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LIFE CYCLE ASSESSMENT (LCA) OF KNAUF INSULATION NORTH AMERICA AND MANSON INSULATION PRODUCTS

Public version

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Author(s)	Jui-Lung Li, Sustainable Minds Kim Hammer, Sustainable Minds

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1 INTRODUCTION

1.1 Opportunity

Knauf Insulation North America (KINA) is committed to the development and commercialization of products and solutions that support the construction industry's transition to a low-energy and sustainable built environment [1]. As part of this commitment, KINA has conducted plant- and product-specific Life Cycle Assessments (LCAs) to evaluate the environmental impacts of selected products throughout their entire life cycle, from raw materials to transportation, manufacturing, and end-of-life.

The objective of the LCA is to identify the full range of environmental impacts of KINA's insulation products, renew their environmental declarations for use in business-to-consumer communications, and identify areas where impacts can be reduced. This project is critical to KINA's commitment to providing the market with the necessary information to evaluate the environmental impacts of their products.

To achieve a comprehensive understanding of the product's impact, KINA has adopted a cradle-to-grave approach in conducting the LCA. This approach ensures that pertinent life cycle stages are included, providing the necessary information to guide impact reduction efforts.

KINA intends to use the LCA results to develop Sustainable Minds Transparency Reports™ (TRs), which are ISO 14025 Type III Environmental Declarations (EPDs) that can be used for communication with other companies, architects, and consumers. Additionally, the TRs can be utilized in whole building LCA tools, in conjunction with the LCA background report and Life Cycle Inventory (LCI). The study aims to comply with the requirements of ISO 14040/14044, ISO 21930 standards, and UL's product category rules (PCRs) for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements, version 4.0, and Part B: Building Envelope Thermal Insulation EPD Requirements v2.0 [2] [3].

KINA has engaged Sustainable Minds, an external practitioner, to develop LCAs for various insulation products. The objective is to communicate environmental information to the market, acquire data for future product improvements, and contribute towards satisfying credits in the Leadership in Energy and Environmental Design (LEED®) building rating system.

1.2 Life cycle assessment (LCA)

This LCA report follows an attributional approach and comprises four key phases:

- Goal and scope definition
- Life cycle inventory analysis
- Life cycle impact assessment
- Interpretation of results

For Type III Environmental Declarations, a critical review of the LCA and an independent verification of the Transparency Reports (TRs) are mandatory. This project includes both.

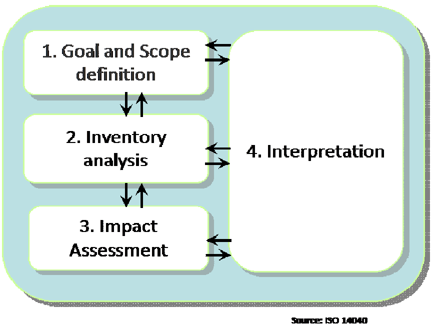


Figure 1. Phases in an LCA

1.3 Status

The information presented in this LCA report is based on the inputs and outputs provided by KINA at the time of data collection, and Sustainable Minds and KINA adhered to best practices in transforming the inventory into this report.

The data used in this report covers the annual manufacturing data for the year 2022 from five of KINA's manufacturing locations: Albion, MI; Inwood, WV; Shelbyville, IN; Lanett, AL; and Shasta Lake, CA, along with secondary data from contracted vendors as well as literature data to complete the inventory and fill gaps as necessary.

In instances where data was not available, assumptions were made based on manufacturing data from KINA's resources and other literature data, and expertise from their employees were utilized to develop estimates or assumptions for other upstream or downstream activities as needed.

The LCA review and verification of the Sustainable Minds Transparency Report / EPD were carried out by Terrie Boguski, Harmony Environmental, LLC, and found to be compliant with ISO 14040/14044 and the relevant PCRs.

1.4 Team

This LCA report is the outcome of the efforts of the project team, led by Gabriela Fleury, Chris Mahin, and Dmitry Liapitch on behalf of KINA, with support from KINA personnel during the data collection, reporting, and interpretation phases. Sustainable Minds led the development of the LCA results, LCA report, and Transparency Reports.

1.5 Structure

The subsequent sections of this LCA report are structured as follows:

Chapter 2: Goal and scope definition
Chapter 3: Life cycle inventory analysis
Chapter 4: Life cycle impact assessment methods
Chapter 5: Results and interpretation

This report incorporates LCA terminology. To facilitate comprehension, special consideration has been given to list definitions of significant terms used at the end of this report.

2 GOAL AND SCOPE

This chapter outlines the objective and scope of the LCA study. The goal and scope establish the boundaries of the analysis and define the level of detail and comprehensiveness of the assessment for the product in question.

2.1 Intended application and audience

This LCA report aims to illustrate the application of the LCA methodology to the life cycle of Knauf Insulation North America (KINA) products. The report serves both internal and external purposes and is intended for a diverse audience. This audience includes the program operator (Sustainable Minds) and reviewer responsible for assessing the LCA for conformance to the PCR, as well as KINA's internal stakeholders in marketing and communications, operations, and design.

The results presented in this document are not meant to support comparative claims. The outcomes will be made available to the public in Sustainable Minds Transparency Reports / EPDs (Type III environmental declaration per ISO 14025), which are intended for communication between businesses and consumers.

2.2 Product description

As a leading manufacturer of fiberglass insulation products with a wealth of experience spanning over 30 years, Knauf Insulation North America is dedicated to promoting sustainability and transparency in its reporting of the cradle-to-grave environmental impacts of its products.

In addition to the KINA-branded products, Manson-branded products are also being evaluated in this study. Table 1 lists the KINA products with their Manson counterparts, which are exactly the same from cradle to grave as their KINA counterparts except for branding (i.e., the way ink is printed on the packaging).

Table 1. KINA product names with Manson counterparts

KINA brand name	Manson brand name
Atmosphere™ Duct Liner	AKOUSTI-LINER™
Black Acoustical Board	Akousti-Board Black™
Earthwool® Insulation Board	AK BOARD™
Wall and Ceiling Liner	AKOUSTI-SHIELD™

The products studied in this report are listed and visually represented in Table 2a and Table 2b with their facing options specified where applicable. All products in this report have previously been studied as part of an LCA. The declaration names with products represented, type of declaration, and manufacturing locations for each product are listed in Table 3. Other product information such as applicable standards and product application descriptions are included in Table 4. The study conducts LCAs for KINA's individual products produced at different manufacturing plants products so as to develop plant- and product-specific SM Transparency Reports / EPDs™.

This study grouped products into declarations depending on their similarities and how they are marketed:

- For EcoBatt® Insulation, facing options differed in at least one environmental impact indicator by more than 10%; therefore, they were not combined as an average. However, the EcoRoll® Insulation unfaced and kraft-faced options only differ from their EcoBatt® Insulation counterparts in that they are rolled instead of being cut into batts. Therefore, EcoBatt® and EcoRoll® Insulation products have very low variation, and the unfaced and kraft-faced versions of each are considered to be the same product for the purposes of this study.

- Wall and Ceiling Liner and Atmosphere™ Duct Liner are similar products but are marketed for different applications; therefore, they were not combined as an average.
- Earthwool® Insulation Board and AK BOARD™ faced products differed in at least one environmental impact indicator by more than 10%; therefore, they were not combined as an average.

Table 2a. Product names, visual representations, facing options and product dimensions

Product name	Product image	Facing options	Previous LCA	Dimensions/quantities of declared product delivered to installation site
EcoBatt® Insulation	 Kraft facing option shown	Unfaced Kraft FSK Foil	Yes Yes Yes Yes	EcoBatt® is sold in batts. One master bag contains 5 plastic bags, and each bag contains 10 to 12 pieces of EcoBatt® batts. The dimensions of each EcoBatt® batt are 3½" thick, 15" – 16" in width, and 93' – 96' in length.
EcoRoll® Insulation	 Kraft facing option shown	Unfaced Kraft	Yes Yes	EcoRoll® is sold in rolls. One master bag contains 6 plastic bags, and each bag contains 1 roll of EcoRoll. The dimensions of each EcoRoll® are 3½" thick, 15" in width, and 32' – 62.67' in length.
JetSpray™ Thermal Spray-On Insulation System		N/A	Yes	JetSpray™ is sold in bags. One master bag contains 42 plastic bags, and each bag weighs 32 pounds.
Jet Stream® Ultra Blowing Wool Insulation		N/A	Yes	Jet Stream® is sold in bags. One master bag contains 42 plastic bags, and each bag weighs 32 pounds.
Wall and Ceiling Liner / AKOUSTI-SHIELD™		N/A	Yes	Wall and Ceiling Liner / AKOUSTI-SHIELD™ is sold in rolls. One master bag contains 4 plastic bags, and each bag contains 1 roll of the product. The dimensions for the product are 1" – 2" thick, 48" in width, and 50' – 100' in length.

Table 2.b Product names, visual representations, acing options and product dimensions

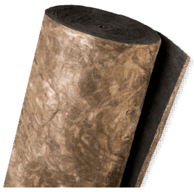
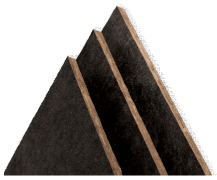
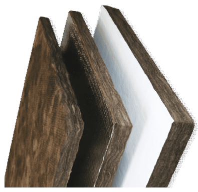
Product name	Product image	Facing options	Previous LCA	Dimension /quantities of the declared delivered to the site of installation
Atmosphere™ Duct Liner / AKOUSTI-LINER™		N/A	Yes	Atmosphere™ Duct Liner / AKOUSTI-LINER™ is sold in rolls. One master bag contains 4 plastic bags, and each bag contains 1 roll of the product. The dimensions for the product are 1" – 2" thick, 48" – 59" in width, and 50' – 100' in length.
KN Series Insulation		N/A	Yes	KN Series Insulation is sold in rolls. One master bag contains 4 plastic bags, and each bag contains 1 roll of the product. The dimensions for the product are 3" thick, 60" in width, and 70.25' in length.
Acoustical Smooth Board		N/A	Yes	Acoustical Smooth Board is sold in sheets. One set of sheets contains 42 pieces of the product separated by cardboard sheets, protected by cardboard corner protectors and wrapped in stretch wrap. The dimensions for each piece of the product are 1" thick, 49" in width, and 97" in length.
Black Acoustical Board / Akousti-Board Black™		N/A	Yes	Black Acoustical Board / Akousti-Board Black™ is sold in sheets. One set of sheets contains 24 pieces of the product separated by cardboard sheets, protected by cardboard corner protectors and wrapped in stretch wrap. The dimensions for each piece of the product are 2" thick, 49" in width, and 96" in length.
Earthwool® Insulation Board / AK BOARD™	 All facing options shown	Unfaced	Yes	Earthwool® Insulation Board / AK BOARD™ is sold in sheets. One carton contains eight pieces wrapped in stretch wrap. The dimensions for each roll of the product are 1.5" – 2" thick, 24" in width, and 48" in length.
		ASJ+	Yes	
		FSK	Yes	

Table 3. Declaration names with products represented, type of declaration, and manufacturing locations

TR #	Transparency Report name	Product name(s)	Type of declaration
1	EcoBatt® and EcoRoll® Insulation	EcoBatt® and EcoRoll® Insulation unfaced EcoBatt® and EcoRoll® Insulation kraft-faced EcoBatt® Insulation FSK-faced EcoBatt® Insulation foil-faced	Four specific products from five of the manufacturer's plants: Albion, MI; Inwood, WV; Lanett, AL; Shasta Lake, CA; Shelbyville, IN
2	JetSpray™ Thermal Spray-On Insulation System	JetSpray™ Thermal Spray-On Insulation System	A specific product from a manufacturer's plant: Albion, MI
3	Jet Stream® Ultra Blowing Wool Insulation	Jet Stream® Ultra Blowing Wool Insulation	A specific product from four of the manufacturer's plants: Albion, MI; Lanett, AL; Shasta Lake, CA; Shelbyville, IN
4	Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™	Wall and Ceiling Liner / AKOUSTI-SHIELD™ Atmosphere™ Duct Liner / AKOUSTI-LINER™	Two specific products from a manufacturer's plant: Shelbyville, IN
5	KN Series Insulation	KN Series Insulation	A specific product from two of the manufacturer's plants: Lanett, AL; Shelbyville, IN
6	Acoustical Smooth Board	Acoustical Smooth Board	A specific product from a manufacturer's plant: Shelbyville, IN
7	Black Acoustical Board / Akousti-Board Black™	Black Acoustical Board / Akousti-Board Black™	A specific product from a manufacturer's plant: Shelbyville, IN
8	Earthwool® Insulation Board / AK BOARD™	Earthwool® Insulation Board / AK BOARD™ unfaced Earthwool® Insulation Board / AK BOARD™ ASJ+-faced Earthwool® Insulation Board / AK BOARD™ FSK-faced	Three specific products from a manufacturer's plant: Shelbyville, IN

Table 4. Other product information

Transparency Report name	CSI MasterFormat® classification	Application	ASTM or ANSI product specification	Material ingredient disclosure[1]
EcoBatt® and EcoRoll® Insulation	07 21 00	Thermal and acoustical barriers for energy-efficient construction. They can be used in new and retrofit wood and metal frame applications in residential and commercial structures, as well as in manufactured housing. These applications include thermal and acoustical treatments to walls, ceilings, and floors.	• ASTM C 665; Type 1, Class A (unfaced) • ASTM C 665; Type II, Class C (kraft faced) • ASTM C 665; Type III, Class A (FSK-25 foil faced) • ASTM C 665; Type III, Class B (foil faced)	• Declare Label o KNF-0033 o KNF-0009 o KNF-0010 • HPD v2.2 o 25164
JetSpray™ Thermal Spray-On Insulation System	07 21 29	Spray-on insulation system installed using a blowing wool machine and water pump, used to activate the powdered adhesive. It is sprayed onto exterior and interior cavity walls for thermal and acoustical performance.	• ASTM C1014	• Declare Label o KNF-0031
Jet Stream® Ultra Blowing Wool Insulation	07 21 26	At the installation site, loose fill is installed using a blowing wool machine and blown into open attics or closed cavities. It can be used to dense-pack sidewalls using the drill and fill technique common in retrofitting homes or in home weatherization activities.	• ASTM C764; Type I	• Declare Label o KNF-0007
Wall and Ceiling Liner & Atmosphere™ Duct Liner	07 21 00	Specifically designed for sheet metal ducts used in heating, ventilating, and air conditioning. It provides an optimum combination of efficient sound absorption, low thermal conductivity, and minimal airstream surface friction. Wall & Ceiling Liner is designed for use as an acoustical and visual barrier for walls and ceilings where a black surface is required. It is primarily used in theaters, sound studios, public concourses and other areas where acoustical treatment is needed.	• ASTM C1071; Type I • ASTM C 665	• HPD v2.2 o 27770
AKOUSTI-SHIELD™ & AKOUSTI-LINER™	07 21 00	Specifically designed for sheet metal ducts used in heating, ventilating, and air conditioning. It provides an optimum combination of efficient sound absorption, low thermal conductivity, and minimal airstream surface friction. Wall & Ceiling Liner is designed for use as an acoustical and visual barrier for walls and ceilings where a black surface is required. It is primarily used in theaters,	• ASTM C1071; Type I • ASTM C 665	• HPD v2.2 o 27770

[1]For more information on the material ingredient disclosure programs, visit the International Living Future Institute to read about Declare, and visit the Health Product Declaration Collaborative (HPDC) to read about HPDs.

		sound studios, public concourses and other areas where acoustical treatment is needed.		
KN Series Insulation	07 21 00	KN Series Insulation is used as thermal and/or acoustical insulation in the appliance, equipment, industrial, commercial, and marine markets. KN Series Insulation has been successfully used as a Red List free and formaldehyde-free core in double wall duct systems.	• ASTM C 1139 - unfaced; Type I, Type II; Grade 1 - 0.75 lb/ft3; Grade 2 - 1.0 lb/ft3; Grade 3 - 1.5 lb/ft3 (Duct Wrap) • ASTM C 553; Type I, II, III (Duct wrap) • ASTM C553: Type I, Type II (KN Utility Insulation)	• HPD v2.3 o 2745898471424 • Declare Label o KNF-0013 o KNF-0038
Acoustical Smooth Board	07 21 13	Acoustical Smooth Board is a versatile product fitting for a variety of acoustical applications such as office partitions, interior panels, and sound baffles.	• ASTM C612; Type IA and Type IB	• Declare Label o KNF-0032
Black Acoustical Board	07 21 13	Designed for use as acoustical insulation and/or a visual barrier on walls and ceilings, where system design requires a rigid product and where additional strength and abuse resistance are required. The black surface provides a visual barrier with an aesthetic appearance, in both wall and ceiling applications.	• ASTM C612; Type IA and Type IB	• Declare Label o KNF-0029
Akousti-Board Black™	07 21 13	Designed for use as acoustical insulation and/or a visual barrier on walls and ceilings, where system design requires a rigid product and where additional strength and abuse resistance are required. The black surface provides a visual barrier with an aesthetic appearance, in both wall and ceiling applications.	• ASTM C612; Type IA and Type IB	• Declare Label o KNF-0029
Earthwool® Insulation Board	07 21 13	Versatile product for thermal and acoustical applications such as: heating & air conditioning ducts, power and process equipment, boiler and stack installations, metal and masonry walls, wall and roof panel systems, curtain wall assemblies, and cavity walls.	• ASTM C612: Type IA (1.6, 2.25, 3.0, 4.25, 6.0 pcf), Type IB (3.0, 4.25, 6.0 pcf) • ASTM C795 • ASTM C1136: Type I, II, III, IV, VIII (ASJ+), Type II, IV (FSK)	• HPD v2.2 o 23750 • HPD v2.3 o 5654780077056 o 1604007936
AK BOARD™	07 21 13	Versatile product for thermal and acoustical applications such as: heating and air conditioning ducts, power & process equipment, boiler and stack installations, metal and masonry walls, wall and roof panel systems, curtain wall assemblies, and cavity walls.	• ASTM C612: Type IA (1.6, 2.25, 3.0, 4.25, 6.0 pcf), Type IB (3.0, 4.25, 6.0 pcf) • ASTM C795 • ASTM C1136: Type I, II, III, IV, VIII (ASJ+), Type II, IV (FSK)	• HPD v2.2 o 23750 • HPD v2.3 o 5654780077056 • 1604007936

2.3 Functional unit

The results of the LCA are expressed in terms of a functional unit, as it covers the entire life cycle of the products. Per the PCR [3], the functional unit is:

> 1 m^2 of installed insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 $m^2 \cdot K/W$ and with a building service life of 75 years (packaging included)

Building envelope thermal insulation is assumed to have a reference service life equal to that of the building [4] when installed per manufacturer's instructions [5], which in this case is 75 years [3]. Therefore, the insulation does not need to be replaced, and 1 m^2 of insulation plus facing and packaging is required to fulfill the functional unit. This reference service life applies for the reference in-use conditions only.

Reference flows express the mass of product required to fulfill the unit and are calculated based on the nominal insulation density for the R-value (ASTM C518) closest to R_{SI} = 1 $m^2 \cdot K/W$, which varies for each product. Reference flows are listed in Table 5.

Table 5. Reference flows

Product	Facing options	Unfaced product (kg)	Adhered facing (kg)	Packaging (kg)	Reference flow total (kg)	Thickness (m)
EcoBatt® and EcoRoll® Insulation	Unfaced	[redacted]	[redacted]	[redacted]	0.546	0.0398
	Kraft		[redacted]		0.632	
	FSK		[redacted]		0.668	
	Foil		[redacted]		0.644	
JetSpray™ Thermal Spray-On Insulation System	N/A	[redacted]	N/A	[redacted]	0.872	0.0357
Jet Stream® Ultra Blowing Wool Insulation	N/A	[redacted]	N/A	[redacted]	0.176	0.0664
Wall and Ceiling Liner / AKOUSTI-SHIELD™	N/A	[redacted]	[redacted]	[redacted]	0.992	0.0356
Atmosphere™ Duct Liner / AKOUSTI-LINER™	N/A	[redacted]	[redacted]	[redacted]	1.072	0.0353
KN Series Insulation	N/A	[redacted]	N/A	[redacted]	0.806	0.0370
Acoustical Smooth Board	N/A	[redacted]	N/A	[redacted]	3.56	0.0320
Black Acoustical Board / Akousti-Board Black™	N/A	[redacted]	[redacted]	[redacted]	1.65	0.0325
Earthwool® Insulation Board / AK BOARD™	Unfaced	[redacted]	[redacted]	[redacted]	2.04	0.0330
	ASJ+	[redacted]	[redacted]	[redacted]	2.30	
	FSK	[redacted]	[redacted]	[redacted]	2.19	

2.4 System boundaries

This section describes the system boundaries for the modeled products. The system boundaries define which life cycle stages are included and which are excluded. Building operational energy and water use are considered outside of this study's scope; any impact the use of insulation may have on a building's energy consumption or water usage is not calculated nor incorporated into this analysis.

This LCA's system boundary include the following life cycle stages:

I. **A1-A5**
   - Raw materials acquisition, transportation, processing, and fabrication
   - Distribution and installation

II. **B1-B7**
   - Use

III. **C1-C4**
   - Disposal/reuse/recycling

These boundaries apply to the modeled products and can be referred to as a "cradle-to-grave" approach. These boundaries apply to the modeled products and can be referred to as "cradle-to-grave" which means that it includes all life cycle stages and modules as identified in the PCR [3]. The life cycle includes all industrial processes from raw material acquisition and pre-processing, production, product distribution, use and maintenance, and end-of-life management. Figure 2 represents the life cycle stages for the entire life cycle of these products. Table 6 lists specific inclusions and exclusions for the system boundary.

Scope	PRODUCTION STAGE			CONSTRUC-TION STAGE		USE STAGE					END-OF-LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY	Reference Service Life
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D	
	Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction/Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste	Reuse, Recovery, Recycling Potential	
						B6 Operational energy use										
						B7 Operational water use										
Cradle to grave	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND	75 years

Figure 2. Applied system boundaries for the modeled insulation products

Table 6. System boundary inclusions and exclusions

Included	Excluded
• Raw material acquisition and pre-processing • Processing of materials • Melting energy • Energy production • Transport of raw materials • Outbound transportation of products • Overhead energy (heating, lighting, forming, finishing, etc.) of manufacturing facilities, where separated data were not available • Packaging of final products • Installation and maintenance, including material loss, energy use, and auxiliary material requirements • End-of-life, including transportation	• Construction of capital equipment • Maintenance and operation of support equipment • Human labor and employee transport • Manufacture, transport, and disposal of packaging materials not associated with final product • Building operational water use not associated with final product

2.4.1. A1-A3: Raw materials acquisition, transportation, and manufacturing

Raw materials acquisition and transportation (A1-A2) The product stage includes, where relevant, the following processes:

- Extraction and processing of raw materials
- Average transport of raw materials from extraction/production to manufacturer
- Processing of recycled materials
- Transport of recycled/used materials to manufacturer

A description of the most important modeling parameters is included below.

Manufacturing (A3) The manufacturing stage includes the following:

- Manufacturing of building envelope thermal insulation products
- Packaging
- Releases to environmental media (air, soil, ground and surface water)
- Manufacturing waste

Some overhead energy was included in the system boundary, as operational energy data were not able to be separated for each of the sites.

2.4.2. A4-A5: Distribution and installation

Distribution (A4) The distribution stage includes the following:

- Transportation of building envelope thermal insulation products from manufacturer to distributor/building site
- Transportation of building envelope thermal insulation products from distributor to building site, if applicable

Installation (A5) The installation stage includes the following:
- Installation in the building including materials specifically required for installation
- Construction waste
- The reference service life of the building is defined as 75 years for building envelope thermal insulation, and the number of replacements of the insulation products will be declared accordingly. The number of replacements shall be calculated by dividing the reference service life of the building by the product service life, as defined by the manufacturer's specifications.
- Installation waste

2.4.3. B1-B7: Use

The use stage includes:
- Product use
- Maintenance
- Repair
- Replacement
- Refurbishment
- Operational energy use
- Operational water use

Use stage environmental benefits of insulation during building operations can be significant as low thermal conductivity and air sealing attributes of insulation limit utility consumption and associated environmental impacts. During its service life, insulation significantly reduces the energy use in a building, thereby reducing the impact on the environment. The exclusion of the building heating and cooling during the insulation material's use phase severely underestimates the benefits that insulation has on the environment.

2.4.4. C1-C4: Disposal/reuse/recycling

The end-of-life stage begins when the used product is ready for disposal, recycling, reuse, etc., and ends when the product is landfilled, returned to nature, or transformed to be recycled or reused. Processes that occur because of the disposal are also included within the end-of-life stage.

When insulation is done being used, it is collected as construction and demolition waste.

The following life cycle stages are used to describe the end-of-life processes.

Deconstruction (C1) The deconstruction stage includes dismantling/demolition.

Transport (C2) The transport stage includes transport from building site to final disposition.

Waste processing (C3) The waste processing stage includes processing required before final disposition.

Disposal (C4) The disposal stage includes final disposition (e.g., recycling, reuse, landfill, waste incineration, or conversion to energy).

2.4.5. D: Benefits and loads beyond the system boundary

This study does not account for benefits and loads beyond the system boundary.

3 INVENTORY ANALYSIS

This chapter includes an overview of the obtained data and data quality that has been used in this study. Complete life cycle inventory calculation workbooks, which catalogue the flows crossing the system boundary and provide the starting point for life cycle impact assessment, can be found in the appendix.

3.1 Data collection

Data used for this project represents a mix of primary data collected from KINA on the production of the insulation products (gate-to-gate) and background data from the LCA for Experts (formerly known as GaBi) 2023 databases. Overall, the quality of the data used in this study is considered to be high and representative of the described systems. All appropriate means were employed to guarantee the data quality and representativeness as described below.

- **Gate-to-gate:** Data on processing materials and manufacturing the insulation products were collected in a consistent manner and level of detail to ensure high quality data. All submitted data were checked for quality multiple times on the plausibility of inputs and outputs. All questions regarding data were resolved with KINA. Data were collected from five of their facilities. Inventory calculations were developed by an analyst at Sustainable Minds and reviewed internally.

- **Background data:** All data from the LCA for Experts 2023 databases were created with consistent system boundaries and upstream data. Expert judgment and advice was used in selecting appropriate datasets to model the materials and energy for this study and have been noted in the following sections. Detailed database documentation for the LCA for Experts datasets can be accessed at https://sphera.com/product-sustainability-gabi-data-search/.

This LCA utilized primary data provided by KINA. The data were thoroughly reviewed upon receipt to ensure their completeness and plausibility through various methods, including mass balance, stoichiometry, and benchmarking. In the case of any gaps, outliers, or other inconsistencies, Sustainable Minds engaged in productive discussions with KINA to address and resolve any open issues in a timely and efficient manner.

3.2 Primary data

Loose fill fiberglass insulation such as Jet Stream® is produced in several manufacturing steps that involve melting the glass materials and forming the fibers. In the case of JetSpray™, an adhesive is added during the fiber forming stage. The other insulation products represented in this study are produced in several manufacturing steps that involve melting the glass materials, forming the fibers, and shaping them into the final products; for these products, binder is added to hold the glass fibers together.

The finished products are then distributed to construction sites where they are installed, and the packaging is discarded. Building envelope thermal insulation has a 75-year reference service life, equal to that of the building. At the end of life, the insulation is removed and disposed of in a landfill. The flow charts in Figures 3 illustrate the life cycle of Jet Stream® and JetSpray™, and the flow chart in Figure 4 illustrates the life cycle of the other fiberglass insulation products in this study.

Data used in this analysis represents insulation production at KINA. All available thicknesses and R-values are included for each product. Results were then scaled to reflect the functional unit.

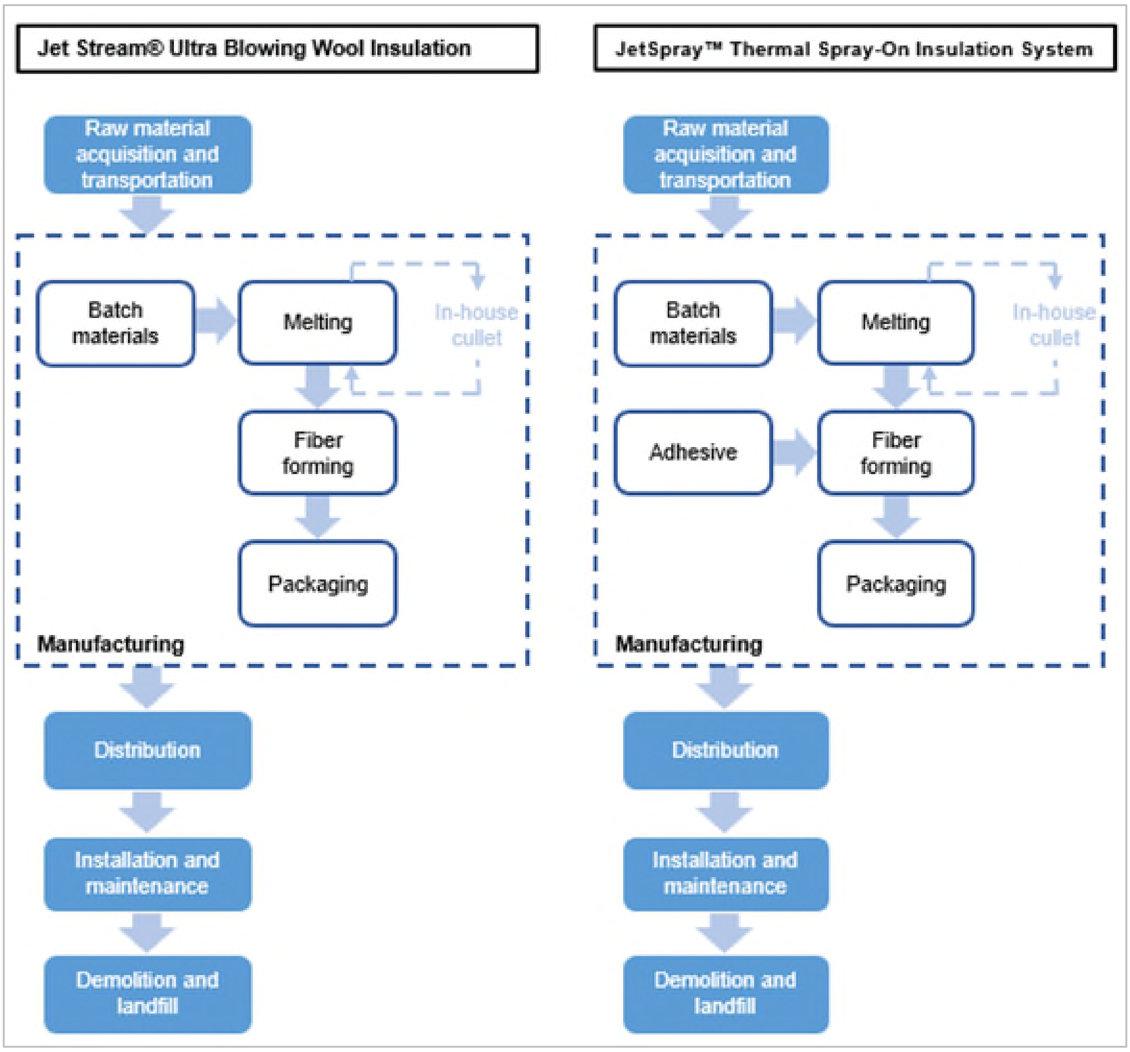


Figure 3. Life cycle flow chart of Jet Stream® and JetSpray™ production

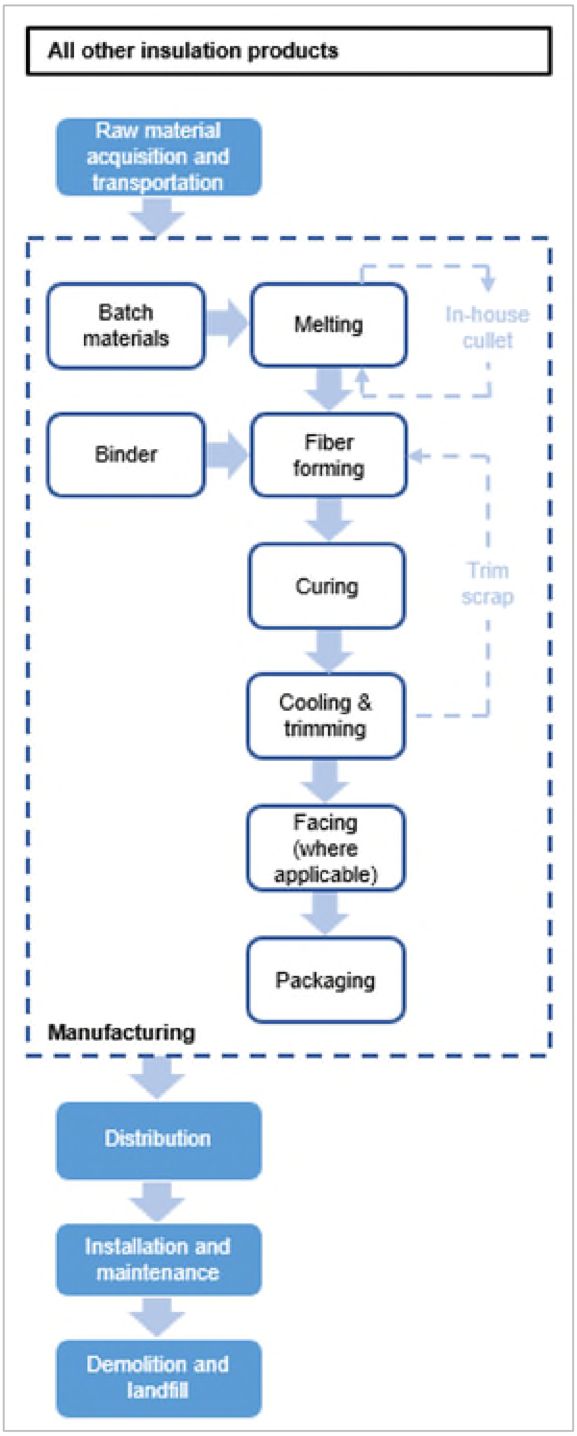


Figure 4. Life cycle flow chart of the production of other insulation products

3.2.1. Raw materials acquisition and transportation (A1-A2)

Glass fibers are made from various inorganic minerals, which make up the batch. The primary materials used in the batch are recycled plate cullet, recycled bottle cullet, and internally recycled cullet. In 2022, across all five plants included in this study, KINA used over 400,000 tons of recycled plate and bottle cullet in its batch. The binder consists of both renewable and non-renewable organic chemicals. Some insulation products are faced with kraft, FSK, foil, or ASJ+ faced options.

