Declaration Owner

Kingspan Group
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https://www.kingspan.com/us/en-us/product-groups/insulated-panel-systems

Product

Laminated Metal Panel

Functional Unit

The functional unit is 100 m^2 of building coverage area over a 75-year period

EPD Number and Period of Validity

SCS-EPD-05682
EPD Valid September 4, 2019 through September 3, 2024
Version: April 21, 2023

Product Category Rule

PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. Sept. 2018

PCR Guidance for Building-Related Products and Services Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels, UL 10010–5. October 23, 2018.

Program Operator

SCS Global Services
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Declaration Owner:	Kingspan Group
Address:	726 Summerhill Drive, DeLand, FL 32724, USA
Declaration Number:	SCS-EPD-05683
Declaration Validity Period:	EPD Valid September 4, 2019 through September 3, 2024
Version Date:	April 21, 2023
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Kovvali Manasa Rao
LCA Software and LCI database:	GaBi - Version 9.1.0.53, Service pack 38
Product RSL:	30 years
Markets of Applicability:	North America
EPD Type:	Product Specific
EPD Scope:	Cradle-to-Grave
LCIA Method and Version:	CML-IA and TRACI 2.1
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Beth Cassese, LCACP, SCS Global Services
Part A Product Category Rule:	PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. December. 2018
Part A PCR Review conducted by:	Lindita Bushi, PhD (Chair); Hugues Imbeault-Tétreault, ing., M.Sc.A.; Jack Geibig
Part B Product Category Rule:	PCR Guidance for Building-Related Products and Services Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels, UL 10010–5. October 23, 2018
Part B PCR Review conducted by:	Thomas Gloria (Chair), Industrial Ecology Consultants; Lindita Bushi, PhD; Bob Zebcik, PE
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Beth Cassese, LCACP, SCS Global Services
Declaration Contents:	

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and ISO 21930.*

Scope of Results Reported: *The PCR requirements limit the scope of the LCA metrics such that the results exclude environmental and social performance benchmarks and thresholds, and exclude impacts from the depletion of natural resources, land use ecological impacts, ocean impacts related to greenhouse gas emissions, risks from hazardous wastes and impacts linked to hazardous chemical emissions.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

In accordance with ISO 21930:2017, EPDs are comparable only if they comply with the core PCR, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

1. About Kingspan Group

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.

2. Product

2.1 Product Description

Insulated metal panels (IMPs) are essentially a rigid foam core sandwiched between two metal sheets and cut to shape and size as required by the customer. Metal sheet provide long-term durability of the product and the ability to be used as an exterior application. These are also available in various colors and finishes to match the design aesthetic of any building. The UNSPSC code for this product is 301415 and the CSI/CSC code is 07 42 13.19.

2.2 Application

Kingspan Laminated Metal Panels are used in a variety of applications including commercial, industrial, institutional and refrigerated buildings owing to the excellent thermal efficiency, ease of installation and overall structural integrity for exterior wall applications.

