Environmental Product Declaration

FOAMULAR® Extruded Polystyrene (XPS) Insulation

OWENS CORNING

Exceptional performance characteristics make FOAMULAR® XPS Insulation an excellent choice for a multitude of applications from foundations and below-grade systems to continuous wall applications and commercial roofing.

Owens Corning, and its family of companies, is a leading global producer of residential and commercial building materials, glass-fiber reinforcements, and engineered materials for composite systems. Founded in 1938, Owens Corning has earned its reputation as a market leading innovator of glass-fiber technology by consistently providing new solutions that deliver a strong combination of quality and value to its customers across 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 composites customers around the world.

This Environmental Product Declaration is a component of our stated goal to provide life cycle information on all core products.

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CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

Environmental Product Declaration

FOAMULAR® Extruded Polystyrene (XPS) Insulation

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	4786077032.101.1
DECLARED PRODUCT	FOAMULAR® XPS Insulation
REFERENCE PCR	PCR Building Envelope Thermal Insulation v1.2

DATE OF ISSUE	November 12, 2013
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 epd@ul.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Paul Firth
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Tom Gloria

Product Definition

Product Description

FOAMULAR® XPS Insulation is a comprehensive line of rigid foam products that are easy to use, resist water absorption, deliver high compressive strength and maintain a high R-value throughout the life of the building.* It is the only XPS foam that is GREENGUARD Gold certified, has third-party certified recycled content – certified by SCS Global Services – and offers the industry's only lifetime limited warranty.*

FOAMULAR® XPS Insulation is made with Owens Corning's patented Hydrovac® process technology under strict quality control measures, which makes it highly resistant to moisture and permits the product to retain its high R-value year after year even after prolonged exposure to moisture and freeze/thaw cycling.

Another primary difference with FOAMULAR® XPS Insulation products is its compressive strength. FOAMULAR® XPS Insulation has compressive strengths of 15, 25, 40, 60 and 100 psi. The variety of products provides different strengths for use in walls, where there is almost no compressive load, or intermediate strength product for use with modest loads such as around foundations, or in low slope roofs. It also is suitable for use under high load pavement, such as floors or plaza decks.

FOAMULAR® XPS Insulation is an integral component of our Owens Corning™ ResidentialComplete™ Wall Systems and the Owens Corning™ CommercialComplete™ Wall Systems portfolios.

**FOAMULAR® XPS Insulation limited lifetime warranty maintains 90% of its R-value for the lifetime of the building and covers all ASTM C578 properties. See actual warranty for complete details, limitations and requirements at www.foamular.com or www.owenscorningcommercial.com*

Manufacturing Locations

Owens Corning North American manufacturing locations can be found across the United States and Canada.

Tallmadge Plant Tallmadge, OH 44278	Rockford Plant Rockford, IL 61109
Gresham Plant Gresham, OR 97080	Valleyfield Plant Valleyfield, QC, Canada J65 0A7

Primary data from these four manufacturing facilities were used for the underlying life cycle assessment. Results provided in this declaration are based on the weighted average of production for these four facilities.

Application and Uses

Available in a wide variety of sizes, thicknesses and compressive strengths, FOAMULAR® XPS Insulation can be used in residential and commercial buildings. It is available for a variety of applications including sheathing, foundation, under slab, re-siding, commercial roofing, under road plaza deck and commercial walls.

Installation

General

Optimum performance of Owens Corning™ FOAMULAR® XPS Insulation products is dependent on the selection of the correct product for the assembly or application into/on which it is to be placed and following these installation instructions. General rules which apply to both selection and installation include:

• The framed assembly or masonry surface onto which the Insulation is to be applied must be flat. FOAMULAR® XPS Insulation is a rigid product and not intended for uneven surfaces. Any deformation of the application surface can result in a weakening of the attachment points and / or cracking of the insulation.

• There should be no voids or gaps in the insulation itself, around any objects that penetrate the insulation or at the interface of the insulation and framing members.

• FOAMULAR® XPS Insulation is not structural. Structural sheathing or bracing must be used when applying to wood or metal framing.

Wood Frame Walls

• Apply FOAMULAR® XPS Insulation to outside of braced framing or structural sheathing. Tongue and groove (T&G) edge panels install horizontally, square edge panels install vertically.

• Use cap-head (min. 1”) nails or screws spaced 12” o.c. for the perimeter and 16” o.c. in the field to attach the panels.

• Choose fasteners of sufficient length to penetrate framing members a minimum ¾” or through structural sheathing.

