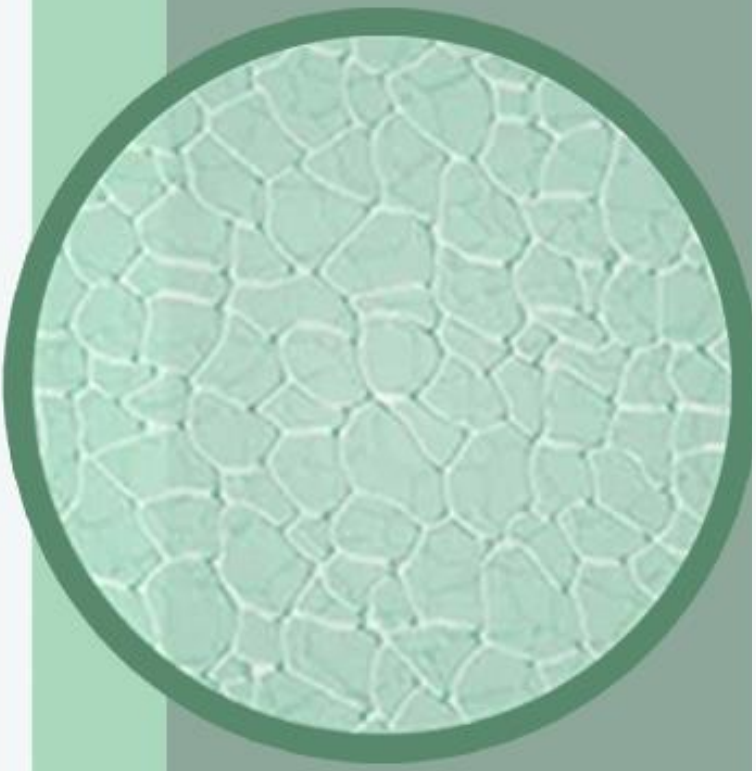


Declaration Owner
Kingspan Insulation LLC
2100 Riveredge Parkway, Suite 175
Atlanta, Georgia, USA 30328
1-800-241-4402 | www.kingspaninsulation.us | info@kingspan.us

Products
XPS Insulation Board, 40 psi
- Standard
- Low-GWP

Functional Unit
1 m² of insulation with a thickness required for an average thermal resistance RSI = 1 m²K/W maintained for 75 years

EPD Number and Period of Validity
SCS-EPD-07176
EPD Valid July 1, 2021 through June 30, 2026
Version: June 15, 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. Sept. 2018

PCR Guidance for Building-Related Products and Services Part B: Building Envelope Thermal Insulation EPD Requirements. Version 2.0. April 2018

Program Operator
SCS Global Services
2000 Powell Street, Ste. 600, Emeryville, CA 94608
+1.510.452.8000 | www.SCSglobalServices.com

Declaration Owner:	Kingspan Insulation LLC
Address:	2100 Riveredge Parkway, Suite 175 Atlanta, Georgia, USA 30328
Declaration Number:	SCS-EPD-07176
Declaration Validity Period:	July 1, 2021 through July 30, 2026
Version:	June 15, 2023
Product:	XPS Insulation boards, 40 psi
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Gerard Mansell, PhD., SCS Global Services
LCA Software:	OpenLCA 1.10
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
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. Sept. 2018
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: Building Envelope Thermal Insulation EPD Requirements. Version 2.0. April 2018
Part B PCR Review conducted by:	Thomas Gloria (chair), Industrial Ecology Consultants; Christoph Koffler, thinkstep; Andre Desjarlais,Oak Ridge National Laboratory
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Declaration Contents:	

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

Kingspan Insulation LLC, headquartered in Atlanta, GA, is a leading manufacturer offering high-performance insulation, building wraps, and pre-insulated HVAC ductwork.

Kingspan XPS insulation and housewrap products are standards in the industry, while newer product lines are among the most thermally efficient and technologically advanced insulation material available.

Kingspan Insulation LLC products are suitable for both new build and renovation in a variety of applications within both residential and non-residential buildings.

2. Product

The products include extruded polystyrene insulation boards manufactured at the company's production facility in Winchester, VA. The products are constructed from polystyrene plastics and various blowing agents sourced from various local and regional suppliers. A product with a standard blowing agent and a low-GWP blowing agent are included.

Product	Product Details
GreenGuard® Type VI XPS Insulation Board	Kingspan GreenGuard® Type VI XPS Insulation Board comprises closed–cell extruded polystyrene (XPS) with a minimum compressive strength of 40 psi. It has high water resistance and R–value of 5.0 per inch of thickness. It is available in a square edge board or a drainage channel board. Excellent for low–temperature freezer floors, cold storage facility floors, ice rinks, parking decks. Kingspan GreenGuard® GG40-LG XPS Insulation Board comprises closed–cell extruded polystyrene (XPS) with a minimum compressive strength of 40 psi. It has high water resistance and R–value of 5.0 per inch of thickness. It has a formulation resulting in a GWP of less than 50. It is available in a square edge board or a drainage channel board. Excellent for high load floor and roofing systems, ice rinks, roadways as well as plaza and parking decks.

2.2 Application

The Kingspan XPS insulation board products provide the primary function of thermal insulation intended for various commercial and residential building applications.

2.3 Technical Data

Technical specifications and product performance testing results for the products are summarized in Table 1. Detailed product characteristics can be found at the manufacturer's website (www.kingspaninsulation.us).

Table 1. *Technical specifications for the XPS 40 psi Kingspan insulation board products.*

Property	Test Method	Result
General		
Nominal Thickness		2, 3, 4 (in)
		50.8, 76.2, 102 (mm)
Nominal Board Width		2 ft , 4 ft
		00.610 m, 0.711 m
Nominal Board Length		8 ft
		2.44 m
Edge Profile		Square or Channeled
Property Type	ASTM C578	VI
Compressive Strength, Min. (@10% deflection)	ASTM D1621	40 psi
		276 kPa
Water Absorption, Max. (% by volume)	ASTM C272	0.3
Water Vapor Permeance (perm)	ASTM E96 (Desiccant Method)	<1.1
Density, Min.	ASTM C303	1.8 lb/ft^3
		28.84 kg/m^3
Service Temperature, Max.		165 °F
		74 °C
Thermal		
Thermal Resistance, R–value	ASTM C518 (@75°F Mean Temperature)	5 °F-ft^2-hr / Btu per in thick
		0.881 m²K/W per in thick
Thermal Conductivity, k–value	ASTM C518 (@75ºF Mean Temperature)	0.2 Btu-in / °F-ft^2-hr
		0.029 W/mK
Fire & Smoke		
Flame Spread	ASTM E84 / UL723	25 (Class A)
Smoke Developed	ASTM E84 / UL723	140

2.4 Base Materials

The primary materials include polystyrene resin, a blend of HFC blowing agents, performance additives, a flame retardant, and colorants. sourced from various suppliers. Packaging materials consist of corrugated board, plastic wrap and wood pallets.