Raw materials are transported to KINA's facilities. Tables 7-25 show the raw material inputs for each product. As indicated in the tables, KINA uses both in-house and post-consumer plate and bottle cullet in its batch. Internal cullet represents glass that is recycled internally, whereas KINA obtains post-consumer cullet from external sources. This cullet is assumed to arrive at KINA burden-free aside from the transportation necessary to deliver it to KINA's facilities. Like a number of fiberglass manufacturers, KINA has been actively working to remove phenol formaldehyde from its products and currently uses a bio-based formulation in many of its binders.

The halogenated flame retardants in the FSK and ASJ+ facer materials contain hazardous substances according to the standards or regulations of the Resource Conservation and Recovery Act (RCRA), Subtitle C. These substances are listed in the raw material inputs. Once installed, the insulation products do not release dangerous, regulated substances that affect health and environment, including indoor air emissions, gamma or ionizing radiation emissions, or chemicals released to the air or leached to water and soil.

Raw materials are transported to KINA's facilities via rail, truck and trailer, and ocean freighter. Transport data were collected for each flow and are shown for transportation to each facility. All ingredients for each facing option were modeled.

Table 7. EcoBatt® and EcoRoll® unfaced insulation raw material and packaging inputs

Part	Material	Mass %, Albion	Mass %, Inwood	Mass %, Lanett	Mass %, Shasta Lake	Mass %, Shelbyville
Batch	Cullet	45-50%	35-40%	25-30%	40-45%	45-50%
Batch	Sand	-	10-15%	10-15%	8-10%	8-10%
Batch	Borates	8-10%	5-8%	5-8%	5-8%	5-8%
Batch	Soda ash	2-5%	5-8%	8-10%	2-5%	2-5%
Batch	Feldspar	2-5%	2-5%	5-8%	-	1-2%
Batch	Limestone	<1%	2-5%	5-8%	2-5%	2-5%
Batch	Oxides	<1%	<1%	-	<1%	<1%
Binder	Water	10-15%	10-15%	10-15%	10-15%	10-15%
Binder	Sugars	2-5%	2-5%	2-5%	2-5%	2-5%
Binder	Additives	2-5%	2-5%	2-5%	2-5%	2-5%
Packaging	Plastic	8-10%	8-10%	8-10%	8-10%	8-10%

Table 8. Kraft facing raw material inputs

Flow	Mass %
[redacted]	[redacted]
[redacted]	[redacted]

Table 9. EcoBatt® and EcoRoll® kraft-faced insulation raw material inputs

Flow	Mass % (same across all locations)
Unfaced packaged EcoBatt® and EcoRoll® (see Table 7)	85-90%
Kraft facing (see Table 8)	10-15%

Table 10. FSK facing raw material inputs

Flow	Mass %
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table 11. EcoBatt® FSK-faced insulation raw material inputs

Flow	Mass % (same across all locations)
Unfaced packaged EcoBatt® and EcoRoll® (see Table 7)	80-85%
FSK facing (see Table 10)	15-20%

Table 12. Foil facing raw material inputs

Flow	Mass %
[redacted]	[redacted]
[redacted]	[redacted]

Table 13. EcoBatt® foil-faced insulation raw material inputs

Flow	Mass % (same across all locations)
Unfaced packaged EcoBatt® and EcoRoll® (see Table 7)	80-85%
Foil facing (see Table 12)	15-20%

Table 14. JetSpray™ Thermal Spray-On Insulation System raw material and packaging inputs

Part	Material	Mass %, Albion
Batch	Cullet	60-70%
Batch	Borates	10-15%
Batch	Soda ash	5-8%
Batch	Feldspar	5-8%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Additives	Oils	<1%
Additives	Others	2-5%
Packaging	Plastic	1-2%

Table 15. Jet Stream® Ultra Blowing Wool Insulation raw material and packaging inputs

Part	Material	Mass %, Albion	Mass %, Lanett	Mass %, Shasta Lake	Mass %, Shelbyville
Batch	Cullet	60-70%	35-40%	60-70%	60-70%
Batch	Sand	-	20-25%	10-15%	10-15%
Batch	Borates	10-15%	10-15%	10-15%	5-8%
Batch	Soda ash	5-8%	10-15%	5-8%	5-8%
Batch	Feldspar	5-8%	5-8%		2-5%
Batch	Limestone	1-2%	8-10%	2-5%	2-5%
Batch	Oxides	<1%		<1%	<1%
Additives	Oils	1-2%	1-2%	1-2%	1-2%
Additives	Others	<1%	<1%	<1%	<1%
Packaging	Plastic	1-2%	1-2%	1-2%	1-2%

Table 16. Black mat facing raw material inputs

Flow	Mass %
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table 17. Wall and Ceiling Liner / AKOUSTI-SHIELD™ raw material and packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	25-30%
Batch	Sand	2-5%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	20-25%
Binder	Sugars	10-15%
Binder	Additives	8-10%
Facer	Black mat facer	10-15%
Packaging	Plastic	<1%
Packaging	Cardboard	1-2%

Table 18. Atmosphere™ Duct Liner / AKOUSTI-LINER™ raw material and packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	25-30%
Batch	Sand	2-5%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	20-25%
Binder	Sugars	10-15%
Binder	Additives	8-10%
Facer	Black mat facer	8-10%
Packaging	Plastic	1-2%
Packaging	Cardboard	1-2%

Table 19. KN Series insulation raw material and packaging inputs

Part	Material	Mass %, Lanett	Mass %, Shelbyville
Batch	Cullet	25-30%	45-50%
Batch	Sand	15-20%	8-10%
Batch	Borates	5-8%	5-8%
Batch	Soda ash	8-10%	2-5%
Batch	Feldspar	5-8%	2-5%
Batch	Limestone	5-8%	2-5%
Batch	Oxides	-	<1%
Binder	Water	15-20%	15-20%
Binder	Sugars	5-8%	5-8%
Binder	Additives	2-5%	2-5%
Packaging	Plastic	2-5%	2-5%

Table 20. Acoustical Smooth Board raw material and packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	25-30%
Batch	Sand	2-5%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	20-25%
Binder	Sugars	15-20%
Binder	Additives	2-5%
Packaging	Plastic	<1%
Packaging	Cardboard	10-15%

Table 21. Black Acoustical Board / Akousti-Board Black™ raw material and packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	30-35%
Batch	Sand	5-8%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	20-25%
Binder	Sugars	10-15%
Binder	Additives	2-5%
Facer	Black mat facer	5-8%
Packaging	Plastic	<1%
Packaging	Cardboard	2-5%

Table 22. Earthwool® Insulation Board / AK BOARD™ unfaced raw material & packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	30-35%
Batch	Sand	5-8%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	15-20%
Binder	Sugars	10-15%
Binder	Additives	2-5%
Packaging	Plastic	<1%
Packaging	Cardboard	15-20%

Table 23. Earthwool® Insulation Board / AK BOARD™ FSK-faced raw material and packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	30-35%
Batch	Sand	5-8%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	15-20%
Binder	Sugars	10-15%
Binder	Additives	2-5%
Facer	FSK facer	8-10%
Packaging	Plastic	<1%
Packaging	Cardboard	15-20%

Table 24. ASJ+ facing raw material inputs

Flow	Mass %
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table 25. Earthwool® Insulation Board / AK BOARD™ ASJ+-faced raw material and packaging inputs

Part	Material	Mass %, Shelbyville
Batch	Cullet	25-30%
Batch	Sand	2-5%
Batch	Borates	2-5%
Batch	Soda ash	2-5%
Batch	Feldspar	1-2%
Batch	Limestone	1-2%
Batch	Oxides	<1%
Binder	Water	15-20%
Binder	Sugars	8-10%
Binder	Additives	2-5%
Facer	ASJ+ facer	10-15%
Packaging	Plastic	<1%
Packaging	Cardboard	15-20%

3.2.2. Manufacturing (A3)

Upon transporting the batch materials to KINA's facilities, they undergo a melting process in a furnace. During this phase, a fusion loss in glass takes place, resulting in approximately a 90% yield. The melted glass is then transferred to a fiberizer that transforms the melt into glass fibers. As they are formed, the fibers are sprayed with additives. For Jet Stream®, de-dusting and anti-static agents are added to reduce dust formed and clumping. For JetSpray™, an adhesive is also added at this stage. These loose fill products are then packaged and shipped to the construction site. For all other insulation products in this study, a binder is added after the fiberizing process that acts as an adhesive to hold the fibers together, and the products are compressed into continuous "rolls".

These rolls are sent through a curing oven and subsequently cooled and trimmed to size. Post-curing, the exterior is sanded to ensure a smooth surface for facing application. The facing for faced products is applied prior to packaging the insulation, which is then shipped to various distribution centers or job sites.

Manufacturing inputs and outputs are shown in Tables 26-34. There are no additional manufacturing impacts associated with the addition of facing; therefore, results are presented independently of facing type. Water in the manufacturing stage is used to quench fibers during fiberizing and to dilute the binder when spraying it onto the fibers. The majority of water consumed is evaporated in the curing oven for products which are cured. Emissions associated with the production of electricity and the combustion of natural gas are accounted for in the LCA for Experts background processes. Stack emissions for carbon monoxide, NOx, and total particulate matter were provided based on KINA's annual report to the Indiana Department of Environmental Management. Carbon dioxide emissions from heating the batch were calculated using the emission factors for decomp products (see section 3.5.5 for more details).

Table 26. EcoBatt® and EcoRoll® insulation annual manufacturing inputs and outputs

	Flow	**Amount, Albion**	**Amount, Inwood**	**Amount, Lanett**	**Amount, Shasta Lake**	**Amount, Shelbyville**	**Unit**
Inputs	Electricity	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	MJ
	Natural gas	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	MJ
	Water	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	m^3
Outputs	Packaged product, including faced & unfaced	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Scrap	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Total particulate	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg
	NOx	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg
	SOx	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Carbon monoxide	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Carbon dioxide	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	kg

Table 27. JetSpray™ Thermal Spray-On Insulation System annual manufacturing inputs and outputs

	Flow	**Amount, Albion**	**Unit**
Inputs	Electricity	[redacted]	MJ
	Natural gas	[redacted]	MJ
	Water	[redacted]	m^3
Outputs	Packaged product	[redacted]	kg
	Scrap	[redacted]	kg
	Total particulate	[redacted]	kg
	NOx	[redacted]	kg
	SOx	[redacted]	kg
	Carbon monoxide	[redacted]	kg
	Carbon dioxide	[redacted]	kg

Table 28. Jet Stream® Ultra Blowing Wool Insulation annual manufacturing inputs and outputs

	Flow	Amount, Albion	Amount, Lanett	Amount, Shasta Lake	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	[redacted]	[redacted]	[redacted]	MJ
	Natural gas	[redacted]	[redacted]	[redacted]	[redacted]	MJ
	Water	[redacted]	[redacted]	[redacted]	[redacted]	m^3
Outputs	Packaged product	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Scrap	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Total particulate	[redacted]	[redacted]	[redacted]	[redacted]	kg
	NOx	[redacted]	[redacted]	[redacted]	[redacted]	kg
	SOx	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Carbon monoxide	[redacted]	[redacted]	[redacted]	[redacted]	kg
	Carbon dioxide	[redacted]	[redacted]	[redacted]	[redacted]	kg

Table 29. Wall and Ceiling Liner / AKOUSTI-SHIELD™ annual manufacturing inputs and outputs

	Flow	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	MJ
	Natural gas	[redacted]	MJ
	Water	[redacted]	m^3
Outputs	Packaged product	[redacted]	kg
	Scrap	[redacted]	kg
	Total particulate	[redacted]	kg
	NOx	[redacted]	kg
	SOx	[redacted]	kg
	Carbon monoxide	[redacted]	kg
	Carbon dioxide	[redacted]	kg

Table 30. Atmosphere™ Duct Liner / AKOUSTI-LINER™ annual manufacturing inputs and outputs

	Flow	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	MJ
	Natural gas	[redacted]	MJ
	Water	[redacted]	m^3
Outputs	Packaged product	[redacted]	kg
	Scrap	[redacted]	kg
	Total particulate	[redacted]	kg
	NOx	[redacted]	kg
	SOx	[redacted]	kg
	Carbon monoxide	[redacted]	kg
	Carbon dioxide	[redacted]	kg

Table 31. KN Series insulation annual manufacturing inputs and outputs

	Flow	Amount, Lanett	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	[redacted]	MJ
	Natural gas	[redacted]	[redacted]	MJ
	Water	[redacted]	[redacted]	m^3
Outputs	Packaged product	[redacted]	[redacted]	kg
	Scrap	[redacted]	[redacted]	kg
	Total particulate	[redacted]	[redacted]	kg
	NOx	[redacted]	[redacted]	kg
	SOx	[redacted]	[redacted]	kg
	Carbon monoxide	[redacted]	[redacted]	kg
	Carbon dioxide	[redacted]	[redacted]	kg

Table 32. Acoustical Smooth Board annual manufacturing inputs and outputs

	Flow	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	MJ
	Natural gas	[redacted]	MJ
	Water	[redacted]	m^3
Outputs	Packaged product	[redacted]	kg
	Scrap	[redacted]	kg
	Total particulate	[redacted]	kg
	NOx	[redacted]	kg
	SOx	[redacted]	kg
	Carbon monoxide	[redacted]	kg
	Carbon dioxide	[redacted]	kg

Table 33. Black Acoustical Board / Akousti-Board Black™ annual manufacturing inputs and outputs

	Flow	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	MJ
	Natural gas	[redacted]	MJ
	Water	[redacted]	m^3
Outputs	Packaged product	[redacted]	kg
	Scrap	[redacted]	kg
	Total particulate	[redacted]	kg
	NOx	[redacted]	kg
	SOx	[redacted]	kg
	Carbon monoxide	[redacted]	kg
	Carbon dioxide	[redacted]	kg

Table 34. Earthwool® Insulation Board / AK BOARD™ annual manufacturing inputs and outputs

	Flow	Amount, Shelbyville	Unit
Inputs	Electricity	[redacted]	MJ
	Natural gas	[redacted]	MJ
	Water	[redacted]	m^3
Outputs	Packaged product, including faced and unfaced	[redacted]	kg
	Scrap	[redacted]	kg
	Total particulate	[redacted]	kg
	NOx	[redacted]	kg
	SOx	[redacted]	kg
	Carbon monoxide	[redacted]	kg
	Carbon dioxide	[redacted]	kg

3.2.3. Distribution (A4)

Products are packaged in the manufacturing plant and shipped directly to distributors, dealers, and showrooms for purchase by the end users in the US. The insulation products arrive finished and require no further assembly. Relevant technical information is shown in Table 35.

Table 35. Relevant technical information for distribution (A4)

Name	Value	Unit
Fuel type	Diesel	-
Vehicle type	Truck and trailer	-
Transportation distance		
Average distance from manufacturing to installation site	161	km
Capacity utilization	27	%
Gross density		
EcoBatt® and EcoRoll® Insulation	96.1	kg/m3
JetSpray™ Thermal Spray-On Insulation System	30.4	kg/m3
Jet Stream® Ultra Blowing Wool Insulation	28.8	kg/m3
Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™	24.0	kg/m3
KN Series Insulation	12.0	kg/m3
Acoustical Smooth Board	96.1	kg/m3
Black Acoustical Board / Akousti-Board Black™	48.1	kg/m3
Earthwool® Insulation Board / AK BOARD™	48.1	kg/m3
Capacity utilization volume factor	1	-

3.3 Secondary data

For life cycle stages after the transport of insulation to the building sites, secondary data sources are used to develop assumptions and generate the results.

3.3.1. Installation (A5)

At the installation site, insulation products are unpackaged and installed. Staples may be used to install batts, rolls, and board products, and tape may be used to install duct liner. For loose fill products, an insulation blower or sprayer is typically used to install the product. The potential impact of the blower/sprayer, staples, and tape is assumed to be negligible since their use is spread out over hundreds of bags of product; therefore, they were not included in the model.

No material is assumed to be lost or wasted. Scraps are typically used to fill corners or crevices. After installation, all packaging is assumed to be sent 100 miles to waste processing and disposed of according to the assumptions listed in Table 36.

Table 36. Packaging disposal rates used and waste treatment method

Material type	Recycling rate	Landfill rate	Incineration rate
Plastics	9%	68%	17%
Pulp (cardboard, paper)	68%	20%	5%

The mass of packaging waste is shown in Table 37. For products where only plastic packaging is used, the biogenic carbon content of the packaging is zero.

Table 37. Relevant technical scenarios for installation (A5) per functional unit

Product	Mass of plastic portion of packaging waste		Biogenic carbon content of paper portion of packaging	
	Value	Unit	Value	Unit
EcoBatt® and EcoRoll® Insulation	0.0544	kg	0	kg CO_2
JetSpray™ Thermal Spray-On Insulation System	0.0134	kg	0	kg CO_2
Jet Stream® Ultra Blowing Wool Insulation	0.00271	kg	0	kg CO_2
Wall and Ceiling Liner / AKOUSTI-SHIELD™	0.00887	kg	0.0198	kg CO_2
Atmosphere™ Duct Liner / AKOUSTI-LINER™	0.0168	kg	0.0234	kg CO_2
KN Series Insulation	0.0168	kg	0	kg CO_2
Acoustical Smooth Board	0.000557	kg	0.751	kg CO_2
Black Acoustical Board / Akousti-Board Black™	0.00400	kg	0.0844	kg CO_2
Earthwool® Insulation Board / AK BOARD™	0.00543	kg	0.451	kg CO_2

3.3.2. Use (B1-B7)

Insulation's reference service life is assumed to be equal to that of the building, which is 75 years for building envelope thermal insulation. No maintenance or replacement is required to achieve this product life span. Because the installed product is expected to remain undisturbed during the life of the building, there are assumed to be no impacts associated with the use stage.

3.3.3. Deconstruction (C1)

Although reuse and recycling of fiberglass pipe insulation at its end of life is possible, there are no formal programs for collection and transport. It is assumed that all product is sent to landfill at end of life. Removal at end of life requires human labor only and therefore does not contribute to the lifetime environmental impacts. There will be no operational energy use and thus, no impacts associated with the deconstruction work after the service life ends.

3.3.4. End-of-life transport (C2)

While fiberglass insulation can be recycled, doing so is not common practice in the industry. Therefore, after removal, the insulation is assumed to be transported 100 miles to the disposal site to be landfilled.

3.3.5. Waste processing (C3)

It was assumed that no waste processing is required before landfilling.

3.3.6. Final disposal (C4)

After removal, the insulation is assumed to be landfilled. A summary of the relevant technical information for end of life is shown in Table 38.

Table 38. Relevant technical scenarios for end of life (C1-C4) per functional unit

Name			Value	Unit
Assumptions for scenario development	Following manual removal of the insulation, it was assumed to be transported 100 miles to disposal. The PCR prescribes that 100% of the insulation is sent to landfill, where no prior waste processing is required.			
Collection process	Collected with mixed construction waste	EcoBatt® and EcoRoll® Insulation	Unfaced: 0.492 Kraft: 0.578 FSK: 0.614 Foil: 0.590	kg
		JetSpray™ Thermal Spray-On Insulation System	0.859	kg
		Jet Stream® Ultra Blowing Wool Insulation	0.173	kg
		Wall and Ceiling Liner / AKOUSTI-SHIELD™	0.971	kg
		Atmosphere™ Duct Liner / AKOUSTI-LINER™	1.04	kg
		KN Series Insulation	0.789	kg
		Acoustical Smooth Board	3.08	kg
		Black Acoustical Board / Akousti-Board Black™	1.50	kg
		Earthwool® Insulation Board / AK BOARD™	Unfaced: 1.75 ASJ+-faced: 2.01 FSK-faced: 1.90	kg
Disposal	Product for final deposition in landfill	EcoBatt® and EcoRoll® Insulation	Unfaced: 0.492 Kraft: 0.578 FSK: 0.614 Foil: 0.590	kg
		JetSpray™ Thermal Spray-On Insulation System	0.859	kg
		Jet Stream® Ultra Blowing Wool Insulation	0.173	kg
		Wall and Ceiling Liner / AKOUSTI-SHIELD™	0.971	kg
		Atmosphere™ Duct Liner / AKOUSTI-LINER™	1.04	kg
		KN Series Insulation	0.789	kg
		Acoustical Smooth Board	3.08	kg
		Black Acoustical Board / Akousti-Board Black™	1.50	kg
		Earthwool® Insulation Board / AK BOARD™	Unfaced: 1.75 ASJ+-faced: 2.01 FSK-faced: 1.90	kg

3.4 Data selection and quality

Data requirements provide guidelines for data quality in the LCA and are important to ensure data quality is consistently tracked. Data quality considerations include precision, completeness, and representativeness. The data used to create the inventory model shall be as precise, complete, consistent, and representative as possible with regards to the goal and scope of the study under given time and budget constraints.

- Measured primary data is considered to be of high precision, followed by calculated and estimated data. Since the inputs/outputs were directly measured by KINA, inventory data is considered to have good precision.
- Completeness is judged based on the completeness of the inputs and outputs per unit process and the completeness of the unit processes themselves. Wherever data was available on material and energy flows, these were included in the model. No known flows are deliberately excluded from this analysis other than those defined to be outside the defined system boundaries. Data collection forms were used to obtain a comprehensive set of primary data associated with the raw materials acquisition and manufacturing processes. Inquiries were made to the KINA team, and a review with key stakeholders leads to the conclusion that the dataset is complete.
- Consistency refers to modeling choices and data sources. The goal is to ensure that differences in results occur due to actual differences between

product systems, and not due to inconsistencies in modeling choices, data sources, emission factors, or other.

- Representativeness expresses the degree to which the data matches the geographical, temporal, and technological requirements defined in the study's goal and scope.

An evaluation of the data quality with regard to these requirements is provided in the interpretation chapter of this report.

Time coverage. Primary data were collected on insulation production for January 2022 to December 2022. Background data for upstream and downstream processes (i.e., raw materials, energy resources, transportation, and ancillary materials) were obtained from the LCA for Experts databases.

Technology coverage. Data was collected for fiberglass insulation production at KINA's facilities in the US.

Geographical coverage. KINA's facilities are located in Albion, MI; Inwood, WV; Lanett, AL; and Shasta Lake, CA; and Shelbyville, IN. As such, the geographical coverage for this study is based on United States system boundaries for all processes and products. Whenever US background data were not readily available, European data or global data were used as proxies. Where multiple locations are used to produce the same product, results are presented per each of the locations. Following production, insulation is shipped for use within the continental United States. Use and end-of-life impact were modeled using background data that represents average conditions for this region.

3.5 Background data

This section details background datasets used in modeling insulation product environmental performance. Each table lists dataset purpose, name, source, reference year, and location.

All data from the LCA for Experts 2023 databases were created with consistent system boundaries and upstream data. Expert judgment and advice was used in selecting appropriate datasets to model the materials and energy for this study. Detailed database documentation for the LCA for Experts datasets can be accessed at https://sphera.com/product-sustainability-gabi-data-search/.

3.5.1. Fuels and energy

National and regional averages for fuel inputs and electricity grid mixes were obtained from the LCA for Experts 2023 databases. When transforming the inputs and outputs of combustible materials into energy, the lower calorific value of fuels is applied. The grid mixes used for electricity are from the eGrid subregion covering each facility. Table 39 shows the most relevant LCI data sets used in modeling the product systems.

Table 39. Key energy datasets used in inventory analysis

Energy	Dataset name	Primary source	Reference year	Geography
Electricity	Electricity grid mix – RFCM	Sphera	2020	US RFCM
Electricity	Electricity grid mix – RFCW	Sphera	2020	US RFCW
Electricity	Electricity grid mix – SRSO	Sphera	2020	US SRSO
Electricity	Electricity grid mix – CAMX	Sphera	2020	US CAMX
Technical heat	Thermal energy from natural gas	Sphera	2019	US
Diesel	Diesel mix at refinery	Sphera	2019	US

3.5.2. Raw materials production

Data for up- and down-stream raw materials were obtained from the LCA for Experts 2023 databases. Table 40 shows the most relevant LCI datasets used in modeling the product systems. Documentation for the Sphera datasets can be found at https://sphera.com/product-sustainability-gabi-data-search/. Data sets older than 10 years old (nepheline, manganese oxide, and kraftliner) were chosen because they closest represent the technology used to manufacture the material and are assumed to be more accurate than other proxies with more precise geography and temporal representativeness.

Table 40. Key material datasets used in inventory analysis

Raw material	Dataset name	Primary source	Reference year	Geography
Batch	[redacted]	Sphera	2022	US
Batch	[redacted]	Sphera	2022	US
Batch	[redacted]	Sphera	2022	US
Batch	[redacted]	Sphera	2022	US
Batch	[redacted]	PE	2008	US
Batch	[redacted]	Sphera	2022	US
Batch	[redacted]	Sphera	2022	US
Batch	[redacted]	PE	2008	AU
Binder	[redacted]	Sphera	2022	US
Binder	[redacted]	Sphera	2022	US
Binder	[redacted]	Sphera	2022	RER
Binder	[redacted]	Sphera	2022	US
Binder	[redacted]	Sphera	2019	US
Additive	[redacted]	Sphera	2022	RER
Additive	[redacted]	Sphera	2022	US
Additive	[redacted]	Sphera	2022	US
Additive	[redacted]	Sphera	2022	US
Facing	[redacted]	Sphera	2022	US
Facing	[redacted]	Sphera	2022	RER
Facing	[redacted]	FEFCO	2006	US
Facing	[redacted]	Sphera	2022	US
Facing	[redacted]	Sphera	2022	DE
Facing	[redacted]	Sphera	2022	US
Facing	[redacted]	Sphera	2022	US
Facing	[redacted]	Sphera	2022	US
Facing	[redacted]	Sphera	2022	DE
Packaging	Polyethylene Film (LDPE/PE-LD)	Sphera	2022	US
Water	Process water from groundwater	Sphera	2022	RER
Water	Water deionized (reverse-osmosis/electro-deionization)	Sphera	2022	US

*Data sets older than 10 years old (nepheline, manganese oxide, and kraftliner) were chosen because they closest represent the technology used to manufacture the material and are assumed to be more accurate than other proxies with more precise geography and temporal representativeness.

3.5.3. Transportation

Transportation distances and modes of transport are included for the transport of the raw materials to production facilities. Transport of the finished product to the construction site is also accounted for, along with the transportation of construction wastes and the deconstructed product at end of life to disposal facilities. Typical vehicles used include trailers and rail cars.

The LCA for Experts datasets for transportation vehicles and fuels were used to model transportation. Truck transportation within the United States was modeled using the LCA for Experts US truck transportation datasets. Rail transportation and ocean freight were modeled using global transportation datasets.

3.5.4. Disposal

Disposal processes were obtained from the LCA for Experts 2023 database. These processes were chosen to correspond to the material being disposed, specifically fiberglass and facer materials. There are no energy recovery credits used from landfill gas capture and combustion. The 'Glass/inert on landfill' data set was used for the fiberglass plus facing, as it was assumed to represent both faced and unfaced landfilled product. Table 41 reviews relevant disposal datasets used in the model.

Table 41. Key disposal datasets used in inventory analysis

Material disposed	Dataset name	Primary source	Year	Geography
Insulation	Inert matter (Glass) on landfill	Sphera	2022	US
Plastic	Plastic waste on landfill, post-consumer	Sphera	2022	US
Paper	Paper waste on landfill, post-consumer	Sphera	2022	US

3.5.5. Emissions to air, water, and soil

All gate-to-gate emissions reported by KINA for the manufacturing stage are taken into account in the study. Emissions measured and reported by KINA are detailed under primary data collection. Batch carbon dioxide emissions generated from certain materials (e.g., dolomite, limestone, soda ash, etc.) are not typically tracked or reported by glass mineral wool manufacturers. The batch composition dictates the quantity of carbon dioxide emitted at each facility due to decomposition and oxidation in the furnace. In this study, these emissions were calculated based on stoichiometry and are displayed in Table 42.

Table 42. Emission factors for batch materials

Batch material	Chemical formula	CO_2 emission factor*
Dolomite	$CaMg(CO_3)_2$	0.477 kg CO_2 / kg
Limestone	$CaCO_3$	0.440 kg CO_2 / kg
Soda ash	Na_2CO_3	0.415 kg CO_2 / kg

*Assumes all carbon contained in batch materials is converted to carbon dioxide

All data for all upstream materials, electricity, and energy carriers were obtained from the LCA for Experts 2023 databases. The emissions due to the use of electricity are accounted for within the database processes. Likewise, emissions from natural gas combustion are accounted for within the database process.

3.6 Limitations

Conducting a life cycle assessment (LCA) of a product system is an extensive and intricate process that inherently necessitates certain assumptions and simplifications. The study's limitations should be acknowledged as follows:

- Fiberglass insulation is assumed to have a reference service life equal to that of the building. Thus, for example if the building has a 75-year service life, the insulation is likewise assumed to last 75 years with no maintenance. Although the building envelope thermal insulation PCR requires a functional unit of R_{SI} = 1 $m^2 \cdot K/W$, it should be noted that a product with this R-value is not sold by KINA. The declared product is delivered to the site of installation with the R-value chosen by the customer.

- Proxy data used in the LCA model were limited to background data for raw material production. US background data were used whenever possible, with European or global data substituted as proxies as necessary.
- Energy data was provided at the plant level
- The categories employed in the impact assessment methodology do not encompass all possible environmental impact categories.
- Characterization factors within the impact assessment methodology may exhibit varying degrees of uncertainty.
- LCA results are expressed in relative terms and do not predict impacts on category endpoints, threshold exceedances, safety margins, or risks.

3.7 Criteria for the exclusion of inputs and outputs

While packaging for inbound raw materials to KINA was excluded, primary data for this was not provided, nor was it required under the scope of the PCR. Otherwise, all energy and material flow data available were included in the model and comply with the cut-off criteria.

The cut-off criteria on a unit process level can be summarized as follows:

- All inputs and outputs to a (unit) process shall be included in the calculation of the pre-set parameters results, for which data are available. Data gaps shall be filled by conservative assumptions with average, generic or proxy data. Any assumptions for such choices shall be documented.
- Particular care should be taken to include material and energy flows that are known or suspected to release substances into the air, water, or soil in quantities that contribute significantly to any of the pre-set indicators of this document. In cases of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1% of renewable primary resource (energy), 1% of non-renewable primary resource (energy) usage, 1% of the total mass input of that unit process, and 1% of environmental impacts. The total of neglected input flows per module shall be a maximum of 5% of energy usage, mass, and environmental impacts. When assumptions are used in combination with plausibility considerations and expert judgement to demonstrate compliance with these criteria, the assumptions shall be conservative.
- All substances with hazardous and toxic properties that can be of concern for human health and/or the environment shall be identified and declared according to normative requirements in standards or regulation applicable in the market for which the EPD is valid, even though the given process unit is under the cut-off criterion of 1% of the total mass.

In this report, no known flows are deliberately excluded; therefore, these criteria have been met. The completeness of the bill of materials defined in this report satisfies the above defined cut-off criteria.

Capital goods such as mixers, furnaces, fiberizers, curing ovens, and packaging lines are expected to last for the life of the plant, and the plant is expected to last about 30 years. For example, if 13,899,305 lb of board products are made in one year, then around 416 million lb of board products are made over the lifetime of the capital goods. Even if we ignore all other products being made, a functional unit reference flow of about 7 lb means that only about 1.68E-06% of the capital goods and infrastructure are used per functional unit. Therefore, they are assumed not to significantly affect the conclusions of the LCA or additional environmental information.

3.8 Allocation

Whenever a system boundary is crossed, environmental inputs and outputs have to be assigned to the different products. Where multi-inputs or multi-outputs are considered, the same applies. The PCR prescribes where and how allocation occurs in the modeling of the LCA. In this LCA, the following rules have been applied.

The model used in this report ensures that the sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation. This means that no double counting or omissions of inputs or outputs through allocation is occurring. The allocation procedures used in background data sets were accepted without modification.

The KINA manufacturing facilities included in this report all produce multiple products. Since only facility level energy, water, and emissions data were available, allocation among a facility's co-products was necessary to determine the input and output flows associated with each product. Allocation of batch materials and energy was done on a product output mass basis, binder materials were allocated based on the mass calculated from the bill of materials and binder formulations, facing was allocated based on mass per product area, and packaging was allocated based on mass per package of product. Allocation of transportation was based on either weight or volume, depending on which was found to restrict the amount of cargo; the limiting factor was used in allocating transportation.

For recycled content and disposal at end of life, system boundaries were drawn consistent with the cut-off allocation approach. Cullet, which is used as part of KINA's manufacturing process, is assumed to enter the system burden-free in that burden associated with the production of virgin glass is not allocated to the fiberglass life cycle. Likewise, the system boundary was drawn to include landfilling of fiberglass at end-of-life (following the polluter pays principle) but exclude any credits from material or energy recovery.

3.9 Software and database

The LCA model was created using the LCA for Experts v10.7 software system for life cycle engineering, developed by Sphera. The LCA for Experts LCI databases (content version 2023.2) provide the life cycle inventory data for several of the raw and process materials obtained from the background system [6].

