ENVIRONMENTAL PRODUCT DECLARATION

THERMAFIBER® MINERAL WOOL INSULATION

THERMAFIBER, INC.

Owens Corning™ Thermafiber® Mineral Wool Insulation enhances comfort, energy savings and sustainability in new and existing structures.

Thermafiber, Inc. (an Owens Corning company) is a leading manufacturer of premium mineral wool insulation products for commercial, residential, industrial and marine applications. For over 80 years, Thermafiber, Inc. has provided industry-leading insulation solutions that conserve energy, control noise, and help provide fire protection. Thermafiber® mineral wool is the #1 specified commercial brand and is installed in 6 of the 12 tallest buildings in the world.

Building Materials products – primarily roofing and insulation are focused on making new and existing homes and buildings energy efficient, comfortable, and attractive. Owens Corning is committed to balancing economic growth with social progress and sustainable solutions to its building materials and composite customers around the world.
This Environmental Product Declaration is a component of our stated goal to provide life cycle information on all core products.

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

Thermafiber® Mineral Wool Insulation
Light and Heavy Density Mineral Wool Insulation Board

According to ISO 14025

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Owens Corning
DECLARATION NUMBER	4786077032.104.1
DECLARED PRODUCT	Thermafiber® Mineral Wool Insulation
REFERENCE PCR	Building Envelope Thermal Insulation v1.2
DATE OF ISSUE	October 1, 2014
PERIOD OF VALIDITY	5 Years
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	UL Environment PCR was approved by panel 333 Pfingsten Road Northbrook, IL 60611
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Wade Stout, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria, Life-Cycle Services, LLC

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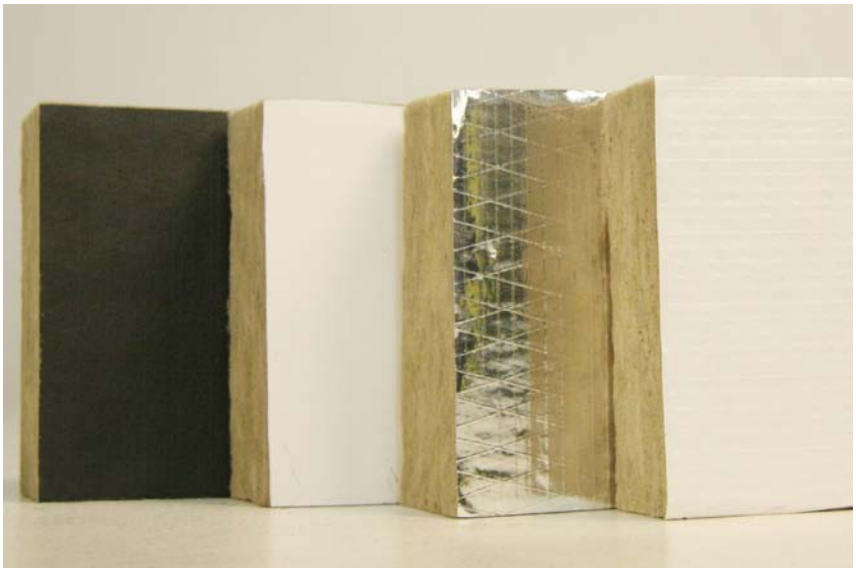
Product Definition and Information

Product Description

Thermafiber® mineral wool insulation products are comprised of semi-rigid and rigid boards and batts. Mineral wool resists mold, fungi, and is vermin proof due to its being an inorganic material.

The R-value of Thermafiber® mineral wool insulation ranges from 3.7 – 4.2 per inch of thickness. It is available in multiple thicknesses, densities, and various facings by product type. Reflected by its R-value, mineral wool's insulating performance is achieved by its densely packed fibers. Its high resistance to heat flow translates into year-round comfort and energy savings.



Manufacturing Locations

Thermafiber® mineral wool insulation is manufactured at Thermafiber, Inc.'s Wabash, IN facility located at 3711 Mill St, Wabash, IN 46992.

Application and Uses

Thermafiber® mineral wool insulation products are used in residential and multi-family construction as nonstructural thermal-insulating materials in floor-ceiling assemblies, attics, crawl spaces and walls. In exterior walls, it can be used as continuous insulation in the building envelope, and within interior walls, it can be used as acoustic insulation for partitions.