2.3 Technical Data

<table>
<tr><th>Property</th><th>Test Results</th><th>Units</th><th>Test Method</th></tr>
<tr><td>Length</td><td>0.60-7.31</td><td>m</td><td>-</td></tr>
<tr><td>Width</td><td>0.30-1.06</td><td>m</td><td>-</td></tr>
<tr><td>Thickness</td><td>381, 342.9, 609.6, 762, 914.4, 1219.2</td><td>mm</td><td>-</td></tr>
<tr><td rowspan="2">Bond Strength</td><td>No metal primer interface corrosion and / or delamination shall occur after 1000 hours at 135°F and 100 percent relative humidity</td><td>-</td><td>Humid aging</td></tr>
<tr><td>Sample placed in an autoclave device and pressurized to 0.013 MPa at 103 °C for 2.5 hours</td><td>MPa</td><td>Autoclave</td></tr>
<tr><td>U-value of assembly including interruptions to insulation</td><td>
<table>
<tr><th>Thickness (mm)</th><th>Thickness (in)</th><th>Benchmark Designwall 2000</th><th>Benchmark Designwall Wave</th><th>Benchmark Designwall 4000</th><th>Benchmark Designwall R Series</th></tr>
<tr><td>50.8</td><td>2</td><td>0.40</td><td>0.38</td><td>0.35</td><td>-</td></tr>
<tr><td>63.5</td><td>2.5</td><td>0.32</td><td>-</td><td>0.28</td><td>0.51</td></tr>
<tr><td>76.2</td><td>3</td><td>0.27</td><td>0.25</td><td>0.23</td><td>0.40</td></tr>
<tr><td>101.6</td><td>4</td><td>0.20</td><td>0.19</td><td>0.17</td><td>0.25</td></tr>
</table>
</td><td>$W/(m^2K)$</td><td>ASTM C518 @ 75 F</td></tr>
<tr><td>R value of typical materials where continuous</td><td>
<table>
<tr><th>Thickness (mm)</th><th>Thickness (in)</th><th>Benchmark Designwall 2000</th><th>Benchmark Designwall Wave</th><th>Benchmark Designwall 4000</th><th>Benchmark Designwall R Series</th></tr>
<tr><td>50.8</td><td>2</td><td>2.46</td><td>2.60</td><td>2.81</td><td>-</td></tr>
<tr><td>63.5</td><td>2.5</td><td>3.08</td><td>-</td><td>3.52</td><td>1.93</td></tr>
<tr><td>76.2</td><td>3</td><td>3.69</td><td>3.90</td><td>4.22</td><td>2.46</td></tr>
<tr><td>101.6</td><td>4</td><td>4.92</td><td>5.20</td><td>5.63</td><td>3.87</td></tr>
</table>
</td><td>m^2K/W</td><td>ASTM C518 @ 75 F</td></tr>
<tr><td rowspan="2">Water</td><td>No uncontrolled water penetration at 341.8 kg/m^2 differential pressure</td><td>kg/m^2</td><td>ASTM E331</td></tr>
<tr><td>Dynamic water pressure testing – no sign of water leakage at 73.24 kg/m^2</td><td>kg/m^2</td><td>AAMA 501.1</td></tr>
</table>

Products contained in this EPD meet the performance requirements listed below:

Structural - ASTM E-72 for walls. The maximum deflection criteria for the insulated panels is typically, L/180 for walls.

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 R7.4 to R48.

Core Physical Properties - The 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.

2.4 Delivery Status

Kingspan supplies IMPs in a variety of sizes and configurations customized to each project's requirements.

Wall panel configurations have a range as follows:
− Thickness: from 2 inches to 4 inches
− Width: from 12 inches to 42 inches
− Length: from 2 feet to 24 feet, depending on product.

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, stainless, stucco embossed steel, aluminum and zinc
Gauge ranges:
22 to 24-gauge steel; 22, 24- and 26-gauge coated steel

2.5 Material Composition

Material	Amount (kg/ 100 m^2)	Percentage of Total Mass
Insulated Metal Panel – Laminated Panels		
Steel	896.3	72.5 %
Polyisocyanurate	301.8	24.4 %
Pentane	16.8	1.4 %
Proprietary chemicals	16.8	1.4 %
Glue	4.0	0.3 %
Total	**1235.6**	**100%**
Packaging		
Oriented strand board	61.9	35.2 %
Polystyrene	112.0	63.7 %
Polyethylene film	2.0	1.1 %
Linear low-density polyethylene	0.058	0.03 %
Total Packaging	**175.9**	**100%**

No substances required to be reported as hazardous are associated with the production of this product.

2.6 Manufacturing

The manufacturing process begins with the mining/ processing of raw materials, which is a mixture composed mostly of steel, polyisocyanurate and some additives. In the lamination (See Figure 1) method, procured foam board stock in an appropriate thickness is adhered to preformed metal facers with structural adhesives and places under pressure in a platen press operation. The panels are then trimmed and embossed following which the top and bottom edge details are profiled. After this, the panels are stacked and packaged. Once the panels are manufactured, foam sheets are layered between insulated metal panels before the panels are stacked on oriented strand board (OSB) and expanded polystyrene underlayment and wrapped in polyethylene film.