Table 2. *Material component summary for the Kingspan Insulation products by mass (per functional unit) and percentage of total mass.*

Material	Standard - PSI 40		Low GWP - PSI 40	
	kg/m^2	Percent	kg/m^2	Percent
Polystyrene	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL
Recycled Polystyrene	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL
Blowing Agent	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL
Flame Retardant	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL
Other	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL	CONFIDENTIAL
Total Product	**0.864**	**100%**	**0.928**	**100%**

Table 3. *Material content for packaging for Kingspan XPS insulation board products , per functional unit.*

Material	Standard - PSI 40		Low GWP - PSI 40	
	kg/m²	Percent	kg/m²	Percent
Corrugated	$2.77x10^{-4}$	12%	$2.77x10^{-4}$	12%
Plastic	$1.99x10^{-3}$	88%	$1.99x10^{-3}$	88%
Total Packaging	**$2.26x10^{-3}$**	**100%**	**$2.26x10^{-3}$**	**100%**

2.5 Manufacture

The products include extruded polystyrene insulation boards manufactured at the company's production facility in Winchester, VA. The products are constructed from polystyrene plastics and various blowing agents sourced from various local and regional suppliers

Resource use at the production facility is allocated to the product based on product mass as a fraction of facility production (mass-based allocation).

2.6 Environment and Health during Manufacture

No environmental or health impacts are expected during the manufacture of the product.

2.7 Product Processing/Installation

Typical installation is accomplished using hand tools.

2.8 Packaging

The Kingspan products are packaged for shipment using corrugated board, plastic wrap and wood pallets.

2.9 Condition of Use

No special conditions of use are noted.

2.10 Environment and Health during use

No environmental or health impacts are expected due to normal use of the products.

2.11 Reference Service Life

Once installed, the products are expected to last for the lifetime of the building. For the present assessment, a reference service lifetime (RSL) equal to the estimated building service lifetime (ESL) is assumed for each product. Based on this assumption, no product replacements are required over the 75-year ESL.

2.12 Extraordinary Effects

No environmental or health impacts are expected due to extraordinary effects including fire and/or water damage and unforeseeable mechanical destruction.

2.13 Further Information

Further information on the product can be found on the manufacturers' website at www.kingspaninsulation.us.

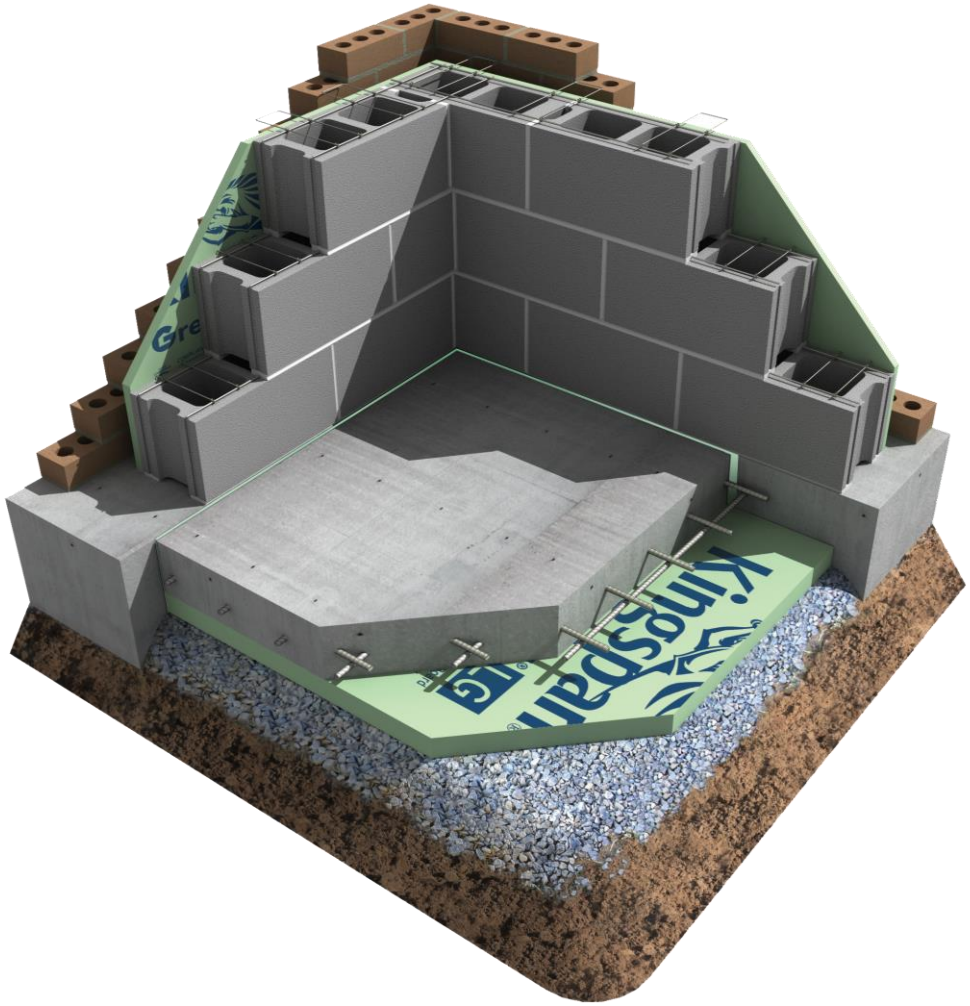
3. LCA: Calculation Rules

3.1 Functional Unit

The Kingspan XPS insulation board products provide the primary function of thermal insulation. According to ISO 14044, the functional unit is "the quantified performance of a product system, for use as a reference unit." According to the PCR, the functional unit applicable to the insulation products, is 1 m^2 of insulation with a thickness required to provide a thermal resistance (R-value) of 1 m²K/W and maintained for 75 years. As the Kingspan products achieve an R-value of 5 °F-ft^2-hr/Btu per inch thickness of product, the required thickness for the functional unit is 1.134 inches (2.88 cm).