• Cover all framing with FOAMULAR® XPS Insulation and fit joints tightly. Joints and openings may be sealed with Owens Corning™ JointSealR® Foam Joint Tape.

Metal Frame Walls

• Apply FOAMULAR® XPS Insulation directly to metal framing members. Tongue and groove edge panels install horizontally, square edge panels install vertically.
• Fasten panels to framing with cap-head (min. 1”) screws spaced 12” o.c. at the perimeter and 16” o.c. in the field.
• Cover all framing with FOAMULAR® XPS Insulation and fit joints tightly. Joints and openings may be sealed with Owens Corning™ JointSealR® Foam Joint Tape.

Foundation Wall-Exterior

• Prior to backfilling, install FOAMULAR® XPS Insulation to the exterior, from top of footing to the full height of the foundation wall, compliant with local building codes.
• Adhere FOAMULAR® XPS Insulation with long edges horizontal, edges tightly butted and vertical joints staggered. Joints and openings may be sealed with Owens Corning™ JointSealR® Foam Joint Tape.
• Secure FOAMULAR® XPS Insulation with construction adhesive compatible with polystyrene or foamed plastics as noted by its manufacturer (follow adhesive manufacturers’ application instructions).
• Apply FOAMULAR® XPS Insulation to wall within 15 minutes after adhesive is applied.
• Backfill carefully to avoid damage to FOAMULAR® XPS Insulation.

Basement Wall - Interior

• For installation on a framed wall built on the interior of the basement (foundation) wall see instructions for “Wood Frame Walls” and “Metal Frame Walls” above.
• For installation with furring, see instructions for FOAMULAR® InsulPink®.

Under Concrete Slab

• Install FOAMULAR® XPS Insulation after gravel fill has been built up to grade, thoroughly tamped and vapor retarder placed.
• Lay FOAMULAR® XPS Insulation in place with edges pressed together and butting the foundation wall or adjacent vertical insulation.
• Pour concrete slab to cover

Reference Documents

• Find specifications, case studies, reports, assemblies and other information at www.ocbuildingspec.com

Production

Material Content

FOAMULAR® XPS Insulation consists of two major components, polystyrene resin and a blend of HFC blowing agents. Although the majority of the polystyrene is virgin material, there is an appreciable amount of pre-consumer, recycled polystyrene content. The remainder of the material is composed of performance additives, HBCD as a flame retardant, and colorant. Each of these minor components is less than 1% by mass of the total material composition.

Material	Mass Composition	Non-renewable	Renewable	Recycled Material	Origin	Transportation Mode	Transportation Miles
Blowing agents	7 - 11%				North America	Truck	30 - 2220
Polystyrene (virgin)	68 - 72%				North America	Truck	110 - 2540
Polystyrene (recycle)	MIN 20%				North America	Truck	4 - 3120
HBCD flame retardant	Less than 1%				North America	Truck	130 - 2600
Additives	Less than 1%				North America	Truck	30 - 2440
Colorant	Less than 1%				North America	Truck	380 - 2870