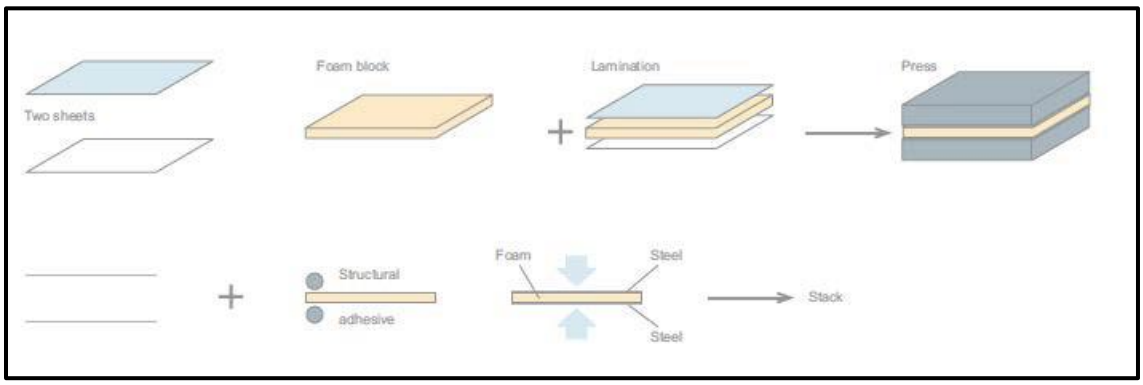

Figure 1: *Schematic of continuous manufacturing process for laminated metal panels.*

2.7 Transportation

The product is delivered to the customer via truck depending on the location of the end-user. Transport to the installation site is assumed to be 554 km as per recommendation by the PCR (Part B) for all insulated metal panels applications.

2.8 Product Installation

The installation instructions require the use of white butyl caulk and some steel trim, clips and fasteners for recommended installation. From the installation instructions, we understand that there is a forklift and panel cutting equipment that is used during installation as well. However, due to limited data availability on the amount of resources (here, electricity and diesel) used for these operations, quantities recommended by the PCR (Part B) have been used.

2.9 Packaging

Provide information on product-specific packaging, which can include type, composition, and possible reuse of materials. Once the panels are manufactured, foam sheets are layered between insulated metal panels before the panels are stacked on oriented strand board (OSB) and expanded polystyrene underlayment and wrapped in polyethylene film.

2.10 Use Conditions

The panels are cleaned twice a year for wall applications. Cleaning frequency and material amount recommendations are taken from Part B of the PCR.

2.12 Reference Service Life

As no additional information on life expectancy was available, the default value of 30 years provided in the PCR was used for the RSL. To meet the ESL of 75 years, 1.5 replacements are required.

2.13 Re-Use Phase

Insulated panels are typically not re-used after their service life.

2.14 Disposal

All waste has been classified and modeled according to regional-specific legislation as required in Section 2.8.6 in Part A: Life Cycle Assessment Calculation rules and Report Requirements from UL Environment. It was conservatively assumed that the entire panel is sent to landfill.

However, Kingspan has designed their IMPs for disassembly and the metal panel can be separated from the insulation core. After separation, the metal panels can be recycled through locally available metal recycling facilities and the insulation core can be reused as stand-alone insulation. Additionally, Kingspan is currently piloting an extended producer responsibility program that will take back panels at the end of their useful life. For more information contact your local Kingspan representative.

3. LCA: Calculation Rules

3.1 Functional Unit

The functional unit used in the study, as specified in the PCR, is coverage of 100 m^2 of panel surface over 75 years.

	Unit	QuadCore
Functional Unit	m^2	100
Weight per Installation	kg / 100 m^2	1,236
Replacements Required	(RSL/ESL)-1	1.5
Weight per Functional Unit	kg / 100 m^2	3,089
Mass conversion factor to 1 kg, one installation	-	8.09E-04
Mass conversion factor to 1 kg, functional unit	-	3.24E-04

3.2 System Boundary

The scope of the EPD is cradle-to-gate with options, including raw material extraction and processing, transportation, product manufacture, product delivery, installation and use, and product disposal. The diagram below is a representation of the most significant contributions to the life cycle of the insulated metal panel products.

