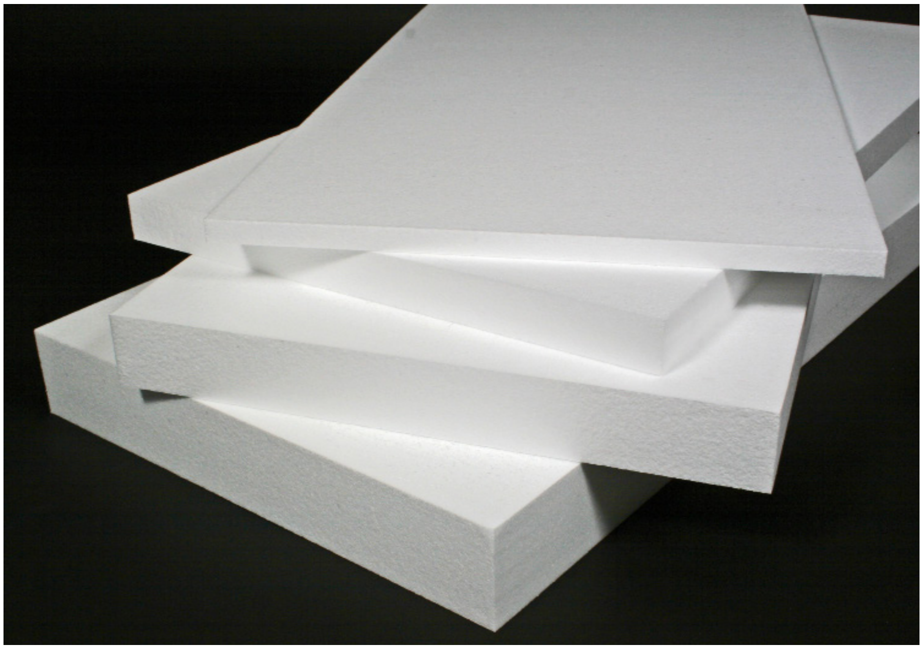
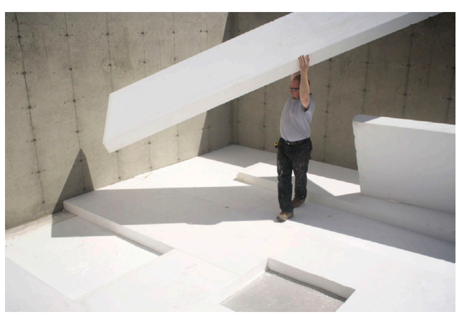
Environmental Product Declaration

Expanded Polystyrene Insulation

MOLDED, CLOSED-CELL FOAM PLASTIC INSULATION
LONG-TERM STABLE R-VALUE



Expanded polystyrene (EPS) is an innovative, high-performance building material engineered to deliver long-term, reliable energy efficiency. EPS insulation is an ideal choice for green building design, offering numerous environmental advantages, including reduced energy consumption, recycled content, localized distribution and improved indoor air quality.



This EPD complies with the Building Envelope Thermal Insulation Product Category Rule (PCR), version 1.4 by Underwriters Laboratory (UL).

The EPS Industry Alliance (EPS-IA), which represents manufacturers and distributors of expanded polystyrene (EPS) products throughout North America, facilitates educational outreach on the technical, environmental and performance advancements of EPS.

The EPS industry is committed to sustainability through innovation. We demonstrate this dedication through lean manufacturing processes, a comprehensive recycling system and by harnessing new technologies to conserve raw materials and reduce waste. The EPS industry is continuously seeking to further market applications, reduce impacts and raise performance.

EPS-IA has invested significant time and resources in life-cycle analysis. This Environmental Product Declaration is part of our goal to provide life-cycle information on all EPS insulation applications.

www.epsindustry.org

EPS Industry Alliance

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	EPS Industry Alliance
DECLARATION NUMBER	4787238561.101.1
DECLARED PRODUCT	EPS Insulation
REFERENCE PCR	UL PCR: Building Envelope Thermal and Mechanical Insulation v1.4 2016
DATE OF ISSUE	8/10/2017
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 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 Peer Review Panel epd@ul.com
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, Industrial Ecology Consultants