Table 4. *Functional unit and reference flows for the XPS insulation board products.*

Product Name	Functional Unit	Thickness to Achieve FU (m)	Reference flow (kg/m^2)	Reference Service Life (years)
Standard - PSI 40	1 m² of insulation with a thickness required for an average thermal resistance RSI = 1 m²K/W	0.0288	0.864	75
low GWP - PSI 40	1 m² of insulation with a thickness required for an average thermal resistance RSI = 1 m²K/W	0.0288	0.928	75



3.2 System Boundary

The scope of the EPD is cradle-to-grave, including raw material extraction and processing, transportation, product manufacture, product delivery, installation and use, and product disposal. The life cycle phases included in the EPD scope are described in Table 5 and illustrated in Figure 1.

Table 5. *The modules and unit processes included in the scope for the Kingspan products.*

Module	Module description from the PCR	Unit Processes Included in Scope
A1	Extraction and processing of raw materials; any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Extraction and processing of raw materials for the insulation board components.
A2	Transport (to the manufacturer)	Transport of component materials to the manufacturing facilities
A3	Manufacturing, including ancillary material production	Manufacturing of products and packaging (incl. upstream unit processes*)
A4	Transport (to the building site)	Transport of product (including packaging) to the building site
A5	Construction-installation process	Impacts from the installation of product are assumed negligible. Only impacts from packaging disposal are included in this phase
B1	Product use	There are no impacts from the use of the insulation in a building setting.
B2	Product maintenance	Maintenance of products over the 75-year ESL, including periodic cleaning. Impacts from product maintenance are assumed negligible
B3	Product repair	The products are not expected to require repair over its lifetime
B4	Product replacement	No product replacements are required over the 75-year ESL of the assessment.
B5	Product refurbishment	The products are not expected to require refurbishment over their lifetime
B6	Operational energy use by technical building systems	There is no operational energy use associated with the use of the product
B7	Operational water uses by technical building systems	There is no operational water use associated with the use of the product
C1	Deconstruction, demolition	Demolition of the product is accomplished using hand tools with no associated emissions and negligible impacts
C2	Transport (to waste processing)	Transport of the product to waste treatment at end-of-life
C3	Waste processing for reuse, recovery and/or recycling	The products are disposed of by landfilling or incineration which require no waste processing
C4	Disposal	Disposal of the product in a municipal landfill. The release of blowing agents encapsulated in the product are included in this phase.
D	Reuse-recovery-recycling potential	Module Not Declared

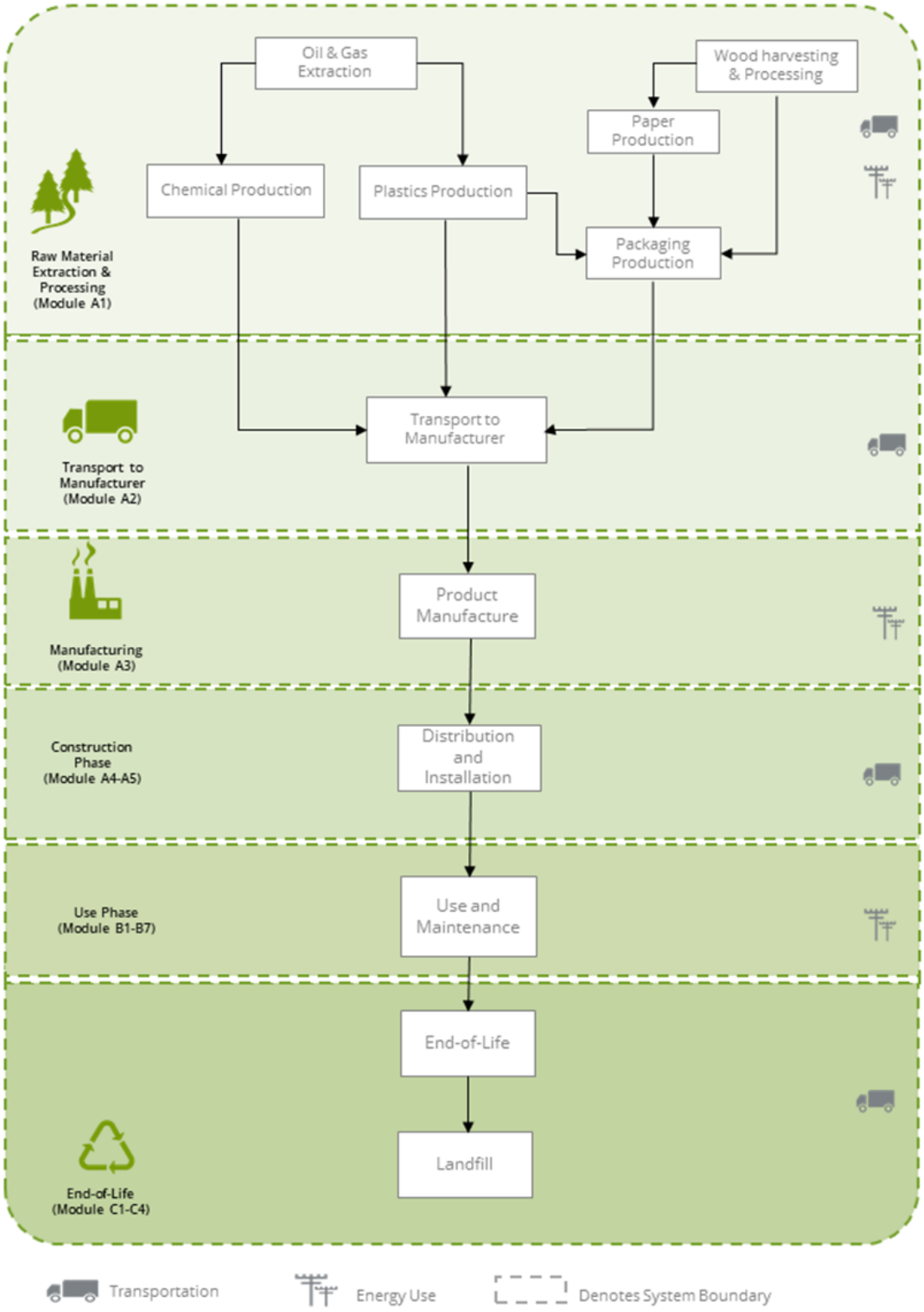


Figure 1. *Flow diagram representing the major unit operations in the life cycle of the Kingspan XPS insulation board products.*