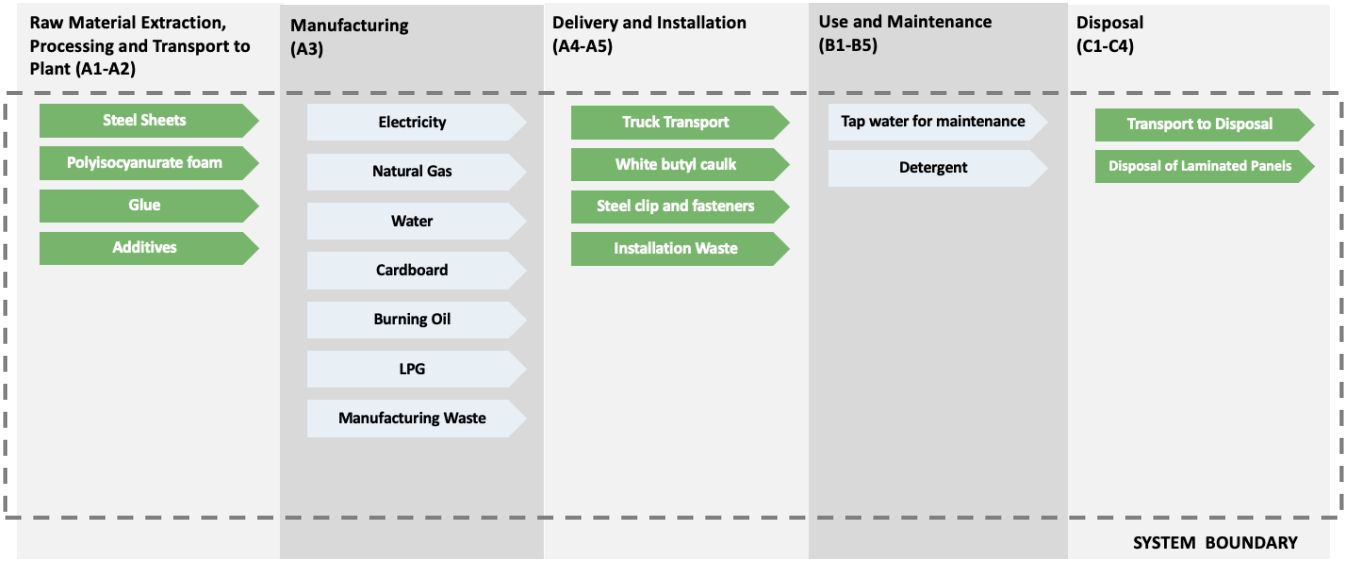

Figure 2: *System Boundary*

3.3 Units

All results are presented using SI units using three significant figures, as per PCR guidance.

3.4 Estimates and Assumptions

All estimates and assumptions are within the requirements of ISO 14040/44. The majority of the estimations are within the primary data. The primary data was collected as annual totals including all utility usage and production information. For the study, the usage information was divided by the production to create an energy and water use per square meter, then extrapolated to 100 square meters. Another assumption is that the installation tools are used enough times that the per square meter impacts are negligible.

It should also be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

The PCR allows for the results for several inventory flows related to construction products to be reported as "other parameters". These are aggregated inventory flows and do not characterize any potential impact; results should be interpreted taking into account this limitation.

3.5 Cut-off criteria

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact are included in the inventory. Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit. No known flows are deliberately excluded from this LCA.

3.6 Background Data

Primary data were provided by Kingspan Group for the Columbus, United States facility and from their suppliers of component materials for the metal panel products. The sources of secondary LCI data are GaBi - Version 9.1.0.53, Service pack 38.

Component	Material Description	Material Dataset	Data Source	Publication Date
Product				
Primary Components				
Internal and External Sheet	Steel Sheets	Steel hot dip galvanized	worldsteel	2014
Foam	Polyisocyanurate foam	Polyisocyanurate (PIR high-density foam)	thinkstep	2018
Auxiliary Components				
Foam	Blowing agent	Pentane	Plastics-Europe	2005
Foam	Chemical intermediate	Aromatic Polyester Polyol (APP) (European average, without flame retardant)	PU Europe	2008
Foam	Chemical intermediate	Diethylene glycol by product ethylene glycol from ethene and oxygen via EO	thinkstep	2018
Glue	Polyurethane-resin based glue	Reactive resins based on polyurethane or SMP, filled or aqueous, solvent-free - DBC/IVK/VdL (A1-A3)	thinkstep	2011
Packaging				
Spacer	Oriented Strand Board	Oriented strand board	ts-EPD	2005
Underlayment	Polystyrene	Expanded polystyrene foam (PS 25) (A1-A3)	thinkstep	2018
Logo Endcap	Polyethylene Film	Polyethylene film (LDPE/PE-LD)	thinkstep	2018
Stretch wrap	Linear low-density polyethylene	Polyethylene Linear Low Density Granulate (LLDPE/PE-LLD)	thinkstep	2018
Electricity/Heat				
Thermal Energy	Thermal energy from natural gas	Thermal energy from natural gas	thinkstep	2016
Electricity	Grid electricity	Electricity grid mix – RFCW	thinkstep	2016
LPG	Liquefied Petroleum Gas	Liquefied Petroleum Gas (LPG) (70% propane; 30% butane)	thinkstep	2016
Water	Process water	Process water from ground water	thinkstep	2018
Transportation				
Transport of Raw Materials	Truck	Truck-trailer, Euro 0 - 6 mix, 34 - 40t gross weight / 27t payload capacity	thinkstep	2018
Transport of Raw Materials	Train	Rail transport cargo - Diesel, average train, gross tonne weight 1,000t / 726t payload capacity	thinkstep	2018
Transport of Raw Materials	Ship	Container ship, 5,000 to 200,000 dwt payload capacity, ocean going	thinkstep	2018

