

ENVIRONMENTAL PRODUCT DECLARATION

Polyiso Wall Insulation Boards



The Polyisocyanurate Insulation Manufacturers Association (PIMA) represents the leading U.S. manufacturers of Polyiso insulation in the development of product technical standards, certification programs, and energy efficiency advocacy. As a leading advocate of energy efficiency, PIMA has received many environmental awards, including the U.S. Environmental Protection Agency's Climate Protection Award in 2007 for the Association's leadership in promoting energy efficiency and climate protection. The EPA also awarded PIMA and its members the Stratospheric Ozone Protection Award in 2002 for "leadership in CFC phase-out in Polyiso insulation and in recognition of exceptional contributions to global environmental protection."

Primary data from the following PIMA manufacturer members were used for the underlying life cycle assessment. Results in this declaration represent the combined weighted average production for these members.



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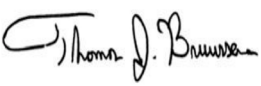

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EPD INFORMATION			
Program Operator		NSF International	
Declaration Holder		Polyisocyanurate Insulation Manufacturers Association	
Product Polyiso Wall Insulation Boards	Date of Issue January 1, 2015	Valid Until 08/06/2020	Declaration Number EPD10042
This EPD was independently verified by NSF International in accordance with ISO 14025: <input type="checkbox"/> Internal <input checked="" type="checkbox"/> External		 Thomas J. Bruursema Bruursema@nsf.org	
This life cycle assessment was independently verified by in accordance with the reference PCR:		 J. Renée Morin morin@pre-sustainability.com	
LCA INFORMATION			
Basis LCA		Life Cycle Assessment of Polyiso Insulation October 14, 2014	
LCA Preparer		John Jewell PE Americas 344 Boylston St., Boston, MA 02116	
This life cycle assessment was critically reviewed in accordance with ISO 14044 by:		Dr. Deanna Matthews Avenue C Advisors 158 Main Entrance Drive, Pittsburgh, PA 15228	
PCR INFORMATION			
Program Operator		UL Environment	
Reference PCR		UL 110116 Building Envelope Thermal Insulation	
Date of Issue		October 14, 2011	
PC Review Conducted By:		Wayne B. Trusty Wayne B. Trusty and Associates Limited PO Box 189, 136 Charlotte Street Merrickville, ON, Canada K0G1N0	



**Certified
Environmental
Product Declaration**
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PRODUCT DESCRIPTION

CSI Master Format Reference: 07210 Thermal Insulation

Brief Product Description: Polyisocyanurate (Polyiso) is a closed-cell, rigid foam board insulation consisting of a foam core sandwiched between two facers. The foam core is composed of closed-cell rigid Polyiso foam produced through the chemical reaction of an “A” side (MDI) and a “B” side (polyester polyol with various additives such as catalysts, surfactants, and flame retardant) plus a blowing agent (pentane). For wall applications, the most common facer is a lamination of aluminum foil over kraft paper. The manufacturing process for Polyiso wall insulation at a typical PIMA member manufacturing plant is illustrated in Figure 1.