Mineral wool is commonly used in curtain wall perimeter fire containment applications because of its fire resistant properties. In commercial applications it can be used as continuous insulation in the building envelope.

Additionally, the high density of mineral wool insulation offers excellent sound absorption properties, making these products an integral part of overall wall systems designed to reduce sound transmission.

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Installation

Thermafiber® mineral wool products are made for easy handling and installation. As a semi-rigid product that is easy to cut and install, its flexibility allows it to conform to building shapes and construction irregularities. It comes in standard-sized sheets and is easily cut with a serrated knife.

The boards and batts can be friction fitted in between studs with the ends of each piece butted closely together to fill all voids. Mineral wool can also be mechanically attached depending on the application.

Rainscreen and cavity wall systems vary greatly from types of hangers and how they are installed. Generally, mineral wool insulation is installed with abutted joints and mechanically secured and attached to the building substrate without the need to tape joints.

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Production

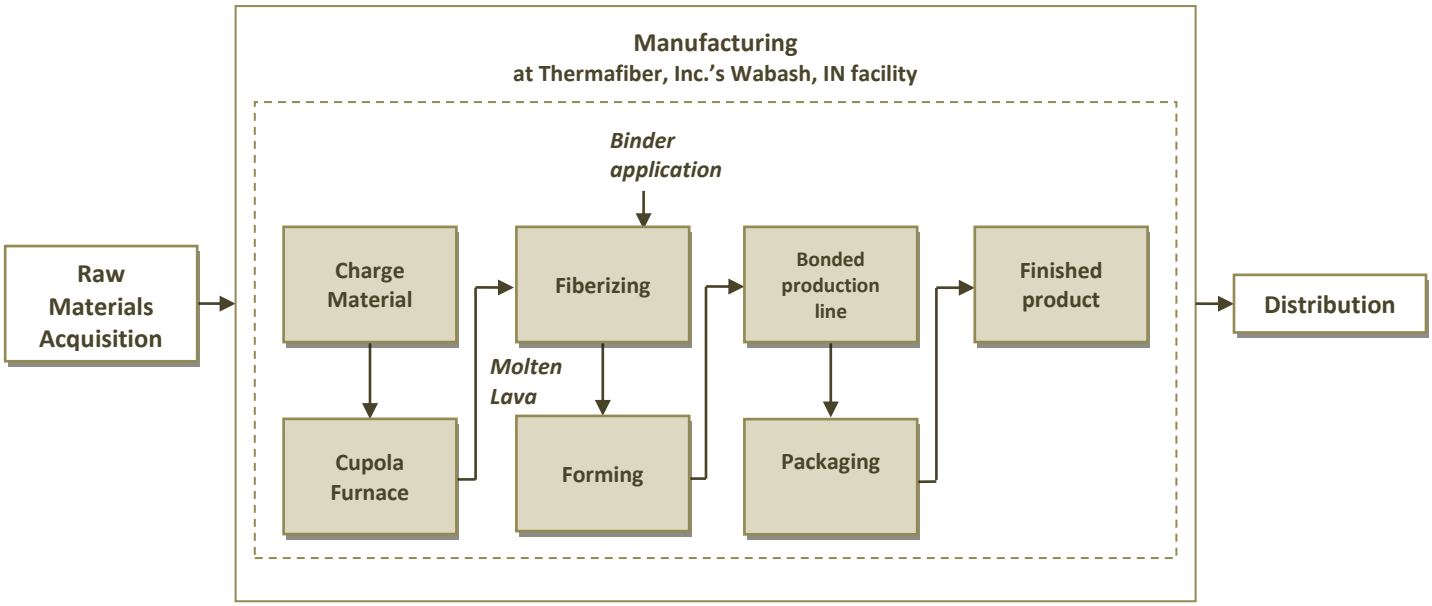
Material Content

Table 1: Material Content of Thermafiber® Mineral Wool Insulation

Material	Quantity (wt %)		Resource		
	Light Density	Heavy Density	Recycled	Mineral	Renewable
Charge					
Slag	69-72%	71-74%	x		
Feldspar	9-12%	12-15%		x	
Trap rock	11-14%	6-9%		x	
Binder					
Resin	1-4%	1-4%			
Urea	1-3%	1-3%			
Other	< 1%	< 1%			

Manufacturing Process

Figure 1: Manufacturing Process of Thermafiber® Mineral Wool Insulation



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Life Cycle Assessment – Product System and Modeling

Functional Unit

The functional unit of the product as defined by the PCR is 1 m^2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W and with a building service life of 60 years. Unless indicated otherwise, all results in this declaration have been provided for the functional unit amount of Thermafiber® mineral wool insulation.