3.7 Data Quality

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	Primary data were provided by Kingspan associates and represent calendar year 2018. Using 2018 data meets the PCR requirement that manufacturer specific data be within the last 5 years. Time coverage of this data is considered good. Data necessary to model cradle-to-gate unit processes was sourced from thinkstep LCI datasets. Time coverage of the GaBi datasets varies from approximately 2011 to present. All datasets rely on at least one 1-year average data. Overall time coverage of the datasets is considered good and meets the requirement of the PCR that all data be updated within a 10-year period. The specific time coverage of secondary datasets can be referenced in the dataset references table in the LCA report.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The geographical scope of the manufacturing portion of the life cycle is Columbus, United States. This LCA uses country specific energy datasets that take into account US eGrid specific energy and transportation mixes. Overall, the geographic coverage of primary data is considered good.
Technology Coverage: Specific technology or technology mix	Primary data provided by Kingspan are specific to the technology that the company uses in manufacturing their product. It is site specific and considered of good quality. It is worth noting that the energy and water used in manufacturing the product includes overhead energy such as lighting, heating and sanitary use of water. Sub-metering was not available to extract process only energy and water use from the total energy use. Sub-metering would improve the technological coverage of data quality. Data necessary to model cradle-to-gate unit processes was sourced from thinkstep LCI datasets. Technological coverage of the datasets is considered good relative to the actual supply chain of Republic. While improved life cycle data from suppliers would improve technological coverage, the use of lower quality generic datasets does meet the goal of this EPD.
Precision: Measure of the variability of the data values for each data expressed	Process-specific data and secondary data for all upstream processes have been averaged over a year, thus reducing the variability in terms of the precision of the data.
Completeness: Percentage of flow that is measured or estimated	Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit. No known flows are deliberately excluded from this EPD.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Data collected for the process are considered typical or representative for the region and temporal scope. This is an average and process are not considered site-specific. Determining the actual process at each site would require us to go to upstream in the supply chain all the way to resource extraction. Improvements can be made through the modification of datasets to incorporate more regional specificity, both in terms of energy and technology. However, the data was considered appropriate in relation to the goal, scope and budget of the project.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data of similar quality and age are taken from GaBi ts database. All life cycle stages were evaluated with equal importance.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	This LCA is reproducible by other LCA practitioners. All the data, assumption, estimates and value choices have been clearly stated in the EPD and background LCA report.
Sources of the Data: Description of all primary and secondary data sources	Primary data was used for all manufacturing processes. Whenever available, supplier data was used for raw materials used in the production process. When primary data did not exist, secondary data for raw material production was used from the GaBi database.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to the product raw materials and packaging is low. Since actual primary data for each of the manufacturing steps were not available, representative datasets were used. The datasets chosen have been verified by the provider (thinkstep – provider of GaBi software and database) and are as close as possible to the regional and temporal scope of this project.

3.7 Period under review

This EPD is based on data for 2018.

3.9 Allocation

General principles of allocation were based on ISO 14040/44. There are no products other than insulated metal panels that are produced as part of the manufacturing processes studied in the LCA. Since there are no co-products, no allocation based on co-products is required. To derive a per unit value for manufacturing inputs such as electricity, natural gas and water, allocation based on total production in square meters was adopted. Discussions with Kingspan staff divulged this was a more representative way than via mass to allocate the manufacturing inputs based on the manufacturing processes used and the types of products created. As a default, secondary GaBi datasets use a physical mass basis for allocation. Throughout the study recycled materials were accounted for via the cut-off method. Under this method, impacts and benefits associated with the previous life of a raw material from recycled stock are excluded from the system boundary. Additionally, impacts and benefits associated with secondary functions of materials at end of life are also excluded (i.e. production into a third life or energy generation from the incineration plant). The study does include the impacts associated with reprocessing and preparation of recycled materials that are part of the bill of materials of the products under study.

Provide information on whether manufacturing resource use was allocated to the products based on mass, volume, price, etc. Manufacturing resource use was allocated to the products based on mass, volume, price, etc. Provide information on whether Impacts from transportation were allocated based on the mass of material and distance transported or an alternative form of allocation.

3.10 Comparability

The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled. Comparability of EPDs is limited to those applying a functional unit.