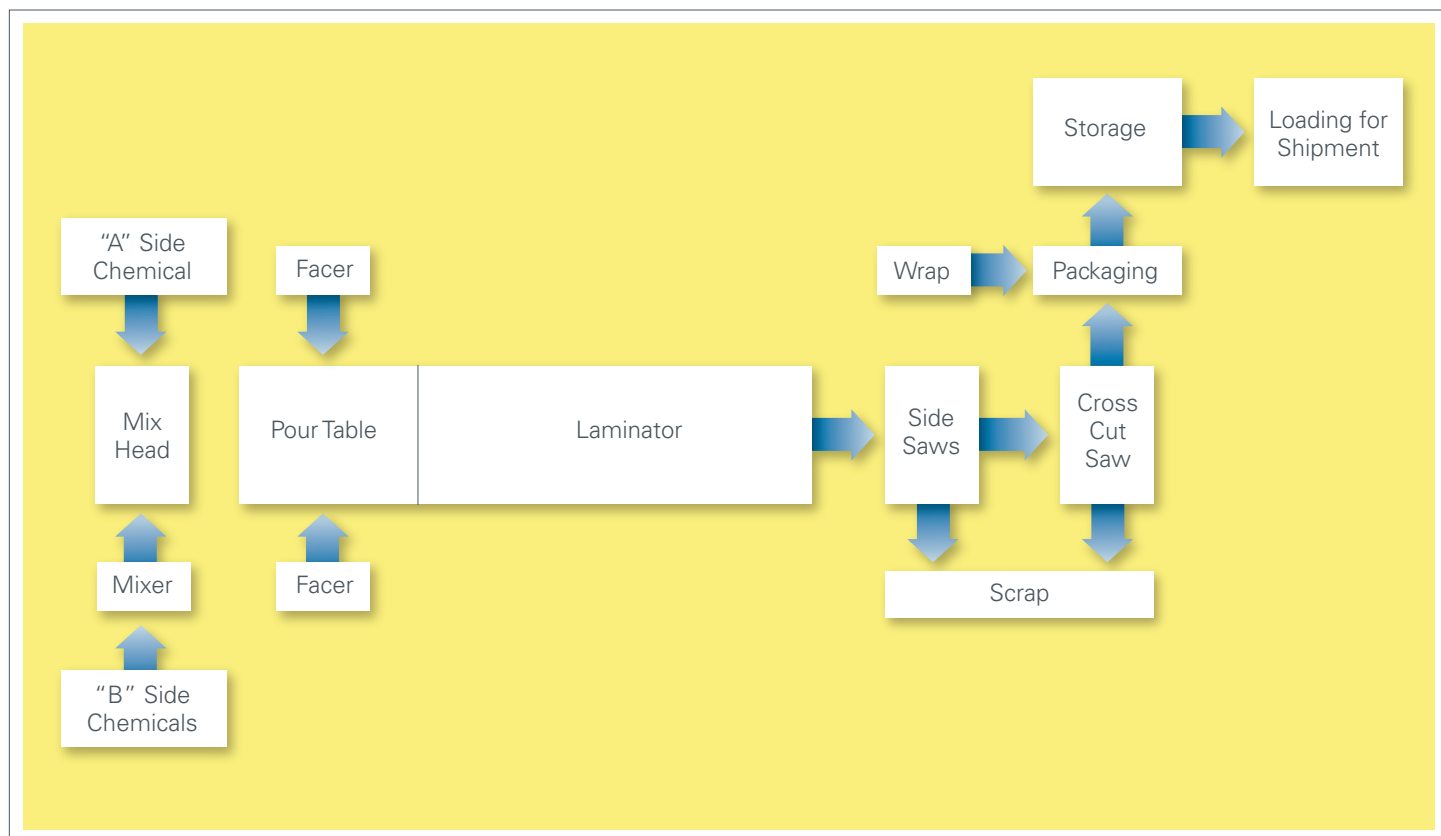


Figure 1:
Polyiso Wall Insulation Manufacturing Process

A typical Polyiso wall insulation board is illustrated in Figure 2.

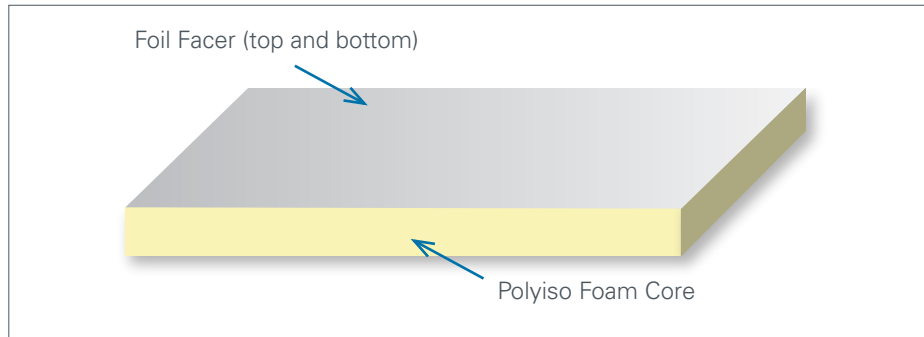


Figure 2:

Typical Polyiso Wall Insulation Board (ASTM C1289-13, Type I, Class 1)

Range of Application: Rigid cellular Polyiso wall insulation board typically is installed as a continuous insulation in a wide variety of commercial and residential wall assemblies. In light framed wood or metal wall construction, Polyiso typically is attached to the exterior of the wall framing and covered by an exterior finish. In concrete or masonry mass wall construction, Polyiso is typically attached to the exterior of the inner wall assembly of the cavity and separated by an air space from the outer wall assembly. When masonry is used as the exterior finish in wood or metal framed wall construction, the Polyiso insulation also typically is separated by an air space from the exterior finish. Examples of typical framed wall and mass wall constructions using continuous Polyiso wall insulation are illustrated in Figure 3.

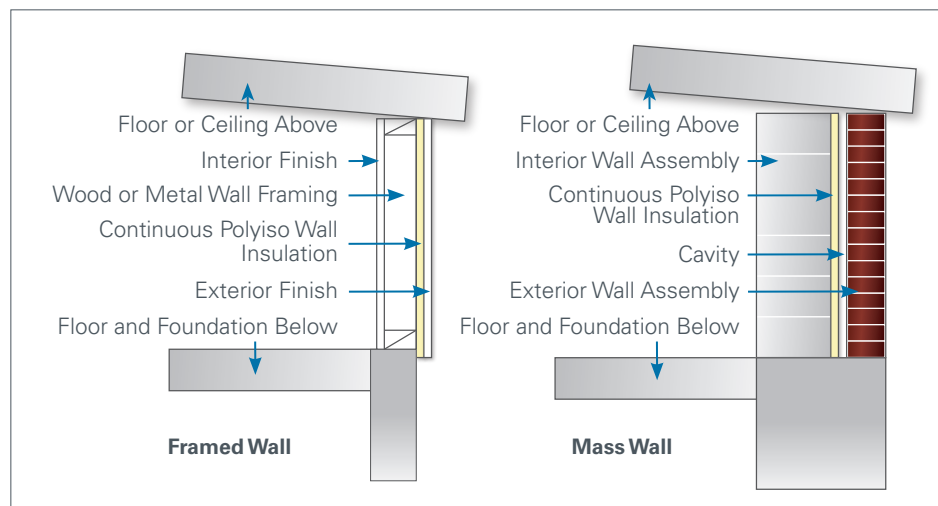


Figure 3:

Typical Wall Assemblies Using Polyiso Wall Insulation

Technical Standards:

The following standards are used to test, evaluate, and specify Polyiso wall insulation:

- ASTM C1289-13
Standard Specification
for Faced Rigid Cellular
Polyisocyanurate Thermal
Insulation Board
- ASTM C-518-13 Standard
Test Method for
Steady-State Thermal
Transmission by Means
of Heat Flow Meter
Apparatus
- ASTM E84-12 Standard
Test Method for Surface
Burning Characteristics of
Building Materials
- ASTM E119-12 / UL263-
11 / NFPA 251-06
Standard Test Methods
for Fire Tests of Building
Construction and
Materials
- NFPA 285-2006
Standard Fire Test
Method for Evaluation
of Fire Propagation
Characteristics of
Exterior Non Load
Bearing Wall Assemblies
Containing Combustible
Components Using the
Intermediate-Scale,
Multistory Apparatus

Thermal Performance: The use of continuous insulation reduces heat loss associated with thermal discontinuities and air infiltration in walls and is increasingly specified within model building codes to increase energy efficiency standards. When insulation joints are taped or sealed, foil-faced Polyiso wall insulation can be used as a water resistive barrier (WRB) or an air barrier, as required by building codes and specifications. Additional information about the use of Polyiso wall insulation as a continuous insulation is provided in “PIMA Technical Bulletin 403: Continuous Insulation Using Polyiso Wall Sheathing,” which may be downloaded from the PIMA website (www.polyiso.org).

