Building with conscience.

EPD for StoTherm® ci XPS Classic

StoTherm® ci XPS Classic is a fully-tested EIFS system providing superior air and weather tightness, excellent long-lasting thermal performance and durability. StoTherm® ci XPS Classic combines StoGuard® liquid-applied air and moisture barrier with Owens Corning Foamular CI-C or Dow STYROFOAM™ Panel Core 20 insulation, and Stolit® textured finishes. This system is available with the standard Stolit®textured finishes as-well-as a wide variety of specialty finish alternatives.

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Dow STYROFOAM Panel Core 20 XPS	View The EPD
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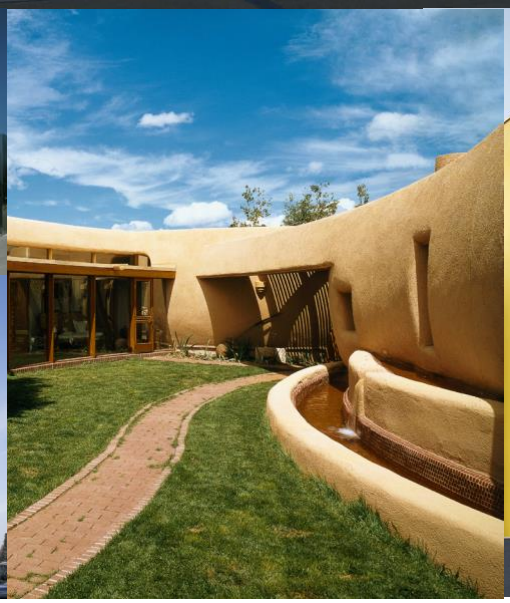
Stolit® Finishes	View The EPD

epd Environmental Product Declaration

Building with conscience.

EPD for Sto Gold Coat®

Sto Gold Coat® is a code recognized, vapor permeable fluid-applied membrane designed for application under ci wall systems. Sto Gold Coat® is a sheathing treatment which is part of the StoGuard® air barrier and moisture barrier family of products.



epstengroup Environmental Product Declaration

epstengroup Solutions for a Sustainable World

PCR Identification	PCR for Architectural Coatings: NAICS 325510 on the basis of ISO 21930:2007, NSF International, 2017. Valid through June 23, 2022
Compliance to ISO 14040/44, ISO 14025 and ISO 21930	Yes
Product Category	Exterior Coating
Manufacturer's name	Sto Corp. 3800 Camp Creek Parkway SW, Building 1400, Suite 120 Atlanta, GA 30331 www.stocorp.com | (800) 221-2397
EPD program operator	Epsten Group 101 Marietta St. Suite 2600, Atlanta, GA 30303 www.epstengroup.com
Declaration Number	01-003
Date of Certification	December 18th, 2019
Period of Validity	5 years from date of certification
Functional Unit	One square meter of covered and protected substrate for 60 years
Market-base life used in assessment	10 Years
Design life used in assessment	N/A
Test method employed for determination of design life	N/A
Amount of colorant needed	See table 3
Overall Data Quality Assessment Score	Good
Site(s) in which the results of the LCA are representative	STO manufacturing sites in Atlanta, Georgia; Glendale, Arizona; and Rutland, Vermont
Information on where explanatory material can be obtained	See references at the end of this document.
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database Version 8.7, Service Pack 39
This declaration was independently verified in accordance with ISO 14025: 2006 and the reference PCR: PCR for Architectural Coatings: NAICS 325510 ☐ Internal ☒ External	Kate McFeaters kmcfeaters@epstengroup.com Kathrin McFeaters
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14040/44 and the reference PCR by:	Kate McFeaters kmcfeaters@epstengroup.com Kathrin McFeaters

Comparability

In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the building level per ISO 21930 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Company

We believe in '**Building with conscience**'.

That means ensuring that all building products are not only safe, effective and easy to install, but also environmentally responsible and sustainable. We know you're always looking for the smartest and newest technology to create energy efficient buildings with superior aesthetics.

That's exactly what our products help you achieve. Products like our wall systems, coatings and finishes are consistent favorites among design professionals, contractors and property owners alike. Whatever your needs or vision may be, we offer products for every type of building project; whether it's new construction, restoration or panelization, commercial or residential work.