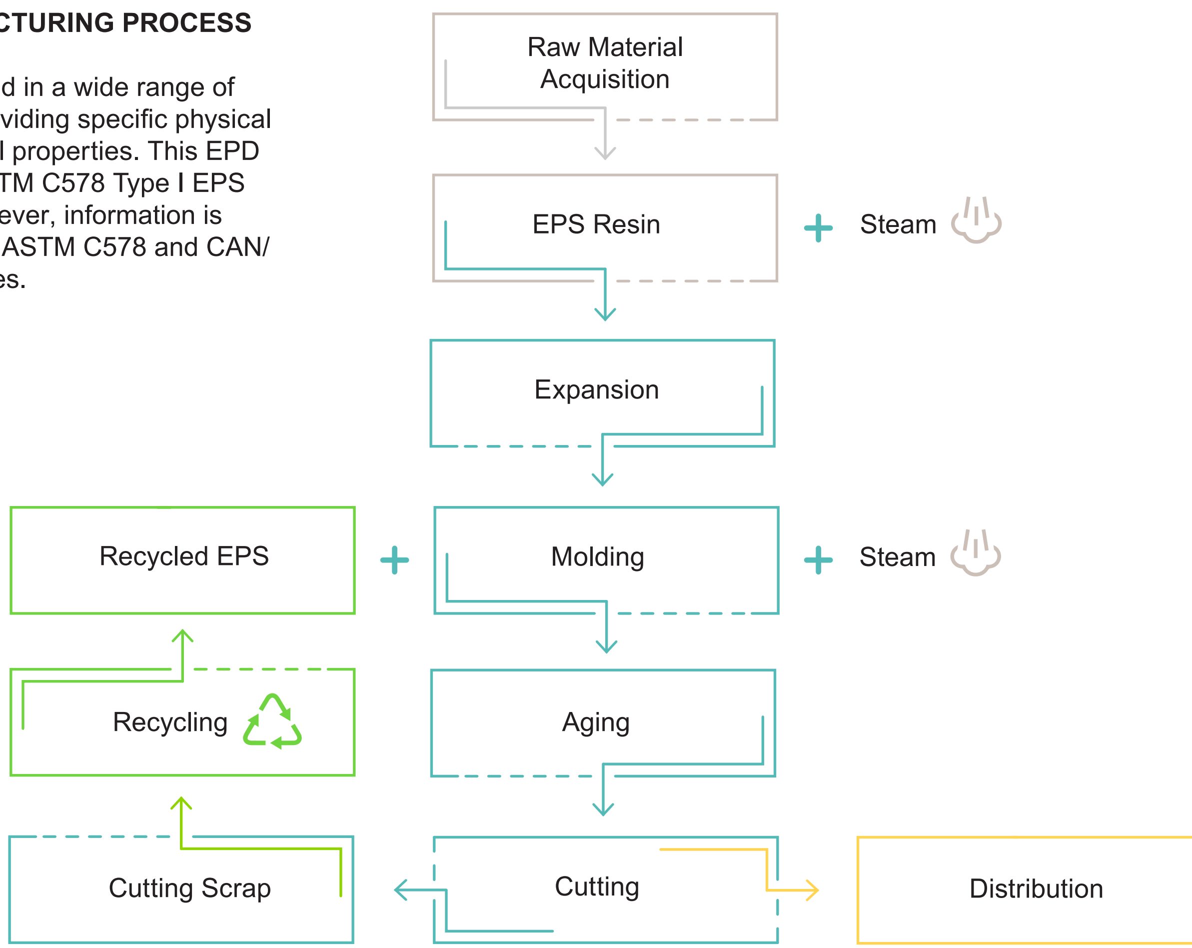
PRODUCT DESCRIPTION

Expanded polystyrene (EPS) insulation is a closed-cell foam plastic that is 98% air. EPS insulation is foam plastic and has never contained chlorofluorocarbon (CFCs), hydrofluorocarbons (HFCs) or hydrochlorofluorocarbon (HCFCs) blowing agents. EPS is easily recyclable and re-incorporated into the manufacturing process.

EPS is created in a two-stage process. First, EPS resin is loaded into an expander and exposed to steam, which causes it to expand. The expanded material is transferred into a block mold where, once again, steam is used to further expand and fuse the material into a solid, homogenous block. Recycled EPS is typically incorporated to produce a recycled content product. Following a short aging process, the EPS block is cut into sheets or various shapes to suit all insulation applications. Cutting scrap is recycled in-house and reused in the production cycle. The basic EPS product is white, although it can be colored.

EPS MANUFACTURING PROCESS

EPS is produced in a wide range of types, each providing specific physical and mechanical properties. This EPD is based on ASTM C578 Type I EPS insulation. However, information is available for all ASTM C578 and CAN/ULC S701 Types.



MANUFACTURING LOCATIONS

Individual EPS manufacturers can be found across the U.S., Canada, and Mexio. With hundreds of North American locations, EPS can help meet other green building goals via localized manufacturing, which reduces the impacts of transportation.

You can find an EPS manufacturer on the EPS-IA website.

APPLICATIONS

Foundations

EPS insulation provides dependable, long-term performance for interior and exterior foundation applications. Its closed-cell structure results in minimal water absorption and moderate vapor permanence. Density, strength and thickness can be specified to meet compressive loading forces as well as thermal resistance requirements.

- Sub-Slab Insulation
- Exterior Perimeter Foundation Walls
- Interior Foundation Walls

Walls/Ceilings/Floors

Versatility, lasting value, and performance make EPS insulation ideal for a variety of wall, ceiling, and floor applications that substantially increase the thermal efficiency of the building structure.

- Walls & Ceilings
- Exterior Insulation Finish Systems (EIFS)
- Exterior Sheathing/Underlayment

TESTING & STANDARDS

EPS products have been the subject of extensive research and evaluation for more than 50 years.

ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

CAN/ULC-S701 Standard for Thermal Insulation, Polystyrene, Boards & Pipe Covering.

ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.

CAN/ULC-S102.2 Standard Method of Test for Surface Burning Characteristics of Building Materials & Assemblies.

ASTM C1512 Standard Test Method for Characterizing the Effect of Exposure to Environmental Cycling on Thermal Performance of Insulation Products.

ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.

NFPA 285 Standard Fire Test Method for Evaluating Fire Propagation Characteristics of Exterior Non-Load Bearing Wall Assemblies Containing Combustible Components.

Roofing

Roofing systems using EPS can meet the needs of the most demanding building requirements. EPS insulation is compatible with all commercial roofing systems, including but not limited to, built-up roofing and modified bitumen systems and single-ply membrane systems that are either ballasted, mechanically fastened or fully adhered.

- Flat, Tapered, Composite, & Flute Fill
- Built-Up & Modified Bitumen Membrane Systems
- Single-Ply Membrane Systems

PERFORMANCE PROPERTIES

STABLE THERMAL RESISTANCE

The FTC R-value Rule recognizes the thermal performance of some insulation materials changes as they age (i.e., off-gassing) or settle, which affects the insulation's Long-Term Thermal Resistance (LTTR). However, the five-year and 50-year thermal resistance (RSI/R-values) for EPS insulation are the same as the initial RSI/R-values since the closed cell structure of EPS contains atmospheric air. The minimum RSI/R-value of EPS insulation provided for each product type may be used as a design value without any adjustment for age. Whether used as a stand-alone component or part of a highly engineered building system, EPS' insulating provides a permanent, lifetime R-value that delivers maximum energy efficiency.

The amount of insulation required will vary depending on the building design, climate, and energy costs, making it important to choose the most cost-effective R-value per inch (RSI per 25mm). The R-value of EPS insulation ranges from 3.1 to 4.3 per inch and the RSI ranges from 0.55 to 0.76 per 25mm.

Material Property	Units	ASTM C578 Types EPS Insulation Thermal Performance						
		XI	I	VIII	II	IX	XIV	XV
Thermal Resistance (R-value/RSI) @ 75°F/24°C	R-value per inch, minimum, ft²•hr•°F/BTU	3.1	3.6	3.8	4.0	4.2	4.2	4.3
	RSI per 25.4 mm, minimum, m²•°C/W	0.55	0.63	0.67	0.70	0.74	0.74	0.76

Material Property	Units	CAN/ULC-S701 Types EPS Insulation Thermal Performance		
		1	2	3
Thermal Resistance (RSI/R-value) @ 24°C/75°F	RSI per 25 mm, minimum, m²•°C/W	0.65	0.70	0.74
	R-value per inch, minimum, ft²•hr•°F/BTU	3.75	4.04	4.27

COMPRESSIVE RESISTANCE

Due to its high resiliency and compressive resistance, EPS is an excellent choice for the repetitive loading of roof insulation (walkability), sub-pavement flooring, road building, and as a general load-bearing insulation. With its flexible production process, the mechanical properties of EPS can be adjusted to suit every specified application.