REQUIREMENTS FOR UNDERLYING LCA

System Boundaries: In accordance with UL Product Category Rule 110116, life cycle stages and system boundaries for Polyiso wall insulation are illustrated in Figure 4 on the following page. These system boundaries encompass the following processes:

Raw Materials Acquisition

This stage includes extraction/production of raw materials, processing of recycled materials, and transport of raw and recycled materials to the PIMA member manufacturing location. These raw and recycled materials include:

- MDI: The “A” side component for the manufacture of Polyiso.
- Polyester Polyol: The primary “B” side component for the manufacturer of Polyiso.
- TCPP: A flame retardant added to the “B” side.
- Catalyst K-15 (2-ethyl hexanoate): A reaction catalyst added to the “B” side.
- Pentane: A blowing agent.
- Foil Facer: A facer consisting of an aluminum foil laminated to kraft paper.
- Low Density Polyethylene: The primary component of the plastic packaging wrap.

Manufacturing

This stage includes manufacturing of Polyiso wall insulation, packaging, manufacturing waste, and associated releases to the air, soil, ground, and surface water. The major raw materials at a Polyiso insulation manufacturing plant consist of chemical liquids stored in tanks onsite. The chemicals for the “A” side (MDI), the “B” side (polyester polyol plus catalysts, surfactants, and flame retardants) and the blowing agent (pentane) are pumped from storage into process tanks. The “B” side and blowing agent are then pumped to a mixer and then to a mix head where they are combined with the “A” side and injected between the top and bottom facers on the pour table. These chemicals combine on the pour table and react rapidly to form a closed cell foam board that is sandwiched between the top and bottom facers. The rigid foam board then travels within a heated laminator on moving conveyor belts, which aids in cell formation and hardens the board. The board then exits the laminator and is fed through saws that trim the board to the desired width and then through a cross-cut saw that cuts the board into desired lengths. The finished rigid boards are then staked, packaged with plastic wrap, labeled, and moved via fork truck to a warehouse area for storage and eventual loading onto trucks for shipment. The manufacturing process for Polyiso wall insulation at a typical PIMA member manufacturing plant is illustrated in Figure 1 in the Product Description section of this declaration.

Transportation

This stage includes direct transport from the PIMA member manufacturer to the project job site, which is typical of the overwhelming majority of Polyiso wall insulation shipments. Transport of the finished product is assumed to be by truck, with an average distance of 250 miles.

Installation and Maintenance

This stage includes the unloading of the Polyiso wall insulation from the truck to the site using a crane or all-terrain forklift. This stage also includes removal of all packaging and the placement of the individual wall insulation boards by a construction crew prior to the application of exterior wall finish, including all associated releases to environmental media (air, soil, ground, and surface water). Once installed within a watertight wall assembly, the Polyiso wall insulation requires no maintenance until the wall assembly is replaced.

Disposal, Reuse, Recycling

This stage includes the removal of the insulation during the replacement of the original wall assembly, loading of the insulation, and transport of the insulation to a landfill. Transport to the landfill was based on a total 50-mile round trip (25 miles each way) for a dump truck arriving at the pickup site empty and returning to the landfill full.