4. LCA: Scenarios and Additional Technical Information

Delivery and Installation stage (A4 - A5)

Table 1: *Transport to building site (A4) – per 100 m^2*

Name	Truck	Unit
Fuel type	Diesel	-
Liters of fuel	39.0625	l/100km
Vehicle type	Heavy duty diesel truck/ 45,000 lb payload	-
Transport distance	554	km
Capacity utilization	78	%
Weight of products transported	1235.6	kg/100 m^2
Gross density of products	122	kg/m^3
Capacity utilization volume factor	1	-

Table 2: *Installation into the building (A5) – per 100 m²*

Name	QuadCore	Unit
White butyl caulk	15.3	kg/100 m²
Steel trims and fasteners	3.57	kg/100 m²
Electricity	2.0	kWh/100 m²
Diesel	3.15	kg/100 m²
Product Wastage	5 57.5	% kg
Waste materials at the construction site before waste processing, generated by product installation	233.4	kg/100 m²
Packaging waste, OSB	61.9	kg/100 m²
Packaging waste, plastic film, polystyrene, stretch wrap	114	kg/100 m²
Output materials resulting from on-site waste processing	233.4	kg
Landfill	19.4	kg
Incineration	197.0	kg
Recycling	17.1	kg
Biogenic carbon contained in packaging	108	kg CO_2-eq
Direct emissions to ambient air, soil, and water	0	kg
VOC emissions	N/A	µg/m³

Use stage (B1)

The RSL only applies to the in-use conditions specified in the below table. As the default RSL provided by the PCR was used, it is understood that the in-use conditions align with accepted industry standard.

Table 3: *Reference Service Life*

Name	Truck	Unit
RSL	30	years
Declared product properties and finishes, etc.	See Technical Data	-
Design application parameters	Installation per recommendation by manufacturer	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Accepted industry standard	-
Outdoor environment	Accepted industry standard	-
Use conditions	Normal building operating conditions	-

Maintenance stage (B2)

Table 4: *Maintenance per 100 m² (B2)*

Name	Truck	Unit
Maintenance process information	Use phase parameters as recommended by the UL PCR Part B	
Cleaning	150	Cycles/ RSL and Cycles/ ESL
Detergent	0.00505	kg/ 100 m²/ cleaning cycle
Net freshwater consumption specified by water source and fate	0.495 tap water, evaporated	kg/ 100 m²/ cleaning cycle
Further assumptions for scenario development	500 ml of 1% (v/v) sodium lauryl sulfate solution, twice per year	

Repair (B3)

Insulated Metal Panels typically do not typically require repair during the service life of the building.

Replacement (B4)

Table 5: *Replacement (B4)*

Name	Truck	Unit
Cleaning	150	Cycles/ RSL and Cycles/ ESL
Reference Service Life	30	Years
Replacement cycle	1.5	(ESL/RSL) – 1
Energy input – Electricity	2	kWh / replacement
Energy input – Diesel	3.15	kg / replacement
Ancillary materials - White butyl caulk	15.3	kg / replacement
Ancillary materials - Steel trims and fasteners	3.57	kg / replacement

Refurbishment stage (B5)

Insulated Metal Panels typically do not typically require refurbishment during the service life of the building.

Building operation stage (B6 – B7)

No energy or water are required during the building operation stage.

Disposal stage (C1 - C4)

Table 6: *End of life per 100 m^2 (C1-C4)*

Name		Quantity	Unit
Assumptions for scenario development		Product is either disposed of with the underlying floor or manually removed via scraping	
Collection process	Collected separately	0	kg
	Collected with mixed construction waste	1236	kg
Recovery	Reuse	0	kg
	Recycling	0	kg
	Landfill	1236	kg
	Incineration	0	kg
	Incineration with energy recovery	0	kg
	Energy conversion efficiency rate	0	%
Disposal	Product or material for final deposition	1236	kg
Removals of biogenic carbon (excluding packaging)		1.17	kg CO_2
Distance to landfill		100	km

Module D

As the cut-off approach was used for the recovery of materials and energy, no environmental credits or burdens fall into this module and therefore there is no relevant scenario information to report.

5. LCA: Results

Product			Construction Process		Use							End-of-life				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 extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks .

The six impact categories under IPCC AR5 and TRACI 2.1 are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.

CML Life Cycle Impact Assessment (LCIA) results for the metal panel product over 75 years. All values are rounded to three significant digits. Results reported in MJ are calculated using higher heating value.