Life Cycle Stages Assessed

The underlying LCA, which provides the basis of this EPD, has been prepared following the requirements set forth in the PCR. The LCA evaluates the cradle-to-grave environmental impacts of Thermafiber® mineral wool insulation and includes the following life cycle stages:

- Raw Materials Acquisition
- Manufacturing
- Transportation
- Installation and Maintenance
- End of Life (e.g., disposal, reuse, or recycle)

This EPD presents data that has been aggregated over the aforementioned life cycle stages.

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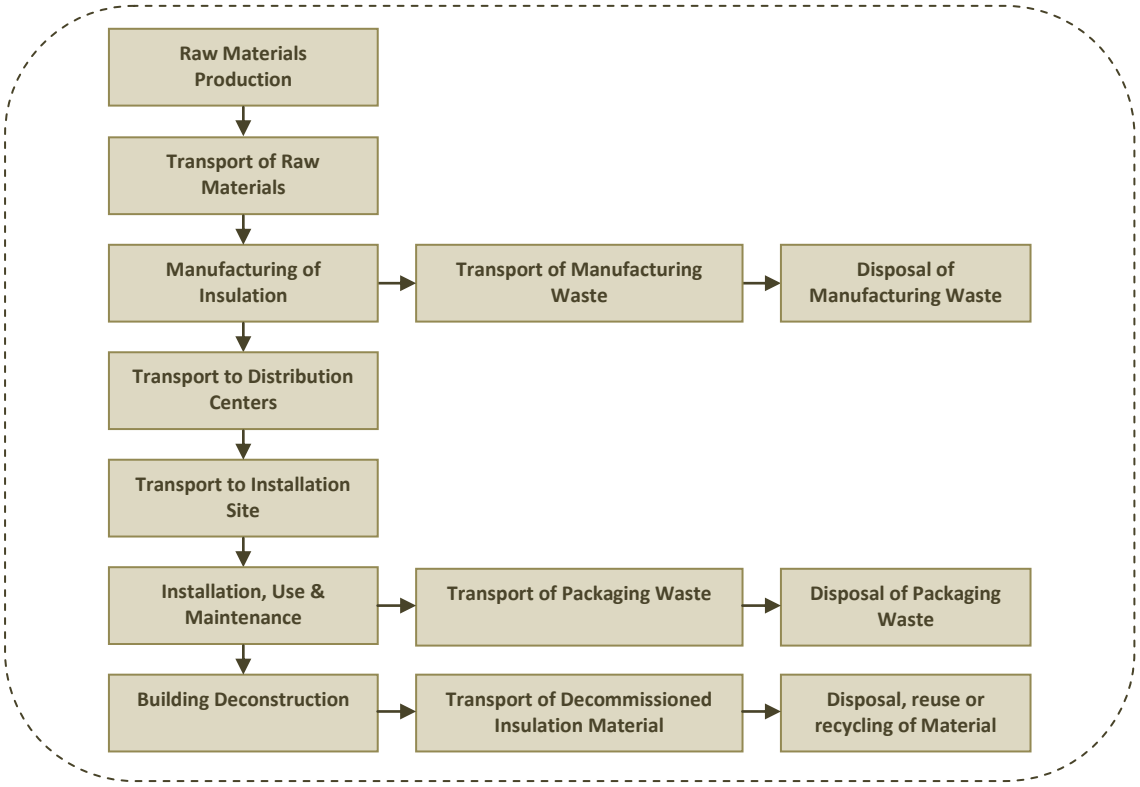
System Boundaries

Figure 2: System Boundaries for the Cradle-to-Grave Life Cycle of Mineral Wool Insulation



Assumptions

Assumptions are normal and necessary in conducting a life cycle assessment. For the underlying cradle-to-grave LCA, assumptions have been made for both the installation and maintenance phase as well as the end-of-life phase. Assumptions regarding these phases can be found in the respective sections below.