3.3 Estimates and Assumptions

- The Winchester, Virginia facility is located in the RFCW eGRID EPA NERC sub-region. An Ecoinvent inventory dataset was modified to reflect the eGRID energy mix for RFCE to estimate resource use and emissions from electricity use at the Virginia facility.
- Electricity and resource use at the production facility were allocated to the insulation products based on the mass of the product and annual production data for 2020 provided by the manufacturer.
- Primary data for upstream material components were not available. Representative LCI datasets from the ecoinvent database were used as appropriate.
- Life cycle inventory data were not available for the low-GWP blowing agent. An ecoinvent dataset for organic chemicals was used as a surrogate dataset.
- The low-GWP version products utilize a blowing agent for which the GWP is reported to be < 1.0 kg CO_2e/kg. As no more specific data were available, a value of 1.0 kg CO_2e/kg is assumed for the current assessment.
- For end-of-life, disposal of the product packaging is modeled based on 2018 statistics for municipal solid waste generation and disposal in the United States, from the US Environmental Protection Agency. These data provide recycling rate estimates for packaging and containers.
- The product is assumed to be disposed in a landfill at end-of-life. Blowing agents used in manufacturing and encapsulated in the product are assumed to be released to the atmosphere when disposed of in a landfill. The global warming potentials (GWPs) for the blowing agents used in the insulation board products are from the US EPA[1].
- For final disposal of the product and packaging materials at end-of-life, all materials are assumed to be transported 20 miles by diesel truck to either a landfill, incineration facility, or material reclamation facility (for recycling). Datasets representing disposal in a landfill and waste incineration are from Ecoinvent.
- Modeling of recycled materials follows the recycled content method (also known as 100-0 method or cut-off method) whereby only the burdens of reprocessing the waste material are allocated to the system from the use of the recycled material.

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.

[1] https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants; https://www.epa.gov/sites/production/files/2014-11/documents/notice25substitutefoams.pdf

3.4 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. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results. No known flows are deliberately excluded from this EPD.

3.5 Background Data

Primary data were provided by Kingspan for the Winchester, Virginia manufacturing facility. The sources of secondary LCI data are the Ecoinvent database.

Table 6. *Data sources for the Kingspan XPS insulation board products.*

Component	Dataset	Data Source	Publication Date
PRODUCT			
Plastics			
Polystyrene resins	polystyrene production, general purpose | polystyrene, general purpose | Cutoff, S/RoW	EI v3.7	2020
	polystyrene production, expandable | polystyrene, expandable | Cutoff, S/RoW	EI v3.7	2020
	polystyrene production, high impact | polystyrene, high impact | Cutoff, S/RoW	EI v3.7	2020
Recycled PS	Recycled GPPS | polystyrene, general purpose | Cutoff, S/RoW	EI v3.7; SCS	2020
Blowing Agents			
CBI	tetrafluoroethane production | tetrafluoroethane | Cutoff, S/GLO	EI v3.7	2020
	chemical production, organic | chemical, organic | Cutoff, S/GLO	EI v3.7	2020
	methyl formate production | methyl formate | Cutoff, S/RoW	EI v3.7	2020
	chemical production, organic | chemical, organic | Cutoff, S/GLO	EI v3.7	2020
Other		EI v3.7	2020
Additives	chemical production, organic | chemical, organic | Cutoff, S/GLO	EI v3.7	2020
	limestone production, crushed, washed | limestone, crushed, washed | Cutoff, S/RoW	EI v3.7	2020
	titanium dioxide production, sulfate process | titanium dioxide | Cutoff, S/RoW	EI v3.7	2020
PACKAGING			
Corrugated	containerboard production, linerboard, kraftliner | containerboard, linerboard | Cutoff, S/RoW	EI v3.7	2020
Plastic	polypropylene production, granulate | polypropylene, granulate | Cutoff, S/RoW		
Wood	EUR-flat pallet production | EUR-flat pallet | Cutoff, S/RoW	EI v3.7	2020
RESOURCES			
Grid electricity	Electricity, medium voltage, per kWh – RFCW/RFCW	EI v3.7; eGRID	2020; 2018
Natural gas	heat production, natural gas, at boiler modulating >100kW | heat, district or industrial, natural gas | Cutoff, S/RoW	EI v3.7	2020
Fuel oil	heat production, light fuel oil, at industrial furnace 1MW | heat, district or industrial, other than natural gas | Cutoff, S/CA-QC	EI v3.7	2020
Propane	heat production, propane, at industrial furnace >100kW | heat, district or industrial, other than natural gas | Cutoff, S/RoW	EI v3.7	2020
TRANSPORTATION			
Road transport	transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, S/RoW	EI v3.7	2020
Rail transport	market for transport, freight train | transport, freight train | Cutoff, S/US	EI v3.7	2020
Ocean transport	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, S/GLO	EI v3.7	2020

3.6 Data Quality

The data quality assessment addressed the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 7. *Data quality assessment for the Kingspan Insulation product system.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 5 years old (typically 2016). All of the data used represented an average of at least one year's worth of data collection, and up to three years in some cases. Manufacturer-supplied data (primary data) are based on annual production for 2020.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Electricity use for product manufacture is modeled using representative data for the US. Surrogate data used in the assessment are representative of global or European operations. Data representative of European operations are considered sufficiently similar to actual processes. Data representing product disposal are based on regional statistics.
Technology Coverage: Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations.
Precision: Measure of the variability of the data values for each data expressed	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness: Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the insulation products. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
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 sources of similar quality and age are used; with a bias towards Ecoinvent v3.7 data where available. Different portions of the product life cycle are equally considered.
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	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data: Description of all primary and secondary data sources	Data representing energy use at Kingspan's manufacturing facility represent an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. For secondary LCI data, Ecoinvent v3.7 LCI data are used.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products and packaging is low. Actual supplier data for upstream operations were not available and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

3.7 Period under review

The period of review is calendar year 2020.