Manufacturing Process

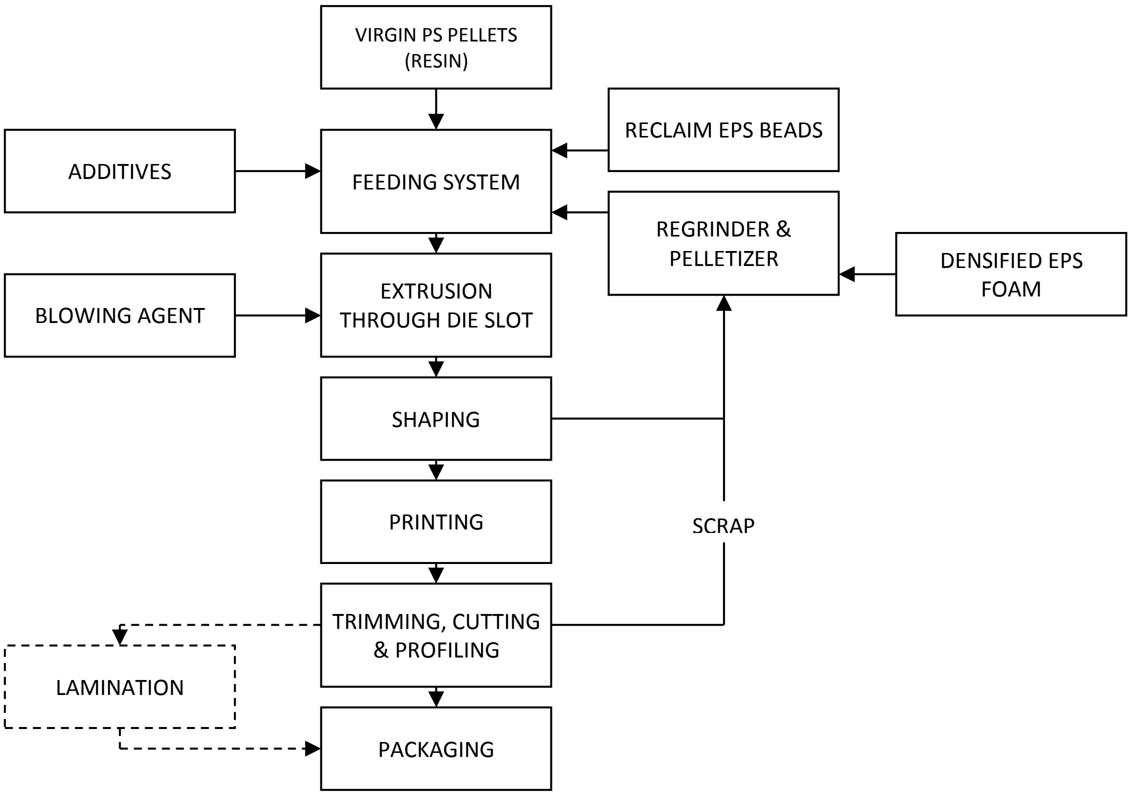


Figure 1 Process Flow Diagram for XPS Insulation Manufacturing

Environmental Product Declaration

Use of Material and Energy Resources

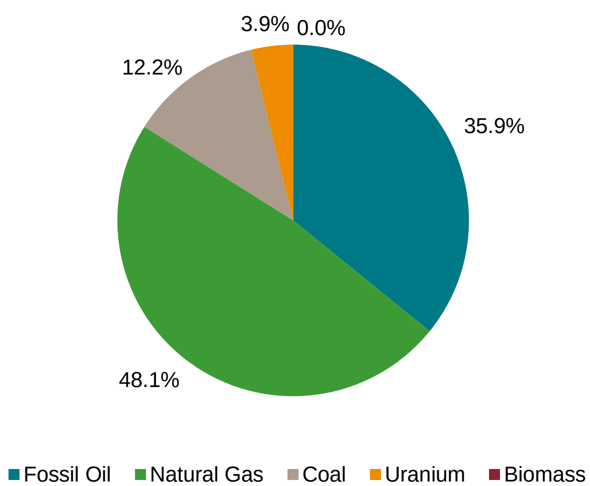
Table 1: Total Primary Energy Use

Primary energy resource category	Energy (MJ eq)
Non-renewable, fossil	7.62E+1
Non-renewable, nuclear	3.06E+0
Non-renewable, biomass	3.62E-5
Renewable, biomass	2.15E-1
Renewable, wind, solar, geothermal	8.30E-3
Renewable, water	1.22E+0
Total	8.07E+1

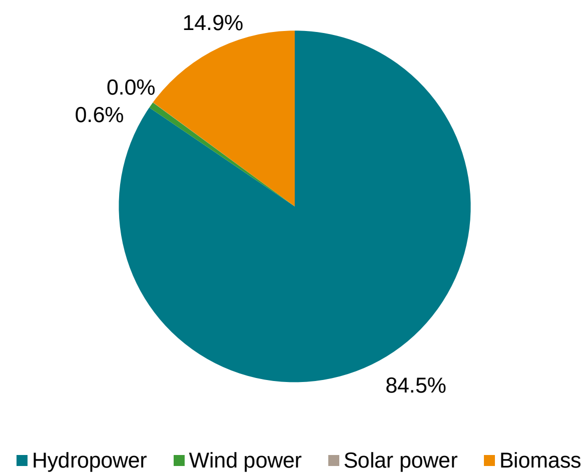
Table 2: Total Primary Energy Use by Resource

Non-renewable primary energy resource	Energy (MJ eq)	Renewable primary energy resource	Energy (MJ eq)
Fossil Oil	2.84E+1	Hydropower	1.22E+0
Natural Gas	3.81E+1	Wind power	8.05E-3
Coal	9.67E+0	Solar power	2.49E-4
Uranium	3.06E+0	Biomass	2.15E-1
Biomass	3.62E-5	Total	1.44E+0
Total	7.93E+1		