Impact Category	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5-B7	C1	C2	C3	C4	D
Global Warming Potential	kg CO_2 eq.	5.41E+03	5.85E+01	4.14E+02	-	3.83E+01	-	8.92E+03	-	-	-	-	3.85E+00	-
Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq.	-6.69E-06	5.53E-15	-3.34E-07	-	2.59E-14	-	-1.05E-05	-	-	-	-	3.65E-16	-
Acidification Potential of Land and Water	kg SO_2 eq.	1.37E+01	2.20E-01	9.20E-01	-	5.63E-02	-	2.26E+01	-	-	-	-	1.45E-02	-
Eutrophication Potential	kg PO_4^{3-} eq.	1.61E+00	6.07E-02	2.44E-01	-	1.02E-02	-	2.94E+00	-	-	-	-	4.03E-03	-
Formation Potential of Tropospheric Ozone	kg Ethene-eq.	3.36E+00	-8.34E-02	2.35E-01	-	1.68E-02	-	5.27E+00	-	-	-	-	-6.09E-03	-
Abiotic Depletion Potential for Non-Fossil Resources (Elements)	kg Sb eq.	1.31E-02	1.11E-05	6.60E-04	-	4.16E-05	-	2.07E-02	-	-	-	-	7.34E-07	-
Abiotic Depletion Potential for Fossil Resources (Fossil Fuels)	MJ eq.	8.25E+04	8.23E+02	4.76E+03	-	8.74E+02	-	1.34E+05	-	-	-	-	5.43E+01	-

TRACI Life Cycle Impact Assessment (LCIA) results for the metal panel product over 75 years. All values are rounded to three significant digits.

Impact Category	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5-B7	C1	C2	C3	C4	D
Acidification Potential	kg SO_2 eq.	1.45E+01	3.00E-01	1.25E+00	-	6.20E-02	-	2.45E+01	-	-	-	-	1.98E-02	-
Eutrophication Potential	kg N eq.	8.67E-01	2.44E-02	1.80E-01	-	5.76E-03	-	1.63E+00	-	-	-	-	1.61E-03	-
Global Warming Potential (100 year)	kg CO_2 eq.	5.38E+03	5.84E+01	4.06E+02	-	3.78E+01	-	8.87E+03	-	-	-	-	3.84E+00	-
Ozone Depletion Potential	kg CFC-11 eq.	-8.71E-06	-3.14E-13	-4.35E-07	-	-6.25E-12	-	-1.37E-05	-	-	-	-	-2.07E-14	-
Depletion of Fossil Fuel Resources	MJ eq.	7.79E+03	1.10E+02	4.80E+02	-	1.21E+02	-	1.28E+04	-	-	-	-	7.27E+00	-
Smog Formation Potential	kg O_3 eq.	2.60E+02	6.85E+00	1.57E+01	-	1.26E+00	-	4.33E+02	-	-	-	-	4.50E-01	-

Carbon uptake and emission results for the metal panel product over 75 years. All values are rounded to three significant digits. Results reported in MJ are calculated using lower heating value.

Impact Category	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5-B7	C1	C2	C3	C4	D
Biogenic Carbon Removal from Product	kg CO_2	1.17E+00	-	5.87E-02	-	-	-	1.85E+00	-	-	-	-	-	-
Biogenic Carbon Emission from Product	kg CO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Biogenic Carbon Removal from Packaging	kg CO_2	1.08E+02	-	5.39E+00	-	-	-	1.70E+02	-	-	-	-	-	-
Biogenic Carbon Emission from Packaging	kg CO_2	-	-	1.05E+01	-	-	-	1.57E+01	-	-	-	-	-	-
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcination Carbon Emissions	kg CO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbonation Carbon Removals	kg CO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes	kg CO_2	-	-	-	-	-	-	-	-	-	-	-	-	-

Resource use and waste flows for the metal panel product over 75 years. All values are rounded to three significant digits. Results reported in MJ are calculated using higher heating value.