Material Property	Units	ASTM C578 Types EPS Insulation Compressive Resistance						
		XI	I	VIII	II	IX	XIV	XV
Compressive Resistance	@ 10% Deformation minimum, psi	5	10	13	15	25	40	60
	@ 10% Deformation minimum, kPa	35	69	90	104	173	276	414

Material Property	Units	CAN/ULC-S701 Types EPS Insulation Compressive Resistance		
		1	2	3
Compressive Resistance	@ 10% Deformation minimum, kPa	70	110	140
	@ 10% Deformation minimum, psi	10	16	20

MOISTURE PROTECTION

EPS is hydrophobic and has a low equilibrium moisture content meaning it does not readily absorb moisture from the atmosphere – its closed-cell structure reduces the absorption and/or migration of moisture. EPS insulation is proven to retain its specified thermal and mechanical properties due to in-situ freeze-thaw cycling. When exposed to the extreme conditions of the ASTM C1512 test, EPS insulation exhibited drying potential under severe exposure conditions, which is critical for maintaining thermal resistance (RSI/R-value) under severe long-term exposure conditions.

INSTALLATION

Specifying the appropriate product for a building application and installing it properly have a critical impact on the long-term performance of a building assembly. There are various building codes and industry standards – both at national and regional levels – that establish best practices for product specification and installation. To provide high-performance, long-lasting buildings, it is imperative for building and design professionals to be well informed about all applicable building codes and product standards, as well as manufacturer recommendations Strict adherence to proper installation requirements ensures all insulation products serve as effective design solutions that complement one another and ensure greater comfort, safety and lower maintenance while leaving a smaller footprint on the environment.

END-OF-LIFE MANAGEMENT & RECYCLING

Recycling has always been an integral part of operations at EPS processing plants. Cutting scrap is recycled and incorporated into the production cycle to make new EPS insulation. Recycled EPS can also be processed into new products such as plastic lumber.

INDOOR AIR QUALITY

EPS insulation products have a low volatile nature and are interior friendly. EPS has never incorporated CFCs, HFCs and HCFCs in its production process. Intertek Testing has verified EPS insulation VOC emissions through the standard methods of California Specification 01350: *Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers*.

Many EPS manufacturers are certified for indoor air quality as low emitting products by UL GREENGUARD. You can view individual company UL GREENGUARD listings on SPOT.

LIFE-CYCLE ASSESSMENT RESULTS & ANALYSIS

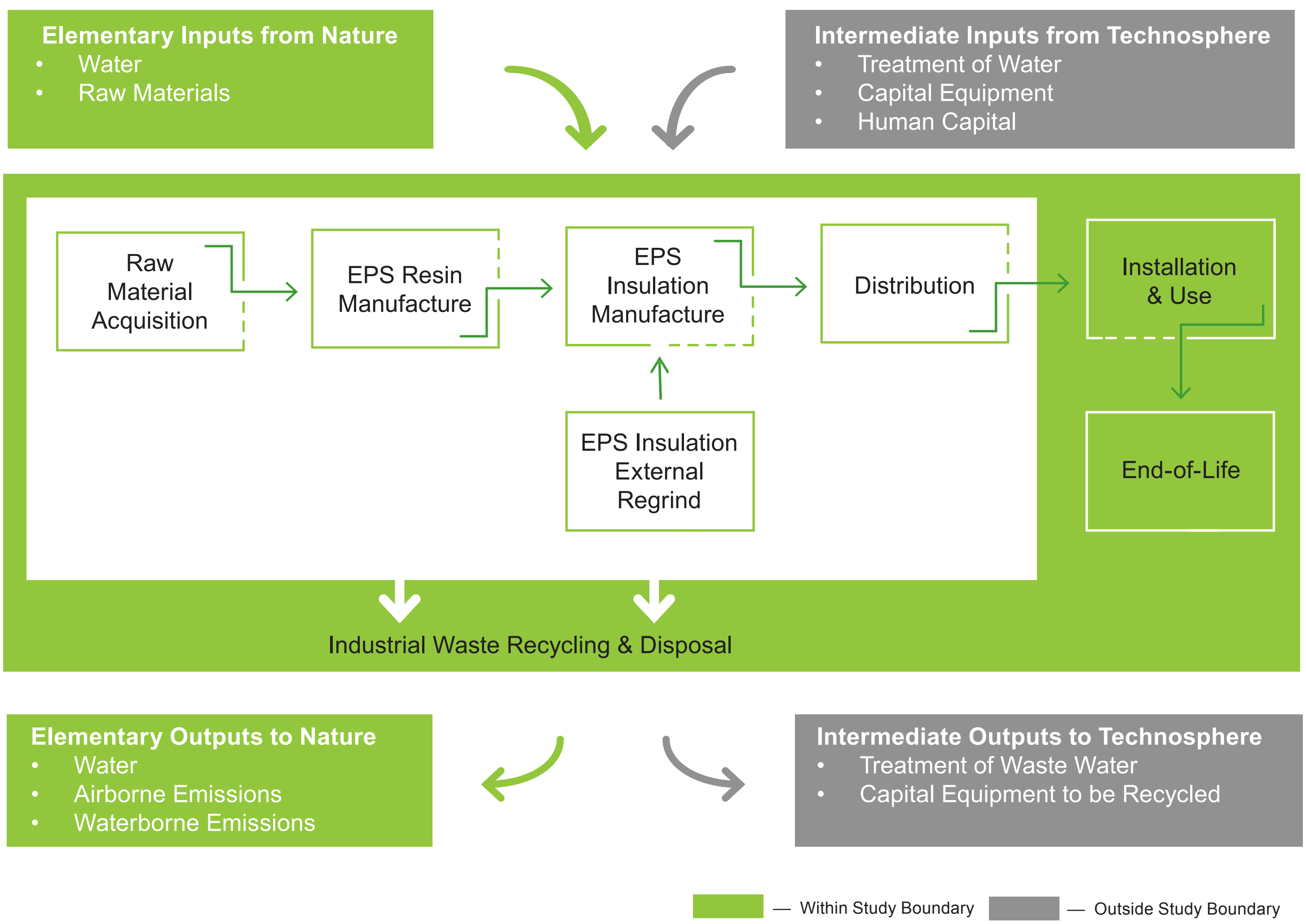
PRODUCT SYSTEM BOUNDARIES

The Life -Cycle Assessment for EPS insulation quantifies energy and resource use, solid waste and environmental impacts for the following phases in the life cycle:

- Raw material acquisition (e.g., feedstocks for plastic resin), and intermediate steps to convert the feedstocks into EPS resin.
- Transportation of virgin EPS resin and recycled EPS to EPS insulation manufacturers.
- Manufacturing of EPS insulation.
- Packaging for incoming materials to the insulation manufacturer, as well as packaging for the shipment of EPS insulation.
- Transporting EPS insulation to customers or a distribution center.
- Installation and maintenance of the insulation are included in the study. Installing the insulation is performed manually and maintaining the product does not require additional energy or resources.
- End-of-life management of insulation and secondary packaging (including disposal, incineration, or recycling).

The principal purpose of the LCA is to provide updated environmental impacts associated with EPS insulation from cradle to grave. The illustration below details EPS insulation production and subsequent life cycle stages.

EPS INSULATION SYSTEM BOUNDARIES



USE OF MATERIAL & ENERGY RESOURCES

Table 1 shows the primary energy demands per functional unit. Energy resource consumption is broken down by type and by resources. Figures 1 and 2 illustrate the results graphically.

	Basis: 1 m² with a thermal resistance RSI = 1 m²K/W and service life of 60 years
	Total Primary Energy
	MJ
NON-RENEWABLE RESOURCES	
Fossil Oil	26.50
Coal	3.80
Natural Gas	37.60
Uranium	1.72
RENEWABLE RESOURCES	
Hydropower	0.18
Landfill Gas	1.15
Wind	0.06
Biomass	0.33
Geothermal	0.01
Solar	0.01
TOTAL	**71.4**

Table 1: Primary Energy Demand for EPS Insulation

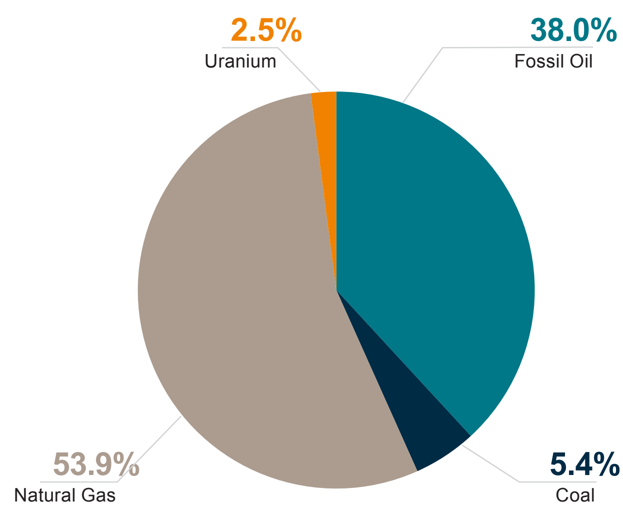


Figure 1: Non-Renewable Primary Energy Resources

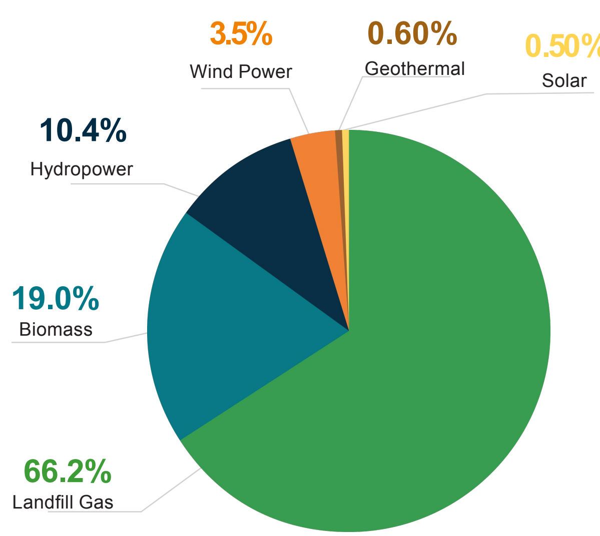


Figure 2: Renewable Primary Energy Resources

FUNCTIONAL UNIT

The functional unit used for this study is 1 m² (10.765 ft²) of insulation material with a thickness that gives an average thermal resistance RSI = 1 m²•K/W (R-value 5.68 ft²•hr•°F/BTU) and with a building service life of 60 years. The thickness of the ASTM C578 Type I EPS insulation required for the functional unit is 4.01 centimeters (1.58 in).

Note: The EPD data is derived from the LCA of EPS Insulation and Cradle-to-Gate LCA of EPS Resin reports by ERG/Franklin Associates. Percentages have been rounded and may not total to 100%.

GEOGRAPHIC ANALYSIS

The geographic scope of the analysis is insulation manufactured, used, and disposed of in North America. End-of-life management of insulation was modeled based on all insulation being taken to a construction and demolition (C&D) landfill. This included transport and landfill machinery. The insulation was modeled as inert within the landfill.

INVENTORY & IMPACT ASSESSMENT

The LCA study addresses global, regional, and local environmental impact categories. For most of the impact categories examined, the TRACI 2.1 methodology, developed by the United States Environmental Protection Agency (EPA) specific to U.S./Canadian conditions and updated in 2012, is employed.

For the category of acidification, units of TRACI 2.04 were used in accordance with the Product Category Rule. For the category of Global Warming Potential (GWP), contributing elementary flows are characterized using factors reported by the Intergovernmental Panel on Climate Change (IPCC) in 2013 with a 100 year time horizon.

DATA QUALITY ASSESSMENT

Primary data was collected from three EPS resin manufacturers in North America – one in Canada, one in the U.S., and one in Mexico. Data was provided by one plant for each manufacturer. A straight average of these three resin data sets was used for the average EPS resin data set.