Non-renewable Primary Energy Resource

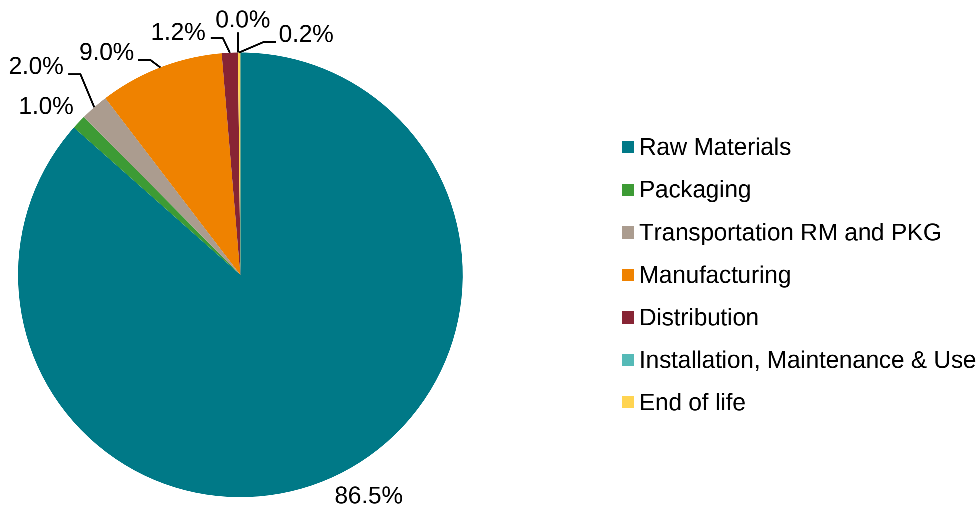


Renewable Primary Energy Resource



Use of Material and Energy Resources

As shown by the pie chart below, the life-cycle stage to which the majority of the primary energy demand can be attributed is the Raw Materials stage. Specifically, 86.5% of the total cradle-to-grave life-cycle primary energy demand of XPS is due to the raw materials. However, because of its function as a thermal insulator and since it is a passive device (i.e., the product does not consume energy), reductions in the energy consumption of a building are actually affected during the use phase of XPS insulation.



Life Cycle Assessment - Product System and Modeling

Functional Unit

The functional unit is 1 m^2 of insulation material with a thickness that gives an average thermal resistance of R_{SI} = 1 $m^2 \cdot K/W$ and with a building service life of 60 years.

Life Cycle Stages Assessed

The life cycle assessment for FOAMULAR® XPS Insulation was a cradle-to-grave study, which included the following stages:

- Raw materials acquisition
  - extraction of resources and production of raw materials
  - collection and processing of recycled materials
  - extraction of resources and production of packaging materials for finished goods
  - transportation of all input materials to manufacturing facilities
- Manufacturing
  - electricity and natural gas consumption
  - water usage
  - blowing agent emissions and other releases to environmental media
- Distribution
  - transportation of packaged XPS insulation from manufacturing facilities to distribution centers
  - transportation of packaged XPS insulation from distribution centers to building site
- Installation, Maintenance & Use
  - blowing agent emissions during installation of XPS insulation and over 60-year reference service life of building
- End of life scenario
  - transportation of XPS insulation from building deconstruction site to landfill

- disposal of XPS insulation in landfill
- blowing agent emissions released from XPS insulation during disposal

System Boundaries

Figure 2 System Boundaries

Assumptions

When considering the breadth of its scope, for a cradle-to-grave LCA, the use of assumptions is often unavoidable; the underlying assessment, which forms the basis of this environmental declaration, is no exception.

Key modeling assumptions, which are described in further detail below, have been made pertaining to the life-cycle stages of distribution; installation, maintenance and use; and the end-of-life scenario.

Although primary data was used to model the outbound transportation of the finished goods to distribution centers, assumptions were used to model the transportation step from a distribution center to a building site. This second transportation step in the distribution stage consisted of a 50-mile distance by means of a tractor-trailer truck.

The installation of XPS foam insulation is performed manually using handheld hardware tools and requires no equipment that requires the use of an energy source such as electricity or natural gas. The human labor, furthermore, which is necessary for installation, has been excluded. With regard to the maintenance phase, XPS foam insulation requires no maintenance during the reference service life of 60 years. This particular service life length, which is specified by the PCR, has also been used to model the use phase.