3.8 Allocation

Manufacturing resource use was allocated to the products based on product mass as a fraction of annual facility production (mass-based allocation). Impacts from transportation were allocated based on the mass of material and distance transported.

The product system includes some recycled materials, which were allocated using the recycled content allocation method (also known as the 100-0 cut-off method). Using the recycled content allocation approach, system inputs with recycled content do not receive any burden from the previous life cycle other than reprocessing of the waste material. At end-of-life, materials which are recycled leave the system boundaries with no additional burden.

3.9 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.

4. LCA: Scenarios and Additional Technical Information

Delivery and Installation stage (A4 - A5)

Distribution of the product to point of sale is included in the model, based on primary data received from the manufacturer. The average transportation distance to the installation site was based on a weighted average of shipments over calendar year 2020 for the products and is estimated as 960 kilometers via diesel truck. Transportation parameters for modeling product distribution are summarized in Table 8.

Table 8. *Product distribution parameters, per functional unit.*

Transport Parameter	Standard - PSI 40	Low GWP - PSI 40
Diesel truck – Fuel utilization (L/100 km)	18.7	18.7
Diesel truck – Capacity utilization (%)	76%	76%
Diesel truck – Distance (km)	960	960
Gross mass of products transported (including packaging)[1] (kg)	0.873	0.937

The impacts associated with the product installation are assumed negligible. The impacts associated with packaging disposal are included with the installation phase as per PCR requirements.

Table 9. *Installation parameters for the Kingspan products, per functional unit.*

Parameter		Standard - PSI 40	low GWP - PSI 40
Ancillary materials		-	-
Net freshwater consumption (m^3)		-	-
Electricity consumption (kWh)		-	-
Product loss per functional unit (kg)		negligible	negligible
Waste materials generated by product installation (kg)		negligible	negligible
Output materials resulting from on-site waste processing (kg)		na	na
Mass of packaging waste (kg)	Corrugated	$2.77x10^{-4}$	$2.77x10^{-4}$
	Plastic	$1.99x10^{-3}$	$1.99x10^{-3}$
	Wood	0.00	0.00
Biogenic carbon contained in packaging (kg CO_2)		$5.08x10^{-4}$	$5.08x10^{-4}$
Direct emissions (kg)		-	-

Use and Maintenance stage (B1 - B2)

No impacts are associated with the use of the products. Impacts from routine cleaning and maintenance of the products are assumed negligible.

Repair stage (B3)

Repair of the product is not relevant during the lifetime of the product; results for this stage are reported as zero.

Replacement stage (B4)

No product replacements are required over the 75-year ESL of the assessment.

Refurbishment stage (B5)

Product refurbishment is not relevant during the lifetime of the product.

Building operation stage (B6 – B7)

There is no operational energy or water use associated with the use of the product.

Disposal stage (C1 - C4)

The disposal stage includes removal of the products (C1); transport of the products to waste treatment facilities (C2); waste processing (C3); and associated emissions as the product degrades in a landfill or is burned in an incinerator (C4). It is assumed the insulation board products are landfilled at end-of-life. No emissions are generated during demolition (C1) while no waste processing (C3) is required for landfill disposal. Blowing agents released at end-of-life are accounted for in the disposal stage C4.

Transportation of waste materials at end-of-life (C2) assumes a 20 mile (~32 km) average distance to disposal, consistent with assumptions used in the US EPA WARM model. The recycling rates used for the product packaging are based on regional statistics regarding municipal solid waste generation and disposal in the United States for 2018, from the US Environmental Protection Agency. The relevant disposal statistics used for the packaging are summarized in Table 10 and Table 11. For material not recycled, 80% are assumed landfilled and 20% incinerated.

Table 10. *Recycling rates for product packaging materials at end-of-life.*

Material	Packaging Recycling rate (%)
Recycling Rates	
Plastic	14.6%
Paper & Pulp	75%
Wood	26.1%
Disposal of Non-recyclables	
Landfill	80.0%
Incineration	20.0%

Table 11. *End-of-life disposal scenario parameters for the Kingspan XPS insulation board products.*

Parameter		Standard - PSI 40	low GWP - PSI 40
Assumptions for scenario development		Landfill	Landfill
Collection process			
Collected with mixed construction waste (kg)		0.864	0.928
Recovery		n/a	n/a
Disposal	Recycled (kg)	-	-
	Landfill (kg)	0.864	0.928
	Incineration (kg)	-	-
Removals of biogenic carbon (kg CO_2 eq)[1]		n/a	n/a

[1] *Excludes Packaging*

5. LCA: Results

Results of the Life Cycle Assessment are presented below. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Table 12. *Life cycle phases included in the product system boundary.*

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	MND

X = Included in system boundary | MND = Module not declared

The following impact indicators, specified by the PCR, are reported below:

TRACI 2.1 Impact Category	Unit
Global Warming Potential (GWP)	kg CO_2 eq
Ozone Depletion Potential (ODP)	kg CFC 11 eq
Acidification Potential (AP)	kg SO_2 eq
Eutrophication Potential (EP)	kg N eq
Smog Formation Potential (SFP)	kg O_3 eq
Fossil Fuel Depletion Potential (ADP_{fossil})	MJ Surplus, LHV

These impact categories 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.

The following inventory parameters, specified by the PCR, are also reported.

Resources	Unit	Waste and Outflows	Unit
RPR_E: Renewable primary resources used as energy carrier (fuel)	MJ, LHV	HWD: Hazardous waste disposed	kg
RPR_M: Renewable primary resources with energy content used as material	MJ, LHV	NHWD: Non-hazardous waste disposed	kg
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	MJ, LHV	HLRW: High-level radioactive waste, conditioned, to final repository	kg
$NRPR_M$: Non-renewable primary resources with energy content used as material	MJ, LHV	ILLRW: Intermediate- and low-level radioactive waste, conditioned, to final repository	kg
SM: Secondary materials	MJ, LHV	CRU: Components for re-use	kg
RSF: Renewable secondary fuels	MJ, LHV	MR: Materials for recycling	kg
NRSF: Non-renewable secondary fuels	MJ, LHV	MER: Materials for energy recovery	kg
RE: Recovered energy	MJ, LHV	EE: Recovered energy exported from the product system	MJ, LHV
FW: Use of net freshwater resources	m^3	-	-

Modules B1, B2, B3, B4, B5, B6, and B7 are not associated with any impact and are therefore declared as zero. In addition, module C1 and C3 are likewise not associated with any impact as the products are expected to be manually deconstructed. Additionally, as the products do not contain significant amounts of bio-based materials, biogenic carbon emissions and removals are not declared. Module D is not declared. In the interest of space and table readability, these modules are not included in the results presented below.