3.10 Critical review

This is a supporting LCA report for fiberglass insulation Transparency Reports. Both this background report and the Transparency Reports were evaluated for conformance to the PCR according to ISO 14025 [7] and the ISO 14040/14044 standards [8]. Critical review was performed by Terrie Boguski, Harmony Environmental, and access to a public version of this critically reviewed report can be found linked in the references section of the Transparency Reports.

4 IMPACT ASSESSMENT METHODS

4.1 Impact assessment

The environmental indicators as required by the PCR are included as well as other indicators required to derive the SM2013 single score [9] (see Table 43). The impact indicators are derived using the 100-year time horizon[2] factors, where relevant, as defined by TRACI 2.1 classification and characterization [10]. Long-term emissions (> 100 years) are not taken into consideration in the impact estimate. USEtox indicators[3] are used to evaluate toxicity. Emissions from waste disposal are considered part of the product system under study, according to the "polluter pays principle".

Table 43. Selected impact categories and units

Impact category	Unit	Description
Acidification	kg SO_2 eq (sulfur dioxide)	Acidification processes increase the acidity of water and soil systems and causes damage to lakes, streams, rivers and various plants and animals as well as building materials, paints and other human-built structures.
Ecotoxicity	CTUe	Ecotoxicity causes negative impacts to ecological receptors and, indirectly, to human receptors through the impacts to the ecosystem.
Eutrophication	kg N eq (nitrogen)	Eutrophication is the enrichment of an aquatic ecosystem with nutrients (nitrates and phosphates) that accelerate biological productivity (growth of algae and weeds) and an undesirable accumulation of algal biomass.
Global warming	kg CO_2 eq (carbon dioxide)	Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere.
Ozone depletion	kg CFC-11 eq	Ozone depletion is the reduction of ozone in the stratosphere caused by the release of ozone depleting chemicals.
Carcinogenics	CTUh	Carcinogens have the potential to form cancers in humans.
Non-carcinogenics	CTUh	Non-Carcinogens have the potential to causes non-cancerous adverse impacts to human health.
Respiratory effects	kg $PM_{2.5}$ eq (fine particulates)	Particulate matter concentrations have a strong influence on chronic and acute respiratory symptoms and mortality rates.
Smog	kg O_3 eq (ozone)	Smog formation (photochemical oxidant formation) is the formation of ozone molecules in the troposphere by complex chemical reactions.
Fossil fuel depletion	MJ surplus	Fossil fuel depletion is the surplus energy to extract minerals and fossil fuels.

With respect to global warming potential, biogenic carbon is included in impact category calculations. Greenhouse gas emissions from land-use change are expected to be insignificant and were not reported.

[2] The 100-year period relates to the period in which the environmental impacts are modeled. This is different from the time period of the functional unit. The two periods are related as follows: all environmental impacts that are created in the period of the functional unit are modeled through life cycle impact assessment using a 100-year time horizon to understand the impacts that take place.

[3] USEtox is available in TRACI and at http://www.usetox.org/

It shall be noted that the above impact categories represent impact potentials. They are approximations of environmental impacts that could occur if the emitted molecules would follow the underlying impact pathway and meet certain conditions in the receiving environment while doing so. In addition, the inventory only captures that fraction of the total environmental load that corresponds to the chosen declared unit (relative approach).

The results from the impact assessment indicate potential environmental effects and do not predict actual impacts on category endpoints, the exceedance of thresholds, or safety margins or risks.

4.2 Normalization and weighting

To arrive at a single score indicator, normalization [11] and weighting [12] as shown in Table 44 conforming to the SM 2013 Methodology were applied. The SM 2013 Methodology uses TRACI 2.1 impact categories developed by the U.S. EPA, and North American normalization and weighting values developed by the EPA and NIST respectively, to calculate single figure LCA results. Sustainable Minds recognizes that weighting is socially defined based on the importance that society attaches to the different environmental impact categories. However, these single score indicators serve as an easy starting point to get to know the product under consideration across all impact categories, rather than focusing all efforts on just one impact category (like global warming potential). The interpretation of the results starts with the Sustainable Minds single score results and then allows users to further explore the underlying impact categories individually. Details including the characterization models, factors, and methods used, including all assumptions and limitations, can be found in the SM 2013 Methodology Report [9].

Table 44. Normalization and weighting factors

Impact category	Normalization	Weighting (%)
Acidification	90.9	3.6
Ecotoxicity	11000	8.4
Eutrophication	21.6	7.2
Global warming	24200	34.9
Ozone depletion	0.161	2.4
Carcinogenics	5.07E-05	9.6
Non carcinogenics	1.05E-03	6.0
Respiratory effects	24.3	10.8
Smog	1390	4.8
Fossil fuel depletion	17300	12.1

5 ASSESSMENT AND INTERPRETATION

This chapter includes the results from the LCA for the products studied. It details the results per product per functional unit, outlines the sensitivity analyses, and concludes with recommendations.

5.1 Resource use and waste flows

Resource use indicators, output flows and waste category indicators, and carbon emissions and removals are presented in this section. These life cycle inventory (LCI) indicators reflect the flows from and to nature for the product system, prior to characterization using an impact assessment methodology to calculate life cycle impact assessment (LCIA) results (as shown in section 5.2).

LCI flows were calculated with the help of the draft American Center for Life Cycle Assessment guide to the ISO 21930:2017 metrics [13]. The consumption of freshwater indicator, which was calculated in accordance with the ISO 21930 guidance, is reported in compliance with ISO 14046. Abiotic depletion potential was calculated using the CML impact assessment methodology [14]. LCI flows were reported in conformance to ISO 21930:2017 [15].

Resource use indicators represent the amount of materials consumed to produce not only the insulation itself, but also the raw materials, electricity, natural gas, etc. that go into the product's life cycle. Secondary materials used in the production of insulation include external recycled cullet.

Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process and is expressed in energy demand from renewable and non-renewable resources. Efficiencies in energy conversion are taken into account when calculating primary energy demand from process energy consumption. Water use represents total water used over the entire life cycle. No energy was recovered.

Non-hazardous waste is calculated based on the amount of waste generated during the manufacturing, installation, and disposal life cycle stages. There is no hazardous or radioactive waste associated with the life cycle. Additionally, all materials are assumed to be landfilled at the end of life rather than incinerated or reused/recycled, so no materials are available for energy recovery or reuse/recycling. Waste occurs at product end-of-life when it is disposed of in a landfill.

The biogenic carbon content of bio-based materials, including ECOSE®, was reported per module. CO_2 from calcination and carbonation does not apply to this study. Carbon emissions from combustion arose from bio-based packaging materials going to incineration.

Tables 45-78 show resource use, output flow and waste categories, and carbon emissions and removals for KINA insulation products per functional unit.

5.1.1 EcoBatt® and EcoRoll® Insulation

5.1.1.1 Albion, MI

Tables 45-48 show resource use, output and waste flows, and carbon emissions and removals for all faced and unfaced options produced in Albion, MI EcoBatt® and EcoRoll® Insulation per functional unit.

Table 45. Resource use, output and waste flows, and carbon emissions and removals for unfaced EcoBatt® and EcoRoll® Insulation produced in Albion, MI per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	3.72E+00	8.84E-03	1.10E-02	0	0	4.35E-03	0	1.93E-02	**3.76E+00**
RPRm	MJ, LHV	2.01E-08	-7.31E-13	2.57E-12	0	0	-3.60E-13	0	3.84E-12	**2.01E-08**
NRPRe	MJ, LHV	1.87E+01	2.27E-01	7.14E-02	0	0	1.12E-01	0	1.65E-01	**1.93E+01**
NRPRm	MJ, LHV	7.43E-08	9.05E-10	1.75E-10	0	0	4.45E-10	0	4.10E-10	**7.63E-08**
SM	kg	2.38E-01	0	0	0	0	0	0	0	**2.38E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.88E-01	3.07E-05	5.99E-05	0	0	1.51E-05	0	2.04E-05	**2.89E-01**
ADPf	MJ, LHV	1.66E+01	2.26E-01	6.07E-02	0	0	1.11E-01	0	1.59E-01	**1.72E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	4.33E-03	0	3.70E-02	0	0	0	0	4.92E-01	**5.33E-01**
HLRW	kg	7.33E-07	6.61E-10	4.56E-09	0	0	3.25E-10	0	2.04E-09	**7.40E-07**
ILLRW	kg	7.46E-04	5.57E-07	3.83E-06	0	0	2.74E-07	0	1.82E-06	**7.53E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.21E-01	0	0	0	0	0	0	0	**1.21E-01**
BCEP	kg CO_2	8.56E-02	0	0	0	0	0	0	8.45E-04	**8.65E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 46. Resource use, output and waste flows, and carbon emissions and removals for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Albion, MI per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.17E+00	1.02E-02	1.09E-02	0	0	5.11E-03	0	2.26E-02	**5.22E+00**
RPRm	MJ, LHV	3.06E-05	-8.47E-13	2.56E-12	0	0	-4.23E-13	0	4.51E-12	**3.06E-05**
NRPRe	MJ, LHV	2.08E+01	2.63E-01	7.12E-02	0	0	1.31E-01	0	1.93E-01	**2.14E+01**
NRPRm	MJ, LHV	7.72E-08	1.05E-09	1.74E-10	0	0	5.23E-10	0	4.82E-10	**7.94E-08**
SM	kg	2.80E-01	0	0	0	0	0	0	0	**2.80E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.75E-01	3.56E-05	5.97E-05	0	0	1.78E-05	0	2.40E-05	**2.75E-01**
ADPf	MJ, LHV	1.86E+01	2.61E-01	6.05E-02	0	0	1.30E-01	0	1.87E-01	**1.92E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	5.08E-03	0	3.70E-02	0	0	0	0	5.78E-01	**6.20E-01**
HLRW	kg	7.92E-07	7.65E-10	4.55E-09	0	0	3.82E-10	0	2.39E-09	**8.00E-07**
ILLRW	kg	7.70E-04	6.45E-07	3.81E-06	0	0	3.22E-07	0	2.14E-06	**7.77E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.98E-01	0	0	0	0	0	0	0	**2.98E-01**
BCEP	kg CO_2	8.20E-02	0	0	0	0	0	0	9.93E-04	**8.30E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 47. Resource use, output and waste flows, and carbon emissions and removals for FSK-faced EcoBatt® Insulation produced in Albion, MI per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	7.12E+00	1.08E-02	1.06E-02	0	0	5.45E-03	0	2.41E-02	**7.17E+00**
RPRm	MJ, LHV	2.12E-05	-8.95E-13	2.48E-12	0	0	-4.51E-13	0	4.80E-12	**2.12E-05**
NRPRe	MJ, LHV	2.63E+01	2.78E-01	6.90E-02	0	0	1.40E-01	0	2.06E-01	**2.70E+01**
NRPRm	MJ, LHV	8.16E-08	1.11E-09	1.69E-10	0	0	5.57E-10	0	5.14E-10	**8.39E-08**
SM	kg	2.97E-01	0	0	0	0	0	0	0	**2.97E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.81E-01	3.76E-05	5.79E-05	0	0	1.89E-05	0	2.55E-05	**2.81E-01**
ADPf	MJ, LHV	2.31E+01	2.76E-01	5.86E-02	0	0	1.39E-01	0	2.00E-01	**2.38E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	5.40E-03	0	3.70E-02	0	0	0	0	6.14E-01	**6.56E-01**
HLRW	kg	1.06E-06	8.09E-10	4.41E-09	0	0	4.07E-10	0	2.55E-09	**1.07E-06**
ILLRW	kg	1.14E-03	6.82E-07	3.69E-06	0	0	3.43E-07	0	2.28E-06	**1.15E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.61E-01	0	0	0	0	0	0	0	**2.61E-01**
BCEP	kg CO_2	1.00E-01	0	0	0	0	0	0	1.06E-03	**1.01E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 48. Resource use, output and waste flows, and carbon emissions and removals for foil-faced EcoBatt® Insulation produced in Albion, MI per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.26E+00	1.04E-02	1.09E-02	0	0	5.22E-03	0	2.31E-02	**5.31E+00**
RPRm	MJ, LHV	1.64E-05	-8.63E-13	2.56E-12	0	0	-4.32E-13	0	4.60E-12	**1.64E-05**
NRPRe	MJ, LHV	2.49E+01	2.68E-01	7.12E-02	0	0	1.34E-01	0	1.97E-01	**2.55E+01**
NRPRm	MJ, LHV	8.68E-08	1.07E-09	1.75E-10	0	0	5.34E-10	0	4.92E-10	**8.91E-08**
SM	kg	2.86E-01	0	0	0	0	0	0	0	**2.86E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.92E-01	3.62E-05	5.97E-05	0	0	1.81E-05	0	2.45E-05	**2.93E-01**
ADPf	MJ, LHV	2.24E+01	2.66E-01	6.05E-02	0	0	1.33E-01	0	1.91E-01	**2.30E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	5.19E-03	0	3.70E-02	0	0	0	0	5.90E-01	**6.32E-01**
HLRW	kg	8.63E-07	7.80E-10	4.55E-09	0	0	3.90E-10	0	2.44E-09	**8.72E-07**
ILLRW	kg	8.84E-04	6.57E-07	3.81E-06	0	0	3.29E-07	0	2.18E-06	**8.91E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.25E-01	0	0	0	0	0	0	0	**2.25E-01**
BCEP	kg CO_2	9.14E-02	0	0	0	0	0	0	1.01E-03	**9.24E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.1.2. Inwood, WV

Tables 49-52 show resource use, output and waste flows, and carbon emissions and removals for all faced and unfaced options produced in Inwood, WV for EcoBatt® and EcoRoll® Insulation per functional unit.

Table 49. Resource use, output and waste flows, and carbon emissions and removals for unfaced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	3.42E+00	8.84E-03	1.10E-02	0	0	4.35E-03	0	1.93E-02	**3.46E+00**
RPRm	MJ, LHV	3.35E-09	-7.31E-13	2.57E-12	0	0	-3.60E-13	0	3.84E-12	**3.35E-09**
NRPRe	MJ, LHV	2.18E+01	2.27E-01	7.14E-02	0	0	1.12E-01	0	1.65E-01	**2.24E+01**
NRPRm	MJ, LHV	7.98E-08	9.05E-10	1.75E-10	0	0	4.45E-10	0	4.10E-10	**8.18E-08**
SM	kg	1.80E-01	0	0	0	0	0	0	0	**1.80E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.72E-01	3.07E-05	5.99E-05	0	0	1.51E-05	0	2.04E-05	**2.72E-01**
ADPf	MJ, LHV	1.86E+01	2.26E-01	6.07E-02	0	0	1.11E-01	0	1.59E-01	**1.92E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	7.17E-02	0	3.70E-02	0	0	0	0	4.92E-01	**6.00E-01**
HLRW	kg	1.20E-06	6.61E-10	4.56E-09	0	0	3.25E-10	0	2.04E-09	**1.20E-06**
ILLRW	kg	1.13E-03	5.57E-07	3.83E-06	0	0	2.74E-07	0	1.82E-06	**1.13E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.13E-01	0	0	0	0	0	0	0	**1.13E-01**
BCEP	kg CO_2	7.32E-02	0	0	0	0	0	0	8.45E-04	**7.40E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 50. Resource use, output and waste flows, and carbon emissions and removals for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.12E+00	1.02E-02	1.09E-02	0	0	5.11E-03	0	2.26E-02	**5.17E+00**
RPRm	MJ, LHV	3.19E-05	-8.47E-13	2.56E-12	0	0	-4.23E-13	0	4.51E-12	**3.19E-05**
NRPRe	MJ, LHV	2.47E+01	2.63E-01	7.12E-02	0	0	1.31E-01	0	1.93E-01	**2.54E+01**
NRPRm	MJ, LHV	8.60E-08	1.05E-09	1.74E-10	0	0	5.23E-10	0	4.82E-10	**8.83E-08**
SM	kg	2.11E-01	0	0	0	0	0	0	0	**2.11E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.73E-01	3.56E-05	5.97E-05	0	0	1.78E-05	0	2.40E-05	**2.73E-01**
ADPf	MJ, LHV	2.14E+01	2.61E-01	6.05E-02	0	0	1.30E-01	0	1.87E-01	**2.20E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	8.43E-02	0	3.70E-02	0	0	0	0	5.78E-01	**6.99E-01**
HLRW	kg	1.30E-06	7.65E-10	4.55E-09	0	0	3.82E-10	0	2.39E-09	**1.30E-06**
ILLRW	kg	1.19E-03	6.45E-07	3.81E-06	0	0	3.22E-07	0	2.14E-06	**1.20E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	3.05E-01	0	0	0	0	0	0	0	**3.05E-01**
BCEP	kg CO_2	7.38E-02	0	0	0	0	0	0	9.93E-04	**7.48E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 51. Resource use, output and waste flows, and carbon emissions and removals for FSK-faced EcoBatt® Insulation produced in Inwood, WV per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	6.87E+00	1.08E-02	1.06E-02	0	0	5.45E-03	0	2.41E-02	**6.92E+00**
RPRm	MJ, LHV	2.11E-05	-8.95E-13	2.48E-12	0	0	-4.51E-13	0	4.80E-12	**2.11E-05**
NRPRe	MJ, LHV	2.94E+01	2.78E-01	6.90E-02	0	0	1.40E-01	0	2.06E-01	**3.01E+01**
NRPRm	MJ, LHV	8.75E-08	1.11E-09	1.69E-10	0	0	5.57E-10	0	5.14E-10	**8.99E-08**
SM	kg	2.24E-01	0	0	0	0	0	0	0	**2.24E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.68E-01	3.76E-05	5.79E-05	0	0	1.89E-05	0	2.55E-05	**2.68E-01**
ADPf	MJ, LHV	2.52E+01	2.76E-01	5.86E-02	0	0	1.39E-01	0	2.00E-01	**2.58E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	8.96E-02	0	3.70E-02	0	0	0	0	6.14E-01	**7.40E-01**
HLRW	kg	1.52E-06	8.09E-10	4.41E-09	0	0	4.07E-10	0	2.55E-09	**1.52E-06**
ILLRW	kg	1.52E-03	6.82E-07	3.69E-06	0	0	3.43E-07	0	2.28E-06	**1.52E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0.00E+00	0	0.00E+00	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.55E-01	0	0	0		0	0	0	**2.55E-01**
BCEP	kg CO_2	8.92E-02	0	0	0		0	0	1.06E-03	**9.03E-02**
BCRK	kg CO_2	0	0	0	0		0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0		0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0		0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 52. Resource use, output and waste flows, and carbon emissions and removals for foil-faced EcoBatt® Insulation produced in Inwood, WV per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.00E+00	1.04E-02	1.09E-02	0	0	5.22E-03	0	2.31E-02	**5.05E+00**
RPRm	MJ, LHV	1.64E-05	-8.63E-13	2.56E-12	0	0	-4.32E-13	0	4.60E-12	**1.64E-05**
NRPRe	MJ, LHV	2.82E+01	2.68E-01	7.12E-02	0	0	1.34E-01	0	1.97E-01	**2.88E+01**
NRPRm	MJ, LHV	9.31E-08	1.07E-09	1.75E-10	0	0	5.34E-10	0	4.92E-10	**9.54E-08**
SM	kg	2.15E-01	0	0	0	0	0	0	0	**2.15E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	2.79E-01	3.62E-05	5.97E-05	0	0	1.81E-05	0	2.45E-05	**2.79E-01**
ADPf	MJ, LHV	2.46E+01	2.66E-01	6.05E-02	0	0	1.33E-01	0	1.91E-01	**2.52E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	8.61E-02	0	3.70E-02	0	0	0	0	5.90E-01	**7.13E-01**
HLRW	kg	1.34E-06	7.80E-10	4.55E-09	0	0	3.90E-10	0	2.44E-09	**1.35E-06**
ILLRW	kg	1.28E-03	6.57E-07	3.81E-06	0	0	3.29E-07	0	2.18E-06	**1.29E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0.00E+00	0	0.00E+00	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.19E-01	0	0	0	0	0	0	0	**2.19E-01**
BCEP	kg CO_2	7.97E-02	0	0	0	0	0	0	1.01E-03	**8.07E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.1.3. Lanett, AL

Tables 53-56 show resource use, output and waste flows, and carbon emissions and removals for all faced and unfaced options produced in Lanett, AL for EcoBatt® and EcoRoll® Insulation per functional unit.

Table 53. Resource use, output and waste flows, and carbon emissions and removals for unfaced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	3.80E+00	8.84E-03	1.10E-02	0	0	4.35E-03	0	1.93E-02	**3.84E+00**
RPRm	MJ, LHV	8.68E-10	-7.31E-13	2.57E-12	0	0	-3.60E-13	0	3.84E-12	**8.74E-10**
NRPRe	MJ, LHV	2.09E+01	2.27E-01	7.14E-02	0	0	1.12E-01	0	1.65E-01	**2.15E+01**
NRPRm	MJ, LHV	8.48E-08	9.05E-10	1.75E-10	0	0	4.45E-10	0	4.10E-10	**8.68E-08**
SM	kg	1.27E-01	0	0	0	0	0	0	0	**1.27E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.23E-01	3.07E-05	5.99E-05	0	0	1.51E-05	0	2.04E-05	**3.24E-01**
ADPf	MJ, LHV	1.84E+01	2.26E-01	6.07E-02	0	0	1.11E-01	0	1.59E-01	**1.90E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	7.65E-02	0	3.70E-02	0	0	0	0	4.92E-01	**6.05E-01**
HLRW	kg	8.59E-07	6.61E-10	4.56E-09	0	0	3.25E-10	0	2.04E-09	**8.67E-07**
ILLRW	kg	8.69E-04	5.57E-07	3.83E-06	0	0	2.74E-07	0	1.82E-06	**8.75E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.33E-01	0	0	0	0	0	0	0	**1.33E-01**
BCEP	kg CO_2	9.46E-02	0	0	0	0	0	0	8.45E-04	**9.55E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 54. Resource use, output and waste flows, and carbon emissions and removals for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.44E+00	1.02E-02	1.09E-02	0	0	5.11E-03	0	2.26E-02	**5.49E+00**
RPRm	MJ, LHV	3.10E-05	-8.47E-13	2.56E-12	0	0	-4.23E-13	0	4.51E-12	**3.10E-05**
NRPRe	MJ, LHV	2.37E+01	2.63E-01	7.12E-02	0	0	1.31E-01	0	1.93E-01	**2.43E+01**
NRPRm	MJ, LHV	9.06E-08	1.05E-09	1.74E-10	0	0	5.23E-10	0	4.82E-10	**9.29E-08**
SM	kg	1.49E-01	0	0	0	0	0	0	0	**1.49E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.24E-01	3.56E-05	5.97E-05	0	0	1.78E-05	0	2.40E-05	**3.24E-01**
ADPf	MJ, LHV	2.10E+01	2.61E-01	6.05E-02	0	0	1.30E-01	0	1.87E-01	**2.17E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	8.99E-02	0	3.70E-02	0	0	0	0	5.78E-01	**7.04E-01**
HLRW	kg	9.55E-07	7.65E-10	4.55E-09	0	0	3.82E-10	0	2.39E-09	**9.63E-07**
ILLRW	kg	9.28E-04	6.45E-07	3.81E-06	0	0	3.22E-07	0	2.14E-06	**9.35E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.59E-03	0	0	0	0	0	0	0	**2.59E-03**
BCEP	kg CO_2	8.87E-02	0	0	0	0	0	0	9.93E-04	**8.97E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 55. Resource use, output and waste flows, and carbon emissions and removals for FSK-faced EcoBatt® Insulation produced in Lanett, AL per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	7.32E+00	1.08E-02	1.06E-02	0	0	5.45E-03	0	2.41E-02	**7.38E+00**
RPRm	MJ, LHV	2.11E-05	-8.95E-13	2.48E-12	0	0	-4.51E-13	0	4.80E-12	**2.11E-05**
NRPRe	MJ, LHV	2.89E+01	2.78E-01	6.90E-02	0	0	1.40E-01	0	2.06E-01	**2.96E+01**
NRPRm	MJ, LHV	9.40E-08	1.11E-09	1.69E-10	0	0	5.57E-10	0	5.14E-10	**9.64E-08**
SM	kg	1.59E-01	0	0	0	0	0	0	0	**1.59E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.25E-01	3.76E-05	5.79E-05	0	0	1.89E-05	0	2.55E-05	**3.25E-01**
ADPf	MJ, LHV	2.53E+01	2.76E-01	5.86E-02	0	0	1.39E-01	0	2.00E-01	**2.60E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	9.55E-02	0	3.70E-02	0	0	0	0	6.14E-01	**7.46E-01**
HLRW	kg	1.21E-06	8.09E-10	4.41E-09	0	0	4.07E-10	0	2.55E-09	**1.22E-06**
ILLRW	kg	1.29E-03	6.82E-07	3.69E-06	0	0	3.43E-07	0	2.28E-06	**1.29E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.77E-01	0	0	0	0	0	0	0	**2.77E-01**
BCEP	kg CO_2	1.12E-01	0	0	0	0	0	0	1.06E-03	**1.13E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 56. Resource use, output and waste flows, and carbon emissions and removals for foil-faced EcoBatt® Insulation produced in Lanett, AL per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.47E+00	1.04E-02	1.09E-02	0	0	5.22E-03	0	2.31E-02	**5.52E+00**
RPRm	MJ, LHV	1.64E-05	-8.63E-13	2.56E-12	0	0	-4.32E-13	0	4.60E-12	**1.64E-05**
NRPRe	MJ, LHV	2.76E+01	2.68E-01	7.12E-02	0	0	1.34E-01	0	1.97E-01	**2.83E+01**
NRPRm	MJ, LHV	9.99E-08	1.07E-09	1.75E-10	0	0	5.34E-10	0	4.92E-10	**1.02E-07**
SM	kg	1.52E-01	0	0	0	0	0	0	0	**1.52E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.39E-01	3.62E-05	5.97E-05	0	0	1.81E-05	0	2.45E-05	**3.39E-01**
ADPf	MJ, LHV	2.47E+01	2.66E-01	6.05E-02	0	0	1.33E-01	0	1.91E-01	**2.54E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	9.18E-02	0.00E+00	3.70E-02	0	0	0	0	5.90E-01	**7.18E-01**
HLRW	kg	1.02E-06	7.80E-10	4.55E-09	0	0	3.90E-10	0	2.44E-09	**1.03E-06**
ILLRW	kg	1.04E-03	6.57E-07	3.81E-06	0	0	3.29E-07	0	2.18E-06	**1.04E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.41E-01	0	0	0	0	0	0	0	**2.41E-01**
BCEP	kg CO_2	1.04E-01	0	0	0	0	0	0	1.01E-03	**1.05E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.1.4. Shasta Lake, CA

Tables 57-60 show resource use, output and waste flows, and carbon emissions and removals for all faced and unfaced options produced in Shasta Lake, CA for EcoBatt® and EcoRoll® Insulation per functional unit.

Table 57. Resource use, output and waste flows, and carbon emissions and removals for unfaced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	6.02E+00	8.84E-03	1.10E-02	0	0	4.35E-03	0	1.93E-02	**6.06E+00**
RPRm	MJ, LHV	3.02E-08	-7.31E-13	2.57E-12	0	0	-3.60E-13	0	3.84E-12	**3.02E-08**
NRPRe	MJ, LHV	1.66E+01	2.27E-01	7.14E-02	0	0	1.12E-01	0	1.65E-01	**1.71E+01**
NRPRm	MJ, LHV	8.41E-08	9.05E-10	1.75E-10	0	0	4.45E-10	0	4.10E-10	**8.60E-08**
SM	kg	2.14E-01	0	0	0	0	0	0	0	**2.14E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.06E-01	3.07E-05	5.99E-05	0	0	1.51E-05	0	2.04E-05	**3.06E-01**
ADPf	MJ, LHV	1.45E+01	2.26E-01	6.07E-02	0	0	1.11E-01	0	1.59E-01	**1.51E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.36E-02	0.00E+00	3.70E-02	0	0	0.00E+00	0	4.92E-01	**5.42E-01**
HLRW	kg	7.04E-07	6.61E-10	4.56E-09	0	0	3.25E-10	0	2.04E-09	**7.12E-07**
ILLRW	kg	7.31E-04	5.57E-07	3.83E-06	0	0	2.74E-07	0	1.82E-06	**7.37E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.25E-01	0	0	0	0	0	0	0	**1.25E-01**
BCEP	kg CO_2	9.23E-02	0	0	0	0	0	0	8.45E-04	**9.32E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 58. Resource use, output and waste flows, and carbon emissions and removals for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	7.71E+00	1.02E-02	1.09E-02	0	0	5.11E-03	0	2.26E-02	**7.75E+00**
RPRm	MJ, LHV	3.07E-05	-8.47E-13	2.56E-12	0	0	-4.23E-13	0	4.51E-12	**3.07E-05**
NRPRe	MJ, LHV	1.94E+01	2.63E-01	7.12E-02	0	0	1.31E-01	0	1.93E-01	**2.01E+01**
NRPRm	MJ, LHV	9.05E-08	1.05E-09	1.74E-10	0	0	5.23E-10	0	4.82E-10	**9.28E-08**
SM	kg	2.52E-01	0	0	0	0	0	0	0	**2.52E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.10E-01	3.56E-05	5.97E-05	0	0	1.78E-05	0	2.40E-05	**3.10E-01**
ADPf	MJ, LHV	1.72E+01	2.61E-01	6.05E-02	0	0	1.30E-01	0	1.87E-01	**1.78E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.60E-02	0.00E+00	3.70E-02	0	0	0.00E+00	0	5.78E-01	**6.31E-01**
HLRW	kg	8.02E-07	7.65E-10	4.55E-09	0	0	3.82E-10	0	2.39E-09	**8.10E-07**
ILLRW	kg	7.94E-04	6.45E-07	3.81E-06	0	0	3.22E-07	0	2.14E-06	**8.01E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	3.10E-01	0	0	0	0	0	0	0	**3.10E-01**
BCEP	kg CO_2	9.37E-02	0	0	0	0	0	0	9.93E-04	**9.47E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 59. Resource use, output and waste flows, and carbon emissions and removals for FSK-faced EcoBatt® Insulation produced in Shasta Lake, CA per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	9.66E+00	1.08E-02	1.06E-02	0	0	5.45E-03	0	2.41E-02	**9.71E+00**
RPRm	MJ, LHV	2.12E-05	-8.95E-13	2.48E-12	0	0	-4.51E-13	0	4.80E-12	**2.12E-05**
NRPRe	MJ, LHV	2.49E+01	2.78E-01	6.90E-02	0	0	1.40E-01	0	2.06E-01	**2.56E+01**
NRPRm	MJ, LHV	9.48E-08	1.11E-09	1.69E-10	0	0	5.57E-10	0	5.14E-10	**9.72E-08**
SM	kg	2.52E-01	0	0	0	0	0	0	0	**2.52E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.15E-01	3.76E-05	5.79E-05	0	0	1.89E-05	0	2.55E-05	**3.15E-01**
ADPf	MJ, LHV	2.16E+01	2.76E-01	5.86E-02	0	0	1.39E-01	0	2.00E-01	**2.23E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.60E-02	0	3.70E-02	0	0	0	0	5.78E-01	**6.31E-01**
HLRW	kg	1.07E-06	8.09E-10	4.41E-09	0	0	4.07E-10	0	2.55E-09	**1.07E-06**
ILLRW	kg	1.16E-03	6.82E-07	3.69E-06	0	0	3.43E-07	0	2.28E-06	**1.17E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.72E-01	0	0	0	0	0	0	0	**2.72E-01**
BCEP	kg CO_2	1.12E-01	0	0	0	0	0	0	1.06E-03	**1.13E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 60. Resource use, output and waste flows, and carbon emissions and removals for foil-faced EcoBatt® Insulation produced in Shasta Lake, CA per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	7.93E+00	1.04E-02	1.09E-02	0	0	5.22E-03	0	2.31E-02	**7.98E+00**
RPRm	MJ, LHV	1.64E-05	-8.63E-13	2.56E-12	0	0	-4.32E-13	0	4.60E-12	**1.64E-05**
NRPRe	MJ, LHV	2.34E+01	2.68E-01	7.12E-02	0	0	1.34E-01	0	1.97E-01	**2.41E+01**
NRPRm	MJ, LHV	1.01E-07	1.07E-09	1.75E-10	0	0	5.34E-10	0	4.92E-10	**1.03E-07**
SM	kg	2.57E-01	0	0	0	0	0	0	0	**2.57E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.29E-01	3.62E-05	5.97E-05	0	0	1.81E-05	0	2.45E-05	**3.29E-01**
ADPf	MJ, LHV	2.08E+01	2.66E-01	6.05E-02	0	0	1.33E-01	0	1.91E-01	**2.15E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.63E-02	0	3.70E-02	0	0	0	0	5.90E-01	**6.43E-01**
HLRW	kg	8.72E-07	7.80E-10	4.55E-09	0	0	3.90E-10	0	2.44E-09	**8.80E-07**
ILLRW	kg	9.08E-04	6.57E-07	3.81E-06	0	0	3.29E-07	0	2.18E-06	**9.15E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.37E-01	0	0	0	0	0	0	0	**2.37E-01**
BCEP	kg CO_2	1.04E-01	0	0	0	0	0	0	1.01E-03	**1.05E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.1.5. Shelbyville, IN

Tables 61-64 show resource use, output and waste flows, and carbon emissions and removals for all faced and unfaced options produced in Shelbyville, IN for EcoBatt® and EcoRoll® Insulation per functional unit.