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Cut-off Criteria

The cut-off criteria used in the underlying LCA are as follows:

- Mass - If a flow is less than 2% of the cumulative mass of the model, it may be excluded, providing its environmental relevance is not a concern.
- Energy - If a flow is less than 1% of the cumulative energy of the model, it may be excluded, provided its environmental relevance is not a concern.
- Environmental Relevance - Materials of omission that may have a relevant contribution will be justified, if applicable, by a sensitivity analysis.
- The sum of the excluded material flows must not exceed 5% of mass, energy or environmental relevance.

Transportation

The transportation stage has been modeled by splitting inbound transportation and outbound transportation (or distribution). Inbound transportation includes the transportation of all raw materials, including the charge, binder and packaging materials from suppliers to the Wabash manufacturing facility. The outbound transportation or distribution includes the transportation of the final product to customers.

Period under Consideration

All Thermafiber, Inc.'s primary data for the Wabash facility were from the fiscal year 2013.

Secondary Background Data

Life-cycle modeling and calculation of potential environmental impacts were conducted using the LCA software SimaPro 8 developed by PRé Consultants bv. The LCI database libraries were the source of the secondary data used in the study. Of the various databases available, the LCI database used primarily for secondary data was the ecoinvent database. In situations where LCI databases did not contain life-cycle inventory data for certain specific materials or processes used in either the manufacturing of precursor, input raw materials or the manufacturing of mineral wool insulation itself, LCI data for a similar material or process was used as a substitute. In order to determine the most representative substitute, preliminary analyses were conducted.

Data Quality

To determine how representative the data used to model the life-cycle of Thermafiber® mineral wool insulation manufactured in 2013 is, the temporal, geographical and technological aspects of the data were assessed. For Thermafiber, Inc.'s Wabash, IN facility analyzed in the underlying LCA study, the data used adequately represents the technology used in 2013 in the United States and Canada. The secondary data used from SimaPro LCI databases was the most appropriate and current data available. When production data was not available for a specific material in use, available LCI data on similar materials were analyzed to determine the best surrogate.

Allocation

Allocation has been avoided and system expansion has been used where possible following the precepts of the ISO 14044 standard. Whenever allocation was necessary, the method chosen was based upon the nature and purpose of the process. Allocation calculations that were made are consistent with the data quality, data availability and the allocation method used. The physical relationship between flows (mass or volume) was used to conduct allocation

when system expansion was not possible.

Installation and Maintenance

Thermafiber® insulation products are installed by hand, which occasionally requires tools and specially designed mechanical fasteners and screws. The energy and material usage associated with the installation stage are below the cut-off rules and therefore have not been considered. The waste generated, furthermore, during installation is limited to the original product packaging. Mineral wool insulation requires no maintenance during the reference service life of 60 years as defined for this study.

End of Life

Multiple end-of-life scenarios exist for mineral wool insulation (e.g., disposal, reuse, or recycling). However, no formal programs currently exist for either the recycling or reuse of mineral wool insulation. Therefore, in this study, for all product systems, the EoL stage consisted of transportation of the particular mass of product a distance of 100 miles to a landfill and its subsequent disposal in that landfill.

Life Cycle Assessment – Results

Use of Material and Energy Resources

Table 2: Primary Energy Demand per Functional Unit (by Type)

Primary Energy Demand	Unit	Light Density	Heavy Density
Non-renewable, fossil oil, coal, natural gas	MJ	36.9	66.6
Non-renewable, nuclear	MJ	3.89	6.99
Non-renewable, biomass	MJ	6.08E-6	1.15E-5
Renewable, biomass	MJ	0.139	0.255
Renewable, hydropower	MJ	0.689	1.279
Renewable, wind, solar geothermal	MJ	3.15E-2	5.68E-2
Total	MJ	41.7	75.1

Table 3: Primary Energy Demand per Functional Unit (by Resource)

Primary Energy Demand	Unit	Light Density	Heavy Density
Non-renewable Resources			
Fossil oil	MJ	9.17	16.7
Natural gas	MJ	9.46	17.2
Coal	MJ	18.0	32.2
Fossil, other	MJ	0.304	0.544
Nuclear	MJ	3.89	6.99
Biomass	MJ	6.08E-6	1.15E-5
Non-renewable total	**MJ**	**40.8**	**73.6**
Renewable Resources			
Biomass	MJ	0.139	0.255
Hydropower	MJ	0.689	1.28
Wind	MJ	3.05E-2	5.50E-2
Solar	MJ	9.65E-4	1.75E-3
Geothermal	MJ	0	0
Renewable total	**MJ**	**0.86**	**1.59**
Total	MJ	41.7	75.1

