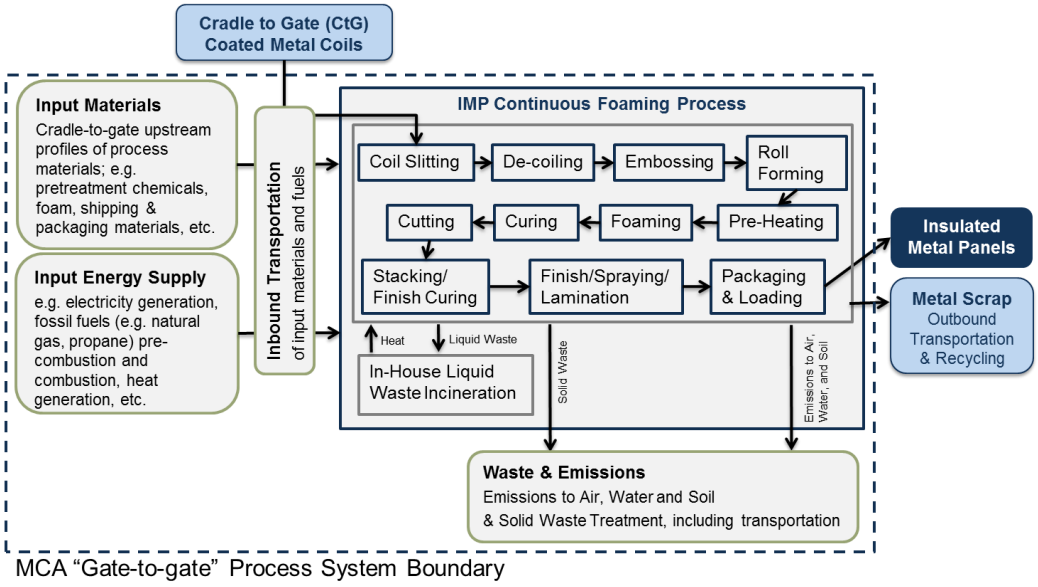


Figure 3: IMP manufacturing process

1.9. Packaging

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

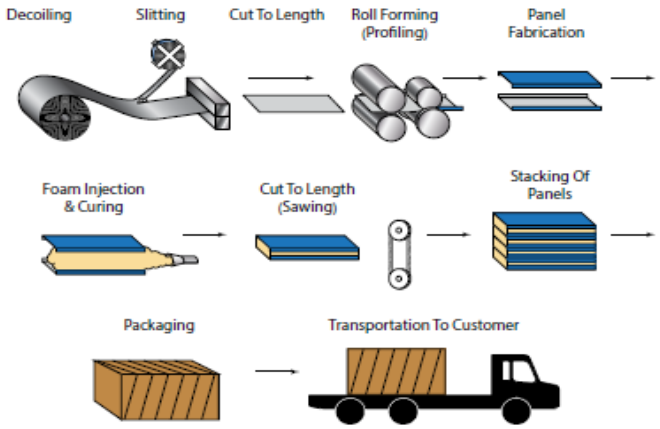


Figure 4: Packaging process for IMP product

1.10. Product Average

This declaration covers IMPs manufactured by 4 different participating MCA member companies, representing a significant majority of annual production in the US and Canada, as seen in Table 5.

Table 5: Products by manufacturer

COMPANY	MANUFACTURING LOCATION
All Weather Insulated Panels	Vacaville, CA / Little Rock, AR
Kingspan	Deland, FL / Modesto, CA
Green Span Profiles	Peachtree City, GA
Cornerstone Building Brands	Kealy, Texas / Prince George, Virginia / Shelbyville, Indiana / Las Vegas, Nevada / Mattoon, Illinois / Hamilton, Ontario

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 IMPs is to provide thermal insulation and weather protection for building walls and roofs. The panels create barriers that control noise, water, air, and thermal 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 6: Reference flows

NAME	IMP
Declared unit [m^2]	100
Product mass [kg / 100 m^2]	1276

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 phase (A4 – A5), building use stage (B1 - B7), and end-of-life stage (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.

Global warming potential for IMP products is overwhelmingly driven by blowing agent emissions. Based on discussions with industry experts, this study assumes that 5 - 27% of blowing agents are emitted during manufacturing. However, actual blowing agent release may vary, thus affecting global warming potential impacts.

Lastly, 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 four specific 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 7: North American Impact Assessment Results

PARAMETER	UNIT	TOTAL	A1	A2	A3
GWP	[kg CO_2 eq.]	**1.07E+04**	4.23E+03	9.15E+01	6.39E+03
ODP	[kg CFC-11 eq.]	**4.03E-05**	4.03E-05	0.00E+00	0.00E+00
AP	[kg SO_2 eq.]	**1.06E+01**	9.74E+00	7.00E-01	1.61E-01
EP	[kg N eq.]	**6.47E-01**	5.91E-01	4.42E-02	1.13E-02
SFP	[kg O_3 eq.]	**1.79E+02**	1.60E+02	1.49E+01	4.27E+00
ADPF	Surplus MJ	**6.34E+03**	5.97E+03	1.77E+02	1.90E+02

4.2. Life Cycle Inventory Results

Table 8: Resource Use

PARAMETER	UNIT	TOTAL	A1	A2	A3
RPRE	[MJ, LHV]	**2.83E+03**	2.56E+03	3.82E+01	2.33E+02
RPRM	[MJ, LHV]	**9.47E+02**	9.47E+02	0.00E+00	0.00E+00
RPRT	[MJ, LHV]	**3.78E+03**	3.51E+03	3.82E+01	2.33E+02
NRPRE	[MJ, LHV]	**6.81E+04**	6.49E+04	1.33E+03	1.84E+03
NRPRM	[MJ, LHV]	**1.21E+04**	1.21E+04	0.00E+00	0.00E+00
NRPRT	[MJ, LHV]	**8.01E+04**	7.70E+04	1.33E+03	1.84E+03
SM	[kg]	**5.39E+01**	5.39E+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]	**1.11E+01**	1.06E+01	1.48E-01	4.06E-01

Table 9: Output Flows and Waste Categories

PARAMETER	UNIT	TOTAL	A1	A2	A3
HWD	[kg]	**2.27E-03**	2.26E-03	9.92E-06	1.10E-06
NHWD	[kg]	**1.40E+02**	1.36E+02	4.75E-02	4.56E+00
HLRW	[kg]	**1.09E-03**	9.75E-04	3.52E-06	1.14E-04
ILLRW	[kg]	**2.53E-02**	2.21E-02	9.51E-05	3.14E-03
CRU	[kg]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	**5.06E+01**	0.00E+00	0.00E+00	5.06E+01
MER	[kg]	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00
EE	[MJ]	**4.31E-03**	4.31E-03	0.00E+00	0.00E+00

5. LCA Interpretation

Manufacturing (A3) is a key contributor to global warming potential due blowing agent emissions. In all other impact categories, the potential impacts of insulated metal panels are primarily driven by raw materials (A1)—specifically, the production of steel, blowing agent, MDI, and polyester polyol. Though some raw materials are transported vast distances, the inbound transportation module (A2) has a modest contribution to overall impact.

6. References

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