Table 13. *Life Cycle Impact Assessment (LCIA) results for the Kingspan **XPS 40 psi Standard** products over a 75-yr time horizon. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Impact Category	A1	A2	A3	A4	A5	C2	C4
TRACI							
GWP (kg CO_2 eq)	2.81	$8.16x10^{-2}$	0.771	0.139	$5.70x10^{-3}$	$3.52x10^{-2}$	65.0
	4.1%	0.12%	1.1%	0.20%	0.01%	0.05%	94%
ODP (kg CFC-11 eq)	$1.52x10^{-7}$	$1.75x10^{-8}$	$6.38x10^{-8}$	$3.23x10^{-8}$	$1.13x10^{-10}$	$8.16x10^{-9}$	$3.01x10^{-9}$
	55%	6.3%	23%	12%	0.04%	2.9%	1.1%
AP (kg SO_2 eq)	$1.00x10^{-2}$	$6.22x10^{-4}$	$4.65x10^{-3}$	$6.29x10^{-4}$	$3.27x10^{-6}$	$2.03x10^{-4}$	$8.08x10^{-5}$
	62%	3.8%	29%	3.9%	0.02%	1.3%	0.50%
EP (kg N eq)	$2.35x10^{-3}$	$1.14x10^{-4}$	$2.83x10^{-3}$	$1.54x10^{-4}$	$9.12x10^{-5}$	$2.61x10^{-5}$	$1.25x10^{-2}$
	13%	0.63%	16%	0.85%	0.50%	0.14%	69%
SFP (kg O_3 eq)	0.124	$1.60x10^{-2}$	$5.01x10^{-2}$	$1.52x10^{-2}$	$9.20x10^{-5}$	$5.75x10^{-3}$	$1.77x10^{-3}$
	58%	7.5%	24%	7.2%	0.04%	2.7%	0.83%
FFD (MJ eq)	9.08	0.159	0.812	0.294	$1.05x10^{-3}$	$7.26x10^{-2}$	$3.02x10^{-2}$
	87%	1.5%	7.8%	2.8%	0.01%	0.69%	0.29%
Resources							
RPR_E (MJ)	0.737	$1.91x10^{-2}$	0.371	$2.32x10^{-2}$	$5.85x10^{-5}$	$1.81x10^{-3}$	$4.99x10^{-3}$
	64%	1.7%	32%	2.0%	0.01%	0.16%	0.43%
RPR_M (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$NRPR_E$ (MJ)	INA	INA	INA	INA	INA	INA	INA
$NRPR_M$ (MJ)	INA	INA	INA	INA	INA	INA	INA
SM (kg)	$7.43x10^{-2}$	0.00	0.00	0.00	0.00	0.00	0.00
	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RSF/NRSF (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
RE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
FW (m^3)	0.151	$1.03x10^{-3}$	$6.23x10^{-2}$	$1.46x10^{-3}$	$6.40x10^{-6}$	$1.55x10^{-4}$	$3.00x10^{-4}$
	70%	0.48%	29%	0.68%	0.00%	0.07%	0.14%
Wastes							
HWD (kg)	$1.28x10^{-5}$	$3.15x10^{-6}$	$5.33x10^{-6}$	$5.47x10^{-6}$	$2.00x10^{-8}$	$1.31x10^{-6}$	$4.03x10^{-7}$
	45%	11%	19%	19%	0.07%	4.6%	1.4%
NHWD (kg)	$7.86x10^{-2}$	$3.87x10^{-2}$	$3.44x10^{-2}$	$9.87x10^{-2}$	$6.25x10^{-3}$	$2.29x10^{-3}$	0.866
	7.0%	3.4%	3.1%	8.8%	0.56%	0.20%	77%
HLRW (kg)	$2.67x10^{-6}$	$8.67x10^{-8}$	$1.23x10^{-5}$	$1.09x10^{-7}$	$2.78x10^{-10}$	$7.99x10^{-9}$	$2.66x10^{-8}$
	18%	0.57%	81%	0.72%	0.00%	0.05%	0.18%
ILLRW (kg)	$1.69x10^{-5}$	$7.38x10^{-6}$	$6.46x10^{-5}$	$1.36x10^{-5}$	$4.64x10^{-8}$	$3.43x10^{-6}$	$1.29x10^{-6}$
	16%	6.9%	60%	13%	0.04%	3.2%	1.2%
CRU (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR (kg)	0.00	0.00	0.00	0.00	$1.52x10^{-3}$	0.00	0.00
	0.00%	0.00%	0.00%	0.00%	100%	0.00%	0.00%
MER (kg)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
EE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