Figure 4: Non-renewable Energy Resources

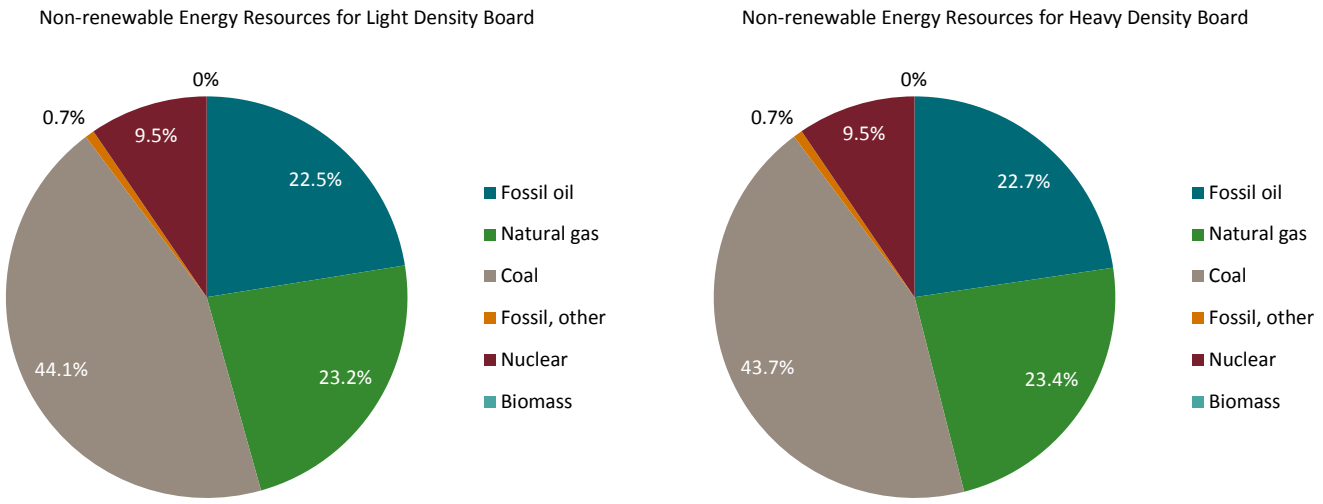


Figure 3: Renewable Energy Resources

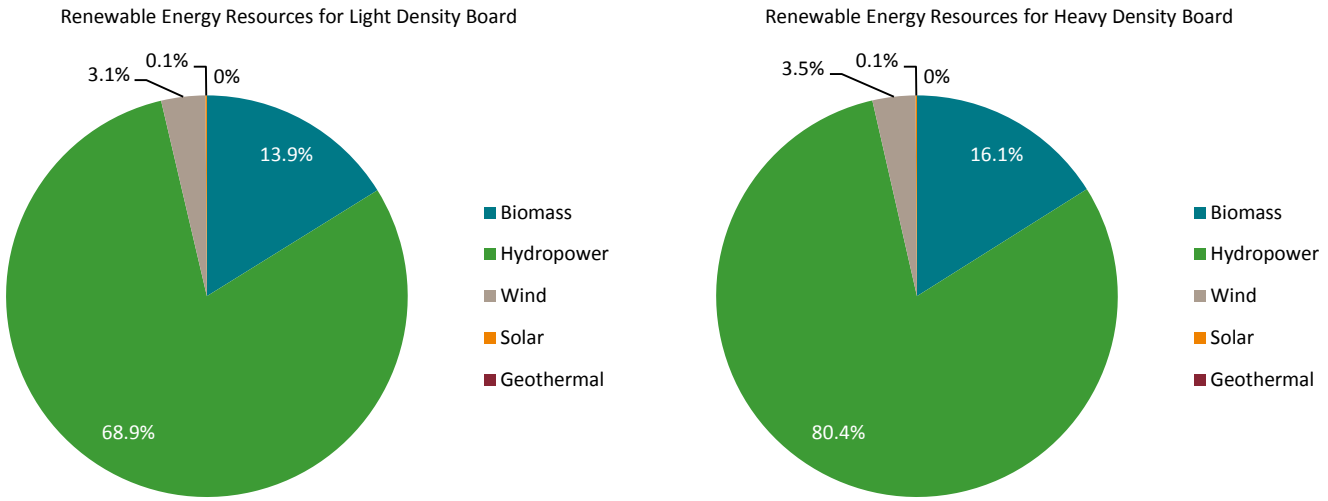
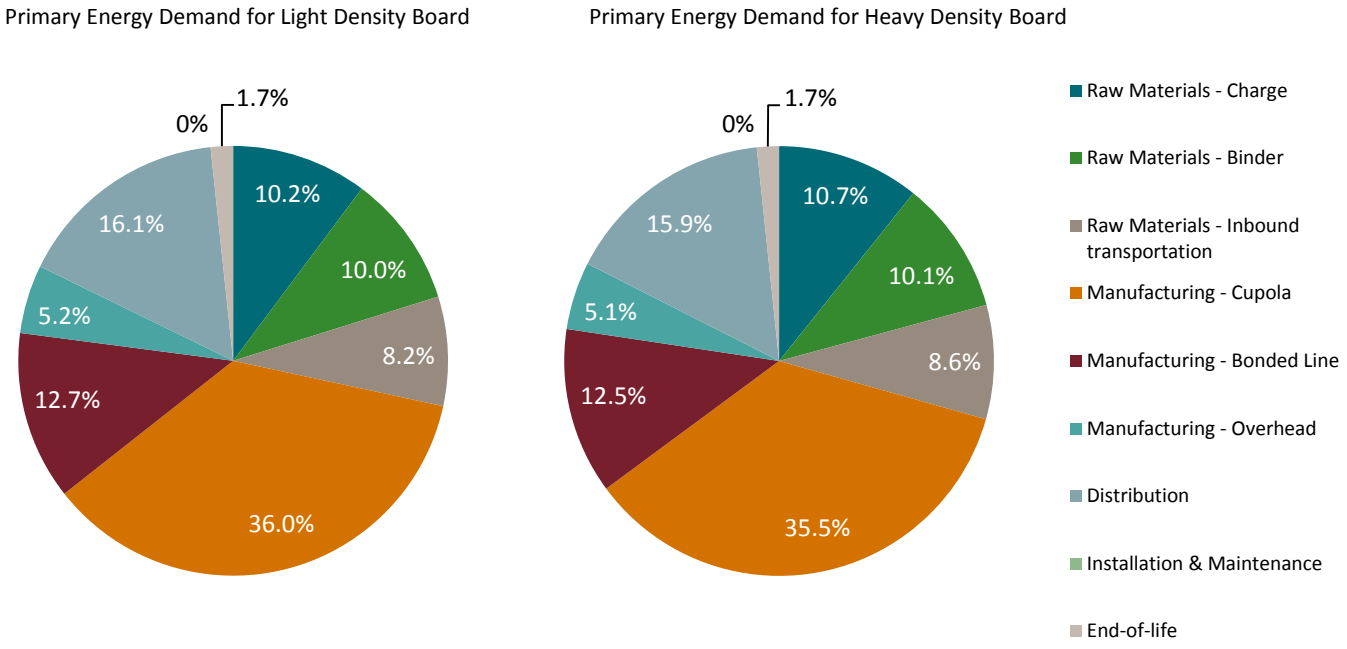


Figure 5: Primary Energy Demand by Life Cycle Stage



Life Cycle Impact Assessment Results

Table 4: Life Cycle Impact Assessment Results for Light Density Mineral Wool Insulation

Impact category	Unit	Total	Raw Materials	Manufacturing	Transportation	Installation	End of Life
Global warming	kg CO2 eq	3.60E+0	2.99E-1	2.57E+0	6.81E-1	8.90E-5	4.72E-2
Acidification	kg SO2 eq	3.68E-2	4.65E-3	2.67E-2	5.24E-3	4.70E-7	2.86E-4
Eutrophication	kg N eq	6.86E-3	6.15E-4	5.57E-3	6.55E-4	3.63E-8	2.27E-5
Smog	kg O3 eq	2.37E-1	2.52E-2	7.12E-2	1.32E-1	1.42E-5	8.91E-3
Ozone depletion	kg CFC-11 eq	1.89E-7	2.32E-8	1.03E-7	5.83E-8	7.69E-12	4.03E-9
Water	m3	4.25E-2	1.17E-2	2.89E-2	1.83E-3	3.09E-7	1.40E-4
Energy	MJ	4.17E+1	8.41E+0	2.24E+1	1.01E+1	1.33E-3	7.00E-1
Waste to landfill	kg	2.99E+0	0.00E+0	1.09E+0	0.00E+0	1.10E-2	1.89E+0