Table 61. Resource use, output and waste flows, and carbon emissions and removals for unfaced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	4.27E+00	8.84E-03	1.10E-02	0	0	4.35E-03	0	1.93E-02	**4.31E+00**
RPRm	MJ, LHV	3.86E-08	-7.31E-13	2.57E-12	0	0	-3.60E-13	0	3.84E-12	**3.86E-08**
NRPRe	MJ, LHV	2.33E+01	2.27E-01	7.14E-02	0	0	1.12E-01	0	1.65E-01	**2.39E+01**
NRPRm	MJ, LHV	8.30E-08	9.05E-10	1.75E-10	0	0	4.45E-10	0	4.10E-10	**8.50E-08**
SM	kg	2.24E-01	0	0	0	0	0	0	0	**2.24E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.66E-01	3.07E-05	5.99E-05	0	0	1.51E-05	0	2.04E-05	**3.66E-01**
ADPf	MJ, LHV	1.92E+01	2.26E-01	6.07E-02	0	0	1.11E-01	0	1.59E-01	**1.98E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	7.73E-02	0	3.70E-02	0	0	0	0	4.92E-01	**6.06E-01**
HLRW	kg	1.53E-06	6.61E-10	4.56E-09	0	0	3.25E-10	0	2.04E-09	**1.54E-06**
ILLRW	kg	1.45E-03	5.57E-07	3.83E-06	0	0	2.74E-07	0	1.82E-06	**1.45E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0.00E+00	0.00E+00	8.16E-03	0	0	0.00E+00	0	0.00E+00	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.33E-01	0	0	0	0	0	0	0	**1.33E-01**
BCEP	kg CO_2	9.54E-02	0	0	0	0	0	0	8.45E-04	**9.62E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 62. Resource use, output and waste flows, and carbon emissions and removals for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.98E+00	1.02E-02	1.09E-02	0	0	5.11E-03	0	2.26E-02	**6.03E+00**
RPRm	MJ, LHV	3.18E-05	-8.47E-13	2.56E-12	0	0	-4.23E-13	0	4.51E-12	**3.18E-05**
NRPRe	MJ, LHV	2.62E+01	2.63E-01	7.12E-02	0	0	1.31E-01	0	1.93E-01	**2.69E+01**
NRPRm	MJ, LHV	8.93E-08	1.05E-09	1.74E-10	0	0	5.23E-10	0	4.82E-10	**9.16E-08**
SM	kg	2.63E-01	0	0	0	0	0	0	0	**2.63E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.68E-01	3.56E-05	5.97E-05	0	0	1.78E-05	0	2.40E-05	**3.68E-01**
ADPf	MJ, LHV	2.20E+01	2.61E-01	6.05E-02	0	0	1.30E-01	0	1.87E-01	**2.26E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	9.08E-02	0	3.70E-02	0	0	0	0	5.78E-01	**7.05E-01**
HLRW	kg	1.63E-06	7.65E-10	4.55E-09	0	0	3.82E-10	0	2.39E-09	**1.64E-06**
ILLRW	kg	1.52E-03	6.45E-07	3.81E-06	0	0	3.22E-07	0	2.14E-06	**1.52E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	3.25E-01	0	0	0	0	0	0	0	**3.25E-01**
BCEP	kg CO_2	9.62E-02	0	0	0	0	0	0	9.93E-04	**9.72E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 63. Resource use, output and waste flows, and carbon emissions and removals for FSK-faced EcoBatt® Insulation produced in Shelbyville, IN per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	7.70E+00	1.08E-02	1.06E-02	0	0	5.45E-03	0	2.41E-02	**7.75E+00**
RPRm	MJ, LHV	2.12E-05	-8.95E-13	2.48E-12	0	0	-4.51E-13	0	4.80E-12	**2.12E-05**
NRPRe	MJ, LHV	3.08E+01	2.78E-01	6.90E-02	0	0	1.40E-01	0	2.06E-01	**3.15E+01**
NRPRm	MJ, LHV	9.06E-08	1.11E-09	1.69E-10	0	0	5.57E-10	0	5.14E-10	**9.30E-08**
SM	kg	2.63E-01	0	0	0	0	0	0	0	**2.63E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.60E-01	3.76E-05	5.79E-05	0	0	1.89E-05	0	2.55E-05	**3.60E-01**
ADPf	MJ, LHV	2.57E+01	2.76E-01	5.86E-02	0	0	1.39E-01	0	2.00E-01	**2.63E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	9.08E-02	0.00E+00	3.70E-02	0	0	0.00E+00	0	5.78E-01	**7.05E-01**
HLRW	kg	1.83E-06	8.09E-10	4.41E-09	0	0	4.07E-10	0	2.55E-09	**1.84E-06**
ILLRW	kg	1.82E-03	6.82E-07	3.69E-06	0	0	3.43E-07	0	2.28E-06	**1.83E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.75E-01	0	0	0	0	0	0	0	**2.75E-01**
BCEP	kg CO_2	1.11E-01	0	0	0	0	0	0	1.06E-03	**1.12E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 64. Resource use, output and waste flows, and carbon emissions and removals for foil-faced EcoBatt® Insulation produced in Shelbyville, IN per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.88E+00	1.04E-02	1.09E-02	0	0	5.22E-03	0	2.31E-02	**5.93E+00**
RPRm	MJ, LHV	1.64E-05	-8.63E-13	2.56E-12	0	0	-4.32E-13	0	4.60E-12	**1.64E-05**
NRPRe	MJ, LHV	2.96E+01	2.68E-01	7.12E-02	0	0	1.34E-01	0	1.97E-01	**3.03E+01**
NRPRm	MJ, LHV	9.64E-08	1.07E-09	1.75E-10	0	0	5.34E-10	0	4.92E-10	**9.87E-08**
SM	kg	2.69E-01	0	0	0	0	0	0	0	**2.69E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.76E-01	3.62E-05	5.97E-05	0	0	1.81E-05	0	2.45E-05	**3.76E-01**
ADPf	MJ, LHV	2.51E+01	2.66E-01	6.05E-02	0	0	1.33E-01	0	1.91E-01	**2.58E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	9.27E-02	0.00E+00	3.70E-02	0	0	0.00E+00	0	5.90E-01	**7.19E-01**
HLRW	kg	1.67E-06	7.80E-10	4.55E-09	0	0	3.90E-10	0	2.44E-09	**1.68E-06**
ILLRW	kg	1.60E-03	6.57E-07	3.81E-06	0	0	3.29E-07	0	2.18E-06	**1.61E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	8.16E-03	0	0	0	0	0	**8.16E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.39E-01	0	0	0	0	0	0	0	**2.39E-01**
BCEP	kg CO_2	1.03E-01	0	0	0	0	0	0	1.01E-03	**1.04E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.2 JetSpray™ Thermal Spray-On Insulation System

Table 65 shows resource use, output and waste flows, and carbon emissions and removals for JetSpray™ Thermal Spray-On Insulation System per functional unit.

Table 65. Resource use, output and waste flows, and carbon emissions and removals for JetSpray™ Thermal Spray-On Insulation System per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.33E+00	1.41E-02	2.65E-03	0	0	7.60E-03	0	3.37E-02	**5.38E+00**
RPRm	MJ, LHV	4.28E-08	-1.17E-12	6.22E-13	0	0	-6.29E-13	0	6.70E-12	**4.28E-08**
NRPRe	MJ, LHV	2.59E+01	3.63E-01	1.74E-02	0	0	1.95E-01	0	2.87E-01	**2.67E+01**
NRPRm	MJ, LHV	6.20E-08	1.45E-09	4.27E-11	0	0	7.78E-10	0	7.17E-10	**6.50E-08**
SM	kg	5.45E-01	0	0	0	0	0	0	0	**5.45E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	4.70E-01	4.91E-05	1.46E-05	0	0	2.64E-05	0	3.56E-05	**4.70E-01**
ADPf	MJ, LHV	2.25E+01	3.60E-01	1.48E-02	0	0	1.94E-01	0	2.78E-01	**2.33E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	7.55E-03	0	9.12E-03	0	0	0	0	8.59E-01	**8.75E-01**
HLRW	kg	1.18E-06	1.06E-09	1.10E-09	0	0	5.68E-10	0	3.55E-09	**1.18E-06**
ILLRW	kg	1.20E-03	8.90E-07	9.25E-07	0	0	4.79E-07	0	3.18E-06	**1.21E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	2.01E-03	0	0	0	0	0	**2.01E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.32E-01	0	0	0	0	0	0	0	**1.32E-01**
BCEP	kg CO_2	1.42E-01	0	0	0	0	0	0	1.48E-03	**1.44E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

5.1.3 Jet Stream® Ultra Blowing Wool Insulation

5.1.3.1. Albion, MI

Table 66 shows resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool produced in Albion, MI per functional unit.

Table 66. Resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool Insulation produced in Albion, MI per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	1.05E+00	2.85E-03	5.36E-04	0	0	1.53E-03	0	6.79E-03	**1.06E+00**
RPRm	MJ, LHV	8.68E-09	-2.36E-13	1.26E-13	0	0	-1.27E-13	0	1.35E-12	**8.68E-09**
NRPRe	MJ, LHV	5.20E+00	7.32E-02	3.51E-03	0	0	3.94E-02	0	5.80E-02	**5.38E+00**
NRPRm	MJ, LHV	1.27E-08	2.92E-10	8.61E-12	0	0	1.57E-10	0	1.45E-10	**1.33E-08**
SM	kg	1.11E-01	0	0	0	0	0	0	0	**1.11E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	9.43E-02	9.90E-06	2.95E-06	0	0	5.33E-06	0	7.19E-06	**9.44E-02**
ADPf	MJ, LHV	4.54E+00	7.27E-02	2.98E-03	0	0	3.91E-02	0	5.62E-02	**4.71E+00**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.52E-03	0	1.84E-03	0	0	0	0	1.73E-01	**1.77E-01**
HLRW	kg	2.29E-07	2.13E-10	2.22E-10	0	0	1.15E-10	0	7.17E-10	**2.30E-07**
ILLRW	kg	2.36E-04	1.80E-07	1.87E-07	0	0	9.66E-08	0	6.41E-07	**2.37E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	4.06E-04	0	0	0	0	0	**4.06E-04**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.62E-02	0	0	0	0	0	0	0	**2.62E-02**
BCEP	kg CO_2	2.83E-02	0	0	0	0	0	0	2.98E-04	**2.86E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

5.1.3.2. Lanett, AL

Table 67 shows resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool produced in Lanett, AL per functional unit.

Table 67. Resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool Insulation produced in Lanett, AL per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	1.11E+00	2.85E-03	5.36E-04	0	0	1.53E-03	0	6.79E-03	**1.12E+00**
RPRm	MJ, LHV	2.95E-10	-2.36E-13	1.26E-13	0	0	-1.27E-13	0	1.35E-12	**2.97E-10**
NRPRe	MJ, LHV	6.45E+00	7.32E-02	3.51E-03	0	0	3.94E-02	0	5.80E-02	**6.63E+00**
NRPRm	MJ, LHV	1.70E-08	2.92E-10	8.61E-12	0	0	1.57E-10	0	1.45E-10	**1.76E-08**
SM	kg	5.89E-02	0	0	0	0	0	0	0	**5.89E-02**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.13E-01	9.90E-06	2.95E-06	0	0	5.33E-06	0	7.19E-06	**1.13E-01**
ADPf	MJ, LHV	5.65E+00	7.27E-02	2.98E-03	0	0	3.91E-02	0	5.62E-02	**5.82E+00**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	2.70E-02	0	1.84E-03	0	0	0	0	1.73E-01	**2.02E-01**
HLRW	kg	2.77E-07	2.13E-10	2.22E-10	0	0	1.15E-10	0	7.17E-10	**2.78E-07**
ILLRW	kg	2.85E-04	1.80E-07	1.87E-07	0	0	9.66E-08	0	6.41E-07	**2.86E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	4.06E-04	0	0	0	0	0	**4.06E-04**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	3.02E-02	0	0	0	0	0	0	0	**3.02E-02**
BCEP	kg CO_2	3.27E-02	0	0	0	0	0	0	2.98E-04	**3.30E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.3.3. Shasta Lake, CA

Table 68 shows resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool produced in Shasta Lake, CA per functional unit.

Table 68. Resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool Insulation produced in Shasta Lake, CA per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	1.98E+00	2.85E-03	5.36E-04	0	0	1.53E-03	0	6.79E-03	**1.99E+00**
RPRm	MJ, LHV	1.06E-08	-2.36E-13	1.26E-13	0	0	-1.27E-13	0	1.35E-12	**1.06E-08**
NRPRe	MJ, LHV	7.25E+00	7.32E-02	3.51E-03	0	0	3.94E-02	0	5.80E-02	**7.43E+00**
NRPRm	MJ, LHV	2.58E-08	2.92E-10	8.61E-12	0	0	1.57E-10	0	1.45E-10	**2.64E-08**
SM	kg	9.97E-02	0	0	0	0	0	0	0	**9.97E-02**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.06E-01	9.90E-06	2.95E-06	0	0	5.33E-06	0	7.19E-06	**1.06E-01**
ADPf	MJ, LHV	6.50E+00	7.27E-02	2.98E-03	0	0	3.91E-02	0	5.62E-02	**6.67E+00**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	4.80E-03	0	1.84E-03	0	0	0	0	1.73E-01	**1.80E-01**
HLRW	kg	2.58E-07	2.13E-10	2.22E-10	0	0	1.15E-10	0	7.17E-10	**2.59E-07**
ILLRW	kg	2.66E-04	1.80E-07	1.87E-07	0	0	9.66E-08	0	6.41E-07	**2.67E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	4.06E-04	0	0	0	0	0	**4.06E-04**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	3.08E-02	0	0	0	0	0	0	0	**3.08E-02**
BCEP	kg CO_2	3.31E-02	0	0	0	0	0	0	2.98E-04	**3.34E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.3.4. Shelbyville, IN

Table 69 shows resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool produced in Shelbyville, IN per functional unit.

Table 69. Resource use, output and waste flows, and carbon emissions and removals for Jet Stream® Ultra Blowing Wool Insulation produced in Shelbyville, IN per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	1.26E+00	2.85E-03	5.36E-04	0	0	1.53E-03	0	6.79E-03	**1.27E+00**
RPRm	MJ, LHV	1.71E-08	-2.36E-13	1.26E-13	0	0	-1.27E-13	0	1.35E-12	**1.71E-08**
NRPRe	MJ, LHV	7.01E+00	7.32E-02	3.51E-03	0	0	3.94E-02	0	5.80E-02	**7.19E+00**
NRPRm	MJ, LHV	1.49E-08	2.92E-10	8.61E-12	0	0	1.57E-10	0	1.45E-10	**1.55E-08**
SM	kg	1.04E-01	0	0	0	0	0	0	0	**1.04E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.23E-01	9.90E-06	2.95E-06	0	0	5.33E-06	0	7.19E-06	**1.23E-01**
ADPf	MJ, LHV	5.56E+00	7.27E-02	2.98E-03	0	0	3.91E-02	0	5.62E-02	**5.73E+00**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	2.72E-02	0	1.84E-03	0	0	0	0	1.73E-01	**2.02E-01**
HLRW	kg	5.48E-07	2.13E-10	2.22E-10	0	0	1.15E-10	0	7.17E-10	**5.49E-07**
ILLRW	kg	5.15E-04	1.80E-07	1.87E-07	0	0	9.66E-08	0	6.41E-07	**5.17E-04**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	4.06E-04	0	0	0	0	0	**4.06E-04**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.95E-02	0	0	0	0	0	0	0	**2.95E-02**
BCEP	kg CO_2	3.23E-02	0	0	0	0	0	0	2.98E-04	**3.26E-02**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.4. Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™

Tables 70-71 show resource use, output and waste flows, and carbon emissions and removals for Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™ per functional unit.

Table 70. Resource use, output and waste flows, and carbon emissions and removals for Wall and Ceiling Liner / AKOUSTI-SHIELD™ per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	9.12E+00	1.61E-02	2.34E-03	0	0	8.59E-03	0	3.80E-02	**9.18E+00**
RPRm	MJ, LHV	8.84E-06	-1.33E-12	5.08E-13	0	0	-7.11E-13	0	7.58E-12	**8.84E-06**
NRPRe	MJ, LHV	5.50E+01	4.13E-01	1.79E-02	0	0	2.21E-01	0	3.25E-01	**5.60E+01**
NRPRm	MJ, LHV	2.22E-07	1.64E-09	4.74E-11	0	0	8.79E-10	0	8.10E-10	**2.26E-07**
SM	kg	2.32E-01	0	0	0	0	0	0	0	**2.32E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	3.78E-01	5.58E-05	1.33E-05	0	0	2.99E-05	0	4.03E-05	**3.78E-01**
ADPf	MJ, LHV	4.83E+01	4.10E-01	1.60E-02	0	0	2.19E-01	0	3.15E-01	**4.92E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.37E-01	0	4.82E-02	0	0	0	0	8.69E-01	**1.05E+00**
HLRW	kg	2.52E-06	1.20E-09	8.00E-10	0	0	6.42E-10	0	4.02E-09	**2.53E-06**
ILLRW	kg	2.37E-03	1.01E-06	6.73E-07	0	0	5.42E-07	0	3.59E-06	**2.37E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	6.27E-02	0	0	0	0	0	**6.27E-02**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.82E-01	0	0	0	0	0	0	0	**2.82E-01**
BCEP	kg CO_2	1.44E-01	0	0	0	0	0	0	1.67E-03	**1.46E-01**
BCRK	kg CO_2	2.49E-02	0	0	0	0	0	0	0	**2.49E-02**
BCEK	kg CO_2	0	0	2.58E-03	0	0	0	0	0	**2.58E-03**
BCEW	kg CO_2	0	0	8.67E-04	0	0	0	0	0	**8.67E-04**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 71. Resource use, output and waste flows, and carbon emissions and removals for Atmosphere™ Duct Liner / AKOUSTI-LINER™ per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	1.27E+01	1.74E-02	3.80E-03	0	0	9.21E-03	0	4.08E-02	**1.27E+01**
RPRm	MJ, LHV	1.99E-05	-1.44E-12	8.59E-13	0	0	-7.62E-13	0	8.12E-12	**1.99E-05**
NRPRe	MJ, LHV	6.19E+01	4.46E-01	2.70E-02	0	0	2.36E-01	0	3.48E-01	**6.29E+01**
NRPRm	MJ, LHV	3.32E-07	1.78E-09	7.00E-11	0	0	9.42E-10	0	8.68E-10	**3.36E-07**
SM	kg	2.50E-01	0	0	0	0	0	0	0	**2.50E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	8.32E-01	6.03E-05	2.23E-05	0	0	3.20E-05	0	4.32E-05	**8.32E-01**
ADPf	MJ, LHV	5.32E+01	4.43E-01	2.34E-02	0	0	2.35E-01	0	3.37E-01	**5.42E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.48E-01	0	6.11E-02	0	0	0	0	9.39E-01	**1.15E+00**
HLRW	kg	3.13E-06	1.30E-09	1.51E-09	0	0	6.89E-10	0	4.31E-09	**3.14E-06**
ILLRW	kg	3.01E-03	1.09E-06	1.27E-06	0	0	5.80E-07	0	3.85E-06	**3.01E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	5.67E-02	0	0	0	0	0	**5.67E-02**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	5.28E-01	0	0	0	0	0	0	0	**5.28E-01**
BCEP	kg CO_2	2.17E-01	0	0	0	0	0	0	1.79E-03	**2.19E-01**
BCRK	kg CO_2	2.97E-02	0	0	0	0	0	0	0	**2.97E-02**
BCEK	kg CO_2	0	0	6.46E-04	0	0	0	0	0	**6.46E-04**
BCEW	kg CO_2	0	0	1.00E-03	0	0	0	0	0	**1.00E-03**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.5. KN Series Insulation

5.1.5.1. Lanett, AL

Table 72 shows resource use, output and waste flows, and carbon emissions and removals for KN Series Insulation produced in Lanett, AL per functional unit.

Table 72. Resource use, output and waste flows, and carbon emissions and removals for KN Series Insulation produced in Lanett, AL per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	6.29E+00	1.30E-02	3.33E-03	0	0	6.98E-03	0	3.09E-02	**6.35E+00**
RPRm	MJ, LHV	3.28E-06	-1.08E-12	7.81E-13	0	0	-5.78E-13	0	6.16E-12	**3.28E-06**
NRPRe	MJ, LHV	2.85E+01	3.35E-01	2.17E-02	0	0	1.79E-01	0	2.64E-01	**2.93E+01**
NRPRm	MJ, LHV	1.32E-07	1.33E-09	5.32E-11	0	0	7.15E-10	0	6.58E-10	**1.35E-07**
SM	kg	1.87E-01	0	0	0	0	0	0	0	**1.87E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	5.34E-01	4.53E-05	1.82E-05	0	0	2.43E-05	0	3.27E-05	**5.34E-01**
ADPf	MJ, LHV	2.46E+01	3.33E-01	1.84E-02	0	0	1.78E-01	0	2.56E-01	**2.54E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.23E-01	0	1.17E-02	0	0	0	0	7.89E-01	**9.23E-01**
HLRW	kg	1.32E-06	9.75E-10	1.39E-09	0	0	5.22E-10	0	3.27E-09	**1.33E-06**
ILLRW	kg	1.35E-03	8.22E-07	1.16E-06	0	0	4.40E-07	0	2.92E-06	**1.36E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	2.58E-03	0	0	0	0	0	**2.58E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.36E-01	0	0	0	0	0	0	0	**2.36E-01**
BCEP	kg CO_2	1.53E-01	0	0	0	0	0	0	1.36E-03	**1.54E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

5.1.5.2. Shelbyville, IN

Table 73 shows resource use, output and waste flows, and carbon emissions and removals for KN Series Insulation produced in Shelbyville, IN per functional unit.

Table 73. Resource use, output and waste flows, and carbon emissions and removals for KN Series Insulation produced in Shelbyville, IN per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	7.19E+00	1.30E-02	3.33E-03	0	0	6.98E-03	0	3.09E-02	**7.25E+00**
RPRm	MJ, LHV	1.51E-05	-1.08E-12	7.81E-13	0	0	-5.77E-13	0	6.16E-12	**1.51E-05**
NRPRe	MJ, LHV	3.58E+01	3.35E-01	2.17E-02	0	0	1.79E-01	0	2.64E-01	**3.66E+01**
NRPRm	MJ, LHV	1.34E-07	1.33E-09	5.32E-11	0	0	7.14E-10	0	6.58E-10	**1.37E-07**
SM	kg	3.30E-01	0	0	0	0	0	0	0	**3.30E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	6.18E-01	4.53E-05	1.82E-05	0	0	2.43E-05	0	3.27E-05	**6.18E-01**
APDf	MJ, LHV	2.91E+01	3.33E-01	1.84E-02	0	0	1.78E-01	0	2.56E-01	**2.99E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	1.24E-01	0	1.17E-02	0	0	0	0	7.89E-01	**9.24E-01**
HLRW	kg	2.41E-06	9.75E-10	1.39E-09	0	0	5.22E-10	0	3.26E-09	**2.41E-06**
ILLRW	kg	2.30E-03	8.22E-07	1.16E-06	0	0	4.40E-07	0	2.92E-06	**2.30E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	2.58E-03	0	0	0	0	0	**2.58E-03**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	2.41E-01	0	0	0	0	0	0	0	**2.41E-01**
BCEP	kg CO_2	1.57E-01	0	0	0	0	0	0	1.36E-03	**1.58E-01**
BCRK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEK	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
BCEW	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.1.6. Acoustical Smooth Board

Table 74 shows resource use, output and waste flows, and carbon emissions and removals for Acoustical Smooth Board per functional unit.

Table 74. Resource use, output and waste flows, and carbon emissions and removals for Acoustical Smooth Board per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	5.02E+01	5.76E-02	8.36E-03	0	0	2.72E-02	0	1.20E-01	**5.04E+01**
RPRm	MJ, LHV	1.70E-07	-4.76E-12	8.77E-13	0	0	-2.25E-12	0	2.40E-11	**1.70E-07**
NRPRe	MJ, LHV	1.34E+02	1.48E+00	1.28E-01	0	0	6.98E-01	0	1.03E+00	**1.37E+02**
NRPRm	MJ, LHV	1.39E-06	5.89E-09	4.43E-10	0	0	2.78E-09	0	2.56E-09	**1.40E-06**
SM	kg	8.65E-01	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**8.65E-01**
RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
FW	m^3	2.63E+00	2.00E-04	9.77E-05	0	0	9.45E-05	0	1.27E-04	**2.63E+00**
ADPf	MJ, LHV	1.07E+02	1.47E+00	1.25E-01	0	0	6.94E-01	0	9.96E-01	**1.11E+02**
Output flows and waste category indicators										
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
NHWD	kg	4.83E-01	0.00E+00	9.78E-02	0	0	0.00E+00	0	3.07E+00	**3.65E+00**
HLRW	kg	9.29E-06	4.30E-09	1.19E-09	0	0	2.03E-09	0	1.27E-08	**9.31E-06**
ILLRW	kg	9.04E-03	3.63E-06	1.02E-06	0	0	1.71E-06	0	1.14E-05	**9.06E-03**
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
MR	kg	0.00E+00	0.00E+00	3.59E-01	0	0	0.00E+00	0	0.00E+00	**3.59E-01**
MER	kg	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
EE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	1.80E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**1.80E+00**
BCEP	kg CO_2	6.56E-01	0.00E+00	0.00E+00	0	0	0.00E+00	0	5.28E-03	**6.61E-01**
BCRK	kg CO_2	9.15E-01	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**9.15E-01**
BCEK	kg CO_2	0.00E+00	0.00E+00	2.06E-02	0	0	0.00E+00	0	0.00E+00	**2.06E-02**
BCEW	kg CO_2	0.00E+00	0.00E+00	3.28E-02	0	0	0.00E+00	0	0.00E+00	**3.28E-02**
CCE	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
CCR	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**
CWR + CWNR	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0	0	0.00E+00	0	0.00E+00	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

5.1.7. Black Acoustical Board / Akousti-Board Black™

Table 75 shows resource use, output and waste flows, and carbon emissions and removals for Black Acoustical Board / Akousti-Board Black™ per functional unit.

Table 75. Resource use, output and waste flows, and carbon emissions and removals for Black Acoustical Board / Akousti-Board Black™ per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	2.00E+01	2.69E-02	1.03E-03	0	0	1.42E-02	0	6.28E-02	**2.01E+01**
RPRm	MJ, LHV	9.25E-08	-2.22E-12	1.16E-13	0	0	-1.17E-12	0	1.25E-11	**9.25E-08**
NRPRe	MJ, LHV	6.41E+01	6.90E-01	1.51E-02	0	0	3.64E-01	0	5.36E-01	**6.57E+01**
NRPRm	MJ, LHV	5.18E-07	2.75E-09	5.20E-11	0	0	1.45E-09	0	1.34E-09	**5.24E-07**
SM	kg	4.66E-01	0	0	0	0	0	0	0	**4.66E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.29E+00	9.34E-05	1.14E-05	0	0	4.93E-05	0	6.65E-05	**1.29E+00**
ADPf	MJ, LHV	5.12E+01	6.85E-01	1.47E-02	0	0	3.62E-01		5.20E-01	**5.28E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	2.36E-01	0	3.22E-02	0	0	0	0	1.50E+00	**1.77E+00**
HLRW	kg	4.64E-06	2.01E-09	1.66E-10	0	0	1.06E-09	0	6.64E-09	**4.65E-06**
ILLRW	kg	4.48E-03	1.69E-06	1.42E-07	0	0	8.94E-07	0	5.93E-06	**4.49E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	1.18E-01	0	0	0	0	0	**1.18E-01**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	8.40E-01	0	0	0	0	0	0	0	**8.40E-01**
BCEP	kg CO_2	3.25E-01	0	0	0	0	0	0	2.76E-03	**3.28E-01**
BCRK	kg CO_2	1.06E-01	0	0	0	0	0	0	0	**1.06E-01**
BCEK	kg CO_2	0	0	2.38E-03	0	0	0	0	0	**2.38E-03**
BCEW	kg CO_2	0	0	3.80E-03	0	0	0	0	0	**3.80E-03**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

5.1.8. Earthwool® Insulation Board / AK BOARD™

Tables 76-78 show resource use, output and waste flows, and carbon emissions and removals for all faced and unfaced options for Earthwool® Insulation Board / AK BOARD™ per functional unit.

Table 76. Resource use, output and waste flows, and carbon emissions and removals for unfaced Earthwool® Insulation Board / AK BOARD™ per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	2.72E+01	3.30E-02	6.62E-03	0	0	1.52E-02	0	6.71E-02	**2.73E+01**
RPRm	MJ, LHV	1.11E-07	-2.73E-12	8.39E-13	0	0	-1.25E-12	0	1.34E-11	**1.11E-07**
NRPRe	MJ, LHV	7.38E+01	8.47E-01	9.13E-02	0	0	3.89E-01	0	5.73E-01	**7.57E+01**
NRPRm	MJ, LHV	7.22E-07	3.37E-09	3.09E-10	0	0	1.55E-09	0	1.43E-09	**7.29E-07**
SM	kg	5.87E-01	0	0	0	0	0	0	0	**5.87E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.41E+00	1.15E-04	6.95E-05	0	0	5.27E-05	0	7.10E-05	**1.41E+00**
ADPf	MJ, LHV	5.93E+01	8.41E-01	8.83E-02	0	0	3.87E-01		5.55E-01	**6.11E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	2.69E-01	0	6.77E-02	0	0	0	0	1.71E+00	**2.05E+00**
HLRW	kg	5.24E-06	2.47E-09	1.26E-09	0	0	1.13E-09	0	7.09E-09	**5.25E-06**
ILLRW	kg	5.07E-03	2.08E-06	1.07E-06	0	0	9.55E-07	0	6.34E-06	**5.08E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	2.39E-01	0	0	0	0	0	**2.39E-01**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	8.51E-01	0	0	0	0	0	0	0	**8.51E-01**
BCEP	kg CO_2	3.54E-01	0	0	0	0	0	0	2.94E-03	**3.57E-01**
BCRK	kg CO_2	6.06E-01	0	0	0	0	0	0	0	**6.06E-01**
BCEK	kg CO_2	0	0	1.37E-02	0	0	0	0	0	**1.37E-02**
BCEW	kg CO_2	0	0	2.18E-02	0	0	0	0	0	**2.18E-02**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

- [RPRE - Renewable primary energy used as energy carrier (fuel)];
- [RPRM - Renewable primary resources with energy content used as material];
- [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)];
- [NRPRM - Non-renewable primary resources with energy content used as material];
- [SM - Secondary materials];
- [RSF - Renewable secondary fuels];
- [NRSF - Non-renewable secondary fuels];
- [RE - Recovered energy];
- [FW - Use of net fresh water resources]
- [ADPf - Abiotic depletion potential, fossil]
- [HWD - Hazardous waste disposed];
- [NHWD - Non-hazardous waste disposed];
- [HLRW - High-level radioactive waste, conditioned, to final repository];
- [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository];
- [CRU - Components for re-use];
- [MR - Materials for recycling];
- [MER - Materials for energy recovery];
- [EE - Exported energy];
- [BCRP - Biogenic Carbon Removal from Product];
- [BCEP - Biogenic Carbon Emission from Product];
- [BCRK - Biogenic Carbon Removal from Packaging];
- [BCEK - Biogenic Carbon Emission from Packaging];
- [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes];
- [CCE - Calcination Carbon Emissions];
- [CCR - Carbonation Carbon Removals];
- [CWR - Carbon Emissions from Combustion of Waste from Renewable Sources used in Production Processes]
- [CWNR - Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes]

Table 77. Resource use, output and waste flows, and carbon emissions and removals for FSK-faced Earthwool® Insulation Board / AK BOARD™ per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	2.13E+01	3.54E-02	7.11E-03	0	0	1.63E-02	0	7.20E-02	**2.14E+01**
RPRm	MJ, LHV	1.90E-07	-2.93E-12	9.01E-13	0	0	-1.35E-12	0	1.43E-11	**1.90E-07**
NRPRe	MJ, LHV	1.01E+02	9.09E-01	9.81E-02	0	0	4.18E-01	0	6.15E-01	**1.03E+02**
NRPRm	MJ, LHV	5.84E-07	3.62E-09	3.32E-10	0	0	1.66E-09	0	1.53E-09	**5.91E-07**
SM	kg	6.30E-01	0	0	0	0	0	0	0	**6.30E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.46E+00	1.23E-04	7.47E-05	0	0	5.65E-05	0	7.62E-05	**1.46E+00**
ADPf	MJ, LHV	8.50E+01	9.03E-01	9.48E-02	0	0	4.15E-01	0	5.96E-01	**8.70E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	2.89E-01	0	7.27E-02	0	0	0	0	1.84E+00	**2.20E+00**
HLRW	kg	5.79E-06	2.65E-09	1.35E-09	0	0	1.22E-09	0	7.61E-09	**5.80E-06**
ILLRW	kg	5.51E-03	2.23E-06	1.15E-06	0	0	1.03E-06	0	6.81E-06	**5.52E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	2.57E-01	0	0	0	0	0	**2.57E-01**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	8.80E-01	0	0	0	0	0	0	0	**8.80E-01**
BCEP	kg CO_2	3.66E-01	0	0	0	0	0	0	3.16E-03	**3.69E-01**
BCRK	kg CO_2	1.25E-02	0	0	0	0	0	0	0	**1.25E-02**
BCEK	kg CO_2	0	0	1.47E-02	0	0	0	0	0	**1.47E-02**
BCEW	kg CO_2	0	0	2.34E-02	0	0	0	0	0	**2.34E-02**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

Table 78. Resource use, output and waste flows, and carbon emissions and removals for ASJ+-faced Earthwool® Insulation Board / AK BOARD™ per functional unit

	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Resource use indicators										
RPRe	MJ, LHV	2.40E+01	3.72E-02	7.48E-03	0	0	1.71E-02	0	7.58E-02	**2.41E+01**
RPRm	MJ, LHV	1.03E-05	-3.08E-12	9.47E-13	0	0	-1.42E-12	0	1.51E-11	**1.03E-05**
NRPRe	MJ, LHV	1.11E+02	9.56E-01	1.03E-01	0	0	4.39E-01	0	6.47E-01	**1.13E+02**
NRPRm	MJ, LHV	6.31E-07	3.81E-09	3.49E-10	0	0	1.75E-09	0	1.61E-09	**6.39E-07**
SM	kg	6.62E-01	0	0	0	0	0	0	0	**6.62E-01**
RSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
RE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
FW	m^3	1.57E+00	1.29E-04	7.85E-05	0	0	5.95E-05	0	8.02E-05	**1.57E+00**
ADPf	MJ, LHV	9.36E+01	9.49E-01	9.97E-02	0	0	4.36E-01	0	6.27E-01	**9.57E+01**
Output flows and waste category indicators										
HWD	kg	0	0	0	0	0	0	0	0	**0.00E+00**
NHWD	kg	3.04E-01	0	7.64E-02	0	0	0	0	1.93E+00	**2.31E+00**
HLRW	kg	6.34E-06	2.78E-09	1.42E-09	0	0	1.28E-09	0	8.00E-09	**6.35E-06**
ILLRW	kg	6.05E-03	2.35E-06	1.21E-06	0	0	1.08E-06	0	7.16E-06	**6.06E-03**
CRU	kg	0	0	0	0	0	0	0	0	**0.00E+00**
MR	kg	0	0	2.70E-01	0	0	0	0	0	**2.70E-01**
MER	kg	0	0	0	0	0	0	0	0	**0.00E+00**
EE	MJ, LHV	0	0	0	0	0	0	0	0	**0.00E+00**
Carbon emissions and removals										
BCRP	kg CO_2	9.46E-01	0	0	0	0	0	0	0	**9.46E-01**
BCEP	kg CO_2	3.93E-01	0	0	0	0	0	0	3.32E-03	**3.97E-01**
BCRK	kg CO_2	1.32E-02	0	0	0	0	0	0	0	**1.32E-02**
BCEK	kg CO_2	0	0	1.54E-02	0	0	0	0	0	**1.54E-02**
BCEW	kg CO_2	0	0	2.46E-02	0	0	0	0	0	**2.46E-02**
CCE	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CCR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**
CWR + CWNR	kg CO_2	0	0	0	0	0	0	0	0	**0.00E+00**

5.2 Life cycle impact assessment (LCIA)

It shall be reiterated at this point that the reported impact categories represent impact potentials; they are approximations of environmental impacts that could occur if the emitted substances would follow the underlying impact pathway and meet certain conditions in the receiving environment while doing so. In addition, the inventory only captures that fraction of the total environmental load that corresponds to the chosen declared unit (relative approach). LCIA results are therefore relative expressions only and do not predict actual impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.