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5-B7	C1	C2	C3	C4	D
Use of renewable primary energy excluding the renewable primary energy resources used as raw materials	MJ eq.	4.59E+03	2.56E+01	2.67E+02	-	1.58E+01	-	7.35E+03	-	-	-	-	1.69E+00	-
Use of renewable primary energy resources used as raw materials	MJ eq.	8.82E+02	-	-	-	-	-	1.41E+03	-	-	-	-	-	-
Total use of renewable primary energy resources	MJ eq.	5.48E+03	2.56E+01	2.67E+02	-	1.58E+01	-	8.76E+03	-	-	-	-	1.69E+00	-
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ eq.	8.41E+04	8.27E+02	5.04E+03	-	8.98E+02	-	1.36E+05	-	-	-	-	5.46E+01	-
Use of non-renewable primary energy resources used as raw materials	MJ eq.	4.73E+03	-	-	-	-	-	7.66E+03	-	-	-	-	-	-
Total use of non-renewable primary energy resources	MJ eq.	8.89E+04	8.27E+02	5.04E+03	-	8.98E+02	-	1.44E+05	-	-	-	-	5.46E+01	-
Use of secondary materials	kg	-	-	-	-	-	-	-	-	-	-	-	-	-
Use of renewable secondary fuels	MJ eq.	-	-	-	-	-	-	-	-	-	-	-	-	-
Use of non-renewable secondary fuels	MJ eq.	-	-	-	-	-	-	-	-	-	-	-	-	-
Recovered Energy	MJ eq.	-	-	-	-	-	-	-	-	-	-	-	-	-
Fresh Water Use	m^3	1.62E+01	9.92E-02	9.23E-01	-	1.11E+00	-	2.60E+01	-	-	-	-	6.55E-03	-
Hazardous waste	kg	5.53E-03	6.71E-06	1.89E-03	-	3.50E-07	-	1.11E-02	-	-	-	-	4.43E-07	-
Non-hazardous waste	kg	3.29E+02	3.12E-02	1.98E+02	-	6.46E-01	-	2.59E+03	-	-	-	-	2.06E-03	-
High-level Radioactive waste	kg	2.99E-03	2.21E-06	1.29E-04	-	1.11E-05	-	4.70E-03	-	-	-	-	1.46E-07	-
Intermediate and low-level Radioactive waste	kg	2.31E+00	1.83E-03	9.83E-02	-	9.21E-03	-	3.63E+00	-	-	-	-	1.21E-04	-
Components for re-use	kg	-	-	-	-	-	-	-	-	-	-	-	-	-
Materials for recycling	kg	-	-	2.02E+01	-	-	-	1.24E+02	-	-	-	-	-	-
Materials for energy recovery	kg	-	-	1.94E+01	-	-	-	2.91E+01	-	-	-	-	-	-
Exported electrical energy	MJ eq.	-	-	6.15E+01	-	-	-	9.23E+01	-	-	-	-	-	-
Exported thermal energy	MJ eq.	5.53E-03	6.71E-06	1.89E-03	-	3.50E-07	-	1.11E-02	-	-	-	-	4.43E-07	-

6. LCA: Interpretation

Overall for Kingspan's insulated metal panel products, Global Warming (GWP) and Abiotic Depletion of fossil fuels are the impact categories of most significance. Within these impact categories, the vast majority of impacts are aggregated in the A1-A3 phase of the life cycle of the product. A1-A3 includes raw material sourcing, transportation and manufacturing. The second largest life cycle stage is A5 in terms of global warming impacts which is installation at customer's job site.

For laminated metal panels, in the sourcing and extraction stage, the largest contributors to the impacts in terms of raw materials are steel (37%) and foam (24%). Additives contribute around 2.4% to overall impacts. Within manufacturing, electricity contributes to 20% of overall GWP impacts while thermal energy from natural gas and LPG contributes to 8%.

Shipping to customer contributes around 1.1% of total GWP impacts, while, installation used contributes around 2.7% of GWP impacts. Finally, disposal of the product to landfill contributes 1.3% to total GWP impacts.

7. Additional Environmental Information

7.1 Environment and Health during Manufacture

Kingspan has established Environmental, Health and Safety programs to ensure all federal, state, and local regulations are met or exceeded.

7.2 Environment and Health during Installation

Personnel working with panel cutting equipment should always wear respiratory and eye protection as per standard safety measure.

7.3 Environmental Activities and Certifications

At Kingspan, we are committed to operating a sustainable business that delivers sustainable products and solutions. With this in mind, we have pledged to continually advance and hone sustainable business practice across seven key areas:

- Energy and Carbon
- Waste and Water
- Supply Chain
- Product Innovation
- Product Lifecycle
- Employees
- Stakeholders and Community

To learn more about Kingspan's sustainability programs please visit: https://www.kingspan.com/us/en-us/about-kingspan/kingspan-insulated-panels/sustainability.

7.4 Further Information

For further information on the product, please visit: https://www.kingspan.com/us/en-us/product-groups/architectural-panel-facade-systems/benchmark-panel-systems.

8. References

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