Table 5: Life Cycle Impact Assessment Results for Heavy Density Mineral Wool Insulation

Impact category	Unit	Total	Raw Materials	Manufacturing	Transportation	Installation	End of Life
Global warming	kg CO2 eq	6.46E+0	5.65E-1	4.58E+0	1.23E+0	1.58E-4	8.39E-2
Acidification	kg SO2 eq	6.61E-2	8.74E-3	4.74E-2	9.47E-3	8.36E-7	5.08E-4
Eutrophication	kg N eq	1.23E-2	1.17E-3	9.91E-3	1.18E-3	6.45E-8	4.03E-5
Smog	kg O3 eq	4.29E-1	4.76E-2	1.27E-1	2.39E-1	2.52E-5	1.58E-2
Ozone depletion	kg CFC-11 eq	3.44E-7	4.84E-8	1.83E-7	1.06E-7	1.37E-11	7.17E-9
Water	m3	7.73E-2	2.25E-2	5.13E-2	3.32E-3	5.49E-7	2.49E-4
Energy	MJ	7.51E+1	1.56E+1	3.99E+1	1.84E+1	2.37E-3	1.25E+0
Waste to landfill	kg	5.31E+0	0.00E+0	1.94E+0	0.00E+0	1.95E-2	3.35E+0

Table 6: Cradle-to-Grave Life Cycle Impact Assessment Results for Facing Material Options (1 m^2)

Impact	Global warming	Acidification	Eutrophication	Smog	Ozone depletion	Water	Energy	Waste to landfill
Unit	kg CO2 eq	kg SO2 eq	kg N eq	kg O3 eq	kg CFC-11 eq	m3	MJ	kg
Facing Material Option								
White All Service Jacket (ASJ)	6.19E-1	4.63E-3	2.46E-3	5.32E-2	3.07E-8	1.80E-2	1.24E+1	1.42E-1
Perforated Foil Scrim (2x3) Kraft	6.22E-1	4.24E-3	1.84E-3	4.89E-2	2.65E-8	2.00E-2	1.30E+1	1.37E-1
Plain Foil Scrim (2x2) Polyethylene	4.24E-1	3.18E-3	1.55E-3	3.12E-2	1.94E-8	8.71E-3	5.71E+0	5.37E-2
Plain Foil Scrim (1.8x1.8) Polyethylene	8.59E-1	6.45E-3	3.36E-3	5.68E-2	3.52E-8	1.72E-2	1.20E+1	9.28E-2
Printed Foil Scrim (1.8x1.8) Polyethylene	8.80E-1	6.58E-3	3.37E-3	6.08E-2	3.70E-8	1.72E-2	1.24E+1	9.28E-2
Printed Foil Scrim (2x2) Polyethylene	4.24E-1	3.18E-3	1.55E-3	3.12E-2	1.94E-8	8.71E-3	5.71E+0	5.37E-2
Printed Foil Scrim (5x5) Polyethylene	4.56E-1	3.32E-3	1.58E-3	3.33E-2	2.01E-8	9.78E-3	6.67E+0	6.35E-2
Plain White Foil Scrim (2x2) Polyethylene	4.81E-1	3.46E-3	1.68E-3	3.51E-2	2.19E-8	1.01E-2	6.98E+0	5.81E-2
Black Nonwoven Glass Fiber Mat	1.81E-1	1.36E-3	3.13E-4	1.93E-2	9.71E-9	4.82E-3	2.84E+0	6.84E-2
Black Nonwoven Polyester Fiber Mat	1.36E-1	5.25E-4	6.36E-4	7.92E-3	9.55E-9	5.19E-3	2.57E+0	3.76E-2
White Nonwoven Glass Fiber Nonwoven Mat	1.92E-1	1.46E-3	3.32E-4	2.05E-2	1.01E-8	5.01E-3	2.93E+0	7.08E-2
White Polypropylene Scrim Kraft	1.90E-1	1.33E-3	8.18E-4	2.09E-2	1.03E-8	1.05E-2	5.32E+0	8.30E-2