Life cycle impact assessment (LCIA) results are shown for KINA's insulation products. Unlike life cycle inventories, which only report sums for individual inventory flows, the LCIA includes a classification of individual emissions with regard to the impacts they are associated with and subsequently a characterization of the emissions by a factor expressing their respective contribution to the impact category indicator. The end result is a single metric for quantifying each potential impact, such as "Global Warming Potential".

The impact assessment results are calculated using characterization factors published by the United States Environmental Protection Agency. The TRACI 2.1 (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.1) methodology is the most widely applied impact assessment method for U.S. LCA studies. The SM 2013 Methodology is also applied to calculate single score results for the sole purpose of representing total impacts per life cycle phase to explain where in the product life cycle greatest impacts are occurring and what is contributing to the impacts.

The six impact categories required by the PCR 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. Impact categories which were not required by the PCR are included in part to allow for the calculation of millipoints using the SM2013 Methodology, but it should be noted that there are known limitations related to these impact categories due to their high degree of uncertainty.

In this section, we present the results of the life cycle impact assessment (LCIA) using TRACI, which quantifies the potential environmental impacts associated with the product under study. By evaluating a comprehensive range of environmental categories, we provide a robust and insightful understanding of the overall ecological footprint. The findings outlined below serve as a valuable resource for decision-makers, enabling them to identify areas for improvement and optimize resource allocation, ultimately contributing to more sustainable practices. Tables 79-162 show the contributions of each stage of the life cycle and the single score results for KINA insulation products per functional unit.

5.2.1.EcoBatt® and EcoRoll® Insulation

5.2.1.1. Albion, MI

Tables 79-86 show the LCIA results and contributions of each stage of the life cycle for the four facing options for EcoBatt® and EcoRoll® Insulation produced in Albion, MI: unfaced, kraft-faced, FSK-faced, and foil-faced. The SM millipoint score by life cycle phase for this product is presented in Table 87.

Table 79. LCIA results for unfaced EcoBatt® and EcoRoll® Insulation produced in Albion, MI per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.75E-11	9.23E-14	3.58E-17	2.73E-16	0	0	1.76E-17	0	5.06E-16	**2.76E-11**
Global warming	kg CO_2 eq	1.23E-01	8.74E-01	1.60E-02	2.70E-02	0	0	7.89E-03	0	1.03E-02	**1.06E+00**
Smog (SFP)	kg O_3 eq	7.06E-03	2.48E-02	2.82E-03	2.10E-04	0	0	4.93E-04	0	9.95E-04	**3.64E-02**
Acidification (AP)	kg SO_2 eq	6.35E-04	1.33E-03	8.23E-05	1.61E-05	0	0	2.16E-05	0	5.46E-05	**2.14E-03**
Eutrophication (EP)	kg N eq	1.88E-04	3.37E-04	7.05E-06	7.45E-06	0	0	2.29E-06	0	2.39E-06	**5.44E-04**
Fossil fuel depletion	MJ surplus	2.57E-01	1.66E+00	3.01E-02	6.56E-03	0	0	1.48E-02	0	2.07E-02	**1.99E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.93E-05	7.32E-05	4.02E-06	7.97E-07	0	0	9.26E-07	0	4.21E-06	**1.32E-04**
Carcinogenics	CTUh	4.3%	92.1%	0.3%	0.4%	0	0	0.1%	0	2.9%	**100.0%**
Non-carcinogenics	CTUh	8.5%	82.5%	0.5%	1.2%	0	0	0.3%	0	7.1%	**100.0%**
Ecotoxicity	CTUe	13.5%	84.3%	1.0%	0.4%	0	0	0.5%	0	0.5%	**100.0%**

Table 80. Percent contributions of each life cycle stage of unfaced EcoBatt® and EcoRoll® Insulation produced in Albion, MI to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	99.7%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	11.6%	82.6%	1.5%	2.6%	0.0%	0.0%	0.7%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	19.4%	68.2%	7.8%	0.6%	0.0%	0.0%	1.4%	0.0%	2.7%
Acidification (AP)	kg SO_2 eq	29.6%	62.2%	3.8%	0.8%	0.0%	0.0%	1.0%	0.0%	2.5%
Eutrophication (EP)	kg N eq	34.6%	61.9%	1.3%	1.4%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	13.0%	83.4%	1.5%	0.3%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	37.2%	55.2%	3.0%	0.6%	0.0%	0.0%	0.7%	0.0%	3.2%
Carcinogenics	CTUh	4.3%	92.1%	0.3%	0.4%	0.0%	0.0%	0.1%	0.0%	2.9%
Non-carcinogenics	CTUh	8.5%	82.5%	0.5%	1.2%	0.0%	0.0%	0.3%	0.0%	7.1%
Ecotoxicity	CTUe	13.5%	84.3%	1.0%	0.4%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 81. LCIA results for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Albion, MI per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.61E-11	4.08E-09	4.14E-17	2.72E-16	0	0	2.07E-17	0	5.94E-16	**4.11E-09**
Global warming	kg CO_2 eq	1.17E-01	8.89E-01	1.86E-02	2.69E-02	0	0	9.27E-03	0	1.21E-02	**1.07E+00**
Smog (SFP)	kg O_3 eq	6.69E-03	3.12E-02	3.27E-03	2.09E-04	0	0	5.79E-04	0	1.17E-03	**4.31E-02**
Acidification (AP)	kg SO_2 eq	6.02E-04	1.72E-03	9.52E-05	1.60E-05	0	0	2.54E-05	0	6.41E-05	**2.52E-03**
Eutrophication (EP)	kg N eq	1.78E-04	4.14E-04	8.16E-06	7.43E-06	0	0	2.69E-06	0	2.81E-06	**6.14E-04**
Fossil fuel depletion	MJ surplus	2.44E-01	1.93E+00	3.48E-02	6.54E-03	0	0	1.74E-02	0	2.43E-02	**2.26E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.68E-05	1.00E-04	4.65E-06	7.94E-07	0	0	1.09E-06	0	4.94E-06	**1.58E-04**
Carcinogenics	CTUh	4.1%	91.6%	0.3%	0.4%	0	0	0.2%	0	3.4%	**100.0%**
Non-carcinogenics	CTUh	7.8%	82.0%	0.6%	1.1%	0	0	0.3%	0	8.1%	**100.0%**
Ecotoxicity	CTUe	12.6%	84.8%	1.1%	0.3%	0	0	0.6%	0	0.5%	**100.0%**

Table 82. Percent contributions of each life cycle stage of kraft-faced EcoBatt® and EcoRoll® Insulation produced in Albion, MI to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.6%	99.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	10.9%	82.9%	1.7%	2.5%	0.0%	0.0%	0.9%	0.0%	1.1%
Smog (SFP)	kg O_3 eq	15.5%	72.4%	7.6%	0.5%	0.0%	0.0%	1.3%	0.0%	2.7%
Acidification (AP)	kg SO_2 eq	23.9%	68.2%	3.8%	0.6%	0.0%	0.0%	1.0%	0.0%	2.5%
Eutrophication (EP)	kg N eq	29.1%	67.5%	1.3%	1.2%	0.0%	0.0%	0.4%	0.0%	0.5%
Fossil fuel depletion	MJ surplus	10.8%	85.5%	1.5%	0.3%	0.0%	0.0%	0.8%	0.0%	1.1%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	29.6%	63.2%	2.9%	0.5%	0.0%	0.0%	0.7%	0.0%	3.1%
Carcinogenics	CTUh	4.1%	91.6%	0.3%	0.4%	0.0%	0.0%	0.2%	0.0%	3.4%
Non-carcinogenics	CTUh	7.8%	82.0%	0.6%	1.1%	0.0%	0.0%	0.3%	0.0%	8.1%
Ecotoxicity	CTUe	12.6%	84.8%	1.1%	0.3%	0.0%	0.0%	0.6%	0.0%	0.5%

Table 83. LCIA results for FSK-faced EcoBatt® Insulation produced in Albion, MI per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.62E-11	2.82E-09	4.38E-17	2.64E-16	0	0	2.21E-17	0	6.33E-16	**2.85E-09**
Global warming	kg CO_2 eq	1.17E-01	1.33E+00	1.96E-02	2.61E-02	0	0	9.88E-03	0	1.29E-02	**1.51E+00**
Smog (SFP)	kg O_3 eq	6.72E-03	4.79E-02	3.45E-03	2.03E-04	0	0	6.17E-04	0	1.25E-03	**6.01E-02**
Acidification (AP)	kg SO_2 eq	6.05E-04	3.31E-03	1.01E-04	1.55E-05	0	0	2.70E-05	0	6.83E-05	**4.13E-03**
Eutrophication (EP)	kg N eq	1.79E-04	4.49E-04	8.63E-06	7.20E-06	0	0	2.86E-06	0	2.99E-06	**6.49E-04**
Fossil fuel depletion	MJ surplus	2.45E-01	2.39E+00	3.68E-02	6.34E-03	0	0	1.85E-02	0	2.59E-02	**2.73E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.70E-05	2.16E-04	4.92E-06	7.70E-07	0	0	1.16E-06	0	5.27E-06	**2.75E-04**
Carcinogenics	CTUh	3.4%	92.8%	0.3%	0.3%	0	0	0.2%	0	3.0%	**100.0%**
Non-carcinogenics	CTUh	5.8%	86.3%	0.5%	0.8%	0	0	0.2%	0	6.4%	**100.0%**
Ecotoxicity	CTUe	11.6%	86.0%	1.1%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 84. Percent contributions of each life cycle stage of FSK-faced EcoBatt® Insulation produced in Albion, MI to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.9%	99.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	7.7%	87.7%	1.3%	1.7%	0.0%	0.0%	0.7%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	11.2%	79.6%	5.7%	0.3%	0.0%	0.0%	1.0%	0.0%	2.1%
Acidification (AP)	kg SO_2 eq	14.6%	80.2%	2.4%	0.4%	0.0%	0.0%	0.7%	0.0%	1.7%
Eutrophication (EP)	kg N eq	27.6%	69.1%	1.3%	1.1%	0.0%	0.0%	0.4%	0.0%	0.5%
Fossil fuel depletion	MJ surplus	9.0%	87.8%	1.3%	0.2%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	17.1%	78.5%	1.8%	0.3%	0.0%	0.0%	0.4%	0.0%	1.9%
Carcinogenics	CTUh	3.4%	92.8%	0.3%	0.3%	0.0%	0.0%	0.2%	0.0%	3.0%
Non-carcinogenics	CTUh	5.8%	86.3%	0.5%	0.8%	0.0%	0.0%	0.2%	0.0%	6.4%
Ecotoxicity	CTUe	11.6%	86.0%	1.1%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 85. LCIA results for foil-faced EcoBatt® Insulation produced in Albion, MI per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.76E-11	2.19E-09	4.22E-17	2.72E-16	0	0	2.11E-17	0	6.06E-16	**2.22E-09**
Global warming	kg CO_2 eq	1.23E-01	1.12E+00	1.89E-02	2.69E-02	0	0	9.46E-03	0	1.23E-02	**1.31E+00**
Smog (SFP)	kg O_3 eq	7.07E-03	3.74E-02	3.33E-03	2.09E-04	0	0	5.91E-04	0	1.19E-03	**4.98E-02**
Acidification (AP)	kg SO_2 eq	6.36E-04	2.12E-03	9.70E-05	1.60E-05	0	0	2.59E-05	0	6.54E-05	**2.96E-03**
Eutrophication (EP)	kg N eq	1.89E-04	4.15E-04	8.32E-06	7.43E-06	0	0	2.74E-06	0	2.87E-06	**6.25E-04**
Fossil fuel depletion	MJ surplus	2.58E-01	2.42E+00	3.55E-02	6.54E-03	0	0	1.78E-02	0	2.48E-02	**2.76E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.95E-05	1.25E-04	4.74E-06	7.94E-07	0	0	1.11E-06	0	5.05E-06	**1.86E-04**
Carcinogenics	CTUh	3.8%	92.4%	0.3%	0.3%	0	0	0.1%	0	3.0%	**100.0%**
Non-carcinogenics	CTUh	6.7%	84.9%	0.5%	0.9%	0	0	0.3%	0	6.7%	**100.0%**
Ecotoxicity	CTUe	12.0%	85.7%	1.0%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 86. Percent contributions of each life cycle stage of foil-faced EcoBatt® Insulation produced in Albion, MI to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	1.2%	98.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	9.4%	85.4%	1.4%	2.1%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	14.2%	75.1%	6.7%	0.4%	0.0%	0.0%	1.2%	0.0%	2.4%
Acidification (AP)	kg SO_2 eq	21.5%	71.6%	3.3%	0.5%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	30.2%	66.4%	1.3%	1.2%	0.0%	0.0%	0.4%	0.0%	0.5%
Fossil fuel depletion	MJ surplus	9.4%	87.6%	1.3%	0.2%	0.0%	0.0%	0.6%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	26.6%	67.2%	2.5%	0.4%	0.0%	0.0%	0.6%	0.0%	2.7%
Carcinogenics	CTUh	3.8%	92.4%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	3.0%
Non-carcinogenics	CTUh	6.7%	84.9%	0.5%	0.9%	0.0%	0.0%	0.3%	0.0%	6.7%
Ecotoxicity	CTUe	12.0%	85.7%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 87. SM millipoint scores for faced and unfaced EcoBatt® and EcoRoll® Insulation produced in Albion, MI by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
Unfaced - SM single figure score	mPts	3.28E-03	7.38E-03	2.97E-04	1.39E-04	3.75E-04	**1.15E-02**
Kraft-faced - SM single figure score	mPts	3.11E-03	8.99E-03	3.44E-04	1.38E-04	4.40E-04	**1.30E-02**
FSK-faced - SM single figure score	mPts	3.12E-03	1.72E-02	3.64E-04	1.34E-04	4.69E-04	**2.13E-02**
Foil-faced - SM single figure score	mPts	3.29E-03	1.13E-02	3.50E-04	1.38E-04	4.50E-04	**1.55E-02**

5.2.1.2. Inwood, WV

Tables 88-95 show the contributions of each stage of the life cycle for the four facing options for EcoBatt® and EcoRoll® Insulation produced in Inwood, WV: unfaced, kraft-faced, FSK-faced, and foil-faced. The SM millipoint score by life cycle phase for this product is presented in Table 96.

Table 88. LCIA results for unfaced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV per functional unit

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**Total**
Ozone depletion (ODP)	kg CFC-11 eq	5.57E-14	8.60E-14	3.58E-17	2.73E-16	0	0	1.76E-17	0	5.06E-16	**1.43E-13**
Global warming	kg CO_2 eq	2.27E-01	9.28E-01	1.60E-02	2.70E-02	0	0	7.89E-03	0	1.03E-02	**1.22E+00**
Smog (SFP)	kg O_3 eq	1.29E-02	3.99E-02	2.82E-03	2.10E-04	0	0	4.93E-04	0	9.95E-04	**5.73E-02**
Acidification (AP)	kg SO_2 eq	1.24E-03	1.73E-03	8.23E-05	1.61E-05	0	0	2.16E-05	0	5.46E-05	**3.15E-03**
Eutrophication (EP)	kg N eq	2.69E-04	3.44E-04	7.05E-06	7.45E-06	0	0	2.29E-06	0	2.39E-06	**6.32E-04**
Fossil fuel depletion	MJ surplus	3.48E-01	1.76E+00	3.01E-02	6.56E-03	0	0	1.48E-02	0	2.07E-02	**2.18E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	9.08E-05	7.70E-05	4.02E-06	7.97E-07	0	0	9.26E-07	0	4.21E-06	**1.78E-04**
Carcinogenics	CTUh	5.8%	90.4%	0.3%	0.4%	0	0	0.1%	0	2.9%	**100.0%**
Non-carcinogenics	CTUh	11.9%	79.3%	0.5%	1.1%	0	0	0.3%	0	6.8%	**100.0%**
Ecotoxicity	CTUe	16.8%	81.0%	1.0%	0.3%	0	0	0.5%	0	0.4%	**100.0%**

Table 89. Percent contributions of each life cycle stage of unfaced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV to each impact category

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**
Ozone depletion (ODP)	kg CFC-11 eq	39.1%	60.4%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.4%
Global warming	kg CO_2 eq	18.7%	76.3%	1.3%	2.2%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	22.5%	69.7%	4.9%	0.4%	0.0%	0.0%	0.9%	0.0%	1.7%
Acidification (AP)	kg SO_2 eq	39.4%	55.0%	2.6%	0.5%	0.0%	0.0%	0.7%	0.0%	1.7%
Eutrophication (EP)	kg N eq	42.5%	54.5%	1.1%	1.2%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	16.0%	80.7%	1.4%	0.3%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	51.1%	43.3%	2.3%	0.4%	0.0%	0.0%	0.5%	0.0%	2.4%
Carcinogenics	CTUh	5.8%	90.4%	0.3%	0.4%	0.0%	0.0%	0.1%	0.0%	2.9%
Non-carcinogenics	CTUh	11.9%	79.3%	0.5%	1.1%	0.0%	0.0%	0.3%	0.0%	6.8%
Ecotoxicity	CTUe	16.8%	81.0%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.4%

Table 90. LCIA results for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV per functional unit

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**Total**
Ozone depletion (ODP)	kg CFC-11 eq	5.57E-14	4.26E-09	4.14E-17	2.72E-16	0	0	2.07E-17	0	5.94E-16	**4.26E-09**
Global warming	kg CO_2 eq	2.27E-01	9.81E-01	1.86E-02	2.69E-02	0	0	9.27E-03	0	1.21E-02	**1.28E+00**
Smog (SFP)	kg O_3 eq	1.29E-02	4.76E-02	3.27E-03	2.09E-04	0	0	5.79E-04	0	1.17E-03	**6.57E-02**
Acidification (AP)	kg SO_2 eq	1.24E-03	2.19E-03	9.52E-05	1.60E-05	0	0	2.54E-05	0	6.41E-05	**3.63E-03**
Eutrophication (EP)	kg N eq	2.69E-04	4.42E-04	8.16E-06	7.43E-06	0	0	2.69E-06	0	2.81E-06	**7.32E-04**
Fossil fuel depletion	MJ surplus	3.48E-01	2.10E+00	3.48E-02	6.54E-03	0	0	1.74E-02	0	2.43E-02	**2.53E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	9.08E-05	1.08E-04	4.65E-06	7.94E-07	0	0	1.09E-06	0	4.94E-06	**2.11E-04**
Carcinogenics	CTUh	5.6%	90.2%	0.3%	0.4%	0	0	0.2%	0	3.3%	**100.0%**
Non-carcinogenics	CTUh	11.1%	79.4%	0.6%	1.1%	0	0	0.3%	0	7.5%	**100.0%**
Ecotoxicity	CTUe	15.8%	81.7%	1.1%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 91. Percent contributions of each life cycle stage of kraft-faced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	17.8%	77.0%	1.5%	2.1%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	19.6%	72.5%	5.0%	0.3%	0.0%	0.0%	0.9%	0.0%	1.8%
Acidification (AP)	kg SO_2 eq	34.1%	60.3%	2.6%	0.4%	0.0%	0.0%	0.7%	0.0%	1.8%
Eutrophication (EP)	kg N eq	36.7%	60.4%	1.1%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	13.8%	83.0%	1.4%	0.3%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	43.1%	51.4%	2.2%	0.4%	0.0%	0.0%	0.5%	0.0%	2.3%
Carcinogenics	CTUh	5.6%	90.2%	0.3%	0.4%	0.0%	0.0%	0.2%	0.0%	3.3%
Non-carcinogenics	CTUh	11.1%	79.4%	0.6%	1.1%	0.0%	0.0%	0.3%	0.0%	7.5%
Ecotoxicity	CTUe	15.8%	81.7%	1.1%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 92. LCIA results for FSK-faced EcoBatt® Insulation produced in Inwood, WV per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	5.37E-14	2.82E-09	4.38E-17	2.64E-16	0	0	2.21E-17	0	6.33E-16	**2.82E-09**
Global warming	kg CO_2 eq	2.19E-01	1.39E+00	1.96E-02	2.61E-02	0	0	9.88E-03	0	1.29E-02	**1.67E+00**
Smog (SFP)	kg O_3 eq	1.24E-02	6.26E-02	3.45E-03	2.03E-04	0	0	6.17E-04	0	1.25E-03	**8.06E-02**
Acidification (AP)	kg SO_2 eq	1.20E-03	3.71E-03	1.01E-04	1.55E-05	0	0	2.70E-05	0	6.83E-05	**5.12E-03**
Eutrophication (EP)	kg N eq	2.59E-04	4.60E-04	8.63E-06	7.20E-06	0	0	2.86E-06	0	2.99E-06	**7.40E-04**
Fossil fuel depletion	MJ surplus	3.35E-01	2.50E+00	3.68E-02	6.34E-03	0	0	1.85E-02	0	2.59E-02	**2.92E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	8.75E-05	2.20E-04	4.92E-06	7.70E-07	0	0	1.16E-06	0	5.27E-06	**3.19E-04**
Carcinogenics	CTUh	4.7%	91.5%	0.3%	0.3%	0	0	0.2%	0	3.1%	**100.0%**
Non-carcinogenics	CTUh	8.3%	84.0%	0.5%	0.8%	0	0	0.2%	0	6.2%	**100.0%**
Ecotoxicity	CTUe	14.5%	83.1%	1.1%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 93. Percent contributions of each life cycle stage of FSK-faced EcoBatt® Insulation produced in Inwood, WV to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	13.1%	82.9%	1.2%	1.6%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	15.4%	77.8%	4.3%	0.3%	0.0%	0.0%	0.8%	0.0%	1.5%
Acidification (AP)	kg SO_2 eq	23.4%	72.5%	2.0%	0.3%	0.0%	0.0%	0.5%	0.0%	1.3%
Eutrophication (EP)	kg N eq	35.0%	62.1%	1.2%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	11.5%	85.5%	1.3%	0.2%	0.0%	0.0%	0.6%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	27.4%	68.8%	1.5%	0.2%	0.0%	0.0%	0.4%	0.0%	1.6%
Carcinogenics	CTUh	4.7%	91.5%	0.3%	0.3%	0.0%	0.0%	0.2%	0.0%	3.1%
Non-carcinogenics	CTUh	8.3%	84.0%	0.5%	0.8%	0.0%	0.0%	0.2%	0.0%	6.2%
Ecotoxicity	CTUe	14.5%	83.1%	1.1%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 94. LCIA results for foil-faced EcoBatt® Insulation produced in Inwood, WV per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	5.65E-14	2.19E-09	4.22E-17	2.72E-16	0	0	2.11E-17	0	6.06E-16	**2.19E-09**
Global warming	kg CO_2 eq	2.30E-01	1.18E+00	1.89E-02	2.69E-02	0	0	9.46E-03	0	1.23E-02	**1.48E+00**
Smog (SFP)	kg O_3 eq	1.30E-02	5.29E-02	3.33E-03	2.09E-04	0	0	5.91E-04	0	1.19E-03	**7.13E-02**
Acidification (AP)	kg SO_2 eq	1.26E-03	2.54E-03	9.70E-05	1.60E-05	0	0	2.59E-05	0	6.54E-05	**4.00E-03**
Eutrophication (EP)	kg N eq	2.72E-04	4.27E-04	8.32E-06	7.43E-06	0	0	2.74E-06	0	2.87E-06	**7.21E-04**
Fossil fuel depletion	MJ surplus	3.53E-01	2.53E+00	3.55E-02	6.54E-03	0	0	1.78E-02	0	2.48E-02	**2.96E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	9.21E-05	1.30E-04	4.74E-06	7.94E-07	0	0	1.11E-06	0	5.05E-06	**2.33E-04**
Carcinogenics	CTUh	5.1%	91.0%	0.3%	0.3%	0	0	0.2%	0	3.1%	**100.0%**
Non-carcinogenics	CTUh	9.6%	82.3%	0.5%	0.9%	0	0	0.2%	0	6.5%	**100.0%**
Ecotoxicity	CTUe	15.0%	82.7%	1.0%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 95. Percent contributions of each life cycle stage of foil-faced EcoBatt® Insulation produced in Inwood, WV to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	15.6%	79.9%	1.3%	1.8%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	18.3%	74.2%	4.7%	0.3%	0.0%	0.0%	0.8%	0.0%	1.7%
Acidification (AP)	kg SO_2 eq	31.5%	63.4%	2.4%	0.4%	0.0%	0.0%	0.6%	0.0%	1.6%
Eutrophication (EP)	kg N eq	37.8%	59.2%	1.2%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	11.9%	85.2%	1.2%	0.2%	0.0%	0.0%	0.6%	0.0%	0.8%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	39.5%	55.5%	2.0%	0.3%	0.0%	0.0%	0.5%	0.0%	2.2%
Carcinogenics	CTUh	5.1%	91.0%	0.3%	0.3%	0.0%	0.0%	0.2%	0.0%	3.1%
Non-carcinogenics	CTUh	9.6%	82.3%	0.5%	0.9%	0.0%	0.0%	0.2%	0.0%	6.5%
Ecotoxicity	CTUe	15.0%	82.7%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 96. SM millipoint scores for faced and unfaced EcoBatt® and EcoRoll® Insulation produced in Inwood, WV by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
Unfaced - SM single figure score	mPts	6.03E-03	7.84E-03	2.97E-04	1.39E-04	3.75E-04	**1.47E-02**
Kraft-faced - SM single figure score	mPts	6.03E-03	9.86E-03	3.44E-04	1.38E-04	4.40E-04	**1.68E-02**
FSK-faced - SM single figure score	mPts	5.81E-03	1.77E-02	3.64E-04	1.34E-04	4.69E-04	**2.45E-02**
Foil-faced - SM single figure score	mPts	6.11E-03	1.18E-02	3.50E-04	1.38E-04	4.50E-04	**1.89E-02**

5.2.1.3. Lanett, AL

Tables 97-104 show the contributions of each stage of the life cycle for the four facing options for EcoBatt® and EcoRoll® Insulation produced in Lanett, AL: unfaced, kraft-faced, FSK-faced, and foil-faced. The SM millipoint score by life cycle phase for this product is presented in Table 105.

Table 97. LCIA results for unfaced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL per functional unit

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**Total**
Ozone depletion (ODP)	kg CFC-11 eq	2.66E-15	1.11E-13	3.58E-17	2.73E-16	0	0	1.76E-17	0	5.06E-16	**1.15E-13**
Global warming	kg CO_2 eq	1.73E-01	9.46E-01	1.60E-02	2.70E-02	0	0	7.89E-03	0	1.03E-02	**1.18E+00**
Smog (SFP)	kg O_3 eq	9.74E-03	3.04E-02	2.82E-03	2.10E-04	0	0	4.93E-04	0	9.95E-04	**4.47E-02**
Acidification (AP)	kg SO_2 eq	9.20E-04	1.40E-03	8.23E-05	1.61E-05	0	0	2.16E-05	0	5.46E-05	**2.49E-03**
Eutrophication (EP)	kg N eq	2.31E-04	3.65E-04	7.05E-06	7.45E-06	0	0	2.29E-06	0	2.39E-06	**6.15E-04**
Fossil fuel depletion	MJ surplus	3.08E-01	1.96E+00	3.01E-02	6.56E-03	0	0	1.48E-02	0	2.07E-02	**2.34E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	7.18E-05	6.60E-05	4.02E-06	7.97E-07	0	0	9.26E-07	0	4.21E-06	**1.48E-04**
Carcinogenics	CTUh	4.5%	92.2%	0.3%	0.3%	0	0	0.1%	0	2.6%	**100.0%**
Non-carcinogenics	CTUh	9.1%	83.1%	0.5%	1.0%	0	0	0.2%	0	6.1%	**100.0%**
Ecotoxicity	CTUe	13.8%	84.1%	0.9%	0.3%	0	0	0.4%	0	0.4%	**100.0%**

Table 98. Percent contributions of each life cycle stage of unfaced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL to each impact category

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**
Ozone depletion (ODP)	kg CFC-11 eq	2.3%	97.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.4%
Global warming	kg CO_2 eq	14.7%	80.1%	1.4%	2.3%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	21.8%	68.1%	6.3%	0.5%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	36.9%	56.1%	3.3%	0.6%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	37.5%	59.4%	1.1%	1.2%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	13.2%	83.7%	1.3%	0.3%	0.0%	0.0%	0.6%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	48.6%	44.7%	2.7%	0.5%	0.0%	0.0%	0.6%	0.0%	2.8%
Carcinogenics	CTUh	4.5%	92.2%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.6%
Non-carcinogenics	CTUh	9.1%	83.1%	0.5%	1.0%	0.0%	0.0%	0.2%	0.0%	6.1%
Ecotoxicity	CTUe	13.8%	84.1%	0.9%	0.3%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 99. LCIA results for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL per functional unit

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**Total**
Ozone depletion (ODP)	kg CFC-11 eq	2.65E-15	4.14E-09	4.14E-17	2.72E-16	0	0	2.07E-17	0	5.94E-16	**4.14E-09**
Global warming	kg CO_2 eq	1.73E-01	9.96E-01	1.86E-02	2.69E-02	0	0	9.27E-03	0	1.21E-02	**1.24E+00**
Smog (SFP)	kg O_3 eq	9.70E-03	3.79E-02	3.27E-03	2.09E-04	0	0	5.79E-04	0	1.17E-03	**5.28E-02**
Acidification (AP)	kg SO_2 eq	9.17E-04	1.84E-03	9.52E-05	1.60E-05	0	0	2.54E-05	0	6.41E-05	**2.96E-03**
Eutrophication (EP)	kg N eq	2.30E-04	4.59E-04	8.16E-06	7.43E-06	0	0	2.69E-06	0	2.81E-06	**7.10E-04**
Fossil fuel depletion	MJ surplus	3.07E-01	2.29E+00	3.48E-02	6.54E-03	0	0	1.74E-02	0	2.43E-02	**2.68E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	7.15E-05	9.63E-05	4.65E-06	7.94E-07	0	0	1.09E-06	0	4.94E-06	**1.79E-04**
Carcinogenics	CTUh	4.4%	92.0%	0.3%	0.3%	0	0	0.1%	0	2.9%	**100.0%**
Non-carcinogenics	CTUh	8.6%	82.9%	0.5%	1.0%	0	0	0.3%	0	6.8%	**100.0%**
Ecotoxicity	CTUe	13.2%	84.6%	1.0%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 100. Percent contributions of each life cycle stage of kraft-faced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	14.0%	80.6%	1.5%	2.2%	0.0%	0.0%	0.8%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	18.4%	71.7%	6.2%	0.4%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	31.0%	62.3%	3.2%	0.5%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	32.4%	64.7%	1.1%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	11.4%	85.5%	1.3%	0.2%	0.0%	0.0%	0.6%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	39.9%	53.7%	2.6%	0.4%	0.0%	0.0%	0.6%	0.0%	2.8%
Carcinogenics	CTUh	4.4%	92.0%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.9%
Non-carcinogenics	CTUh	8.6%	82.9%	0.5%	1.0%	0.0%	0.0%	0.3%	0.0%	6.8%
Ecotoxicity	CTUe	13.2%	84.6%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 101. LCIA results for FSK-faced EcoBatt® Insulation produced in Lanett, AL per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.63E-15	2.82E-09	4.38E-17	2.64E-16	0	0	2.21E-17	0	6.33E-16	**2.82E-09**
Global warming	kg CO_2 eq	1.71E-01	1.42E+00	1.96E-02	2.61E-02	0	0	9.88E-03	0	1.29E-02	**1.66E+00**
Smog (SFP)	kg O_3 eq	9.61E-03	5.41E-02	3.45E-03	2.03E-04	0	0	6.17E-04	0	1.25E-03	**6.92E-02**
Acidification (AP)	kg SO_2 eq	9.08E-04	3.41E-03	1.01E-04	1.55E-05	0	0	2.70E-05	0	6.83E-05	**4.53E-03**
Eutrophication (EP)	kg N eq	2.28E-04	4.88E-04	8.63E-06	7.20E-06	0	0	2.86E-06	0	2.99E-06	**7.37E-04**
Fossil fuel depletion	MJ surplus	3.04E-01	2.73E+00	3.68E-02	6.34E-03	0	0	1.85E-02	0	2.59E-02	**3.12E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	7.08E-05	2.11E-04	4.92E-06	7.70E-07	0	0	1.16E-06	0	5.27E-06	**2.93E-04**
Carcinogenics	CTUh	3.8%	92.9%	0.3%	0.3%	0	0	0.1%	0	2.7%	**100.0%**
Non-carcinogenics	CTUh	6.6%	86.4%	0.4%	0.7%	0	0	0.2%	0	5.6%	**100.0%**
Ecotoxicity	CTUe	12.2%	85.7%	0.9%	0.3%	0	0	0.5%	0	0.4%	**100.0%**