Primary data was collected from a total of 29 insulation manufacturing plants (23 in the U.S. and six in Canada). The following companies provided data for this assessment: ACH Foam Technologies, Inc., Atlas EPS, Insulation Technology, Inc., Insulfoam, NOVA Chemicals Inc., Plasti-Fab Ltd., VersaTech, Inc., Styropek. All insulation data sets were weighted using production amounts provided by each plant.

The data quality goals were to use data that are (1) geographically representative for each insulation system based on the locations where material sourcing and resin manufacturing operations, insulation manufacturing, distribution, and end-of-life management take place, and (2) representative of current industry practices in these regions. EPS-IA provided current, geographically representative data for both the EPS resin and the EPS insulation system. Those data sets used in the models that were not collected for this analysis were drawn largely from reliable published databases (U.S. LCI Database) or from the ERG/Franklin Associates confidential database of primary North American unit process data. The data sets used were the most current and most geographically and technologically relevant data sets available during the data collection phase of the project.

METHODOLOGY

The LCA has been conducted following internationally accepted standards for LCA methodology as outlined in the ISO 14040 and 14044 standards, which provide guidance and requirements for conducting life cycle assessments. However, for some specific aspects of life cycle assessment, the ISO standards have some flexibility and allow for methodological choices to be made. These include the method used to allocate energy requirements and environmental releases among more than one useful product produced by a process, the methodology used to allocate environmental burdens for recycled content, and the methodology used for end of life management. The following sections describe the approach to each issue used in this study.

ENERGY DEMAND

Figure 3 shows total energy demand for the life cycle of the insulation system. The production of raw materials makes the largest contribution (81.8 percent) of the total energy demand for the EPS insulation. Insulation manufacturing also makes a significant contribution at 12 percent of the total. The manufacturing process for EPS insulation includes expansion of the resin, regrinding and converting scrap for reuse in the process, and, at some plants, combustion of captured blowing agent emissions. Transportation steps make up almost five percent of the total energy. A little more than two percent of that energy comes from distributing the insulation to the distribution centers and users. Packaging the resin and insulation requires very little energy. The insulation is installed manually, so no energy is required to complete that process. The use of the insulation also requires no energy. One percent of the total energy is required to dispose of the insulation, which includes transport to the C&D (construction and demolition) landfill, as well as for landfill equipment.

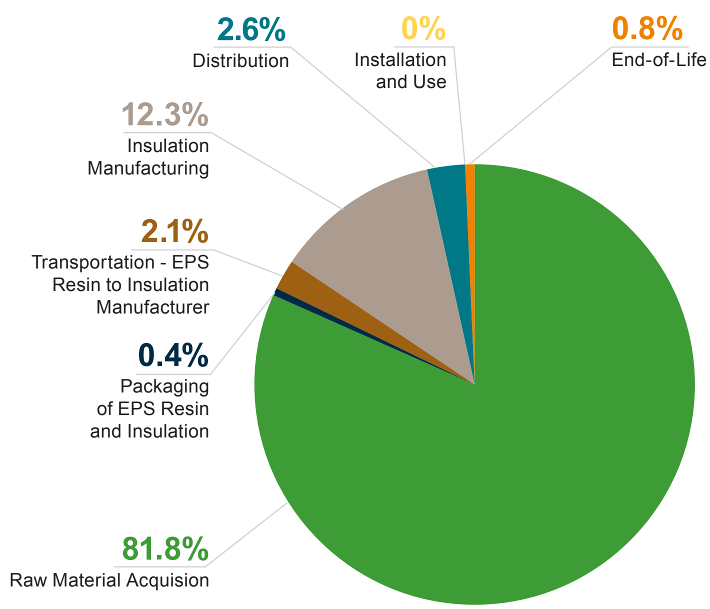


Figure 3: Total energy Demand for EPS Insulation

Table 2 displays the percent of total energy required as feedstock as well as the energy required for process and fuel-related energy. A little less than half (46 percent) of the total energy is used to create the plastic material used in the EPS insulation. If only the process and fuel-related energy is examined, two-thirds of the energy still comes from material acquisition and almost a quarter is used by the insulation production.

	Basis: 1 m^2 with a thermal resistance RSI=1 m^{2}K/W and service life of 60 years		
	Cumulative Energy	Non-Renewable Energy	Renewable Energy
	MJ	MJ	MJ
Raw Material Acquisition	58.4	57.1	1.32
Packaging of EPS Resin and Insulation	0.27	0.22	0.05
Transportation-Resin to Insulation	1.50	1.50	0.0023
Insulation Manufacturing	8.81	8.49	0.32
Distribution	1.85	1.85	0.0029
Installation and Use	0	0	0
End-of-Life	0.55	0.55	8.6E-04
TOTAL	**71.4**	**69.7**	**1.70**
	Percentage		
	Cumulative Energy	Non-Renewable Energy	Renewable Energy
	%	%	%
Raw Material Acquisition	81.8%	80.0%	1.9%
Packaging of EPS Resin and Insulation	0.4%	0.3%	0.1%
Transportation-Resin to Insulation	2.1%	2.1%	0.0%
Insulation Manufacturing	12.3%	11.9%	0.4%
Distribution	2.6%	2.6%	0.0%
Installation and Use	0.0%	0.0%	0.0%
End-of-Life	0.8%	0.8%	0.0%
TOTAL	**100%**	**98%**	**2%**

Table 2: Cumulative, Non-Renewable, and Renewable Energy Demand for EPS Insulation

GLOBAL WARMING POTENTIAL

Table 3 and Figure 4 show life cycle GWP results for the insulation systems. The raw material production of the insulation system accounts for the largest share of GWP (70 percent), followed by insulation manufacturing at 20 percent. The GWP emissions from the raw material stage are mainly associated with fossil fuel resources used as fuel and as feedstocks for the plastic resin and blowing agent. GWP from insulation manufacturing includes emissions from combustion of fuels used in the insulation manufacturing process, emissions from operation of a thermal oxidizer used to destroy blowing agent emissions at the manufacturing plant (including carbon dioxide from combustion of both the fuel and pentane burned in the thermal oxidizer), as well as emissions associated with production of the electricity used in the insulation manufacturing processes. More than 8 percent comes from combustion of the fuels used to transport the resin, as well as the transportation during distribution. End-of-life management of disposed EPS insulation contributes a little more than 1% of the total GWP for the insulation system; this is largely carbon dioxide emissions from the combustion of the fuels used to transport and distribute the insulation during landfilling.