Multiple end-of-life scenarios exist for XPS foam insulation (e.g., disposal, reuse, recycling). While XPS foam can be reused, currently, no formal programs exist for collection or transport for either the reuse or the recycling of XPS foam insulation. Therefore, in the underlying LCA, the waste treatment scenario considered for the end-of-life stage of XPS foam insulation is landfill disposal. In particular, this consisted of transportation of the XPS foam insulation for a distance of 100 miles to a landfill and its subsequent disposal in that landfill.

Cut-Off Criteria

The cut-off criteria for the study are as follows:

- Mass - If a flow is less than 2% of the cumulative mass of the model, it may be excluded, provided 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.

The packaging materials have been included in the LCA; however, their disposal has been excluded. After assessing the end-of-life of the packaging, it was found that when included in the life-cycle, the above cut-off criteria are not violated. After conducting a preliminary impact assessment, the the packaging contributed less than 1% to the total impact for each impact category including energy except for the *Waste to Landfill* category, where it contributed less than 2% of the category total. Therefore, the sum of these excluded material flows (i.e., the EoL of packaging) does not exceed 5% of mass, energy or environmental relevance.

Transportation

For each plant, Owens Corning sourcing and logistics personnel provided the data used to calculate the transportation distances for both the inbound raw materials and packaging to the manufacturing facility as well as the outbound XPS insulation from the manufacturing facility to distribution centers. The mode of transportation for these inbound and outbound transportation steps was by tractor-trailer truck. As noted in the section regarding assumptions, a 50-mile distance by tractor-trailer truck was used to model the transportation of XPS insulation from a distribution center to a building site. At its end of life, transportation of the used XPS insulation consisted of an assumed 100-mile distance to a landfill by tractor-trailer truck.

Period under Consideration

For the manufacturing facilities considered in the LCA, Owens Corning primary data was collected for the 2012 calendar year.

Secondary (Background) Data

Life-cycle modeling and calculation of potential environmental impacts were conducted using the LCA software SimaPro 7, version 7.3.3, developed by PRé Consultants bv. The LCI database library, provided with the Analyst version of the software, was used as 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 US-EI LCI 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 the XPS 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 Owens Corning FOAMULAR® XPS Insulation manufactured in 2012 is, the temporal, geographical and technological aspects of the data were assessed. For the four Owens Corning facilities analyzed in the underlying LCA study, the data used adequately represents the technology used in 2012 in the United States and Canada.

Allocation

In a production process where more than one type of product is generated, it is necessary to allocate the environmental impacts from the process to the different products in order to obtain product-based results.

The products, for which this environmental declaration is applicable, are all members of Owens Corning FOAMULAR® XPS Insulation product family. The characteristics that differentiate one product from another within the family are its compressive strength, density and thickness. These three attributes are the main physical properties that distinguish one product from another. Aside from having the same composition and method of production, all products within the FOAMULAR® XPS Insulation product family have a thermal resistance of R-5 per inch thickness; this is a unifying characteristic. Exceptions to this are FOAMULAR® High-R CW Plus, which provides a slightly higher R-value per unit thickness, and two sheathing (i.e., laminated) products, FOAMULAR® Insulating Sheathing and PROPINK® XPS Insulation. For each of these three products, it was possible to avoid allocation.

The incremental amount of thermal resistance per inch provided by FOAMULAR® High-R CW Plus is approximately 0.129 hr•ft^2•°F/BTU, and the amount produced was less than 1% of total production. It is on these bases, allocation was avoided for this particular product. In the case of the two sheathing products, allocation was avoided by treating the laminating film materials as separate modular processes, the LCIs of which were analyzed separately.

With regard to the other products, which constitute the remaining 96% of the FOAMULAR® XPS insulation board-feet produced, it had been decided initially that mass allocation would be used to attribute quantities of process inputs and outputs among these various products based on the relative output of board-feet and the average density of the products. However, since these remaining products have essentially the same composition and differ only in compressive strength and density, the total mass of inputs and outputs were modeled without any allocation. Aside from those mentioned, no other allocation modeling considerations were necessary for the study.

Use

Due to its nature, XPS foam insulation is a passive device and does not require any external resources to perform its intended application as a thermal insulator. Nevertheless, provided the XPS foam is used as intended, during the use phase, reductions in a building's energy consumption and releases of blowing agents do occur. Although both of these can be attributed to the use of XPS foam insulation, only the environmental impacts due to the blowing agent emissions have been included within the system boundaries since diffusion of the blowing agent occurs whether or not the XPS foam is used for thermal insulation to affect these subsequent energy savings.