Table 102. Percent contributions of each life cycle stage of FSK-faced EcoBatt® Insulation produced in Lanett, AL to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	10.3%	85.6%	1.2%	1.6%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	13.9%	78.2%	5.0%	0.3%	0.0%	0.0%	0.9%	0.0%	1.8%
Acidification (AP)	kg SO_2 eq	20.0%	75.3%	2.2%	0.3%	0.0%	0.0%	0.6%	0.0%	1.5%
Eutrophication (EP)	kg N eq	30.9%	66.2%	1.2%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	9.7%	87.5%	1.2%	0.2%	0.0%	0.0%	0.6%	0.0%	0.8%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	24.1%	71.7%	1.7%	0.3%	0.0%	0.0%	0.4%	0.0%	1.8%
Carcinogenics	CTUh	3.8%	92.9%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.7%
Non-carcinogenics	CTUh	6.6%	86.4%	0.4%	0.7%	0.0%	0.0%	0.2%	0.0%	5.6%
Ecotoxicity	CTUe	12.2%	85.7%	0.9%	0.3%	0.0%	0.0%	0.5%	0.0%	0.4%

Table 103. LCIA results for foil-faced EcoBatt® Insulation produced in Lanett, AL per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.76E-15	2.19E-09	4.22E-17	2.72E-16	0	0	2.11E-17	0	6.06E-16	**2.19E-09**
Global warming	kg CO_2 eq	1.80E-01	1.22E+00	1.89E-02	2.69E-02	0	0	9.46E-03	0	1.23E-02	**1.47E+00**
Smog (SFP)	kg O_3 eq	1.01E-02	4.39E-02	3.33E-03	2.09E-04	0	0	5.91E-04	0	1.19E-03	**5.94E-02**
Acidification (AP)	kg SO_2 eq	9.55E-04	2.23E-03	9.70E-05	1.60E-05	0	0	2.59E-05	0	6.54E-05	**3.39E-03**
Eutrophication (EP)	kg N eq	2.39E-04	4.56E-04	8.32E-06	7.43E-06	0	0	2.74E-06	0	2.87E-06	**7.17E-04**
Fossil fuel depletion	MJ surplus	3.20E-01	2.77E+00	3.55E-02	6.54E-03	0	0	1.78E-02	0	2.48E-02	**3.17E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	7.45E-05	1.20E-04	4.74E-06	7.94E-07	0	0	1.11E-06	0	5.05E-06	**2.06E-04**
Carcinogenics	CTUh	4.1%	92.6%	0.3%	0.3%	0	0	0.1%	0	2.7%	**100.0%**
Non-carcinogenics	CTUh	7.5%	85.2%	0.4%	0.8%	0	0	0.2%	0	5.8%	**100.0%**
Ecotoxicity	CTUe	12.6%	85.4%	0.9%	0.3%	0	0	0.4%	0	0.4%	**100.0%**

Table 104. Percent contributions of each life cycle stage of foil-faced EcoBatt® Insulation produced in Lanett, AL to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	12.3%	83.1%	1.3%	1.8%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	17.0%	74.0%	5.6%	0.4%	0.0%	0.0%	1.0%	0.0%	2.0%
Acidification (AP)	kg SO_2 eq	28.2%	65.8%	2.9%	0.5%	0.0%	0.0%	0.8%	0.0%	1.9%
Eutrophication (EP)	kg N eq	33.4%	63.6%	1.2%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	10.1%	87.3%	1.1%	0.2%	0.0%	0.0%	0.6%	0.0%	0.8%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	36.2%	58.2%	2.3%	0.4%	0.0%	0.0%	0.5%	0.0%	2.4%
Carcinogenics	CTUh	4.1%	92.6%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.7%
Non-carcinogenics	CTUh	7.5%	85.2%	0.4%	0.8%	0.0%	0.0%	0.2%	0.0%	5.8%
Ecotoxicity	CTUe	12.6%	85.4%	0.9%	0.3%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 105. SM millipoint scores for faced and unfaced EcoBatt® and EcoRoll® Insulation produced in Lanett, AL by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	A3	A4	A5, B1-B7	C1-C4	
Unfaced - SM single figure score	mPts	4.75E-03	7.26E-03	2.97E-04	1.39E-04	3.75E-04	**1.28E-02**
Kraft-faced - SM single figure score	mPts	4.73E-03	9.21E-03	3.44E-04	1.38E-04	4.40E-04	**1.49E-02**
FSK-faced - SM single figure score	mPts	4.68E-03	1.73E-02	3.64E-04	1.34E-04	4.69E-04	**2.30E-02**
Foil-faced - SM single figure score	mPts	4.93E-03	1.14E-02	3.50E-04	1.38E-04	4.50E-04	**1.72E-02**

5.2.1.4. Shasta Lake, CA

Tables 106-113 show the contributions of each stage of the life cycle for the four facing options for EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA: unfaced, kraft-faced, FSK-faced, and foil-faced. The SM millipoint score by life cycle phase for this product is presented in Table 114.

Table 106. LCIA results for unfaced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	6.32E-13	2.32E-13	3.58E-17	2.73E-16	0	0	1.76E-17	0	5.06E-16	**8.65E-13**
Global warming	kg CO_2 eq	1.10E-01	7.12E-01	1.60E-02	2.70E-02	0	0	7.89E-03	0	1.03E-02	**8.83E-01**
Smog (SFP)	kg O_3 eq	6.40E-03	2.41E-02	2.82E-03	2.10E-04	0	0	4.93E-04	0	9.95E-04	**3.50E-02**
Acidification (AP)	kg SO_2 eq	5.68E-04	1.55E-03	8.23E-05	1.61E-05	0	0	2.16E-05	0	5.46E-05	**2.29E-03**
Eutrophication (EP)	kg N eq	1.75E-04	3.39E-04	7.05E-06	7.45E-06	0	0	2.29E-06	0	2.39E-06	**5.34E-04**
Fossil fuel depletion	MJ surplus	2.38E-01	1.54E+00	3.01E-02	6.56E-03	0	0	1.48E-02	0	2.07E-02	**1.85E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.51E-05	5.85E-05	4.02E-06	7.97E-07	0	0	9.26E-07	0	4.21E-06	**1.14E-04**
Carcinogenics	CTUh	3.9%	92.6%	0.3%	0.3%	0	0	0.1%	0	2.8%	**100.0%**
Non-carcinogenics	CTUh	7.7%	83.4%	0.5%	1.1%	0	0	0.3%	0	6.9%	**100.0%**
Ecotoxicity	CTUe	12.6%	85.2%	1.0%	0.3%	0	0	0.5%	0	0.4%	**100.0%**

Table 107. Percent contributions of each life cycle stage of unfaced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	73.0%	26.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	12.4%	80.7%	1.8%	3.1%	0.0%	0.0%	0.9%	0.0%	1.2%
Smog (SFP)	kg O_3 eq	18.3%	68.8%	8.1%	0.6%	0.0%	0.0%	1.4%	0.0%	2.8%
Acidification (AP)	kg SO_2 eq	24.8%	67.6%	3.6%	0.7%	0.0%	0.0%	0.9%	0.0%	2.4%
Eutrophication (EP)	kg N eq	32.9%	63.5%	1.3%	1.4%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	12.9%	83.2%	1.6%	0.4%	0.0%	0.0%	0.8%	0.0%	1.1%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	39.7%	51.5%	3.5%	0.7%	0.0%	0.0%	0.8%	0.0%	3.7%
Carcinogenics	CTUh	3.9%	92.6%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.8%
Non-carcinogenics	CTUh	7.7%	83.4%	0.5%	1.1%	0.0%	0.0%	0.3%	0.0%	6.9%
Ecotoxicity	CTUe	12.6%	85.2%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.4%

Table 108. LCIA results for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	6.36E-13	4.09E-09	4.14E-17	2.72E-16	0	0	2.07E-17	0	5.94E-16	**4.09E-09**
Global warming	kg CO_2 eq	1.10E-01	7.67E-01	1.86E-02	2.69E-02	0	0	9.27E-03	0	1.21E-02	**9.44E-01**
Smog (SFP)	kg O_3 eq	6.44E-03	3.16E-02	3.27E-03	2.09E-04	0	0	5.79E-04	0	1.17E-03	**4.33E-02**
Acidification (AP)	kg SO_2 eq	5.72E-04	2.00E-03	9.52E-05	1.60E-05	0	0	2.54E-05	0	6.41E-05	**2.77E-03**
Eutrophication (EP)	kg N eq	1.77E-04	4.36E-04	8.16E-06	7.43E-06	0	0	2.69E-06	0	2.81E-06	**6.34E-04**
Fossil fuel depletion	MJ surplus	2.40E-01	1.88E+00	3.48E-02	6.54E-03	0	0	1.74E-02	0	2.43E-02	**2.20E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.55E-05	8.88E-05	4.65E-06	7.94E-07	0	0	1.09E-06	0	4.94E-06	**1.46E-04**
Carcinogenics	CTUh	3.8%	92.3%	0.3%	0.3%	0	0	0.2%	0	3.1%	**100.0%**
Non-carcinogenics	CTUh	7.3%	83.2%	0.6%	1.1%	0	0	0.3%	0	7.6%	**100.0%**
Ecotoxicity	CTUe	11.9%	85.7%	1.0%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 109. Percent contributions of each life cycle stage of kraft-faced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	11.7%	81.2%	2.0%	2.9%	0.0%	0.0%	1.0%	0.0%	1.3%
Smog (SFP)	kg O_3 eq	14.9%	73.0%	7.5%	0.5%	0.0%	0.0%	1.3%	0.0%	2.7%
Acidification (AP)	kg SO_2 eq	20.6%	72.1%	3.4%	0.6%	0.0%	0.0%	0.9%	0.0%	2.3%
Eutrophication (EP)	kg N eq	27.9%	68.8%	1.3%	1.2%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	10.9%	85.3%	1.6%	0.3%	0.0%	0.0%	0.8%	0.0%	1.1%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	31.2%	60.9%	3.2%	0.5%	0.0%	0.0%	0.7%	0.0%	3.4%
Carcinogenics	CTUh	3.8%	92.3%	0.3%	0.3%	0.0%	0.0%	0.2%	0.0%	3.1%
Non-carcinogenics	CTUh	7.3%	83.2%	0.6%	1.1%	0.0%	0.0%	0.3%	0.0%	7.6%
Ecotoxicity	CTUe	11.9%	85.7%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 110. LCIA results for FSK-faced EcoBatt® Insulation produced in Shasta Lake, CA per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	6.38E-13	2.82E-09	4.38E-17	2.64E-16	0	0	2.21E-17	0	6.33E-16	**2.82E-09**
Global warming	kg CO_2 eq	1.11E-01	1.20E+00	1.96E-02	2.61E-02	0	0	9.88E-03	0	1.29E-02	**1.38E+00**
Smog (SFP)	kg O_3 eq	6.46E-03	4.82E-02	3.45E-03	2.03E-04	0	0	6.17E-04	0	1.25E-03	**6.02E-02**
Acidification (AP)	kg SO_2 eq	5.74E-04	3.59E-03	1.01E-04	1.55E-05	0	0	2.70E-05	0	6.83E-05	**4.38E-03**
Eutrophication (EP)	kg N eq	1.77E-04	4.69E-04	8.63E-06	7.20E-06	0	0	2.86E-06	0	2.99E-06	**6.68E-04**
Fossil fuel depletion	MJ surplus	2.40E-01	2.33E+00	3.68E-02	6.34E-03	0	0	1.85E-02	0	2.59E-02	**2.66E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.56E-05	2.04E-04	4.92E-06	7.70E-07	0	0	1.16E-06	0	5.27E-06	**2.62E-04**
Carcinogenics	CTUh	3.2%	93.3%	0.3%	0.3%	0	0	0.1%	0	2.8%	**100.0%**
Non-carcinogenics	CTUh	5.5%	87.0%	0.5%	0.8%	0	0	0.2%	0	6.1%	**100.0%**
Ecotoxicity	CTUe	11.0%	86.7%	1.0%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 111. Percent contributions of each life cycle stage of FSK-faced EcoBatt® Insulation produced in Shasta Lake, CA to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	8.0%	87.0%	1.4%	1.9%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	10.7%	80.1%	5.7%	0.3%	0.0%	0.0%	1.0%	0.0%	2.1%
Acidification (AP)	kg SO_2 eq	13.1%	82.1%	2.3%	0.4%	0.0%	0.0%	0.6%	0.0%	1.6%
Eutrophication (EP)	kg N eq	26.5%	70.2%	1.3%	1.1%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	9.0%	87.7%	1.4%	0.2%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	17.4%	78.0%	1.9%	0.3%	0.0%	0.0%	0.4%	0.0%	2.0%
Carcinogenics	CTUh	3.2%	93.3%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.8%
Non-carcinogenics	CTUh	5.5%	87.0%	0.5%	0.8%	0.0%	0.0%	0.2%	0.0%	6.1%
Ecotoxicity	CTUe	11.0%	86.7%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 112. LCIA results for foil-faced EcoBatt® Insulation produced in Shasta Lake, CA per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	6.71E-13	2.19E-09	4.22E-17	2.72E-16	0	0	2.11E-17	0	6.06E-16	**2.19E-09**
Global warming	kg CO_2 eq	1.16E-01	9.90E-01	1.89E-02	2.69E-02	0	0	9.46E-03	0	1.23E-02	**1.17E+00**
Smog (SFP)	kg O_3 eq	6.80E-03	3.77E-02	3.33E-03	2.09E-04	0	0	5.91E-04	0	1.19E-03	**4.99E-02**
Acidification (AP)	kg SO_2 eq	6.04E-04	2.41E-03	9.70E-05	1.60E-05	0	0	2.59E-05	0	6.54E-05	**3.22E-03**
Eutrophication (EP)	kg N eq	1.87E-04	4.37E-04	8.32E-06	7.43E-06	0	0	2.74E-06	0	2.87E-06	**6.45E-04**
Fossil fuel depletion	MJ surplus	2.53E-01	2.35E+00	3.55E-02	6.54E-03	0	0	1.78E-02	0	2.48E-02	**2.69E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.80E-05	1.13E-04	4.74E-06	7.94E-07	0	0	1.11E-06	0	5.05E-06	**1.73E-04**
Carcinogenics	CTUh	3.5%	93.0%	0.3%	0.3%	0	0	0.1%	0	2.8%	**100.0%**
Non-carcinogenics	CTUh	6.3%	85.8%	0.5%	0.9%	0	0	0.2%	0	6.3%	**100.0%**
Ecotoxicity	CTUe	11.4%	86.4%	1.0%	0.3%	0	0	0.5%	0	0.5%	**100.0%**

Table 113. Percent contributions of each life cycle stage of foil-faced EcoBatt® Insulation produced in Shasta Lake, CA to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	9.9%	84.3%	1.6%	2.3%	0.0%	0.0%	0.8%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	13.6%	75.7%	6.7%	0.4%	0.0%	0.0%	1.2%	0.0%	2.4%
Acidification (AP)	kg SO_2 eq	18.7%	74.9%	3.0%	0.5%	0.0%	0.0%	0.8%	0.0%	2.0%
Eutrophication (EP)	kg N eq	28.9%	67.8%	1.3%	1.2%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	9.4%	87.4%	1.3%	0.2%	0.0%	0.0%	0.7%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	27.8%	65.5%	2.7%	0.5%	0.0%	0.0%	0.6%	0.0%	2.9%
Carcinogenics	CTUh	3.5%	93.0%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.8%
Non-carcinogenics	CTUh	6.3%	85.8%	0.5%	0.9%	0.0%	0.0%	0.2%	0.0%	6.3%
Ecotoxicity	CTUe	11.4%	86.4%	1.0%	0.3%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 114. SM millipoint scores for faced and unfaced EcoBatt® and EcoRoll® Insulation produced in Shasta Lake, CA by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	A3	A4	A5, B1-B7	C1-C4	
Unfaced - SM single figure score	mPts	2.99E-03	6.00E-03	2.97E-04	1.39E-04	3.75E-04	**9.80E-03**
Kraft-faced - SM single figure score	mPts	3.01E-03	7.96E-03	3.44E-04	1.38E-04	4.40E-04	**1.19E-02**
FSK-faced - SM single figure score	mPts	3.02E-03	1.62E-02	3.64E-04	1.34E-04	4.69E-04	**2.01E-02**
Foil-faced - SM single figure score	mPts	3.18E-03	1.02E-02	3.50E-04	1.38E-04	4.50E-04	**1.43E-02**

5.2.1.5. Shelbyville, IN

Tables 115-122 show the contributions of each stage of the life cycle for the four facing options for EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN: unfaced, kraft-faced, FSK-faced, and foil-faced. The SM millipoint score by life cycle phase for this product is presented in Table 123.

Table 115. LCIA results for unfaced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	8.10E-13	1.15E-13	3.58E-17	2.73E-16	0	0	1.76E-17	0	5.06E-16	**9.26E-13**
Global warming	kg CO_2 eq	1.07E-01	1.09E+00	1.60E-02	2.70E-02	0	0	7.89E-03	0	1.03E-02	**1.25E+00**
Smog (SFP)	kg O_3 eq	6.66E-03	3.34E-02	2.82E-03	2.10E-04	0	0	4.93E-04	0	9.95E-04	**4.46E-02**
Acidification (AP)	kg SO_2 eq	5.79E-04	1.72E-03	8.23E-05	1.61E-05	0	0	2.16E-05	0	5.46E-05	**2.48E-03**
Eutrophication (EP)	kg N eq	1.95E-04	4.26E-04	7.05E-06	7.45E-06	0	0	2.29E-06	0	2.39E-06	**6.40E-04**
Fossil fuel depletion	MJ surplus	2.52E-01	1.92E+00	3.01E-02	6.56E-03	0	0	1.48E-02	0	2.07E-02	**2.24E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.51E-05	9.22E-05	4.02E-06	7.97E-07	0	0	9.26E-07	0	4.21E-06	**1.47E-04**
Carcinogenics	CTUh	3.6%	93.5%	0.2%	0.3%	0	0	0.1%	0	2.3%	**100.0%**
Non-carcinogenics	CTUh	6.9%	85.8%	0.4%	0.9%	0	0	0.2%	0	5.6%	**100.0%**
Ecotoxicity	CTUe	11.8%	86.4%	0.8%	0.3%	0	0	0.4%	0	0.4%	**100.0%**

Table 116. Percent contributions of each life cycle stage of unfaced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	87.5%	12.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	8.6%	86.6%	1.3%	2.2%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	14.9%	74.9%	6.3%	0.5%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	23.4%	69.6%	3.3%	0.6%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	30.5%	66.5%	1.1%	1.2%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	11.2%	85.6%	1.3%	0.3%	0.0%	0.0%	0.7%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	30.6%	62.6%	2.7%	0.5%	0.0%	0.0%	0.6%	0.0%	2.9%
Carcinogenics	CTUh	3.6%	93.5%	0.2%	0.3%	0.0%	0.0%	0.1%	0.0%	2.3%
Non-carcinogenics	CTUh	6.9%	85.8%	0.4%	0.9%	0.0%	0.0%	0.2%	0.0%	5.6%
Ecotoxicity	CTUe	11.8%	86.4%	0.8%	0.3%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 117. LCIA results for kraft-faced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	8.12E-13	4.24E-09	4.14E-17	2.72E-16	0	0	2.07E-17	0	5.94E-16	**4.24E-09**
Global warming	kg CO_2 eq	1.08E-01	1.14E+00	1.86E-02	2.69E-02	0	0	9.27E-03	0	1.21E-02	**1.32E+00**
Smog (SFP)	kg O_3 eq	6.67E-03	4.12E-02	3.27E-03	2.09E-04	0	0	5.79E-04	0	1.17E-03	**5.31E-02**
Acidification (AP)	kg SO_2 eq	5.80E-04	2.19E-03	9.52E-05	1.60E-05	0	0	2.54E-05	0	6.41E-05	**2.97E-03**
Eutrophication (EP)	kg N eq	1.95E-04	5.25E-04	8.16E-06	7.43E-06	0	0	2.69E-06	0	2.81E-06	**7.41E-04**
Fossil fuel depletion	MJ surplus	2.52E-01	2.27E+00	3.48E-02	6.54E-03	0	0	1.74E-02	0	2.43E-02	**2.60E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.52E-05	1.24E-04	4.65E-06	7.94E-07	0	0	1.09E-06	0	4.94E-06	**1.80E-04**
Carcinogenics	CTUh	3.5%	93.2%	0.3%	0.3%	0	0	0.1%	0	2.6%	**100.0%**
Non-carcinogenics	CTUh	6.6%	85.6%	0.5%	0.9%	0	0	0.2%	0	6.3%	**100.0%**
Ecotoxicity	CTUe	11.2%	86.8%	0.9%	0.3%	0	0	0.4%	0	0.4%	**100.0%**

Table 118. Percent contributions of each life cycle stage of kraft-faced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	8.2%	86.7%	1.4%	2.0%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	12.6%	77.6%	6.2%	0.4%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	19.6%	73.7%	3.2%	0.5%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	26.4%	70.8%	1.1%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	9.7%	87.1%	1.3%	0.3%	0.0%	0.0%	0.7%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	25.1%	68.6%	2.6%	0.4%	0.0%	0.0%	0.6%	0.0%	2.7%
Carcinogenics	CTUh	3.5%	93.2%	0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	2.6%
Non-carcinogenics	CTUh	6.6%	85.6%	0.5%	0.9%	0.0%	0.0%	0.2%	0.0%	6.3%
Ecotoxicity	CTUe	11.2%	86.8%	0.9%	0.3%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 119. LCIA results for FSK-faced EcoBatt® Insulation produced in Shelbyville, IN per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	7.85E-13	2.82E-09	4.38E-17	2.64E-16	0	0	2.21E-17	0	6.33E-16	**2.82E-09**
Global warming	kg CO_2 eq	1.04E-01	1.53E+00	1.96E-02	2.61E-02	0	0	9.88E-03	0	1.29E-02	**1.71E+00**
Smog (SFP)	kg O_3 eq	6.45E-03	5.64E-02	3.45E-03	2.03E-04	0	0	6.17E-04	0	1.25E-03	**6.83E-02**
Acidification (AP)	kg SO_2 eq	5.61E-04	3.70E-03	1.01E-04	1.55E-05	0	0	2.70E-05	0	6.83E-05	**4.47E-03**
Eutrophication (EP)	kg N eq	1.89E-04	5.40E-04	8.63E-06	7.20E-06	0	0	2.86E-06	0	2.99E-06	**7.50E-04**
Fossil fuel depletion	MJ surplus	2.44E-01	2.65E+00	3.68E-02	6.34E-03	0	0	1.85E-02	0	2.59E-02	**2.98E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.37E-05	2.34E-04	4.92E-06	7.70E-07	0	0	1.16E-06	0	5.27E-06	**2.90E-04**
Carcinogenics	CTUh	3.0%	93.8%	0.2%	0.2%	0	0	0.1%	0	2.5%	**100.0%**
Non-carcinogenics	CTUh	5.1%	88.2%	0.4%	0.7%	0	0	0.2%	0	5.4%	**100.0%**
Ecotoxicity	CTUe	10.4%	87.6%	0.9%	0.3%	0	0	0.4%	0	0.4%	**100.0%**

Table 120. Percent contributions of each life cycle stage of FSK-faced EcoBatt® Insulation produced in Shelbyville, IN to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	6.1%	89.9%	1.1%	1.5%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	9.4%	82.5%	5.1%	0.3%	0.0%	0.0%	0.9%	0.0%	1.8%
Acidification (AP)	kg SO_2 eq	12.5%	82.7%	2.3%	0.3%	0.0%	0.0%	0.6%	0.0%	1.5%
Eutrophication (EP)	kg N eq	25.2%	71.9%	1.1%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	8.2%	88.9%	1.2%	0.2%	0.0%	0.0%	0.6%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	15.1%	80.8%	1.7%	0.3%	0.0%	0.0%	0.4%	0.0%	1.8%
Carcinogenics	CTUh	3.0%	93.8%	0.2%	0.2%	0.0%	0.0%	0.1%	0.0%	2.5%
Non-carcinogenics	CTUh	5.1%	88.2%	0.4%	0.7%	0.0%	0.0%	0.2%	0.0%	5.4%
Ecotoxicity	CTUe	10.4%	87.6%	0.9%	0.3%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 121. LCIA results for foil-faced EcoBatt® Insulation produced in Shelbyville, IN per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	8.26E-13	2.19E-09	4.22E-17	2.72E-16	0	0	2.11E-17	0	6.06E-16	**2.19E-09**
Global warming	kg CO_2 eq	1.10E-01	1.34E+00	1.89E-02	2.69E-02	0	0	9.46E-03	0	1.23E-02	**1.51E+00**
Smog (SFP)	kg O_3 eq	6.79E-03	4.63E-02	3.33E-03	2.09E-04	0	0	5.91E-04	0	1.19E-03	**5.85E-02**
Acidification (AP)	kg SO_2 eq	5.90E-04	2.53E-03	9.70E-05	1.60E-05	0	0	2.59E-05	0	6.54E-05	**3.32E-03**
Eutrophication (EP)	kg N eq	1.99E-04	5.11E-04	8.32E-06	7.43E-06	0	0	2.74E-06	0	2.87E-06	**7.31E-04**
Fossil fuel depletion	MJ surplus	2.57E-01	2.69E+00	3.55E-02	6.54E-03	0	0	1.78E-02	0	2.48E-02	**3.03E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	4.60E-05	1.45E-04	4.74E-06	7.94E-07	0	0	1.11E-06	0	5.05E-06	**2.03E-04**
Carcinogenics	CTUh	3.3%	93.6%	0.2%	0.3%	0	0	0.1%	0	2.5%	**100.0%**
Non-carcinogenics	CTUh	5.8%	87.3%	0.4%	0.8%	0	0	0.2%	0	5.5%	**100.0%**
Ecotoxicity	CTUe	10.8%	87.3%	0.8%	0.3%	0	0	0.4%	0	0.4%	**100.0%**

Table 122. Percent contributions of each life cycle stage of foil-faced EcoBatt® Insulation produced in Shelbyville, IN to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	7.2%	88.3%	1.2%	1.8%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	11.6%	79.3%	5.7%	0.4%	0.0%	0.0%	1.0%	0.0%	2.0%
Acidification (AP)	kg SO_2 eq	17.8%	76.1%	2.9%	0.5%	0.0%	0.0%	0.8%	0.0%	2.0%
Eutrophication (EP)	kg N eq	27.2%	69.9%	1.1%	1.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	8.5%	88.7%	1.2%	0.2%	0.0%	0.0%	0.6%	0.0%	0.8%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	22.7%	71.5%	2.3%	0.4%	0.0%	0.0%	0.5%	0.0%	2.5%
Carcinogenics	CTUh	3.3%	93.6%	0.2%	0.3%	0.0%	0.0%	0.1%	0.0%	2.5%
Non-carcinogenics	CTUh	5.8%	87.3%	0.4%	0.8%	0.0%	0.0%	0.2%	0.0%	5.5%
Ecotoxicity	CTUe	10.8%	87.3%	0.8%	0.3%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 123. SM millipoint scores for faced and unfaced EcoBatt® and EcoRoll® Insulation produced in Shelbyville, IN by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	A3	A4	A5, B1-B7	C1-C4	
Unfaced - SM single figure score	mPts	2.99E-03	9.26E-03	2.97E-04	1.39E-04	3.75E-04	**1.31E-02**
Kraft-faced - SM single figure score	mPts	2.99E-03	1.13E-02	3.44E-04	1.38E-04	4.40E-04	**1.52E-02**
FSK-faced - SM single figure score	mPts	2.89E-03	1.91E-02	3.64E-04	1.34E-04	4.69E-04	**2.29E-02**
Foil-faced - SM single figure score	mPts	3.05E-03	1.32E-02	3.50E-04	1.38E-04	4.50E-04	**1.72E-02**

5.2.1.6. Interpretation

For the unfaced EcoBatt® and EcoRoll® Insulation, the manufacturing stage dominates the results for all impact categories except ozone depletion, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

For the kraft, FSK, and foil faced products, the manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. Since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts as shown in the results tables below are likely much larger than the actual impacts in the raw material acquisition stage. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Variations

The four different facing options impact the type and amount of raw materials extracted during the raw materials acquisition stage. When facing is added, the increased mass of the product and material consumption cause a higher impact.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for over 50% of the score result for all EcoBatt® and EcoRoll® Insulation prodcuts manufactured by KINA's five plants.

5.2.2. JetSpray™ Thermal Spray-On Insulation System

Tables 124-125 show the LCIA results and contributions of each stage of the life cycle for JetSpray™ Thermal Spray-On Insulation System. The SM millipoint score by life cycle phase for this product is presented in Table 126.

Table 124. LCIA results for JetSpray™ Thermal Spray-On Insulation System per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	5.93E-11	1.47E-13	5.72E-17	6.61E-17	0	0	3.08E-17	0	8.83E-16	**5.94E-11**
Global warming	kg CO_2 eq	3.47E-01	1.32E+00	2.56E-02	6.62E-03	0	0	1.38E-02	0	1.79E-02	**1.73E+00**
Smog (SFP)	kg O_3 eq	1.59E-02	3.47E-02	4.51E-03	5.13E-05	0	0	8.61E-04	0	1.74E-03	**5.77E-02**
Acidification (AP)	kg SO_2 eq	4.84E-03	1.98E-03	1.31E-04	3.93E-06	0	0	3.77E-05	0	9.53E-05	**7.08E-03**
Eutrophication (EP)	kg N eq	1.50E-04	5.40E-04	1.13E-05	1.83E-06	0	0	4.00E-06	0	4.18E-06	**7.11E-04**
Fossil fuel depletion	MJ surplus	4.16E-01	1.95E+00	4.80E-02	1.60E-03	0	0	2.59E-02	0	3.62E-02	**2.48E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.14E-04	1.12E-04	6.42E-06	1.95E-07	0	0	1.62E-06	0	7.35E-06	**2.41E-04**
Carcinogenics	CTUh	4.7%	91.7%	0.3%	0.1%	0	0	0.2%	0	3.1%	**100.0%**
Non-carcinogenics	CTUh	10.7%	80.5%	0.5%	0.2%	0	0	0.3%	0	7.7%	**100.0%**
Ecotoxicity	CTUe	6.2%	91.5%	1.1%	0.1%	0	0	0.6%	0	0.6%	**100.0%**

Table 125. Percent contributions of each life cycle stage of JetSpray™ Thermal Spray-On Insulation System to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	99.8%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	20.1%	76.2%	1.5%	0.4%	0.0%	0.0%	0.8%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	27.6%	60.0%	7.8%	0.1%	0.0%	0.0%	1.5%	0.0%	3.0%
Acidification (AP)	kg SO_2 eq	68.3%	27.9%	1.9%	0.1%	0.0%	0.0%	0.5%	0.0%	1.3%
Eutrophication (EP)	kg N eq	21.1%	75.9%	1.6%	0.3%	0.0%	0.0%	0.6%	0.0%	0.6%
Fossil fuel depletion	MJ surplus	16.8%	78.7%	1.9%	0.1%	0.0%	0.0%	1.0%	0.0%	1.5%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	47.3%	46.3%	2.7%	0.1%	0.0%	0.0%	0.7%	0.0%	3.0%
Carcinogenics	CTUh	4.7%	91.7%	0.3%	0.1%	0.0%	0.0%	0.2%	0.0%	3.1%
Non-carcinogenics	CTUh	10.7%	80.5%	0.5%	0.2%	0.0%	0.0%	0.3%	0.0%	7.7%
Ecotoxicity	CTUe	6.2%	91.5%	1.1%	0.1%	0.0%	0.0%	0.6%	0.0%	0.6%

Table 126. SM millipoint scores for JetSpray™ Thermal Spray-On Insulation System by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	7.78E-03	1.12E-02	4.75E-04	3.40E-05	6.55E-04	**2.01E-02**

For the JetSpray™ Thermal Spray-On Insulation System, the manufacturing stage dominates all impact categories except ozone depletion, acidification, and respiratory effects, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

Moreover, batch materials account for a relatively higher portion of the total materials used in producing JetSpray™ as compared to other KINA products. Since the batch ingredients (e.g., sand and borax) significantly contribute to the respiratory effects category, they can lead to higher impact results in the raw materials acquisition stage. However, since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts, as shown in the results tables, are likely much larger than the actual impacts in the raw material acquisition stage. This implies that the manufacturing stage may have a greater share of the impact than what is displayed in the total impacts by the life cycle stage.

The manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for over 57% of the results for JetSpray™ Thermal Spray-On Insulation System.

5.2.3. Jet Stream® Ultra Blowing Wool Insulation

5.2.3.1. Albion, MI

Tables 127-128 show the LCIA results and contributions of each stage of the life cycle Jet Stream® Ultra Blowing Wool Insulation produced in Albion, MI. The SM millipoint score by life cycle phase for this product is presented in Table 129.