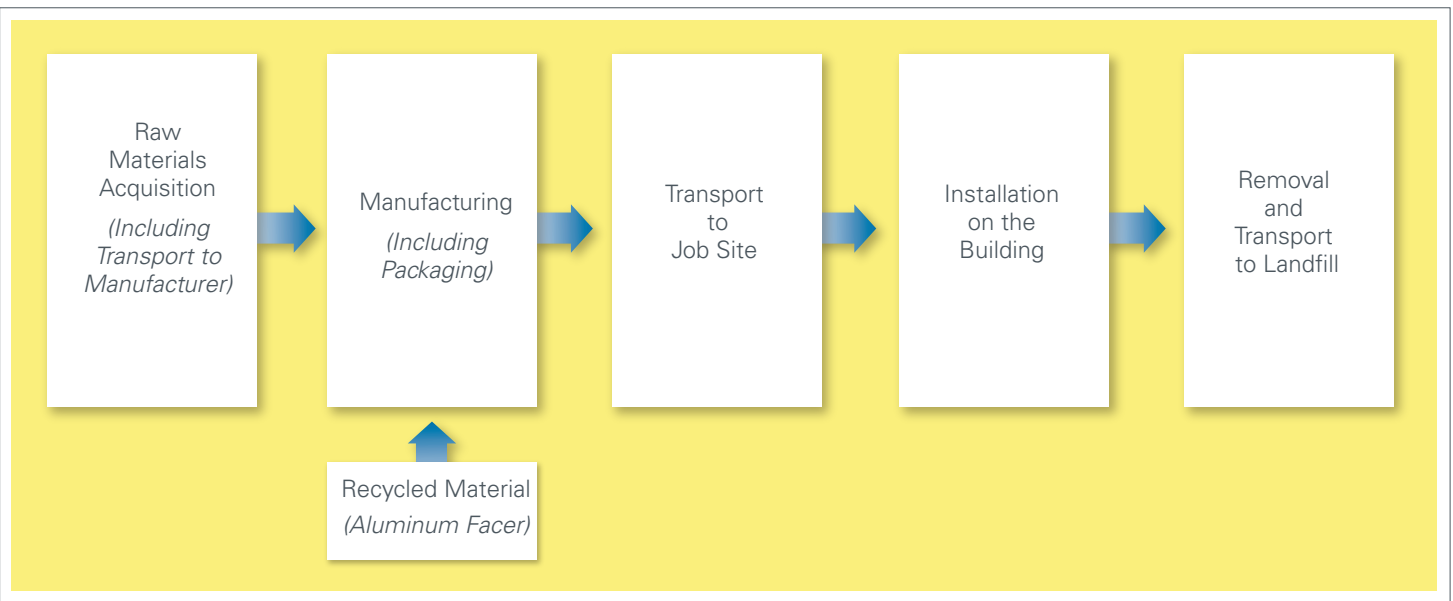


Figure 4:

Life Cycle Stages and System Boundaries for Polyiso Wall Insulation

Functional Unit: UL Product Category Rule 110116 defines the preferred functional unit for building envelope thermal insulation using metric (SI) measures, stated as:

1 m² of insulation material that gives an average thermal resistance of $R_{SI} = 1 \text{ m}^2 \cdot ^\circ\text{K}/\text{W}$ and with a building service life of 60 years (packaging included)

Because thermal resistance is reported in the United States using Inch-Pound (IP) measures, it should be noted that a product with an R_{SI} of 1 is equivalent to a product with an R_{IP} of 5.68.

For Polyiso wall insulation, thermal resistance, or R-value, is determined based on Thermal Resistance (R) value as prescribed in ASTM C1289-13 Standard Specification for faced Rigid Cellular Polyisocyanurate Thermal Insulation Board (Type I, Class 1) and as measured using ASTM C518-13 Standard Test Method for Steady-State Thermal Transmission by Means of Heat Flow Meter Apparatus.

It should be noted that the foil facers on Polyiso wall insulation are an integral part of the product, and their environmental aspects are captured within the system boundaries of the Basis LCA for this disclosure. Considering the material dissimilarity between the foil facers and the foam core (particularly with regard to mass density) the contributing relative impacts associated with the facers attached to each insulation board varies with the R-value or thickness of the product. In accordance with UL 110116 Product Category Rule for Building Envelope Thermal Insulation and in order to provide the user of this declaration a meaningful means of comparing Polyiso with other wall insulation products, the relative contribution of the facers is given appropriate consideration in the development of the Functional Unit results as summarized in Table 2 of this declaration. To serve this purpose, a quantitative normalization calculation was performed on a commonly used product thickness, specifically a 1.5 inch thickness of Polyiso wall insulation with an R-value of 9.8.

Cut-Off Rules: The following cut-off criteria were used to ensure that all relevant environmental impacts were represented in the study:

Mass

If a flow is less than 1 % of the cumulative mass of all inputs and outputs of the LCI model, it is excluded, provided its environmental relevance is not a concern.