Water Consumption and Non-hazardous Waste

The water consumed and waste generated over the cradle-to-grave life cycle of mineral wool insulation is shown in the table below. The values, which are applicable for the functional unit amount of insulation, have been calculated for both light and heavy density mineral wool insulation. As indicated, all disposed waste is non-hazardous

Table 7: Water Consumption and Non-hazardous Waste Generated per the Functional Unit

Impact category	Unit	Total	Raw Materials	Manufacturing	Transportation	Installation	End of Life
Light Density Board							
Water	m3	4.25E-2	1.17E-2	2.89E-2	1.83E-3	3.09E-7	1.40E-4
Waste to landfill (non-hazardous)	kg	2.99E+0	0.00E+0	1.09E+0	0.00E+0	1.10E-2	1.89E+0
Heavy Density Board							
Water	m3	7.73E-2	2.25E-2	5.13E-2	3.32E-3	5.49E-7	2.49E-4
Waste to landfill (non-hazardous)	kg	5.31E+0	0.00E+0	1.94E+0	0.00E+0	1.95E-2	3.35E+0

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Calculation of Environmental Impacts for Different Product Specifications

The environmental impact assessment results have been calculated for both light and heavy density mineral wool insulation. These results, found in Tables 4 and 5, respectively, are for the functional unit and correspond to 1 m^2 of insulation with a thermal resistance of R_{SI} – 1. Thermafiber® mineral insulation, however, is manufactured in a variety of thicknesses and has a wide array of facing material options. In order to calculate impact values for Thermafiber® mineral wool insulation having a specific thickness (in) with or without a specific facing material, the following equation can be used:

$$\text{Impact} = [\text{Impact of Functional unit}^a] \times [\text{Density Scaling Factor (in}^{-1})^b] \times [\text{Thickness (in)}] + [\text{Impact of Facing material}^c]$$

Notes:

a. For light density products (≤ 4 PCF), impact values can be found in **Table 4**.
   For heavy density products (> 4 PCF), impact values can be found in **Table 5**.
b. *Density Scaling Factor* = 0.652 in^{-1} for light density products (≤ 4 PCF) and = 0.734 in^{-1} for heavy density products (> 4PCF).
c. Impact values for 1 m^2 of various facing materials can be found in **Table 6**. If product is unfaced, impact value is 0.

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Optional Environmental Information

The material recycled content of Thermafiber® mineral wool insulation has been verified by ICC-ES. The amounts and type of recycled content for Thermafiber® mineral wool insulation products can be found in Table 8 below.

Table 8: Thermafiber® Mineral Wool Insulation Material Recycled Content by Weight

Product Name	% Pre-Consumer Recycled Content		% Post-Consumer Recycled Content	%Total Recycled Content
	Standard Fiber	EPA Choice Fiber		
Thermafiber® SAFB™ Sound Control Insulation	70	75	0	70 – 75[1]
Thermafiber® Safing™ Insulation	75		0	75
Thermafiber® FireSpan® 40 and 90 Curtain Wall Insulation	75		0	75
Thermafiber® UltraBatt™ Exterior Wall Insulation	70	N/A	0	70
Thermafiber® RainBarrier® 45 and HD Continuous Insulation	70	75	0	70 – 75[1]
Thermafiber® TopStop® Head-of-Wall Insulation	75		0	75
Thermafiber® VersaBoard® Commercial Insulation	70	75	0	70 – 75[1]

1. The values represent the minimum and maximum range of available recycled content for the product. The actual recycled content amount for the product provided to the end user depends on the product formulation requested by the customer.

References

- Product Category Rules for Preparing an Environmental Product Declaration (EPD) for Product Group: Building Envelope Thermal Insulation, Version 1.2, 29 October 2013
- ISO 14025:2006(E), Environmental labels and declarations – Type III environmental declarations – Principles and procedures, 1 July 2006
- ISO 14040:2006(E), Environmental management – Life cycle assessment – Principles and framework, 1 July 2006
- ISO 14044:2006(E), Environmental management – Life cycle assessment – Requirements and guidelines, 1 July 2006
- ASTM Standard Specification C665 - 12, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
- ICC-ES Environmental Criteria for Determination of Recycled Content of Materials (EC 101), dated March 2012.