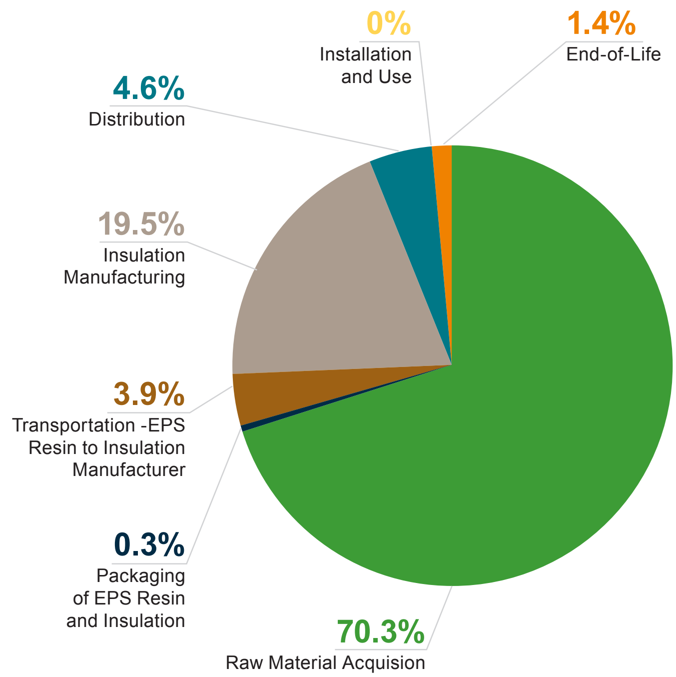


Figure 4: Global Warming Potential Results for EPS Insulation

	Basis: 1 m² with a thermal resistance RSI = 1 m²K/W and service life of 60 years	
	Global Warming Potential	Percentage of Total
	kg CO_2 eq	%
Raw Material Acquisition	1.96	70%
Packaging of EPS Resin and Insulation	0.0074	0.3%
Transportation-Resin to Insulation	0.11	3.9%
Insulation Manufacturing	0.55	20%
Distribution	0.13	4.6%
Installation and Use	0	0.0%
End-of-Life	0.038	1.4%
TOTAL	**2.79**	**100%**

Table 3: Global Warming Potential Results for EPS Insulation

WATER CONSUMPTION

Consumptive use of water in this study includes freshwater that is withdrawn from a water source or watershed and not returned to that source. Consumptive water use includes water consumed in chemical reactions, water that is incorporated into a product or waste stream, water that becomes evaporative loss, and water that is discharged to a different watershed or water body than the one from which it was withdrawn. Water consumption results shown for each life cycle stage include process water consumption as well as water consumption associated with production of the electricity and fuels used in that stage. Electricity-related water consumption includes evaporative losses associated with thermal generation of electricity from fossil and nuclear fuels, as well as evaporative losses due to establishment of dams for hydropower.

Water consumption results are shown in Figure 5. Process water consumption for EPS insulation manufacturing is associated with generation of electricity used in the processes, as well as extraction of oil and gas for material and fuel uses. These account for almost half of the consumed water. The insulation manufacturing itself accounts for 29 percent of the water consumed, due to steam production and cooling water makeup.

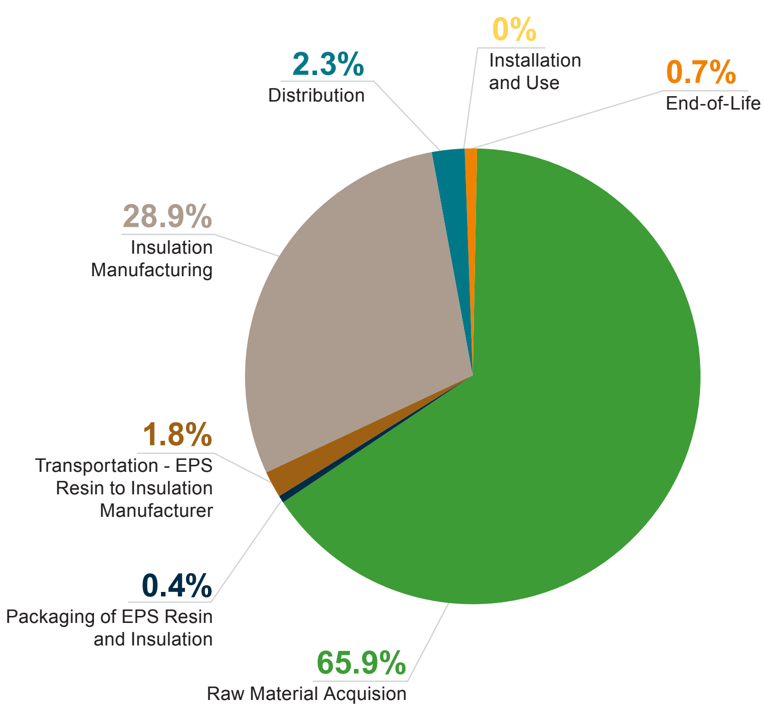
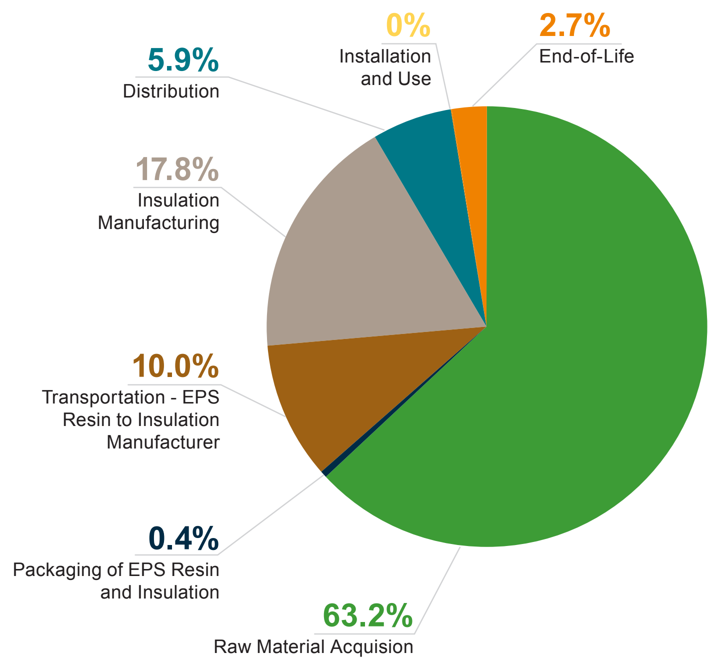