Energy

If a flow is less than 1 % of the cumulative energy of all inputs and outputs of the LCI model, it is excluded, provided its environmental relevance is not a concern.

Environmental Relevance

If a flow meets the above criteria for exclusion, yet it is thought to potentially have a significant environmental impact, it is included.

Excluded Material Flows

The sum of all excluded material flows does not exceed 5% of mass, energy, or environmental relevance.

Assumptions and Estimations. The product presented is representative for the product range for all PIMA member manufacturers identified in this declaration.

Allocation. Allocation associated with the transport of Polyiso wall insulation is based on volume rather than weight, because volume restricts the amount of product that can be loaded on a truck. No other allocation was necessary in the production of Polyiso wall insulation since there are no co-products.

DATA QUALITY

Data Collection. Primary energy and emissions data regarding manufacturing processes were collected through a plant-by-plant survey of all PIMA member manufacturing plants in the United States and Canada. The survey was conducted in January 2014 and reported annual values based on 2013 plant operations. In addition to energy use, the survey included information in regard to packaging, scrap/waste, and emissions rates associated with the manufacture of Polyiso wall insulation. In addition to data collected directly from PIMA member manufacturing operations, primary data was collected from the following sources:

- All three polyester polyol plants in the U.S.
- Energy/emissions factors from one facer plant for aluminum foil/kraft facer
- Energy use for insulation installation on a building

Energy/emissions data from life cycle databases, studies in the literature, etc., were used for all other modeling of raw materials, transportation factors, and land disposal.

In all cases, the data collected represented technologies currently in use, and all secondary data was not older than 10 years.

Description of Data

Fuels and Energy

National and regional (when available) averages for electricity grid mixes were obtained from the GaBi 4 database. For each of the polyol and facer manufacturers, a regional dataset was chosen based on the plant location. For the Polyiso manufacture, averaged regional data are based on U.S. average data in the GaBi 4 database.

Raw Materials

When available, primary data and data from the literature were used for the production of Polyiso insulation. Data when applicable were taken from the GaBi 4 database.

Emissions to Air, Water, and Soil

Emissions data associated with the production of Polyiso wall insulation were determined by primary technical contacts familiar with the specific operations. Data for most upstream materials and electricity and energy carriers were obtained from the GaBi 4 database. Emissions associated with transportation were determined by capturing the logistical operations (mode and distance). Energy use and the associated emissions were calculated using pre-configured transportation models from the GaBi 4 database. End-of-life emissions were determined by municipal waste operations data associated with landfilling.

Material Content. The material content for Polyiso wall insulation is provided in Table 1.

BASE MATERIALS			
Component	Material	Availability	Origin
Top/Bottom Facer	Aluminum Foil Laminated to Kraft Paper	Recycled Material, Abundant	U.S.
Polyiso Foam Core	"A" Side Chemical (MDI)	Fossil Resource, Limited	U.S. & Canada
	"B" Side Chemicals (Polyester Polyol, Catalysts, Surfactants, Flame Retardant)	Fossil Resource, Limited	U.S.
	Blowing Agent (Pentane)	Fossil Resource, Limited	U.S.

Table 1:
Polyiso Wall Insulation Material Content

DECLARATION OF ENVIRONMENTAL ASPECTS

This declaration represents an average performance for a number of products or manufacturing plant locations for all PIMA member manufacturers identified in this declaration. Declarations from programs different than ISO 14025 may not be compatible with this declaration.

LCA Results and Analysis: Life Cycle Impact Assessment (LCIA) results were calculated for 10.76 ft² of Polyiso wall insulation with $R_{SI} = 1 \text{ m}^2 \cdot \text{°K/W}$ ($R_{IP} = 5.68 \text{ °F} \cdot \text{hr/Btu}$) with a service life of 60 years. As noted previously, LCIA results are based on a commonly used product thickness, specifically a 1.5 inch thickness of Polyiso wall insulation with an R_{IP} value of 9.8.

LCIA results included the following 5 impact categories as defined in the U.S. EPA TRACI (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) Tool:

- Global Warming Potential, measured in kg CO₂ equiv.
- Acidification Potential, measured in mole H⁺ equiv.
- Eutrophication Potential, measured in kg N equiv.
- Smog Creation Potential, measured in kg O₃ equiv.
- Ozone Depletion Potential, measured in kg R11 equiv.