An architect or specifier focuses on aesthetics and feasibility, a contractor needs products that are easy to work with, and a building owner requires high value and low costs on properties. Sto understands these unique needs, and delivers the smart, innovative materials and solutions that make this all possible. That's why Sto remains the innovative leader in integrated exterior wall systems.

When you combine that commitment to product support and innovation with value-added offerings like consultative design and color services through Sto Studio or training in proper application techniques through the Sto Institute, you get an integrated exterior wall system solution unmatched in the industry.

Manufacturing Sites Covered in this EPD

Atlanta Plant

Glendale Plant

Rutland Plant

Product Identification

Sto Gold Coat® is a fluid-applied vapor permeable air barrier offered in 5-gallon pails. There are no finish or color base options provided.

Table 1: Sto Gold Coat® Identification

Product Name	Product Number	Base Type	Finish Type
Sto Gold Coat®	81636	n/a	n/a

Product Description

Sto Gold Coat® is a fluid-applied vapor permeable air barrier and water-resistive barrier (WRB) with built-in anti-freeze properties. It is used over prepared vertical above grade concrete, concrete masonry, brick masonry, wood and glass mat gypsum sheathing behind StoTherm® ci and other wall claddings. Gold Coat® is treated in the study as a undercoater and it only utilizes the market-based lifetime (10 years for exterior undercoater).

Performance Features

Waterproof Material	Structural and Durable	Low Temperature Application	Spray Applied with Airless Spray Equipment
Vapor Permeable	UV Durable	Build-in Freeze Protection	Water-base and Low VOC

Material Composition

The material composition of Sto Gold Coat® is listed below:

Table 2: Material composition for Gold Coat®

Ingredient	Gold Coat®
Additives	1-2%
Colorant	3-4%
Polymer	25-26%
Silica	41-42%
Silicate	0%
Surfactant	0-1%
Water	25-26%

Components related to Life Cycle Assessment

The functional unit for the LCA study was covering and protecting 1 square meter (m2) of substrate for a period of 60 years—the assumed lifetime of a building. The reference flow required for the functional unit is calculated based on the product lifespan scenarios prescribed in the PCR. The market-based lifetime is 10 years. By default, Gold Coat® has a 5-year warranty. In case it is applied on Sto's wall systems, the warranty is extended to 10 years. The reference flow required for one functional unit is provided in Table 3.

Table 3: Market-based lifetime and reference flow

	Functional Unit [1 m^2]	Reference Flow [kg]	Tint needed [kg]
Lifespan		Market-based Lifetime [10 years]	
Gold Coat® over plywood)	1	3.08	N/A
Gold Coat® over CMU	1	8.87	N/A

Scope and Boundaries of the Life Cycle Assessment

The LCA was performed in accordance with ISO 14040 standards. The study is a cradle-to-grave LCA and includes the following life stages as prescribed in the PCR.