Table 127. LCIA results for Jet Stream® Ultra Blowing Wool Insulation produced in Albion, MI per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	1.20E-11	2.96E-14	1.15E-17	1.33E-17	0	0	6.21E-18	0	1.78E-16	**1.21E-11**
Global warming	kg CO_2 eq	6.29E-02	2.65E-01	5.17E-03	1.34E-03	0	0	2.78E-03	0	3.62E-03	**3.41E-01**
Smog (SFP)	kg O_3 eq	2.68E-03	6.99E-03	9.09E-04	1.04E-05	0	0	1.74E-04	0	3.50E-04	**1.11E-02**
Acidification (AP)	kg SO_2 eq	2.62E-04	3.98E-04	2.65E-05	7.94E-07	0	0	7.61E-06	0	1.92E-05	**7.14E-04**
Eutrophication (EP)	kg N eq	2.86E-05	1.09E-04	2.27E-06	3.69E-07	0	0	8.06E-07	0	8.43E-07	**1.42E-04**
Fossil fuel depletion	MJ surplus	9.23E-02	3.94E-01	9.69E-03	3.23E-04	0	0	5.21E-03	0	7.30E-03	**5.08E-01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	2.07E-05	2.25E-05	1.30E-06	3.93E-08	0	0	3.26E-07	0	1.48E-06	**4.63E-05**
Carcinogenics	CTUh	4.7%	91.7%	0.3%	0.1%	0	0	0.2%	0	3.1%	**100.0%**
Non-carcinogenics	CTUh	11.7%	79.6%	0.5%	0.2%	0	0	0.3%	0	7.7%	**100.0%**
Ecotoxicity	CTUe	6.9%	90.8%	1.1%	0.1%	0	0	0.6%	0	0.6%	**100.0%**

Table 128. Percent contributions of each life cycle stage of Jet Stream® Ultra Blowing Wool Insulation produced in Albion, MI to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	99.8%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	18.4%	77.8%	1.5%	0.4%	0.0%	0.0%	0.8%	0.0%	1.1%
Smog (SFP)	kg O_3 eq	24.1%	62.9%	8.2%	0.1%	0.0%	0.0%	1.6%	0.0%	3.2%
Acidification (AP)	kg SO_2 eq	36.7%	55.8%	3.7%	0.1%	0.0%	0.0%	1.1%	0.0%	2.7%
Eutrophication (EP)	kg N eq	20.2%	76.7%	1.6%	0.3%	0.0%	0.0%	0.6%	0.0%	0.6%
Fossil fuel depletion	MJ surplus	18.1%	77.4%	1.9%	0.1%	0.0%	0.0%	1.0%	0.0%	1.4%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	44.6%	48.6%	2.8%	0.1%	0.0%	0.0%	0.7%	0.0%	3.2%
Carcinogenics	CTUh	4.7%	91.7%	0.3%	0.1%	0.0%	0.0%	0.2%	0.0%	3.1%
Non-carcinogenics	CTUh	11.7%	79.6%	0.5%	0.2%	0.0%	0.0%	0.3%	0.0%	7.7%
Ecotoxicity	CTUe	6.9%	90.8%	1.1%	0.1%	0.0%	0.0%	0.6%	0.0%	0.6%

Table 129. SM millipoint scores for Jet Stream® Ultra Blowing Wool Insulation produced in Albion, MI by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	1.41E-03	2.25E-03	9.57E-05	6.86E-06	1.32E-04	**3.90E-03**

5.2.3.2. Lanett, AL

Tables 130-131 show the LCIA results and contributions of each stage of the life cycle Jet Stream® Ultra Blowing Wool Insulation produced in Lanett, AL. The SM millipoint score by life cycle phase for this product is presented in Table 132.

Table 130. LCIA results for Jet Stream® Ultra Blowing Wool Insulation produced in Lanett, AL per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	1.05E-15	3.80E-14	1.15E-17	1.33E-17	0	0	6.21E-18	0	1.78E-16	**3.93E-14**
Global warming	kg CO_2 eq	9.18E-02	3.16E-01	5.17E-03	1.34E-03	0	0	2.78E-03	0	3.62E-03	**4.21E-01**
Smog (SFP)	kg O_3 eq	4.09E-03	1.01E-02	9.09E-04	1.04E-05	0	0	1.74E-04	0	3.50E-04	**1.56E-02**
Acidification (AP)	kg SO_2 eq	4.12E-04	4.61E-04	2.65E-05	7.94E-07	0	0	7.61E-06	0	1.92E-05	**9.28E-04**
Eutrophication (EP)	kg N eq	4.55E-05	1.26E-04	2.27E-06	3.69E-07	0	0	8.06E-07	0	8.43E-07	**1.76E-04**
Fossil fuel depletion	MJ surplus	1.21E-01	5.50E-01	9.69E-03	3.23E-04	0	0	5.21E-03	0	7.30E-03	**6.93E-01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	3.25E-05	2.11E-05	1.30E-06	3.93E-08	0	0	3.26E-07	0	1.48E-06	**5.68E-05**
Carcinogenics	CTUh	5.1%	91.9%	0.2%	0.0%	0	0	0.1%	0	2.6%	**100.0%**
Non-carcinogenics	CTUh	12.5%	80.6%	0.4%	0.1%	0	0	0.2%	0	6.2%	**100.0%**
Ecotoxicity	CTUe	7.8%	90.3%	0.9%	0.1%	0	0	0.5%	0	0.5%	**100.0%**

Table 131. Percent contributions of each life cycle stage of Jet Stream® Ultra Blowing Wool Insulation produced in Lanett, AL to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	2.7%	96.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
Global warming	kg CO_2 eq	21.8%	75.1%	1.2%	0.3%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	26.1%	64.7%	5.8%	0.1%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	44.4%	49.7%	2.9%	0.1%	0.0%	0.0%	0.8%	0.0%	2.1%
Eutrophication (EP)	kg N eq	25.8%	71.7%	1.3%	0.2%	0.0%	0.0%	0.5%	0.0%	0.5%
Fossil fuel depletion	MJ surplus	17.4%	79.3%	1.4%	0.0%	0.0%	0.0%	0.8%	0.0%	1.1%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	57.3%	37.2%	2.3%	0.1%	0.0%	0.0%	0.6%	0.0%	2.6%
Carcinogenics	CTUh	5.1%	91.9%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	2.6%
Non-carcinogenics	CTUh	12.5%	80.6%	0.4%	0.1%	0.0%	0.0%	0.2%	0.0%	6.2%
Ecotoxicity	CTUe	7.8%	90.3%	0.9%	0.1%	0.0%	0.0%	0.5%	0.0%	0.5%

Table 132. SM millipoint scores for Jet Stream® Ultra Blowing Wool Insulation produced in Lanett, AL by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	**Total**
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	2.19E-03	2.38E-03	9.57E-05	6.86E-06	1.32E-04	**4.80E-03**

5.2.3.3. Shasta Lake, CA

Tables 133-134 show the LCIA results and contributions of each stage of the life cycle Jet Stream® Ultra Blowing Wool Insulation produced in Shasta Lake, CA. The SM millipoint score by life cycle phase for this product is presented in Table 135.

Table 133. LCIA results for Jet Stream® Ultra Blowing Wool Insulation produced in Shasta Lake, CA per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.23E-13	8.02E-14	1.15E-17	1.33E-17	0	0	6.21E-18	0	1.78E-16	**3.03E-13**
Global warming	kg CO_2 eq	1.53E-01	2.09E-01	5.17E-03	1.34E-03	0	0	2.78E-03	0	3.62E-03	**3.75E-01**
Smog (SFP)	kg O_3 eq	4.44E-03	6.73E-03	9.09E-04	1.04E-05	0	0	1.74E-04	0	3.50E-04	**1.26E-02**
Acidification (AP)	kg SO_2 eq	3.18E-04	4.76E-04	2.65E-05	7.94E-07	0	0	7.61E-06	0	1.92E-05	**8.48E-04**
Eutrophication (EP)	kg N eq	3.45E-05	1.14E-04	2.27E-06	3.69E-07	0	0	8.06E-07	0	8.43E-07	**1.53E-04**
Fossil fuel depletion	MJ surplus	4.53E-01	3.56E-01	9.69E-03	3.23E-04	0	0	5.21E-03	0	7.30E-03	**8.32E-01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	2.25E-05	1.77E-05	1.30E-06	3.93E-08	0	0	3.26E-07	0	1.48E-06	**4.34E-05**
Carcinogenics	CTUh	26.2%	71.2%	0.2%	0.0%	0	0	0.1%	0	2.2%	**100.0%**
Non-carcinogenics	CTUh	46.8%	48.4%	0.3%	0.1%	0	0	0.2%	0	4.3%	**100.0%**
Ecotoxicity	CTUe	29.0%	69.4%	0.8%	0.0%	0	0	0.4%	0	0.4%	**100.0%**

Table 134. Percent contributions of each life cycle stage of Jet Stream® Ultra Blowing Wool Insulation produced in Shasta Lake, CA to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	73.5%	26.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	40.8%	55.8%	1.4%	0.4%	0.0%	0.0%	0.7%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	35.2%	53.3%	7.2%	0.1%	0.0%	0.0%	1.4%	0.0%	2.8%
Acidification (AP)	kg SO_2 eq	37.5%	56.1%	3.1%	0.1%	0.0%	0.0%	0.9%	0.0%	2.3%
Eutrophication (EP)	kg N eq	22.6%	74.6%	1.5%	0.2%	0.0%	0.0%	0.5%	0.0%	0.6%
Fossil fuel depletion	MJ surplus	54.5%	42.8%	1.2%	0.0%	0.0%	0.0%	0.6%	0.0%	0.9%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	52.0%	40.8%	3.0%	0.1%	0.0%	0.0%	0.8%	0.0%	3.4%
Carcinogenics	CTUh	26.2%	71.2%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	2.2%
Non-carcinogenics	CTUh	46.8%	48.4%	0.3%	0.1%	0.0%	0.0%	0.2%	0.0%	4.3%
Ecotoxicity	CTUe	29.0%	69.4%	0.8%	0.0%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 135. SM millipoint scores for Jet Stream® Ultra Blowing Wool Insulation produced in Shasta Lake, CA by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	1.87E-03	1.80E-03	9.57E-05	6.86E-06	1.32E-04	**3.90E-03**

5.2.3.4. Shelbyville, IN

Tables 1356-137 show the LCIA results and contributions of each stage of the life cycle Jet Stream® Ultra Blowing Wool Insulation produced in Shelbyville, IN. The SM millipoint score by life cycle phase for this product is presented in Table 138.

Table 136. LCIA results for Jet Stream® Ultra Blowing Wool Insulation produced in Shelbyville, IN per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	3.62E-13	3.81E-14	1.15E-17	1.33E-17	0	0	6.21E-18	0	1.78E-16	**4.00E-13**
Global warming	kg CO_2 eq	5.84E-02	3.51E-01	5.17E-03	1.34E-03	0	0	2.78E-03	0	3.62E-03	**4.22E-01**
Smog (SFP)	kg O_3 eq	2.51E-03	1.07E-02	9.09E-04	1.04E-05	0	0	1.74E-04	0	3.50E-04	**1.47E-02**
Acidification (AP)	kg SO_2 eq	2.40E-04	5.64E-04	2.65E-05	7.94E-07	0	0	7.61E-06	0	1.92E-05	**8.59E-04**
Eutrophication (EP)	kg N eq	2.60E-05	1.43E-04	2.27E-06	3.69E-07	0	0	8.06E-07	0	8.43E-07	**1.74E-04**
Fossil fuel depletion	MJ surplus	8.95E-02	4.90E-01	9.69E-03	3.23E-04	0	0	5.21E-03	0	7.30E-03	**6.02E-01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.91E-05	3.05E-05	1.30E-06	3.93E-08	0	0	3.26E-07	0	1.48E-06	**5.28E-05**
Carcinogenics	CTUh	3.9%	93.3%	0.2%	0.0%	0	0	0.1%	0	2.4%	**100.0%**
Non-carcinogenics	CTUh	9.5%	83.7%	0.4%	0.1%	0	0	0.2%	0	6.0%	**100.0%**
Ecotoxicity	CTUe	5.5%	92.7%	0.9%	0.0%	0	0	0.5%	0	0.4%	**100.0%**

Table 137. Percent contributions of each life cycle stage of Jet Stream® Ultra Blowing Wool Insulation produced in Shelbyville, IN to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	90.4%	9.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	13.8%	83.1%	1.2%	0.3%	0.0%	0.0%	0.7%	0.0%	0.9%
Smog (SFP)	kg O_3 eq	17.1%	73.0%	6.2%	0.1%	0.0%	0.0%	1.2%	0.0%	2.4%
Acidification (AP)	kg SO_2 eq	28.0%	65.7%	3.1%	0.1%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	15.0%	82.6%	1.3%	0.2%	0.0%	0.0%	0.5%	0.0%	0.5%
Fossil fuel depletion	MJ surplus	14.9%	81.4%	1.6%	0.1%	0.0%	0.0%	0.9%	0.0%	1.2%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	36.2%	57.8%	2.5%	0.1%	0.0%	0.0%	0.6%	0.0%	2.8%
Carcinogenics	CTUh	3.9%	93.3%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	2.4%
Non-carcinogenics	CTUh	9.5%	83.7%	0.4%	0.1%	0.0%	0.0%	0.2%	0.0%	6.0%
Ecotoxicity	CTUe	5.5%	92.7%	0.9%	0.0%	0.0%	0.0%	0.5%	0.0%	0.4%

Table 138. SM millipoint scores for Jet Stream® Ultra Blowing Wool Insulation produced in Shelbyville, IN by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	1.31E-03	3.03E-03	9.57E-05	6.86E-06	1.32E-04	**4.57E-03**

5.2.3.5. Interpretation

For the Jet Stream® Ultra Blowing Wool Insulation, the manufacturing stage dominates all impact categories except ozone depletion, acidification, and respiratory effects, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

Moreover, batch materials account for a relatively higher portion of the total materials used in producing Jet Stream® as compared to other KINA products.

Since the batch ingredients (e.g., sand and borax) significantly contribute to the respiratory effects category, they can lead to higher impact results in the raw materials acquisition stage. However, since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts, as shown in the results tables are likely much larger than the actual impacts in the raw material acquisition stage. This implies that the manufacturing stage may have a greater share of the impact than what is displayed in the total impacts by the life cycle stage.

The manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Single score results

The SM millipoint score by life cycle phase for these products partially conflicts with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can dominate the characterized and single score results.

The table shows that the raw material aquisition and transportation stage accounts for 47% of the score result for Jet Stream® Ultra Blowing Wool Insulation produced in Shasta Lake, CA.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results for Jet Stream® Ultra Blowing Wool Insulation produced in the rest of the three plants, accounting for over 55% of the results.

5.2.4. Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™

Tables 139-142 show the LCIA results and contributions of each stage of the life cycle for Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™. The SM millipoint score by life cycle phase for this product is presented in Table 143.

Table 139. LCIA results for Wall and Ceiling Liner / AKOUSTI-SHIELD™ per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	5.65E-12	2.00E-13	6.50E-17	5.73E-17	0	0	3.48E-17	0	9.98E-16	**5.85E-12**
Global warming	kg CO_2 eq	4.18E-01	2.38E+00	2.91E-02	1.44E-02	0	0	1.56E-02	0	2.03E-02	**2.88E+00**
Smog (SFP)	kg O_3 eq	1.68E-02	8.45E-02	5.13E-03	1.52E-04	0	0	9.73E-04	0	1.96E-03	**1.10E-01**
Acidification (AP)	kg SO_2 eq	1.04E-03	8.05E-03	1.49E-04	3.06E-05	0	0	4.26E-05	0	1.08E-04	**9.42E-03**
Eutrophication (EP)	kg N eq	5.51E-04	7.17E-04	1.28E-05	5.89E-06	0	0	4.52E-06	0	4.72E-06	**1.30E-03**
Fossil fuel depletion	MJ surplus	1.08E+00	4.89E+00	5.46E-02	1.87E-03	0	0	2.92E-02	0	4.09E-02	**6.09E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	5.98E-05	4.62E-04	7.31E-06	7.49E-07	0	0	1.83E-06	0	8.31E-06	**5.40E-04**
Carcinogenics	CTUh	59.5%	38.8%	0.1%	0.0%	0	0	0.1%	0	1.5%	**100.0%**
Non-carcinogenics	CTUh	75.4%	22.5%	0.1%	0.1%	0	0	0.1%	0	1.8%	**100.0%**
Ecotoxicity	CTUe	27.3%	71.0%	0.8%	0.0%	0	0	0.4%	0	0.4%	**100.0%**

Table 140. Percent contributions of each life cycle stage of Wall and Ceiling Liner / AKOUSTI-SHIELD™ to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	96.6%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	14.5%	82.8%	1.0%	0.5%	0.0%	0.0%	0.5%	0.0%	0.7%
Smog (SFP)	kg O_3 eq	15.3%	77.2%	4.7%	0.1%	0.0%	0.0%	0.9%	0.0%	1.8%
Acidification (AP)	kg SO_2 eq	11.0%	85.5%	1.6%	0.3%	0.0%	0.0%	0.5%	0.0%	1.1%
Eutrophication (EP)	kg N eq	42.5%	55.3%	1.0%	0.5%	0.0%	0.0%	0.3%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	17.7%	80.2%	0.9%	0.0%	0.0%	0.0%	0.5%	0.0%	0.7%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	11.1%	85.6%	1.4%	0.1%	0.0%	0.0%	0.3%	0.0%	1.5%
Carcinogenics	CTUh	59.5%	38.8%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	1.5%
Non-carcinogenics	CTUh	75.4%	22.5%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	1.8%
Ecotoxicity	CTUe	27.3%	71.0%	0.8%	0.0%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 141. LCIA results for Atmosphere™ Duct Liner / AKOUSTI-LINER™ per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	1.27E-11	2.58E-13	7.03E-17	9.29E-17	0	0	3.73E-17	0	1.07E-15	**1.30E-11**
Global warming	kg CO_2 eq	9.40E-01	2.40E+00	3.15E-02	1.22E-02	0	0	1.67E-02	0	2.17E-02	**3.43E+00**
Smog (SFP)	kg O_3 eq	3.78E-02	7.15E-02	5.54E-03	1.11E-04	0	0	1.04E-03	0	2.10E-03	**1.18E-01**
Acidification (AP)	kg SO_2 eq	2.34E-03	5.34E-03	1.62E-04	1.27E-05	0	0	4.57E-05	0	1.15E-04	**8.02E-03**
Eutrophication (EP)	kg N eq	1.24E-03	1.19E-03	1.38E-05	3.61E-06	0	0	4.84E-06	0	5.06E-06	**2.45E-03**
Fossil fuel depletion	MJ surplus	2.43E+00	4.02E+00	5.91E-02	2.62E-03	0	0	3.13E-02	0	4.38E-02	**6.58E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.35E-04	2.94E-04	7.90E-06	4.32E-07	0	0	1.96E-06	0	8.90E-06	**4.48E-04**
Carcinogenics	CTUh	66.3%	32.8%	0.1%	0.0%	0	0	0.0%	0	0.8%	**100.0%**
Non-carcinogenics	CTUh	83.5%	15.4%	0.1%	0.0%	0	0	0.0%	0	1.0%	**100.0%**
Ecotoxicity	CTUe	35.8%	63.0%	0.5%	0.0%	0	0	0.3%	0	0.3%	**100.0%**

Table 142. Percent contributions of each life cycle stage of Atmosphere™ Duct Liner / AKOUSTI-LINER™ to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	98.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	27.4%	70.2%	0.9%	0.4%	0.0%	0.0%	0.5%	0.0%	0.6%
Smog (SFP)	kg O_3 eq	32.0%	60.5%	4.7%	0.1%	0.0%	0.0%	0.9%	0.0%	1.8%
Acidification (AP)	kg SO_2 eq	29.2%	66.6%	2.0%	0.2%	0.0%	0.0%	0.6%	0.0%	1.4%
Eutrophication (EP)	kg N eq	50.5%	48.4%	0.6%	0.1%	0.0%	0.0%	0.2%	0.0%	0.2%
Fossil fuel depletion	MJ surplus	36.8%	61.1%	0.9%	0.0%	0.0%	0.0%	0.5%	0.0%	0.7%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	30.0%	65.7%	1.8%	0.1%	0.0%	0.0%	0.4%	0.0%	2.0%
Carcinogenics	CTUh	66.3%	32.8%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%
Non-carcinogenics	CTUh	83.5%	15.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Ecotoxicity	CTUe	35.8%	63.0%	0.5%	0.0%	0.0%	0.0%	0.3%	0.0%	0.3%

Table 143. SM millipoint scores for Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™ by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score – Wall and Ceiling Liner / AKOUSTI-SHIELD™	mPts	5.99E-03	3.51E-02	5.40E-04	9.24E-05	7.40E-04	**4.24E-02**
SM single figure score – Atmosphere™ Duct Liner / AKOUSTI-LINER™	mPts	1.35E-02	2.56E-02	5.84E-04	6.66E-05	7.93E-04	**4.06E-02**

The manufacturing stage dominates the results for all impact categories except ozone depletion, carcinogenics, and non-carcinogenics, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts. The manufacturing stage dominates the results for impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. Since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts as shown in the results tables above are likely much larger than the actual impacts in the raw material acquisition stage. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for over 60% of the results for Wall and Ceiling Liner / AKOUSTI-SHIELD™ & Atmosphere™ Duct Liner / AKOUSTI-LINER™.

5.2.5. KN Series Insulation

5.2.5.1. Lanett, AL

Tables 144-145 show the LCIA results and contributions of each stage of the life cycle KN Series Insulation produced in Lanett, AL. The SM millipoint score by life cycle phase for this product is presented in Table 146.

Table 144. LCIA results for KN Series Insulation produced in Lanett, AL per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	4.42E-15	1.79E-13	5.28E-17	8.29E-17	0	0	2.83E-17	0	8.11E-16	**1.84E-13**
Global warming	kg CO_2 eq	2.55E-01	1.40E+00	2.37E-02	8.20E-03	0	0	1.27E-02	0	1.65E-02	**1.71E+00**
Smog (SFP)	kg O_3 eq	1.55E-02	4.28E-02	4.16E-03	6.37E-05	0	0	7.91E-04	0	1.60E-03	**6.49E-02**
Acidification (AP)	kg SO_2 eq	1.43E-03	2.23E-03	1.21E-04	4.88E-06	0	0	3.47E-05	0	8.75E-05	**3.90E-03**
Eutrophication (EP)	kg N eq	4.28E-04	6.23E-04	1.04E-05	2.26E-06	0	0	3.67E-06	0	3.84E-06	**1.07E-03**
Fossil fuel depletion	MJ surplus	4.87E-01	2.46E+00	4.44E-02	1.99E-03	0	0	2.38E-02	0	3.32E-02	**3.05E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.11E-04	1.08E-04	5.93E-06	2.42E-07	0	0	1.49E-06	0	6.75E-06	**2.34E-04**
Carcinogenics	CTUh	5.0%	92.0%	0.2%	0.1%	0	0	0.1%	0	2.6%	**100.0%**
Non-carcinogenics	CTUh	9.9%	83.0%	0.4%	0.2%	0	0	0.2%	0	6.2%	**100.0%**
Ecotoxicity	CTUe	16.2%	82.1%	0.8%	0.1%	0	0	0.4%	0	0.4%	**100.0%**

Table 145. Percent contributions of each life cycle stage of KN Series Insulation produced in Lanett, AL to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	2.4%	97.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Global warming	kg CO_2 eq	14.9%	81.6%	1.4%	0.5%	0.0%	0.0%	0.7%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	23.8%	66.0%	6.4%	0.1%	0.0%	0.0%	1.2%	0.0%	2.5%
Acidification (AP)	kg SO_2 eq	36.6%	57.1%	3.1%	0.1%	0.0%	0.0%	0.9%	0.0%	2.2%
Eutrophication (EP)	kg N eq	40.0%	58.1%	1.0%	0.2%	0.0%	0.0%	0.3%	0.0%	0.4%
Fossil fuel depletion	MJ surplus	15.9%	80.7%	1.5%	0.1%	0.0%	0.0%	0.8%	0.0%	1.1%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	47.5%	46.3%	2.5%	0.1%	0.0%	0.0%	0.6%	0.0%	2.9%
Carcinogenics	CTUh	5.0%	92.0%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	2.6%
Non-carcinogenics	CTUh	9.9%	83.0%	0.4%	0.2%	0.0%	0.0%	0.2%	0.0%	6.2%
Ecotoxicity	CTUe	16.2%	82.1%	0.8%	0.1%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 146. SM millipoint scores for KN Series Insulation produced in Lanett, AL by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	**Total**
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	7.30E-03	1.13E-02	4.38E-04	4.22E-05	6.02E-04	**1.97E-02**

5.2.5.2. Shelbyville, IN

Tables 147-148 show the LCIA results and contributions of each stage of the life cycle KN Series Insulation produced in Shelbyville, IN. The SM millipoint score by life cycle phase for this product is presented in Table 149.

Table 147. LCIA results for KN Series Insulation produced in Shelbyville, IN per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	1.25E-12	1.88E-13	5.28E-17	8.29E-17	0	0	2.83E-17	0	8.11E-16	**1.44E-12**
Global warming	kg CO_2 eq	1.57E-01	1.81E+00	2.36E-02	8.20E-03	0	0	1.27E-02	0	1.65E-02	**2.03E+00**
Smog (SFP)	kg O_3 eq	1.10E-02	5.37E-02	4.16E-03	6.37E-05	0	0	7.91E-04	0	1.60E-03	**7.13E-02**
Acidification (AP)	kg SO_2 eq	9.24E-04	3.68E-03	1.21E-04	4.88E-06	0	0	3.46E-05	0	8.75E-05	**4.85E-03**
Eutrophication (EP)	kg N eq	3.82E-04	8.91E-04	1.04E-05	2.26E-06	0	0	3.67E-06	0	3.84E-06	**1.29E-03**
Fossil fuel depletion	MJ surplus	4.09E-01	2.83E+00	4.44E-02	1.99E-03	0	0	2.37E-02	0	3.32E-02	**3.35E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	7.16E-05	1.98E-04	5.93E-06	2.42E-07	0	0	1.49E-06	0	6.75E-06	**2.84E-04**
Carcinogenics	CTUh	4.1%	93.3%	0.2%	0.1%	0	0	0.1%	0	2.2%	**100.0%**
Non-carcinogenics	CTUh	7.7%	85.9%	0.4%	0.2%	0	0	0.2%	0	5.6%	**100.0%**
Ecotoxicity	CTUe	13.9%	84.6%	0.7%	0.1%	0	0	0.4%	0	0.4%	**100.0%**

Table 148. Percent contributions of each life cycle stage of KN Series Insulation produced in Shelbyville, IN to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	86.9%	13.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	7.7%	89.3%	1.2%	0.4%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	15.4%	75.3%	5.8%	0.1%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	19.0%	75.8%	2.5%	0.1%	0.0%	0.0%	0.7%	0.0%	1.8%
Eutrophication (EP)	kg N eq	29.6%	68.9%	0.8%	0.2%	0.0%	0.0%	0.3%	0.0%	0.3%
Fossil fuel depletion	MJ surplus	12.2%	84.7%	1.3%	0.1%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	25.3%	69.7%	2.1%	0.1%	0.0%	0.0%	0.5%	0.0%	2.4%
Carcinogenics	CTUh	4.1%	93.3%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	2.2%
Non-carcinogenics	CTUh	7.7%	85.9%	0.4%	0.2%	0.0%	0.0%	0.2%	0.0%	5.6%
Ecotoxicity	CTUe	13.9%	84.6%	0.7%	0.1%	0.0%	0.0%	0.4%	0.0%	0.4%

Table 149. SM millipoint scores for KN Series Insulation produced in Shelbyville, IN by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	**Total**
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	4.70E-03	1.79E-02	4.38E-04	4.21E-05	6.01E-04	**2.37E-02**

5.2.5.3. Interpretation

For the KN Series Insulation, the manufacturing stage dominates the results for all impact categories except ozone depletion, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

The manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. Since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts as shown in the results tables below are likely much larger than the actual impacts in the raw material acquisition stage. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for over 75% of the results for KN Series Insulation.

5.2.6. Acoustical Smooth Board

Tables 150-151 show the LCIA results and contributions of each stage of the life cycle for Acoustical Smooth Board. The SM millipoint score by life cycle phase for this product is presented in Table 152.

Table 150. LCIA results for Acoustical Smooth Board per functional unit

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**Total**
Ozone depletion (ODP)	kg CFC-11 eq	3.53E-12	7.95E-13	2.33E-16	1.51E-16	0	0	1.10E-16	0	3.16E-15	**4.33E-12**
Global warming	kg CO_2 eq	2.57E-01	5.82E+00	1.04E-01	1.14E-01	0	0	4.93E-02	0	6.42E-02	**6.40E+00**
Smog (SFP)	kg O_3 eq	5.21E-02	2.04E-01	1.84E-02	1.44E-03	0	0	3.08E-03	0	6.22E-03	**2.85E-01**
Acidification (AP)	kg SO_2 eq	4.88E-03	1.07E-02	5.36E-04	2.46E-04	0	0	1.35E-04	0	3.41E-04	**1.69E-02**
Eutrophication (EP)	kg N eq	3.84E-03	3.17E-03	4.59E-05	3.98E-05	0	0	1.43E-05	0	1.49E-05	**7.13E-03**
Fossil fuel depletion	MJ surplus	2.41E+00	9.59E+00	1.96E-01	1.64E-02	0	0	9.25E-02	0	1.29E-01	**1.24E+01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	3.46E-04	6.39E-04	2.62E-05	5.75E-06	0	0	5.79E-06	0	2.63E-05	**1.05E-03**
Carcinogenics	CTUh	9.1%	88.5%	0.2%	0.1%	0	0	0.1%	0	2.0%	**100.0%**
Non-carcinogenics	CTUh	14.6%	79.9%	0.4%	0.2%	0	0	0.2%	0	4.7%	**100.0%**
Ecotoxicity	CTUe	27.6%	71.2%	0.6%	0.1%	0	0	0.3%	0	0.3%	**100.0%**

Table 151. Percent contributions of each life cycle stage of Acoustical Smooth Board to each impact category

Impact category	**Unit**	**A1-A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**
Ozone depletion (ODP)	kg CFC-11 eq	81.6%	18.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	4.0%	90.8%	1.6%	1.8%	0.0%	0.0%	0.8%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	18.3%	71.5%	6.5%	0.5%	0.0%	0.0%	1.1%	0.0%	2.2%
Acidification (AP)	kg SO_2 eq	28.9%	63.7%	3.2%	1.5%	0.0%	0.0%	0.8%	0.0%	2.0%
Eutrophication (EP)	kg N eq	53.9%	44.5%	0.6%	0.6%	0.0%	0.0%	0.2%	0.0%	0.2%
Fossil fuel depletion	MJ surplus	19.4%	77.1%	1.6%	0.1%	0.0%	0.0%	0.7%	0.0%	1.0%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	33.0%	60.9%	2.5%	0.5%	0.0%	0.0%	0.6%	0.0%	2.5%
Carcinogenics	CTUh	9.1%	88.5%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	2.0%
Non-carcinogenics	CTUh	14.6%	79.9%	0.4%	0.2%	0.0%	0.0%	0.2%	0.0%	4.7%
Ecotoxicity	CTUe	27.6%	71.2%	0.6%	0.1%	0.0%	0.0%	0.3%	0.0%	0.3%

Table 152. SM millipoint scores for Acoustical Smooth Board by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	**Total**
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	2.11E-02	5.84E-02	1.93E-03	7.17E-04	2.34E-03	**8.45E-02**

The manufacturing stage dominates the results for all impact categories except ozone depletion and eutrophication, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

The manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. Since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts as shown in the results tables below are likely much larger than the actual impacts in the raw material acquisition stage. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for approximately 70% of the results for Acoustical Smooth Board.

5.2.7. Black Acoustical Board / Akousti-Board Black™

Tables 153-154 show the LCIA results and contributions of each stage of the life cycle for Black Acoustical Board / Akousti-Board Black™. The SM millipoint score by life cycle phase for this product is presented in Table 155.

Table 153. LCIA results for Black Acoustical Board / Akousti-Board Black™ per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	1.93E-12	3.86E-13	1.09E-16	1.89E-17	0	0	5.74E-17	0	1.65E-15	**2.31E-12**
Global warming	kg CO_2 eq	1.59E-01	3.05E+00	4.87E-02	1.32E-02	0	0	2.57E-02	0	3.35E-02	**3.33E+00**
Smog (SFP)	kg O_3 eq	2.56E-02	9.00E-02	8.58E-03	1.67E-04	0	0	1.61E-03	0	3.24E-03	**1.29E-01**
Acidification (AP)	kg SO_2 eq	2.41E-03	4.93E-03	2.50E-04	2.85E-05	0	0	7.04E-05	0	1.78E-04	**7.87E-03**
Eutrophication (EP)	kg N eq	1.76E-03	1.44E-03	2.14E-05	4.61E-06	0	0	7.46E-06	0	7.80E-06	**3.24E-03**
Fossil fuel depletion	MJ surplus	1.14E+00	4.49E+00	9.14E-02	1.92E-03	0	0	4.83E-02	0	6.75E-02	**5.83E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.73E-04	2.81E-04	1.22E-05	6.67E-07	0	0	3.02E-06	0	1.37E-05	**4.83E-04**
Carcinogenics	CTUh	8.5%	89.0%	0.2%	0.0%	0	0	0.1%	0	2.1%	**100.0%**
Non-carcinogenics	CTUh	14.2%	80.0%	0.4%	0.0%	0	0	0.2%	0	5.2%	**100.0%**
Ecotoxicity	CTUe	26.5%	72.2%	0.6%	0.0%	0	0	0.3%	0	0.3%	**100.0%**

Table 154. Percent contributions of each life cycle stage of Black Acoustical Board / Akousti-Board Black™ to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	83.3%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	4.8%	91.6%	1.5%	0.4%	0.0%	0.0%	0.8%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	19.8%	69.7%	6.6%	0.1%	0.0%	0.0%	1.2%	0.0%	2.5%
Acidification (AP)	kg SO_2 eq	30.6%	62.7%	3.2%	0.4%	0.0%	0.0%	0.9%	0.0%	2.3%
Eutrophication (EP)	kg N eq	54.4%	44.3%	0.7%	0.1%	0.0%	0.0%	0.2%	0.0%	0.2%
Fossil fuel depletion	MJ surplus	19.5%	76.9%	1.6%	0.0%	0.0%	0.0%	0.8%	0.0%	1.2%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	35.8%	58.1%	2.5%	0.1%	0.0%	0.0%	0.6%	0.0%	2.8%
Carcinogenics	CTUh	8.5%	89.0%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	2.1%
Non-carcinogenics	CTUh	14.2%	80.0%	0.4%	0.0%	0.0%	0.0%	0.2%	0.0%	5.2%
Ecotoxicity	CTUe	26.5%	72.2%	0.6%	0.0%	0.0%	0.0%	0.3%	0.0%	0.3%

Table 155. SM millipoint scores for Black Acoustical Board / Akousti-Board Black™ by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
SM single figure score	mPts	1.07E-02	2.73E-02	9.03E-04	8.32E-05	1.22E-03	**4.02E-02**

The manufacturing stage dominates the results for all impact categories except ozone depletion and eutrophication, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

The manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. Since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts as shown in the results tables below are likely much larger than the actual impacts in the raw material acquisition stage. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for over 65% of the results for for Black Acoustical Board / Akousti-Board Black™.