End-of-Life

Multiple end-of-life scenarios exist for XPS foam insulation (e.g., disposal, reuse, recycling). However, currently, no formal programs exist for either the reuse or the recycling of XPS foam insulation. Therefore, in this study, the waste treatment scenario considered for the end-of-life stage of XPS foam insulation is disposal. In particular, this consisted of transportation of the XPS foam insulation for a distance of 100 miles to a landfill and its subsequent disposal in that landfill.

Life Cycle Assessment - Product

The impact assessment results for the cradle-to-grave life-cycle of FOAMULAR® XPS insulation are shown separately for its various stages. As indicated below, and shown in Table 3, the raw material acquistion stage has been further divided into separate stages for the raw materials for XPS insulation, the raw materials for packaging, and the transporation of these raw materials to manufacturing.

- Raw materials acquisition
  - Raw Materials
    - extraction of resources and production of raw materials
    - collection and processing of recycled materials
  - Packaging
    - extraction of resources and production of packaging materials for finished goods
  - Transportation RM and PKG
    - transportation of all input materials to manufacturing facilities
- Manufacturing
    - electricity and natural gas consumption
    - water usage
    - blowing agent emissions and other releases to environmental media
- Distribution
  - transportation of packaged XPS insulation from manufacturing facilities to distribution centers
  - transportation of packaged XPS insulation from distribution centers to building site
- Installation, Maintenance & Use
  - blowing agent emissions during installation of XPS insulation and over 60-year reference service life of building
- End of life
  - transportation of XPS insulation from building deconstruction site to landfill
  - disposal of XPS insulation in landfill
  - blowing agent emissions released from XPS insulation during disposal

Table 3: Life-cycle Impact Category Results for the Functional Unit of FOAMULAR® XPS Insulation

FOAMULAR® XPS Insulation, 1 m^2, R_{SI}=1			Raw materials acquisition			Manufacturing	Distribution	Installation, Maintenance & Use	End of life
Impact category	Unit	Total	Raw Materials	Packaging	Transportation RM and PKG				
Global warming	kg CO2 eq	6.08E+1	5.70E+0	2.50E-2	1.33E-1	1.95E+1	7.58E-2	2.93E+1	6.05E+0
Acidification	mol H+ eq	1.78E+0	1.45E+0	5.05E-3	4.43E-2	2.53E-1	2.52E-2	0.00E+0	3.83E-3
Eutrophication	kg N eq	9.85E-4	8.42E-4	4.66E-6	4.23E-5	6.83E-5	2.41E-5	0.00E+0	3.66E-6
Smog	kg O3 eq	2.08E-1	1.35E-1	1.05E-3	2.17E-2	3.55E-2	1.23E-2	3.25E-4	1.88E-3
Ozone depletion	kg CFC-11 eq	3.63E-4	3.63E-4	4.12E-10	5.82E-12	2.16E-10	3.31E-12	0.00E+0	5.03E-13
Waste to Landfill	kg	8.57E-1	8.57E-2	4.91E-4	0.00E+0	1.09E-4	0.00E+0	0.00E+0	7.71E-1
Metered Water	kg	3.79E+1	3.54E+1	1.76E+0	0.00E+0	7.31E-1	0.00E+0	0.00E+0	0.00E+0
Energy	MJ eq	8.07E+1	6.99E+1	8.47E-1	1.65E+0	7.30E+0	9.38E-1	0.00E+0	1.42E-1

Calculating Impact Category Results for Products with Specific Performance Properties

The impact category values found in Table 3 are for the functional unit amount of XPS insulation. This corresponds to XPS insulation with a surface area of 1 m^2 and having a thermal resistance of R_{SI} = 1. In Imperial units, this thermal resistance, or R-value, is equivalent to 5.68 hr·ft2·°F/BTU (i.e., R_{IP} = 5.68 or R - 5.68). However, FOAMULAR® XPS insulation is a available in a variety of R-values and compressive strengths. In order to calculate *adapted* impact category values for XPS insulation, which has a specific R-value and compressive strength, the following equation and chart can be used:

$$\text{Impact}_{\text{AD}} = \text{Impact}_{\text{FU}} \times \text{CS}_{\text{factor}} \times \text{R}_{\text{factor}}$$

where $Impact_{AD}$ is the adapted impact category value, $Impact_{FU}$ is the impact category value of the functional unit found in Table 3, CS_{factor} is the multiplier for a specific compressive strength, and R_{factor} is the multiplier for a specific thermal resistance.