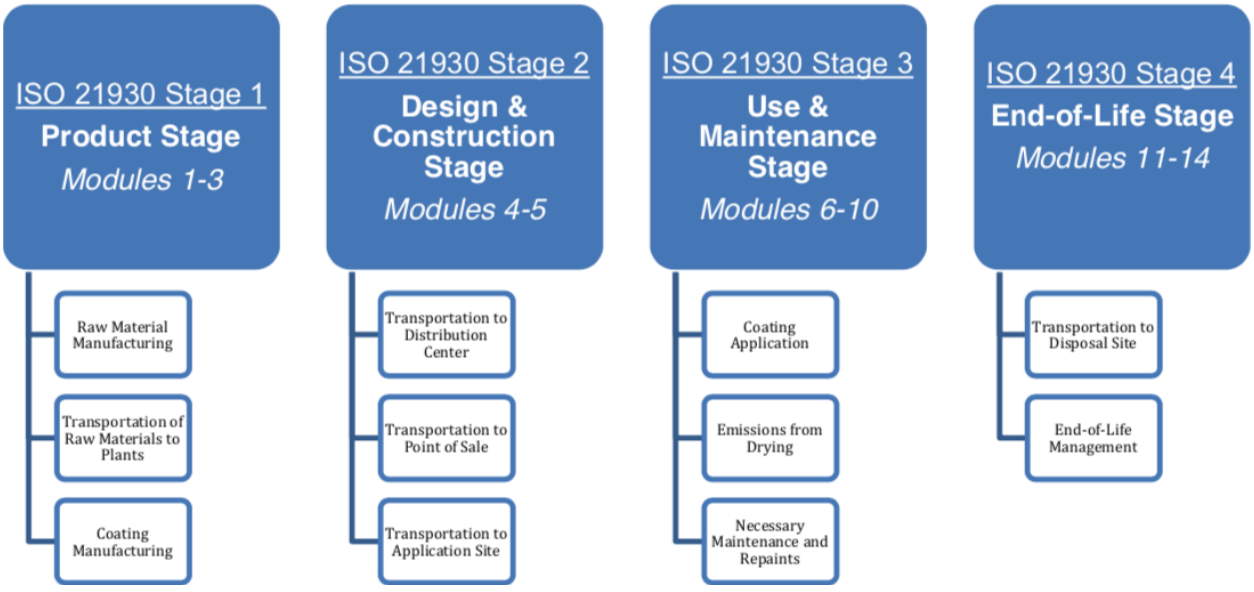


Figure 1: Life stages for the cradle-to-grave LCA

Cut-off Criteria

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

Data Quality

The overall data quality level was determined to be good. Primary data was collected from Sto's facilities in Atlanta, GA, Glendale, AZ and Rutland, VT for the 2018 reference year. When primary data did not exist, secondary data were obtained from the Gabi V8.7 Database Service Pack 39. Overall, both primary and secondary data are considered good quality in terms of geographic, temporal and technological coverage.

Estimates and Assumption

Assumptions were made to represent the cradle-to-grave environmental performance of Sto's products. These assumptions were made in accordance with the PCR and include the transportation distances, the disposal of packaging material and the product at its end of life and use phase assumptions.

Allocation

General principles of allocation were based on ISO 14040/44. Where possible, allocation was avoided. When allocation was necessary it was done on a physical mass basis.

Product Stage

Sto Gold Coat is produced at Sto's Atlanta, GA, Glendale, AZ and Rutland, VT facilities. This stage includes an aggregation of raw material extraction, supplier processing, delivery, manufacturing and packaging by Sto. Sto Gold Coat is supplied in 5-gallon pails.

Design and Construction Stage

The design and construction process stage starts with the packaged product leaving the production site and ends with being delivered to the application site.

During this stage, the finished product is moved from a shipping dock for distribution. The end gate is the application site after the purchaser acquires the finished product and transports it to the application site.

Use and Maintenance Stage

The use stage begins when the user prepares the product before applying it to a substrate and ends with any leftover coating and discarded packaging entering the end-of-life stage. Detailed application instructions are provided online. The application procedure includes mixing and applying. As recommended, an electric drill/mixer and a spray pump are assumed to be used for mixing and application. The equipment is not included in the study as these are multi-use tools and the impacts per declared unit is considered negligible, but electricity to power application tools has been included.

As prescribed in the PCR, 10% of the wet mass of Sto Gold Coat is assumed to be unused and properly disposed of.

End-of-Life Stage

Table 4: End-of-life Disposal Scenarios

Waste Flow	Recycling	Incineration	Landfilling
Paper Packaging	66.6%	6.01%	27.39%
Steel Packaging	33.3%	12.01%	54.69%
Plastic Packaging	9.1%	16.36%	74.54%
Unused Product	0%	0%	100%
Post-Consumer Product	0%	0%	100%

In this stage, the disposal of installation waste, packaging waste and product waste at its end of life is included. The disposal pathway of each waste stream is modeled based on the recommendation of PCR and US EPA's latest waste management fact sheet.

Life Cycle Assessment Results

As prescribed by the PCR, TRACI 2.1 impact characterization methodology and IPCC 5th assessment report are adopted to calculate the environment impacts. Table 5 provides the acronym key of the impact indicators declared in this EPD.