Figure 5: Consumptive Water Use for EPS Insulation

ACIDIFICATION

For the EPS insulation system, raw material production accounts for almost two-thirds of the total acidification potential, followed by insulation manufacturing (17.8 percent) and the transportation of resin and distribution, which together account for over 15 percent. The combustion of natural gas, coal and oil is the largest contributor to the acidification potential.

Figure 6: Acidification Potential Results for EPS Insulation



SOLID WASTE

Solid waste results include the following types of wastes:

- Process wastes that are generated by the various processes from raw material acquisition through production of insulation (e.g., sludges and residues from chemical reactions and material processing steps)
- Fuel-related wastes from the production and combustion of fuels used for process energy and transportation energy (e.g., refinery wastes, coal combustion ash)
- Postconsumer wastes that include the landfilling of the insulation and packaging included, plus ash from the 18% of the packaging that are managed by WTE combustion.

Results for solid waste by weight are shown in Table 4. The largest share of solid waste for all insulation systems is post-consumer solid waste (insulation disposed at the end of its useful life). The next largest contributor is raw material production, which accounts for 10% of the waste for the EPS insulation. Raw material solid wastes are largely associated with production and combustion of fuels (particularly coal used to generate electricity used in raw material production processes) and the production of crude oil and natural gas used as feedstocks for the EPS resin and blowing agent. The insulation manufacture creates approximately 5 percent of the total solid wastes, which include some off-spec resin sent to landfill, as well as solid wastes from emissions control devices. The small amounts of packaging used does not make a large contribution (1 percent) to solid waste results.

The total solid waste is also separated by hazardous and non-hazardous wastes, as well as by the fate of the solid waste. Hazardous waste accounts for only 0.03 percent of the total solid waste for the EPS insulation, while non-hazardous makes up the remaining. More than 99 percent of the solid waste is landfilled, with only 0.02 percent being incineration and less than 0.01 percent used for waste-to-energy.

	Basis: 1 m^2 with a thermal resistance RSI = 1 m^2K/W and service life of 60 years								
		Hazardous Wastes				Non-Hazardous Wastes			
	Total Solid Waste	Waste-to-Energy	Incineration	Landfill	Hazardous Waste Total	Waste-to-Energy	Incineration	Landfill	Non-Hazardous Waste Total
	kg	kg	kg	kg	kg	kg	kg	kg	kg
Raw Material Acquisition	0.081	1.0E-05	1.5E-04	2.3E-05	1.9E-04	1.1E-06	0.0021	0.079	0.081
Packaging of EPS Resin and Insulation	0.011	5.2E-08	3.9E-06	1.2E-07	4.1E-06	1.2E-07	5.3E-05	0.011	0.011
Transportation-Resin to Insulation	0.0015	0	0	0	0	0	0	0.0015	0.0015
Insulation Manufacturing	0.037	0	0	0	0	0	0	0.037	0.037
Distribution	0.0019	0	0	0	0	0	0	0.0019	0.0019
Installation and Use	0	0	0	0	0	0	0	0	0
End-of-Life	0.61	0	0	0	0	0	0	0.61	0.61
TOTAL	**0.75**	**1.0E-05**	**1.6E-04**	**2.3E-05**	**1.9E-04**	**1.3E-06**	**0.0021**	**0.74**	**0.75**
	Percentage of Total								
		Hazardous Wastes				Non-Hazardous Wastes			
	Total Solid Waste	Waste-to-Energy	Incineration	Landfill	Hazardous Waste Total	Waste-to-Energy	Incineration	Landfill	Non-Hazardous Waste Total
	%	%	%	%	%	%	%	%	%
Raw Material Acquisition	10.9%	0%	0.02%	0%	0.03%	0%	0.28%	10.6%	10.8%
Packaging of EPS Resin and Insulation	1.4%	0%	0%	0%	0%	0%	0.01%	1.43%	1.45%
Transportation-Resin to Insulation	0.2%	0%	0%	0%	0%	0%	0%	0.20%	0.20%
Insulation Manufacturing	4.9%	0%	0%	0%	0%	0%	0%	4.92%	4.92%
Distribution	0.3%	0%	0%	0%	0%	0%	0%	0.25%	0.25%
Installation and Use	0%	0%	0%	0%	0%	0%	0%	0%	0%
End-of-Life	82.3%	0%	0%	0%	0%	0%	0%	82.3%	82.3%
TOTAL	**100%**	**0.00%**	**0.02%**	**0.00%**	**0.03%**	**0.00%**	**0.29%**	**99.7%**	**99.97%**

Table 4: Solid Waste by Weight for EPS Insulation

RESULTS SUMMARY

A summary table including result totals in each category for EPS insulation is displayed in Table 5. Normalized results for EPS insulation for all results categories are presented in Figure 7. For each results category, the values are displayed on a percentage basis, with each phase of the LCA shown based on its percent of the total amount (100%) for that category.