5.2.8. Earthwool® Insulation Board / AK BOARD™

Tables 156-161 show the LCIA results and contributions of each stage of the life cycle for the three facing options for Earthwool® Insulation Board / AK BOARD™: unfaced, FSK-faced, and ASJ+-faced. The SM millipoint score by life cycle phase for this product is presented in Table 162.

Table 156. LCIA results for unfaced Earthwool® Insulation Board / AK BOARD™ per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.31E-12	4.32E-13	1.33E-16	1.27E-16	0	0	6.14E-17	0	1.76E-15	**2.75E-12**
Global warming	kg CO_2 eq	2.11E-01	3.20E+00	5.98E-02	7.74E-02	0	0	2.75E-02	0	3.58E-02	**3.61E+00**
Smog (SFP)	kg O_3 eq	2.76E-02	1.19E-01	1.05E-02	9.74E-04	0	0	1.72E-03	0	3.46E-03	**1.63E-01**
Acidification (AP)	kg SO_2 eq	2.62E-03	6.16E-03	3.07E-04	1.65E-04	0	0	7.52E-05	0	1.90E-04	**9.51E-03**
Eutrophication (EP)	kg N eq	1.74E-03	1.77E-03	2.63E-05	2.70E-05	0	0	7.97E-06	0	8.33E-06	**3.58E-03**
Fossil fuel depletion	MJ surplus	1.16E+00	5.38E+00	1.12E-01	1.14E-02	0	0	5.15E-02	0	7.21E-02	**6.79E+00**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.90E-04	3.67E-04	1.50E-05	3.88E-06	0	0	3.23E-06	0	1.46E-05	**5.94E-04**
Carcinogenics	CTUh	7.7%	89.8%	0.2%	0.1%	0	0	0.1%	0	2.1%	**100.0%**
Non-carcinogenics	CTUh	12.6%	81.7%	0.4%	0.3%	0	0	0.2%	0	4.9%	**100.0%**
Ecotoxicity	CTUe	23.7%	74.9%	0.7%	0.1%	0	0	0.3%	0	0.3%	**100.0%**

Table 157. Percent contributions of each life cycle stage of unfaced Earthwool® Insulation Board / AK BOARD™ to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	84.2%	15.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Global warming	kg CO_2 eq	5.8%	88.6%	1.7%	2.1%	0.0%	0.0%	0.8%	0.0%	1.0%
Smog (SFP)	kg O_3 eq	16.9%	72.9%	6.4%	0.6%	0.0%	0.0%	1.1%	0.0%	2.1%
Acidification (AP)	kg SO_2 eq	27.5%	64.7%	3.2%	1.7%	0.0%	0.0%	0.8%	0.0%	2.0%
Eutrophication (EP)	kg N eq	48.6%	49.5%	0.7%	0.8%	0.0%	0.0%	0.2%	0.0%	0.2%
Fossil fuel depletion	MJ surplus	17.1%	79.2%	1.7%	0.2%	0.0%	0.0%	0.8%	0.0%	1.1%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	32.0%	61.8%	2.5%	0.7%	0.0%	0.0%	0.5%	0.0%	2.5%
Carcinogenics	CTUh	7.7%	89.8%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	2.1%
Non-carcinogenics	CTUh	12.6%	81.7%	0.4%	0.3%	0.0%	0.0%	0.2%	0.0%	4.9%
Ecotoxicity	CTUe	23.7%	74.9%	0.7%	0.1%	0.0%	0.0%	0.3%	0.0%	0.3%

Table 158. LCIA results for FSK-faced Earthwool® Insulation Board / AK BOARD™ per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.39E-12	1.05E-11	1.43E-16	1.36E-16	0	0	6.59E-17	0	1.89E-15	**1.29E-11**
Global warming	kg CO_2 eq	2.18E-01	4.38E+00	6.42E-02	8.31E-02	0	0	2.95E-02	0	3.84E-02	**4.82E+00**
Smog (SFP)	kg O_3 eq	2.86E-02	1.36E-01	1.13E-02	1.05E-03	0	0	1.84E-03	0	3.72E-03	**1.82E-01**
Acidification (AP)	kg SO_2 eq	2.71E-03	6.89E-03	3.29E-04	1.77E-04	0	0	8.07E-05	0	2.04E-04	**1.04E-02**
Eutrophication (EP)	kg N eq	1.80E-03	1.67E-03	2.82E-05	2.90E-05	0	0	8.55E-06	0	8.94E-06	**3.55E-03**
Fossil fuel depletion	MJ surplus	1.20E+00	8.87E+00	1.20E-01	1.23E-02	0	0	5.53E-02	0	7.74E-02	**1.03E+01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	1.97E-04	3.66E-04	1.61E-05	4.17E-06	0	0	3.46E-06	0	1.57E-05	**6.03E-04**
Carcinogenics	CTUh	7.5%	90.0%	0.2%	0.1%	0	0	0.1%	0	2.1%	**100.0%**
Non-carcinogenics	CTUh	12.4%	81.8%	0.4%	0.3%	0	0	0.2%	0	5.0%	**100.0%**
Ecotoxicity	CTUe	22.6%	76.0%	0.7%	0.1%	0	0	0.3%	0	0.3%	**100.0%**

Table 159. Percent contributions of each life cycle stage of FSK-faced Earthwool® Insulation Board / AK BOARD™ to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	18.5%	81.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	4.5%	91.0%	1.3%	1.7%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	15.7%	74.5%	6.2%	0.6%	0.0%	0.0%	1.0%	0.0%	2.0%
Acidification (AP)	kg SO_2 eq	26.1%	66.3%	3.2%	1.7%	0.0%	0.0%	0.8%	0.0%	2.0%
Eutrophication (EP)	kg N eq	50.8%	47.1%	0.8%	0.8%	0.0%	0.0%	0.2%	0.0%	0.3%
Fossil fuel depletion	MJ surplus	11.6%	85.8%	1.2%	0.1%	0.0%	0.0%	0.5%	0.0%	0.7%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	32.7%	60.8%	2.7%	0.7%	0.0%	0.0%	0.6%	0.0%	2.6%
Carcinogenics	CTUh	7.5%	90.0%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	2.1%
Non-carcinogenics	CTUh	12.4%	81.8%	0.4%	0.3%	0.0%	0.0%	0.2%	0.0%	5.0%
Ecotoxicity	CTUe	22.6%	76.0%	0.7%	0.1%	0.0%	0.0%	0.3%	0.0%	0.3%

Table 160. LCIA results for ASJ+-faced Earthwool® Insulation Board / AK BOARD™ per functional unit

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4	Total
Ozone depletion (ODP)	kg CFC-11 eq	2.57E-12	1.35E-09	1.51E-16	1.43E-16	0	0	6.93E-17	0	1.99E-15	**1.36E-09**
Global warming	kg CO_2 eq	2.34E-01	4.85E+00	6.75E-02	8.74E-02	0	0	3.10E-02	0	4.04E-02	**5.31E+00**
Smog (SFP)	kg O_3 eq	3.07E-02	1.53E-01	1.19E-02	1.10E-03	0	0	1.94E-03	0	3.91E-03	**2.03E-01**
Acidification (AP)	kg SO_2 eq	2.91E-03	8.01E-03	3.46E-04	1.86E-04	0	0	8.49E-05	0	2.14E-04	**1.18E-02**
Eutrophication (EP)	kg N eq	1.94E-03	1.84E-03	2.97E-05	3.05E-05	0	0	8.99E-06	0	9.40E-06	**3.86E-03**
Fossil fuel depletion	MJ surplus	1.29E+00	9.79E+00	1.27E-01	1.29E-02	0	0	5.82E-02	0	8.14E-02	**1.14E+01**
Additional environmental information											
Respiratory effects	kg $PM_{2.5}$ eq	2.12E-04	4.37E-04	1.69E-05	4.38E-06	0	0	3.64E-06	0	1.65E-05	**6.90E-04**
Carcinogenics	CTUh	7.4%	90.1%	0.2%	0.1%	0	0	0.1%	0	2.0%	**100.0%**
Non-carcinogenics	CTUh	12.1%	82.3%	0.4%	0.3%	0	0	0.2%	0	4.8%	**100.0%**
Ecotoxicity	CTUe	22.4%	76.3%	0.7%	0.1%	0	0	0.3%	0	0.3%	**100.0%**

Table 161. Percent contributions of each life cycle stage of ASJ+-faced Earthwool® Insulation Board / AK BOARD™ to each impact category

Impact category	Unit	A1-A2	A3	A4	A5	B1-B7	C1	C2	C3	C4
Ozone depletion (ODP)	kg CFC-11 eq	0.2%	99.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Global warming	kg CO_2 eq	4.4%	91.3%	1.3%	1.6%	0.0%	0.0%	0.6%	0.0%	0.8%
Smog (SFP)	kg O_3 eq	15.2%	75.5%	5.9%	0.5%	0.0%	0.0%	1.0%	0.0%	1.9%
Acidification (AP)	kg SO_2 eq	24.8%	68.2%	2.9%	1.6%	0.0%	0.0%	0.7%	0.0%	1.8%
Eutrophication (EP)	kg N eq	50.2%	47.8%	0.8%	0.8%	0.0%	0.0%	0.2%	0.0%	0.2%
Fossil fuel depletion	MJ surplus	11.4%	86.2%	1.1%	0.1%	0.0%	0.0%	0.5%	0.0%	0.7%
Additional environmental information										
Respiratory effects	kg $PM_{2.5}$ eq	30.7%	63.3%	2.5%	0.6%	0.0%	0.0%	0.5%	0.0%	2.4%
Carcinogenics	CTUh	7.4%	90.1%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	2.0%
Non-carcinogenics	CTUh	12.1%	82.3%	0.4%	0.3%	0.0%	0.0%	0.2%	0.0%	4.8%
Ecotoxicity	CTUe	22.4%	76.3%	0.7%	0.1%	0.0%	0.0%	0.3%	0.0%	0.3%

Table 162. SM millipoint scores for faced and Earthwool® Insulation Board / AK BOARD™ by life cycle stage per functional unit

	Unit	Raw material acquisition	Manufacturing	Transportation	Installation and maintenance	Disposal/reuse/ recycling	Total
		A1-A2	**A3**	**A4**	**A5, B1-B7**	**C1-C4**	
Unfaced - SM single figure score	mPts	1.18E-02	3.30E-02	1.11E-03	4.87E-04	1.31E-03	**4.78E-02**
FSK-faced - SM single figure score	mPts	1.22E-02	3.71E-02	1.19E-03	5.23E-04	1.40E-03	**5.24E-02**
ASJ+-faced - SM single figure score	mPts	1.32E-02	4.28E-02	1.25E-03	5.50E-04	1.47E-03	**5.92E-02**

The manufacturing stage dominates the results for all impact categories except ozone depletion and eutrophication, where the raw material acquisition stage takes precedence. However, the total life cycle impact of ozone depletion is relatively low. This implies that a small change in different stages can affect the overall result and make any particular stage the major contributor to the impacts.

For the unfaced, FSK, and ASJ+ faced product, the manufacturing stage dominates the results for all impact categories. Following these manufacturing stage, the next highest impacts come from the raw material acquisition and transportation stages.

The energy required to melt the glass and produce the glass fibers is the largest contributor to the manufacturing stage.The impact of the raw material acquisition stage is mostly due to the batch and binder materials. Since sand and borax are melted in the oven with the other batch materials, they are not released into the air as fine particulates. Therefore, the calculated potential impacts as shown in the results tables below are likely much larger than the actual impacts in the raw material acquisition stage. The contributions to outbound transportation are casued by the use of trucks and rail transport. The landfilling of the discarded product contributes to the disposal stage. The only impacts associated with installation and maintenance are due to the disposal of packaging waste, which is the smallest contributor of all the stages.

Variations

The three different facing options impact the type and amount of raw materials extracted during the raw materials acquisition stage. The addition of facing contributes to higher impacts.

Single score results

The SM millipoint score by life cycle phase for these products aligns with the trends in the results using the impact assessment results before normalization and weighting. Due to the normalization and weighting required to create single score results, different stages can contribute differently to the characterized and single score results.

The energy used for material mixing, heating, fiberizing, etc. causes the manufacturing stage to dominate the mPt results. This stage accounts for over 60% of the results for unfaced, kraft faced, and ASJ+ faced Earthwool® Insulation Board / AK BOARD™.

5.3 Sensitivity analyses

These sensitivity analyses were performed to address the differences in results between uncured products made using different manufacturing and raw material scenarios. Since the plant in Shelbyville, IN is the only facility that produces all series of all KINA products, this sensitivity analyses assumed the same material composition, recycled cullet content, transportation, manufacturing processes, and energy and water consumption as is used at the Shelbyville plant.

In the past, uncured products were made from various virgin materials and phenol formaldehyde (PF)-based binders. KINA intends to utilize these sensitivity analyses to evaluate the results of shifting to adopt a bio-based formulation, a higher amount of recycled ingredients, or a 100% renewable energy sources.

5.3.1. Comparing uncured products made with PF-based and ECOSE®-based binders

A sensitivity analysis was performed to address the difference in results between an uncured product using a phenol formaldehyde (PF)-based binder, and an uncured product using an ECOSE®-based binder. While none of the products included in this study are made using a PF-based binder, this analysis aligns with KINA's goal of identifying areas for focusing its health- and sustainability-related efforts.

Uncured products are products which have undergone manufacturing steps through the fiberizing stage, and they are being compared at this stage to analyze the difference among many product types whose manufacturing steps may differ after this point. The electricity, natural gas, and water used during the fiberizing stage is the same between each product type.

Table 163. LCIA results for 1 kg of a black uncured product made with a PF-based binder and 1kg of an ECOSE® uncured product made with an ECOSE®-based binder

Impact category	Unit	A1	A2	A3	Total
PF-based binder					
Acidification	kg SO_2 eq	9.52E-03	3.31E-05	2.87E-03	**1.24E-02**
Eutrophication	kg N eq	2.29E-04	2.91E-06	7.88E-04	**1.02E-03**
Global warming	kg CO_2 eq	9.78E-01	6.95E-03	1.80E+00	**2.78E+00**
Ozone depletion	kg CFC-11 eq	2.74E-11	1.56E-17	2.13E-13	**2.76E-11**
Carcinogenics	CTUh	4.22E-09	2.72E-12	4.74E-09	**8.96E-09**
Non-carcinogenics	CTUh	1.33E-07	2.40E-10	1.99E-07	**3.32E-07**
Respiratory effects	kg $PM_{2.5}$ eq	5.87E-04	1.44E-06	1.57E-04	**7.46E-04**
Smog	kg O_3 eq	5.25E-02	9.85E-04	5.29E-02	**1.06E-01**
Ecotoxicity	CTUe	2.39E+00	5.70E-04	2.56E-01	**2.65E+00**
Fossil fuel depletion	MJ surplus	2.93E+00	1.31E-02	2.47E+00	**5.42E+00**
ECOSE®-based binder					
Acidification	kg SO_2 eq	1.16E-03	3.11E-05	2.87E-03	**4.06E-03**
Eutrophication	kg N eq	6.39E-04	2.70E-06	7.88E-04	**1.43E-03**
Global warming	kg CO_2 eq	1.58E-01	6.27E-03	1.80E+00	**1.96E+00**
Ozone depletion	kg CFC-11 eq	1.56E-12	1.40E-17	2.13E-13	**1.78E-12**
Carcinogenics	CTUh	2.65E-10	2.45E-12	4.74E-09	**5.01E-09**
Non-carcinogenics	CTUh	2.14E-08	2.17E-10	1.99E-07	**2.20E-07**
Respiratory effects	kg $PM_{2.5}$ eq	9.14E-05	1.36E-06	1.57E-04	**2.50E-04**
Smog	kg O_3 eq	1.33E-02	9.39E-04	5.29E-02	**6.71E-02**
Ecotoxicity	CTUe	6.07E-02	5.14E-04	2.56E-01	**3.17E-01**
Fossil fuel depletion	MJ surplus	4.78E-01	1.18E-02	2.47E+00	**2.96E+00**

In general, the uncured product using ECOSE®-based binder achieves overall lower environmental impacts compared to the PF-based product across all impact categories.

The total potential CO_2-equivalent emissions generated during the A1-A3 stages for PF-based products (2.78E+00 kg CO_2 eq) are higher than those for ECOSE®-based products (1.96E+00 kg CO_2 eq). The uncured product using PF-based binder contributes to 9.78E-01 kg CO_2 eq and ECOSE®-based products contributes to 1.58E-01 kg CO_2 eq during the A1 stage, meaning the amount of CO_2 eq emission in the A1 stage for the uncured product using PF-based binder is about 6 times higher than for the uncured product using ECOSE®-based binder.

In the respiratory effects category, the total potential kg $PM_{2.5}$ generated during the A1-A3 stages for PF-based products (7.46E-04 kg $PM_{2.5}$ eq) is much higher than for ECOSE®-based products (5.01E-09 kg $PM_{2.5}$ eq). PF-based products contribute 5.87E-04 kg $PM_{2.5}$ eq, while ECOSE®-based products contribute 9.14E-05 kg $PM_{2.5}$ eq.

Focusing only on the raw materials acquisition stage (A1) reveals that the results for the PF-based products are approximately 16 times higher for carcinogenics, 39 times higher for ecotoxicity, and 17 times higher for ozone depletion as compared to the ECOSE®-based products. This highlights the relatively large impact the addition of formaldehyde has across all impact categories.

If all stages from cradle to grave are considered, assuming the same per-kg impacts as unfaced EcoBatt®, the total potential CO_2-equivalent emissions for the PF-based products (2.89 kg CO_2 eq) are about 1.4 times higher than those for the ECOSE®-based products (2.07 kg CO_2 eq). This shows that the environmental performance improvement of using formaldehyde-free binders is maintained across the entire life cycle of the products, not just from cradle to gate.

The impacts generated during the A3 stage between the two product types are the same since the energy and water used during the fiberizing stage are assumed to be the same.

5.3.2. Impact of using recycled cullet

A sensitivity analysis was conducted to address the differences in results between an uncured product with 100% virgin batch materials and an uncured product with a standard batch containing 65% recycled materials. Uncured products are products which have undergone manufacturing steps through the fiberizing stage, and they are being compared at this stage to analyze the difference among many product types whose manufacturing steps may differ after this point.

The product using 100% virgin batch materials is expected to consume an extra ~8% electricity and materials related to the batch and binder manufacturing because there is no internal cullet used in this case. The electricity, natural gas, and water for the rest of the manufacturing processes until the fiberizing stage is assumed to be the same between each product type

Table 164. LCIA results for 1 kg of uncured product made with 100% virgin batch materials and 1kg of uncured product made with a batch containing 65% recycled materials

Impact category	Unit	A1	A2	A3	Total
100% virgin batch materials					
Acidification	kg SO_2 eq	1.24E-02	4.06E-05	2.94E-03	**1.54E-02**
Eutrophication	kg N eq	4.74E-04	3.88E-06	7.94E-04	**1.27E-03**
Global warming	kg CO_2 eq	1.49E+00	1.12E-02	1.84E+00	**3.34E+00**
Ozone depletion	kg CFC-11 eq	8.08E-04	1.64E-06	1.61E-04	**9.70E-04**
Carcinogenics	CTUh	4.67E-09	4.38E-12	4.75E-09	**9.42E-09**
Non-carcinogenics	CTUh	1.57E-07	3.88E-10	1.99E-07	**3.56E-07**
Respiratory effects	kg $PM_{2.5}$ eq	8.08E-04	1.64E-06	1.61E-04	**9.70E-04**
Smog	kg O_3 eq	7.63E-02	1.06E-03	5.46E-02	**1.32E-01**
Ecotoxicity	CTUe	2.61E+00	9.19E-04	2.56E-01	**2.86E+00**
Fossil fuel depletion	MJ surplus	3.62E+00	2.11E-02	2.50E+00	**6.14E+00**
Batch containing 65% recycled materials					
Acidification	kg SO_2 eq	9.52E-03	3.31E-05	2.87E-03	**1.24E-02**
Eutrophication	kg N eq	2.29E-04	2.91E-06	7.88E-04	**1.02E-03**
Global warming	kg CO_2 eq	9.78E-01	6.95E-03	1.80E+00	**2.78E+00**
Ozone depletion	kg CFC-11 eq	2.74E-11	1.56E-17	2.13E-13	**2.76E-11**
Carcinogenics	CTUh	4.22E-09	2.72E-12	4.74E-09	**8.96E-09**
Non-carcinogenics	CTUh	1.33E-07	2.40E-10	1.99E-07	**3.32E-07**
Respiratory effects	kg $PM_{2.5}$ eq	5.87E-04	1.44E-06	1.57E-04	**7.46E-04**
Smog	kg O_3 eq	5.25E-02	9.85E-04	5.29E-02	**1.06E-01**
Ecotoxicity	CTUe	2.39E+00	5.70E-04	2.56E-01	**2.65E+00**
Fossil fuel depletion	MJ surplus	2.93E+00	1.31E-02	2.47E+00	**5.42E+00**

The total potential CO_2-equivalent emissions generated during the A1-A3 stages for the uncured product using 100% virgin batch materials (3.34E+00 kg CO_2 eq) are 1.2 times higher than the uncured product using a batch with 65% recycled materials (2.78E+00 kg CO_2 eq). The uncured product using 100% virgin batch materials contributes to 1.49E+00 kg CO_2 eq and the uncured product using a batch with 65% recycled materials contributes to 9.78E-01 kg CO_2 eq during the A1 stage.

In summary, the product using 100% virgin batch materials generates about 50% more CO_2 eq emissions than the uncured product made with a batch including 65% recycled materials in the A1 stage, and overall generates a higher environmental impact across all impact categories.

5.3.3. Potential conversion to renewable energy sources

A sensitivity analysis was conducted to address the differences in results between manufacturing with electricity using the eGrid-RFCW energy source in Shelbyville, IN, and electricity using renewable energy sources. The analyzed renewable energy mix includes the renewable sources accessible within the RFCW region. The proportion of wind power, photovoltaic, hydro power, and biogas in the renewable energy mix was determined based on the ratio of these renewable resources allocated in the eGrid-RFCW energy mix.

Uncured products are products which have undergone manufacturing steps through the fiberizing stage, and they are being compared at this stage to analyze the difference among many product types whose manufacturing steps may differ after this point. The amount of electricity, natural gas and water used during the fiberizing stage is assumed to be the same between each product type.

Table 165. Contribution of each energy source for eGrid- RFCW and the renewable energy mix*

eGrid- RFCW	Percentage (%)	Renewable energy mix	Scaled percentage (%)
Gas	27.7	--	--
Coal	35.6	--	--
Nuclear	28.5	--	--
Hydro	1.1	Hydro	15.5
Wind	5.2	Wind	73.2
Biomass	0.5	Biomass	7.0
Solar	0.3	Solar	4.2
Oil	0.3	--	--
Geothermal	0	--	--
Other fossil fuel	0.7	--	--
Other unknown fuel	0.1	--	--

*Power Profiler | US EPA - https://www.epa.gov/egrid/power-profiler#/RFCW

Table 166. LCIA results for 1 kg of uncured products manufactured with electricity using an eGrid-RFCW electricity source and a renewable energy mix

Impact category	Unit	A1	A2	A3	Total
eGrid-RFCW					
Acidification	kg SO_2 eq	9.52E-03	3.31E-05	2.87E-03	**1.24E-02**
Eutrophication	kg N eq	2.29E-04	2.91E-06	7.88E-04	**1.02E-03**
Global warming	kg CO_2 eq	9.78E-01	6.95E-03	1.80E+00	**2.78E+00**
Ozone depletion	kg CFC-11 eq	2.74E-11	1.56E-17	2.13E-13	**2.76E-11**
Carcinogenics	CTUh	4.22E-09	2.72E-12	4.74E-09	**8.96E-09**
Non-carcinogenics	CTUh	1.33E-07	2.40E-10	1.99E-07	**3.32E-07**
Respiratory effects	kg $PM_{2.5}$ eq	5.87E-04	1.44E-06	1.57E-04	**7.46E-04**
Smog	kg O_3 eq	5.25E-02	9.85E-04	5.29E-02	**1.06E-01**
Ecotoxicity	CTUe	2.39E+00	5.70E-04	2.56E-01	**2.65E+00**
Fossil fuel depletion	MJ surplus	2.93E+00	1.31E-02	2.47E+00	**5.42E+00**
Renewable energy mix					
Acidification	kg SO_2 eq	9.52E-03	3.31E-05	2.37E-03	**1.19E-02**
Eutrophication	kg N eq	2.29E-04	2.91E-06	7.66E-04	**9.98E-04**
Global warming	kg CO_2 eq	9.78E-01	6.95E-03	1.18E+00	**2.16E+00**
Ozone depletion	kg CFC-11 eq	2.74E-11	1.56E-17	3.79E-13	**2.77E-11**
Carcinogenics	CTUh	4.22E-09	2.72E-12	4.87E-09	**9.09E-09**
Non-carcinogenics	CTUh	1.33E-07	2.40E-10	1.71E-07	**3.04E-07**
Respiratory effects	kg $PM_{2.5}$ eq	5.87E-04	1.44E-06	1.07E-04	**6.96E-04**
Smog	kg O_3 eq	5.25E-02	9.85E-04	4.66E-02	**1.00E-01**
Ecotoxicity	CTUe	2.39E+00	5.70E-04	2.34E-01	**2.62E+00**
Fossil fuel depletion	MJ surplus	2.93E+00	1.31E-02	1.98E+00	**4.92E+00**

The total potential CO_2-equivalent emissions generated during the A1-A3 stages for the uncured product manufactured using electricity from an eGrid-RFCW energy source across the A1-A3 stages (2.78E+00 kg CO_2 eq) and across A3 only (1.80E+00 kg CO_2 eq) are higher than that from a renewable energy mix across the A1-A3 stages (2.16E+00 kg CO_2 eq) and across A3 only (1.18E+00 kg CO_2 eq).

In summary, the product manufactured with electricity using the eGrid-RFCW energy source generates about two times more CO_2 eq emissions than the product manufactured using a renewable energy mix in the A3 stage, and overall generates a higher environmental impact across all impact categories.

5.4 Overview of relevant findings

This Life Cycle Assessment (LCA) report evaluates a wide range of inventory and environmental indicators. As is expected for insulation products, the primary finding is that manufacturing dominates the environmental impacts due to the energy required to melt the glass and produce the glass fibers.

Raw material production also constitutes a significant contribution to the impacts across all inventory and impact indicators. Borax, manganese oxide, and soda ash emerge as the three main contributors to the insulation products studied. Since the same batch is used for all products in each plant, this is true for all products studied.

Outbound transport accounts for a notable impact in most of the impact categories. For ozone depletion, carcinogenics, and non-carcinogenics, outbound transport plays a minor role.

Installation contributes a small fraction of the overall life cycle impact, with the only installation impacts being associated with packaging disposal. While insulation can influence building energy performance, this aspect is considered beyond the scope of this study. Furthermore, it is assumed that no replacements or other activities during the use phase are necessary.

At the end of life, insulation is manually removed from the building and landfilled. For most impact categories, the impacts associated with landfilling the insulation at the end of life are only slightly higher than the impacts associated with transporting it to the landfill, which reflects the relatively low end-of-life impacts for these products.

5.5 Discussion on data quality

Inventory data quality is judged by its precision (measured, calculated or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied on a study serving as a data source), and representativeness (geographical, temporal, and technological).

To cover these requirements and to ensure reliable results, first-hand industry data in combination with consistent background LCA information from the LCA for Experts LCI databases were used. The LCI datasets from the LCA for Experts 2023 databases are widely distributed and used with the LCA for Experts Software. In the process of providing these datasets they are cross-checked with other databases and values from industry and science.

Precision and completeness

- Precision: As the relevant foreground data is primary data or modeled based on primary information sources of the owner of the technology, precision is considered to be high. Seasonal variations were balanced out by collecting 12 months of data. All background data are from LCA for Experts databases with the documented precision.
- Completeness: Each unit process was checked for mass balance and completeness of the emission inventory. Capital equipment was excluded under cut-off criteria. Otherwise, no data were knowingly omitted.

Consistency and reproducibility

- Consistency: To ensure consistency, all primary data were collected with the same level of detail, while all background data were sourced from the LCA for Experts databases. Allocation and other methodological choices were made consistently throughout the model.

- Reproducibility: Reproducibility is warranted as much as possible through the disclosure of input-output data, dataset choices, and modeling approaches in this report. Based on this information, any third party should be able to approximate the results of this study using the same data and modeling approaches.

Representativeness

- Temporal: All primary data were collected for CY2022 in order to ensure representativeness of post-consumer content. All secondary data were obtained from the LCA for Experts 2023 databases and are typically representative.
- Geographical: Primary data are representative of KINA's production in the US. Data were collected from five plants: Albion, MI; Inwood, WV; Lanett, AL; Shasta Lake, CA; Shelbyville, IN. In general, secondary data were collected specific to the country under study. Where country-specific data were unavailable, proxy data were used. Geographical representativeness is considered to be high.
- Technological: All primary and secondary data were modeled to be specific to the technologies under study. Technological representativeness is considered to be high.

5.6 Conclusions, limitations, and recommendations

The goal of this study was to conduct a cradle-to-grave LCA on several insulation products so as to develop SM Transparency Reports / EPDs™. The creation of these Transparency Reports will allow consumers in the building and construction industry to make better informed decisions about the environmental impacts associated with the products they choose. Overall, the study found that environmental performance is driven primarily by cradle-to-gate impacts. Manufacturing emissions and energy consumption drive environmental performance. Additionally, raw materials also account for a notable contribution to impacts. The gate-to-installation and end-of-life stages account for minimal contributions to life cycle performance.

This study did not consider the energy savings associated with the use of insulation in a building. It is expected that these savings, compared to a building that does not use insulation, would far outweigh the impacts attributed to the manufacturing, transportation, and installation of the product.

It should be noted that the contribution to impact results associated with facing is high relative to the contribution of fiberglass due to the PCR's "artificial" functional unit of R_{SI} = 1. Fiberglass insulation used in practice is associated with a higher fiberglass-to-facing mass ratio and thus a smaller relative contribution from the facing itself.

The results show that the largest area for reduction of each product's environmental impact is in the manufacturing phase. This is an important area for KINA to focus its efforts on and one which it can influence. [redacted]

Comparing the use of phenol formaldehyde (PF)-based binders and ECOSE®-based binders shows that minimizing the use of PF binders is expected to lower potential environmental impacts across all impact categories, notably including those related to human health. It is recommended that KINA continue to phase out PF binders from its product offerings.

Upon exploring potential strategies for changing KINA's manufacturing practices, the results of sensitivity analyses show that increasing the amount of recycled cullet used in the batch and switching to renewable energy sources are both expected to lower potential environmental impacts. It is recommended that KINA consider these changes to its manufacturing activities to maximize their impact on the LCIA results.

Combining the findings of these sensitivity analyses shows that uncured KINA products with at least 65% recycled batch materials and an ECOSE®-based binder generate 40% less embodied carbon emissions than uncured KINA products with 100% virgin batch materials and a PF-based uncured binder.

It is recommended that in 2024, KINA collects new life cycle assessment data covering the 2023 calendar year for the products analyzed in this study, as well as update this LCA and associated Transparency Reports. This would enable high-quality year-to-year comparisons and serve as the basis for any potential optimized EPDs. A post-project review could provide opportunities for improving the data collection process in 2024 and for continuing to align with KINA's goals for sustainability.

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ACRONYMS

ASJ+	All-service jacket
FSK	Foil scrim kraft
ISO	International Standardization Organization
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact analysis
PCR	Product Category Rule document
SSL	Self-sealing lap
TR	Transparency Report / EPD™
USLCI	US Life Cycle Inventory

GLOSSARY

For the purposes of this report, the terms and definitions given in ISO 14020, ISO 14025, the ISO 14040 series, and ISO 21930 apply. The most important ones are included here:

Allocation	Partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems
Close loop & open loop	A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties.
Cradle to grave	Addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition until the end of life
Cradle to gate	Addresses the environmental aspects and potential environmental impacts (e.g., use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition until the end of the production process ("gate of the factory"). It may also include transportation until use phase
Declared unit	Quantity of a product for use as a reference unit in an EPD based on one or more information modules
Functional unit	Quantified performance of a product system for use as a reference unit
Life cycle	Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal
Life cycle assessment - LCA	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle
Life cycle impact assessment - LCIA	Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product
Life cycle inventory - LCI	phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle
Life cycle interpretation	Phase of life cycle assessment in which the findings of either the inventory analysis or the impact assessment, or both, are evaluated in relation to the defined goal and scope in order to reach conclusions and recommendations

APPENDIX

To model the LCA different data sources have been used. This appendix includes a list of all datasheets that have been used:

- [redacted]