Table 14. *Life Cycle Impact Assessment (LCIA) results for the Kingspan **XPS 40 psi low-GWP products** over a 75-yr time horizon. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Impact Category	A1	A2	A3	A4	A5	C2	C4
TRACI							
GWP (kg CO_2 eq)	2.91	$9.35x10^{-2}$	0.771	0.149	$5.70x10^{-3}$	$3.78x10^{-2}$	0.486
	65%	2.1%	17%	3.3%	0.13%	0.85%	11%
ODP (kg CFC-11 eq)	$5.56x10^{-8}$	$2.04x10^{-8}$	$6.38x10^{-8}$	$3.47x10^{-8}$	$1.13x10^{-10}$	$8.77x10^{-9}$	$3.24x10^{-9}$
	30%	11%	34%	19%	0.06%	4.7%	1.7%
AP (kg SO_2 eq)	$9.54x10^{-3}$	$6.90x10^{-4}$	$4.65x10^{-3}$	$6.75x10^{-4}$	$3.27x10^{-6}$	$2.18x10^{-4}$	$8.83x10^{-5}$
	60%	4.3%	29%	4.3%	0.02%	1.4%	0.56%
EP (kg N eq)	$1.66x10^{-3}$	$1.25x10^{-4}$	$2.83x10^{-3}$	$1.66x10^{-4}$	$9.12x10^{-5}$	$2.80x10^{-5}$	$1.33x10^{-2}$
	9.1%	0.69%	16%	0.91%	0.50%	0.15%	73%
SFP (kg O_3 eq)	0.115	$1.73x10^{-2}$	$5.01x10^{-2}$	$1.63x10^{-2}$	$9.20x10^{-5}$	$6.18x10^{-3}$	$1.91x10^{-3}$
	55%	8.4%	24%	7.9%	0.04%	3.0%	0.93%
FFD (MJ eq)	10.1	0.185	0.812	0.315	$1.05x10^{-3}$	$7.79x10^{-2}$	$3.25x10^{-2}$
	88%	1.6%	7.1%	2.7%	0.01%	0.68%	0.28%
Resources							
RPR_E (MJ)	0.456	$2.04x10^{-2}$	0.371	$2.49x10^{-2}$	$5.85x10^{-5}$	$1.94x10^{-3}$	$5.52x10^{-3}$
	52%	2.3%	42%	2.8%	0.01%	0.22%	0.63%
RPR_M (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$NRPR_E$ (MJ)	INA	INA	INA	INA	INA	INA	INA
$NRPR_M$ (MJ)	INA	INA	INA	INA	INA	INA	INA
SM (kg)	$4.07x10^{-2}$	0.00	0.00	0.00	0.00	0.00	0.00
	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RSF/NRSF (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
RE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
FW (m^3)	0.141	$1.13x10^{-3}$	$6.23x10^{-2}$	$1.57x10^{-3}$	$6.40x10^{-6}$	$1.66x10^{-4}$	$3.30x10^{-4}$
	68%	0.55%	30%	0.76%	0.00%	0.08%	0.16%
Wastes							
HWD (kg)	$4.68x10^{-6}$	$3.58x10^{-6}$	$5.33x10^{-6}$	$5.87x10^{-6}$	$2.00x10^{-8}$	$1.41x10^{-6}$	$4.45x10^{-7}$
	22%	17%	25%	28%	0.09%	6.6%	2.1%
NHWD (kg)	$4.46x10^{-2}$	$4.79x10^{-2}$	$3.44x10^{-2}$	0.106	$6.25x10^{-3}$	$2.46x10^{-3}$	0.930
	3.8%	4.1%	2.9%	9.0%	0.53%	0.21%	79%
HLRW (kg)	$9.41x10^{-7}$	$9.33x10^{-8}$	$1.23x10^{-5}$	$1.17x10^{-7}$	$2.78x10^{-10}$	$8.58x10^{-9}$	$2.95x10^{-8}$
	7.0%	0.69%	91%	0.87%	0.00%	0.06%	0.22%
ILLRW (kg)	$1.06x10^{-5}$	$8.59x10^{-6}$	$6.46x10^{-5}$	$1.46x10^{-5}$	$4.64x10^{-8}$	$3.68x10^{-6}$	$1.39x10^{-6}$
	10%	8.3%	62%	14%	0.04%	3.6%	1.3%
CRU (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR (kg)	0.00	0.00	0.00	0.00	$1.52x10^{-3}$	0.00	0.00
	0.00%	0.00%	0.00%	0.00%	100%	0.00%	0.00%
MER (kg)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
EE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

6. LCA: Interpretation

The interpretation phase conforms to ISO 14044 with further guidance from the ILCD General Guide for Life Cycle Assessment. The interpretation included the use of evaluation and sensitivity checks to steer the iterative process during the assessment, and a final evaluation including completeness, sensitivity, and consistency checks, at the end of the study.

With the exception of the Global Warming (GWP) and Eutrophication Potential (EP) impact indicators, the contributions to total indicator impacts for the Standard XPS insulation boards are dominated by the raw material extraction and processing stages followed by product manufacturing. Product distribution is generally the next highest contributor while contributions from the remaining life cycle stages are minimal. Both the GWP and EP impacts are dominated by the disposal stage. The release of the standard blowing agents at end-of-life account for over 95% of the overall GWP impacts, while the relatively high EP impacts are due to the decomposition of the waste in a landfill.

With few exceptions, most notably the Eutrophication Potential, the contributions to total indicator impacts for the low-GWP XPS insulation boards are dominated by the raw material extraction and processing stages followed by product manufacturing. Product distribution is generally the next highest contributor while contributions from the remaining life cycle stages are minimal. The benefits of using a low-GWP blowing agent in the XPS insulation boards is clearly evident when evaluating these results, particularly for the Global Warming Potential impacts