Compressive Strength (psi)	CS_{factor}
15	0.779
25	0.929
40	1.079
60	1.318
100	1.798

Thermal Resistance, hr·ft^2·°F/Btu (R_{IP})	R_{factor}
R - 5	0.881
R - 10	1.761
R - 15	2.642
R - 20	3.522

For example, in order to caluclate the GWP of 1 m^2 of FOAMULAR® 250, a product which has a compressive strength of 25 psi, and provides a thermal resistance of R - 10, the calculation is as follows:

$$\text{Impact}_{\text{AD}} = 60.8\ CO_{2\ eq} \times 0.929 \times 1.761 = 99.5\ \text{CO}_{2\ \text{eq}}$$

This procedure can be repeated for the remaining impact categories to generate the following table:

Impact category	Unit	FOAMULAR® 250 XPS Insulation, 1 m^2, R - 10
Global warming	kg CO2 eq	9.95E+1
Acidification	mol H+ eq	2.91E+0
Eutrophication	kg N eq	1.61E-3
Smog	kg O3 eq	3.40E-1
Ozone depletion	kg CFC-11 eq	5.94E-4
Waste to Landfill	kg	1.40E+0
Metered Water	kg	6.19E+1
Energy	MJ eq	1.32E+2

The FOAMULAR® XPS Insulation product family has two sheathing products, FOAMULAR® **PRO**PINK and FOAMULAR®

Insulating Sheathing XPS Insulation. The impacts for these products are based on thickness and the impacts due to the lamination must be *added*. The impacts for the sheathing products can be calculated using the equation below.

$$\text{Impact}_{AD} = \text{Impact}_{FU} \times \text{d}_{factor} \times +\text{Impact}_{lamination}$$

Thickness (in)	d_{factor}
½	0.440
¾	0.660
1	0.881

FOAMULAR® Insulating Sheathing XPS Insulation

$\text{Impact}_{AD} = \text{Impact}_{FU} \times d_{factor} + \text{Impact}_{lamination}$

	Impact_{FU}	d_{factor}	$\text{Impact}_{lamination}$	
Global warming	6.08E+1		1.92E-1	kg CO2 eq
Acidification	1.78E+0	0.440 (½ in)	4.01E-2	mol H+ eq
Eutrophication	9.85E-4		3.71E-5	kg N eq
Smog	2.08E-1	0.660 (¾ in)	9.20E-3	kg O3 eq
Ozone depletion	3.63E-4		3.02E-9	kg CFC-11 eq
Waste to Landfill	8.57E-1	0.881 (1 in)	7.37E-2	kg
Metered Water	3.79E+1		1.29E+1	kg
Energy	8.07E+1		6.32E+0	MJ eq

FOAMULAR® **PRO**PINK® XPS Insulation

$\text{Impact}_{AD} = \text{Impact}_{FU} \times d_{factor} + \text{Impact}_{lamination}$

	Impact_{FU}	d_{factor}	$\text{Impact}_{lamination}$	
Global warming	6.08E+1		5.22E-1	kg CO2 eq
Acidification	1.78E+0	0.440 (½ in)	1.14E-1	mol H+ eq
Eutrophication	9.85E-4		3.50E-4	kg N eq
Smog	2.08E-1	0.660 (¾ in)	2.48E-2	kg O3 eq
Ozone depletion	3.63E-4		1.58E-8	kg CFC-11 eq
Waste to Landfill	8.57E-1	0.881 (1 in)	1.93E-1	kg
Metered Water	3.79E+1		2.99E+1	kg
Energy	8.07E+1		1.58E+1	MJ eq

Non-hazardous Waste and Water Consumption

No hazardous waste is generated from the manufacturing of FOAMULAR® XPS Insulation. Amounts of non-hazardous waste generated for the functional unit amount of XPS insulation can be found in Table 4 below.

Table 4: Non-hazardous Waste and Water Consumption for the Functional Unit of XPS Insulation

	Raw materials acquisition	Manufacturing	End of Life
Non-hazardous Waste (kg per functional unit)	8.62E-2	1.09E-4	7.71E-1
Water Consumption (gal per functional unit)	9.81E+0	1.93E-1	0.00E+0

Additional Environmental Information

Indoor Environmental

FOAMULAR® XPS Insulation has achieved GREENGUARD Gold Certification.