LCIA results also included 5 environmental indicators:

- Primary Energy Demand (both renewable and non-renewable), measured in MJ
- Resource Depletion (both renewable and non-renewable), measured in kg
- Waste to Disposal (both hazardous and non-hazardous), measured in kg
- Water Use, measured in l
- Waste to Energy, measured in kg

LCIA results are summarized in Table 2.

IMPACT CATEGORY / ENVIRONMENTAL INDICATOR	Measure
Global Warming Potential (kg CO ₂ equiv.)	2.32
Acidification Potential (mole H ⁺ equiv.)	9.60E-03
Eutrophication Potential (kg N equiv.)	1.28E-03
Smog Creation Potential (kg O ₃ equiv.)	0.232
Ozone Depletion Potential (kg R11 equiv.)	1.14E-07
Primary Energy Demand (MJ)	53.50
Resource Depletion (kg)	7.10
Waste to Disposal (kg)	0.78
Water Use (l)	160.00
Waste to Energy (kg)	4.60-04

Table 2:

Polyiso Wall Insulation Life Cycle Impact Assessment (LCIA) Results
 For 1 m² (10.76391 ft²) of Polyiso wall insulation with $R_{SI} = 1 \text{ m}^2 \cdot \text{°K/W}$ ($R_{IP} = 5.68 \text{ °F} \cdot \text{hr/Btu}$)

ADDITIONAL ENVIRONMENTAL INFORMATION

Additional LCIA Information for Common Polyiso Thicknesses

To allow the user of this declaration to evaluate a variety of commonly installed Polyiso wall insulation thicknesses and to facilitate the integration of this declaration into whole building LCA tools, environmental aspects for additional thicknesses of Polyiso wall insulation are included as additional information in Table 3. Please note the environmental aspects are stated for 1 ft² and 1 m² of each identified application, because different whole building LCA tools may use either metric or English units of measure in North America.

IMPACT CATEGORY/ ENVIRONMENTAL INDICATOR	0.75 inch thickness (R _{IP} = 4.9)		1.50 inch thickness (R _{IP} = 9.8)		2.25 inch thickness (R _{IP} = 14.6)		3.00 inch thickness (R _{IP} = 19.5)	
	Per 1ft ²	Per 1m ²	Per 1ft ²	Per 1m ²	Per 1ft ²	Per 1m ²	Per 1ft ²	Per 1m ²
Global Warming Potential (kg CO ₂ equiv.)	0.23	2.48	0.39	4.20	0.53	5.70	0.67	7.21
Acidification Potential (mole H ⁺ equiv.)	9.54E-04	1.03E-02	1.54E-03	1.66E-02	2.06E-03	2.22E-02	2.62E-03	2.82E-02
Eutrophication Potential (kg N equiv.)	1.20E-03	1.29E-03	2.13E-04	2.29E-03	2.94E-04	3.16E-03	3.82E-04	4.11E-03
Smog Creation Potential (kg O ₃ equiv.)	0.02	0.22	0.03	0.32	0.04	0.43	0.06	0.65
Ozone Depletion Potential (kg R11 equiv.)	1.27E-08	1.37E-07	1.84E-08	1.98E-07	2.33E-08	2.51E-07	2.88E-08	3.10E-07
Primary Energy Demand (MJ)	5.12	55.11	8.66	93.22	11.84	127.44	15.22	163.83
Resource Depletion (kg)	1.07	11.52	1.14	12.27	1.19	12.81	1.26	13.56
Waste to Disposal (kg)	0.34	3.66	0.56	6.03	0.77	8.29	0.99	10.66
Water Use (l)	12.60	135.63	25.10	270.17	36.80	396.11	48.90	526.36
Waste to Energy (kg)	7.30E-05	7.86E-04	7.30E-05	7.86E-04	7.30E-05	7.86E-04	7.30E-05	7.86E-04

Table 3:
Polyiso Wall Insulation LCIA Results For Common Product Thickness
(Per 1ft²/1m² at specified R_{IP} value)

Environmental Benefits of the Product during Use:

High Thermal Efficiency

Because it is one of the most thermally efficient building insulations available in today's marketplace, Polyiso requires less total thickness to deliver specified R-value in roof and wall assemblies, reducing overall construction costs and increasing usable building space.