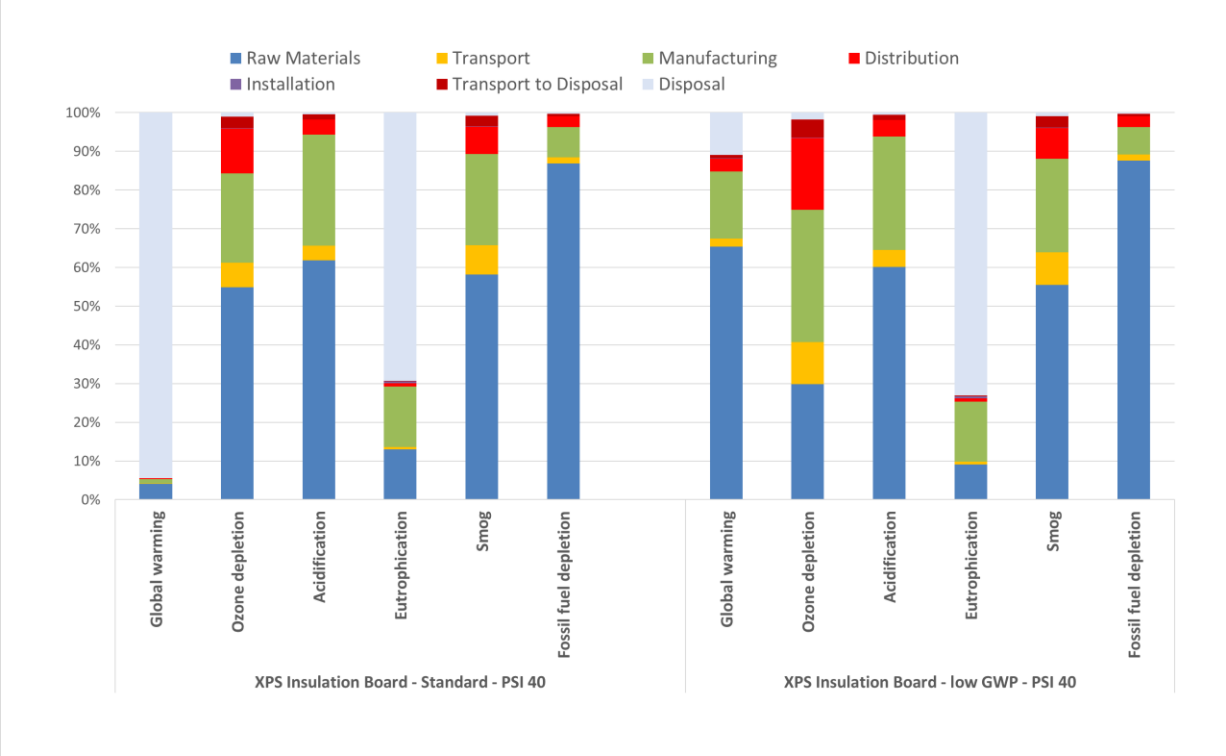


Figure 2. *Contribution analysis for the Kingspan XPS insulation board products – TRACI 2.1.*

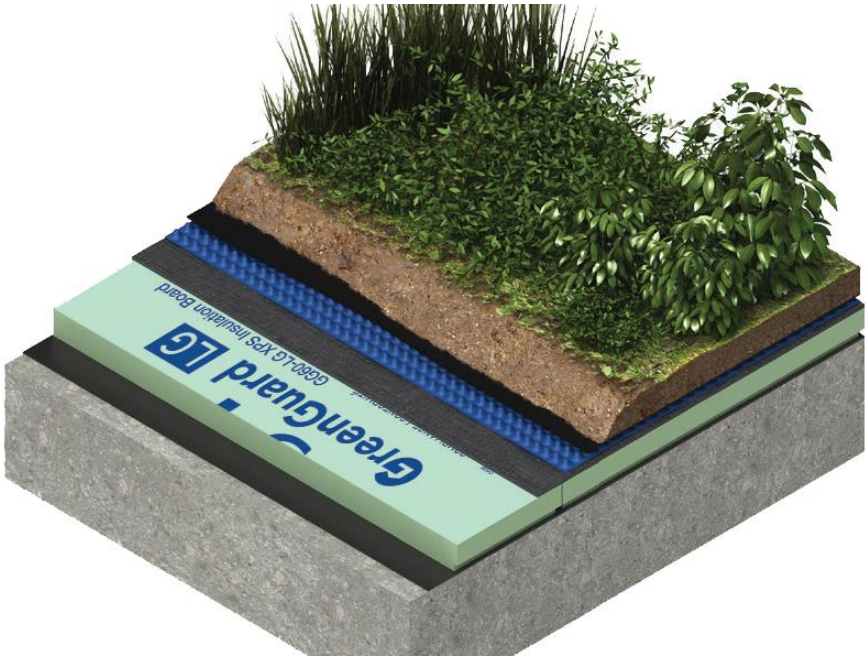
7. Additional Environmental Information

Kingspan understands its impact on the environment, both in terms of the role its products can play in optimizing energy efficiency, and the responsibility the company has with a global footprint of over 159 manufacturing facilities and over 15,000 employees. Kingspan seeks to operate as sustainably as possible throughout its supply chain.

Planet Passionate is Kingspan's ambitious 10-year global sustainability strategy that will impact on three big global issues: climate change, circularity, and protection of our natural world. Through Planet Passionate Kingspan will contribute to the world's renewable energy mix, reduce carbon emissions, divert waste from landfill, conserve water, provide upcycling solutions for plastic waste and help clean the world's oceans and protect biodiversity.

The strategy is made up of 12 ambitious targets, addressing the impact of Kingspan's business operations and manufacturing on the four key areas of energy, carbon, circularity and water, with commitments by 2030 to include:

- Energy: powering 60% of all Kingspan operations directly from renewable energy with a minimum of 20% of this energy generated on manufacturing sites (up from 5.3% today). This will include install solar PV on all wholly owned facilities.
- Carbon: achieving net zero carbon manufacturing and a 50% reduction in product CO2 intensity from primary supply partners.
- Circularity: upcycling of 1 billion PET bottles per annum into insulation products plus zero company waste to landfill across all sites.
- Water: harvesting 100 million liters of Kingspan's water usage from rainwater with a goal of five active ocean clean-up projects by 2025.
- Waste: target of zero company waste sent to landfill.



8. References

1. Life Cycle Assessment of Kingspan Extruded Polystyrene (XPS) Insulation Boards. SCS Global Services Report. Prepared for Kingspan. June 2021.
2. ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
3. ISO 14040: 2006 Environmental Management – Life cycle assessment – Principles and Framework
4. ISO 14044: 2006/AMD 1:2017/ AMD 2:2020 Environmental Management – Life cycle assessment – Requirements and Guidelines.
5. 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
6. PCR Guidance for Building-Related Products and Services Part B: Building Envelope Thermal Insulation EPD Requirements. Version 2.0. April 2018.
7. ISO 21930: 2017 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.
8. SCS Type III Environmental Declaration Program: Program Operator Manual. V10.1 May 2021. SCS Global Services.
9. Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). Dr. Bare, J., https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci
10. Ecoinvent Centre (2020) ecoinvent data from v3.7. Swiss Center for Life Cycle Inventories, Dübendorf, 2020, http://www.ecoinvent.org
11. US EPA. Advancing Sustainable Materials Management:2018 Fact Sheet Assessing Trends in Materials Generation and Management in the United States. November 2020. https://www.epa.gov/sites/production/files/2020-11/documents/2018_ff_fact_sheet.pdf.

For more information, contact:

Kingspan Insulation LLC
2100 Riveredge Parkway, Suite 175
Atlanta, Georgia, USA 30328
1-800-241-4402 | www.kingspaninsulation.us | info@kingspan.us

SCS Global Services
2000 Powell Street, Ste. 600, Emeryville, CA 94608 USA
Main +1.510.452.8000 | fax +1.510.452.8001