Other Environmental

- FOAMULAR® XPS Insulation is third party certified for recycled content by Scientific Certification Systems (SCS) to contain a minimum of 20% recycled content.
- Qualified as an ENERGY STAR® product, under the U.S. Environmental Protection Agency and the U.S. Department of Energy.
- Approved under the Home Innovation Research Labs NGBS Green Certification Program.
- Utilizing FOAMULAR® XPS Insulation can help builders achieve green building program certifications including the Environmental Protection Agency's ENERGY STAR®, the National Association of Home Builders' National Green Building Standard ICC 700-2008, and the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Rating Systems.
- FOAMULAR® XPS Insulation is reusable.

Building Use Stage Benefits

Insulation is a passive device that requires no extra utilities to operate over its useful life. Insulation of a building is responsible for reducing the energy burden associated with heating and cooling of a building. The example below provides the net energy savings (energy saved minus life cycle energy for rigid polystyrene insulation) and the global warming gas avoidance associated with the energy that is saved.

Example Basis:

A three-story 55,628 square foot office building insulated with only extruded polystyrene for the walls and roof. The roof insulated area is 17,876 square feet. The wall insulating area is 14,263 square feet. The example includes two types of building structure for two locations. A cinder block wall structure and a steel wall frame structure building were used in the analysis. Chicago, Illinois and Phoenix, Arizona locations were used for the building locations. Buildings were insulated in compliance with ASHRAE Standard 90.1-2007 code. The energy analysis was performed using EnergyPlus, hourly energy analysis simulation program.

Energy Savings

Chicago - Illinois Energy Savings	Life Cycle MJ For Insulation Product Used in Building	MJ Saved/Year for an Insulated Building	Net MJ Saved (First Year)	Payback Time (Years)	MJ Saved over 60 Year Use Phase
Cinder Block	707,000	873,000	166,000	0.8	5.17E+07
Steel Stud	755,000	1,050,000	295,000	0.7	6.22E+07
Phoenix - Arizona Energy Savings					
Cinder Block	613,000	520,000	-93,000	1.2	3.06E+07
Steel Stud	617,000	668,000	51,000	0.9	3.95E+07

Depending on building structure type and location, the energy saved for a properly insulated building over a non-insulated building can have a payback from 0.7 years to 1.2 years.

Based on the USEPA Greenhouse Gas Equivalent Calculator, the 60-year energy savings for the steel-stud Chicago structure is equivalent to the annual greenhouse gases of 42 automobiles for each of the 60 years. The 60-year energy savings for the steel-stud Phoenix structure is equivalent to the annual greenhouse gases of 27 automobiles for each of the 60 years.

Greenhouse Gas Avoidance

Chicago - Illinois CO2 Equivalent Savings	Life Cycle Kg-CO2 Eqiv. For Insulation Product Used in Building	Kg-CO2 Equiv. Saved/Year for an Insulated Building	Net Kg-CO2 Equiv. Saved (First Year)	Payback Time (Years)	Kg-CO2 Equiv. Saved over 60 Year Use Phase
Cinder Block	533,000	149,000	-384,000	3.6	8.41E+06
Steel Stud	569,000	183,000	-386,000	3.1	1.04E+07
Phoenix - Arizona CO2 Equivalent Savings					
Cinder Block	462,000	67,200	-394,800	6.9	3.57E+06
Steel Stud	465,000	86,300	-378,700	5.4	4.71E+06

Note: The CO2 Equivalent Numbers due to electricity generation were calculated using the USEPA eGRID2012 Version 1.0, Year 2009 GHG annual Output Emission Rates. The CO2 equivalent factor of 117.08 Lbs/MMBTUs as used for natural gas energy is from the EPA study on fuel sources and their impacts

Based on the steel-stud Chicago building, the greenhouse gas avoidance for the energy savings on an insulated building would be equal to 10,400 metric tonnes of CO_2. This represents an annual greenhouse gas avoidance of 173 metric tonnes per year for the 60 year life of the building. The greenhouse gas avoidance for the steel-stud Phoenix building is equal to 4,710 metric tonnes over the 60 year life of the structure. This represents an annual greenhouse gas avoidance of 78.5 metric tonnes over the 60-year life of the building.

References

- Product Category Rules for Preparing an Environmental Product Declaration (EPD) for Product Group: Building Envelope Thermal Insulation, Version 1.0, 23 September 2011
- ISO 14025:2006(E), Environmental labels and declarations – Type III environmental declarations – Principles and procedures
- ISO 14040:2006(E), Environmental management – Life cycle assessment – Principles and framework
- ISO 14044:2006(E), Environmental management – Life cycle assessment – Requirements and guidelines
- ASTM C578-10 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- ASTM C518-10 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings

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