ASTM C578 TYPE I EPS INSULATION

IMPACT CATEGORY/ENVIRONMENTAL INDICATOR	UNITS	TOTAL
Total Energy	MJ	71.4
Non-Renewable Energy	MJ	69.7
Renewable Energy	MJ	1.74
Total Solid Waste	kg	0.75
Water Consumption	L	9.94
Global Warming	kg CO_2 eq	2.79
Eutrophication	kg N eq	3.6E-04
Smog Formation	kg O_3 eq	0.20
Ozone Depletion	kg CFC-11 eq	1.6E-08
Acidification	mol H+ eq	0.46

Table 5: Results Summary

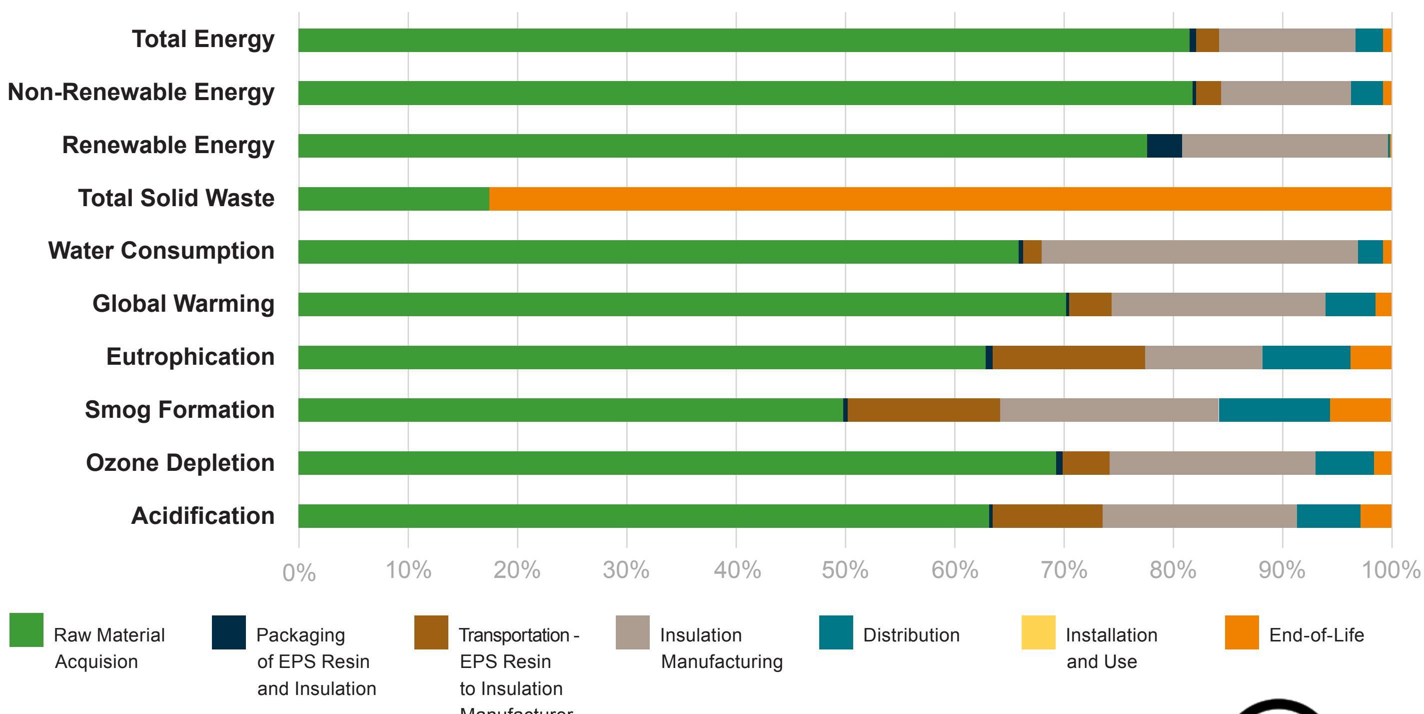


Figure 7: Normalized Results for EPS Insulation

RESULTS SUMMARY

The LCA is based on a functional unit of 1 m² (10.765 ft²) of ASTM C578 Type I EPS insulation with a thickness that gives an average thermal resistance RSI = 1 m²K/W (R-value 5.68 ft²•hr•°F/BTU) and with a building service life of 60 years. For this functional unit, the ASTM C578 Type I EPS insulation thickness would be 4.01 centimeters (1.57 inches).

Table 6 provides the EPS LCA results for ASTM C578 and CAN/ULC S701 EPS Types based on a functional unit of 1 m² (10.765 ft²) of insulation that gives a thermal resistance of RSI=1 m²K/W (R-value 5.68 ft²•hr•°F/BTU) and with a building service life of 60 years.

LCA RESULTS FOR ASTM C578 & CAN/ULC-S701 EPS TYPES

IMPACT CATEGORY/ ENVIRONMENTAL INDICATOR	UNITS	ASTM C578							CAN/ULC S701		
		Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	1	2	3
Total Energy	MJ	64.3	71.4	86.4	96.4	122	163	199	68.5	95.7	121
Non-Renewable Energy	MJ	62.7	69.7	84.3	94.1	119	160	194	66.9	93.4	118
Renewable Energy	MJ	1.53	1.74	2.06	2.30	2.90	3.89	4.74	1.63	2.28	2.87
Total Solid Waste	kg	0.66	0.75	0.91	1.01	1.28	1.72	2.09	0.72	1.01	1.27
Water Consumption	L	8.95	9.94	12.0	13.4	17.0	22.8	27.7	9.54	13.3	16.8
Global Warming	kg CO_2 eq	2.51	2.79	3.38	3.77	4.77	6.39	7.78	2.68	3.74	4.72
Eutrophication	kg N eq	3.2E-04	3.6E-04	4.4E-04	4.9E-04	6.2E-04	8.2E-04	10E-04	3.5E-04	4.8E-04	6.1E-04
Smog Formation	kg O_3 eq	0.18	0.20	0.24	0.27	0.34	0.46	0.56	0.19	0.27	0.34
Ozone Depletion	kg CFC-11 eq	1.4E-08	1.6E-08	1.9E-08	2.2E-08	2.7E-08	3.7E-08	4.4E-08	1.5E-08	2.1E-08	2.7E-08
Acidification	mol H+ eq	0.41	0.46	0.56	0.62	0.79	1.05	1.28	0.44	0.62	0.78

Table 6: EPS LCA Results for ASTM C578 & CAN/ULC-S701 EPS Types

REFERENCES

- *Product Category Rules for Preparing an Environmental Product Declaration (EPD) for Product Group: Building Envelope Thermal Insulation, Version 1.4, 23 September 2011*
- *Life Cycle Assessment of Expanded Polystyrene Insulation, Franklin Associates/ERG, 2017*
- *Cradle-to-Gate Life Cycle Analysis of Expanded Polystyrene Resin, Franklin Associates/ERG, 2017*
- *ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*
- *CAN/ULC S701 Standard for Thermal Insulation, Polystyrene, Boards & Pipe Coverings*