High Net Return on Embodied Energy

A recent study comparing initial embodied energy to long-term energy savings achieved over 60 years in a typical commercial building suggests that the net energy savings potential of Polyiso wall insulation ranges between 20 and 47 times the initial embodied energy required to produce, transport, and install the Polyiso insulation.¹

Zero Ozone Depletion Potential

All PIMA Polyiso manufacturer members produce rigid foam board with third-generation, zero ozone-depleting blowing agents. The blowing agent (pentane) used in Polyiso also is among the lowest in Global Warming Potential.

Recycled Content

Polyiso insulation typically is manufactured using recycled material. The percentage of the recycled material by weight depends on the individual manufacturer, the thickness of the product, and the type of facer.

Opportunity for Reuse

Although this declaration assumes the Polyiso wall insulation boards will be landfilled at the end of the wall assembly service life, it is possible to salvage and reuse the boards, either at the original site or on another construction site. Used Polyiso wall insulation may be collected and resold by several national logistics firms, including Nationwide Foam Recycling (www.nationwidefoam.com) and the Green Insulation Group (www.greeninsulationgroup.com). In addition, the reuse of existing board insulations in place is being promoted by several leading green building rating systems such as LEED (www.usgbc.org/LEED), Green Globes (www.greenglobes.com), and RoofPoint (www.roofpoint.org).

Polyiso and LEED: Because it offers high thermal efficiency, zero ozone depletion potential, and high levels of recycled content, Polyiso is an ideal choice for LEED building designs. "PIMA Technical Bulletin 116: An Integral Part of Sustainable Building and LEED Credits" provides detailed information how Polyiso may contribute to specific LEED Prerequisites and Credits.

OTHER RELEVANT INFORMATION

Fire Performance: Polyiso wall insulation has a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in accordance with ASTM E-84, as required by most building codes. Polyiso wall insulation is commonly incorporated into interior and exterior wall assemblies when protected by an approved thermal barrier or when the assembly is tested and approved by code for specific applications. Additional information about the fire performance of Polyiso wall insulation is provided in "PIMA Technical Bulletin 405: Fire Resistance Properties of Polyiso Foam Plastic Insulation Used in Wall Assemblies," which may be downloaded from the PIMA website (www.polyiso.com).

REFERENCES

- ISO 14044-2006 Environmental Management - Life Cycle Assessment - Requirements and Guidelines. International Organization for Standardization (ISO).
- ISO 14025-2006 Environmental labels and declarations - Type III Environmental Declarations - Principles and Procedures. International Organization for Standardization (ISO).
- ISO 21930-2007 Sustainability in Building construction - Environmental Declaration of Building Products. International Organization for Standardization (ISO).
- Life Cycle Assessment of Polyiso Insulation (Date TBD). Boston, MA: PE Americas
- Phelan, J., Hoff, J., and Pavlovich, G. (2010). The energy and environmental potential of commercial buildings: Implications for energy policy and industry growth through green building market transformation. *Proceedings of the RCI, Inc. 25th International Convention and Trade Show: Exploring the Sustainably Built Environment*, 213-230. Raleigh, NC: RCI, Inc.
- UL 110116-2011 Product Category Rule for Building Envelope Thermal Insulation. Underwriters Laboratories. 3 September, 2011.

¹ See Phelan, Hoff, & Pavlovich (2010). Note: Net energy savings varied from 9 times initial embodied energy in U.S. Climate Zone 2 (Typical city: Houston, Texas) to 44 times initial embodied energy in U.S. Climate Zone 6 (Typical city: Minneapolis, MN). Modeling based on the typical configuration and energy demand of a strip mall shopping center as identified in the U.S. DOE Commercial Building Benchmark Project.

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