Table 5: LCIA impact category and LCI Indicator keys

Abbreviation	Parameter	Unit
	TRACI 2.1	
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg N eq
GWP	Global warming potential including biogenic carbon emission	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg O_3 eq
	Resource Use Parameters	
RPR	Use of renewable primary energy	MJ, net calorific value (LHV)
RMR	Use of renewable Material Resources	kg
NRER	Depletion of Non-Renewable Energy Resources	MJ, net calorific value
NRMR	Depletion of Non-Renewable Material Resources	kg
FW	Consumption of Freshwater	m^3
	Waste Parameters	
HWD	Disposed-of-hazardous waste	kg
NHWD	Disposed-of non-hazardous waste	kg
	Biogenic Carbon Parameter	
BC	Biogenic Carbon	kg CO_2 eq
	Energy Differentiation Parameters	
HWP	Hydro/wind Power	MJ, net calorific value (LHV)
FE	Fossil Energy	MJ, net calorific value (LHV)
BE	Bio-energy	MJ, net calorific value (LHV)
NE	Nuclear Energy	MJ, net calorific value (LHV)
OE	Other Energy	MJ, net calorific value (LHV)

Sto Gold Coat® over Plywood

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	2.88E-02	1.24E-03	2.39E-05	8.39E-04
	EP [kg N eq]	9.37E-04	1.01E-04	1.00E-06	1.48E-04
	GWP [kg CO_2 eq]	5.35E+00	2.42E-01	8.46E-03	1.79E-01
	ODP [kg CFC 11 eq]	-1.42E-13	2.30E-17	2.81E-17	4.44E-16
	POCP [kg O_3 eq]	2.04E-01	2.84E-02	3.14E-01	1.36E-02
	RPRE [MJ]	5.79E+00	1.06E-01	1.86E-02	1.29E-01
	NRPRE [MJ]	1.22E+02	3.43E+00	1.36E-01	1.96E+00
	FW [m3]	3.11E-02	4.09E-04	4.76E-05	2.61E-04
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.23E+00	0.00E+00	0.00E+00	0.00E+00
	HWD [kg]	1.12E-07	2.78E-08	5.98E-11	8.47E-09
	NHWD [kg]	2.21E-01	1.29E-04	4.28E-05	3.16E+00
	BC [kg CO_2 eq]	3.81E-01			
	HWP [MJ]	1.98E-01			
	FE [MJ]	3.00E+00			
	BE [MJ]	9.76E-02			
	NE [MJ]	7.85E-01			
	OE [MJ]	7.88E-02			

Sto Gold Coat® over CMU

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	8.29E-02	3.58E-03	6.86E-05	2.41E-03
	EP [kg N eq]	2.69E-03	2.92E-04	2.89E-06	4.26E-04
	GWP [kg CO_2 eq]	1.54E+01	6.96E-01	2.43E-02	5.16E-01
	ODP [kg CFC 11 eq]	-4.07E-13	6.61E-17	8.07E-17	1.28E-15
	POCP [kg O_3 eq]	5.87E-01	8.17E-02	9.04E-01	3.91E-02
	RPRE [MJ]	1.67E+01	3.05E-01	5.36E-02	3.70E-01
	NRPRE [MJ]	3.50E+02	9.87E+00	3.92E-01	5.63E+00
	FW [m3]	8.93E-02	1.18E-03	1.37E-04	7.52E-04
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	9.31E+00	0.00E+00	0.00E+00	0.00E+00
	HWD [kg]	3.22E-07	8.00E-08	1.72E-10	2.44E-08
	NHWD [kg]	6.36E-01	3.72E-04	1.23E-04	9.09E+00
	BC [kg CO_2 eq]	1.10E+00			
	HWP [MJ]	5.70E-01			
	FE [MJ]	8.63E+00			
	BE [MJ]	2.81E-01			
	NE [MJ]	2.26E+00			
	OE [MJ]	2.27E-01			

Interpretation

Overall, the Product Stage which includes raw material extraction delivery and product manufacturing are the highest contributors to all impact indicators except POCP where the contribution from application phase is more prominent because of VOC emission.

Reference

- Life Cycle Assessment, LCA report for Sto Corp. WAP Sustainability, September 2019
- PCR for Architectural Coatings: NAICS 325510. NSF International, 2017
- ISO14044:2006 Environmental Management–Life cycle assessment–Requirements and Guidelines.
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
- ISO 21930:2007 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
- Advancing Sustainable Materials Management: 2015 Fact Sheet. US EPA. Available at https://www.epa.gov/sites/production/files/2018-07/documents/2015_smm_msw_factsheet_07242018_fnl_508_002.pdf
- Product Bulletin – Sto Gold Coat. Sto Corp. Available at https://www.stocorp.com/wp-content/content/Products_TechService/Air%20Moisture%20Barriers/Product%20Bulletins/PB_81636_Sto_Gold%20Coat_EN.pdf

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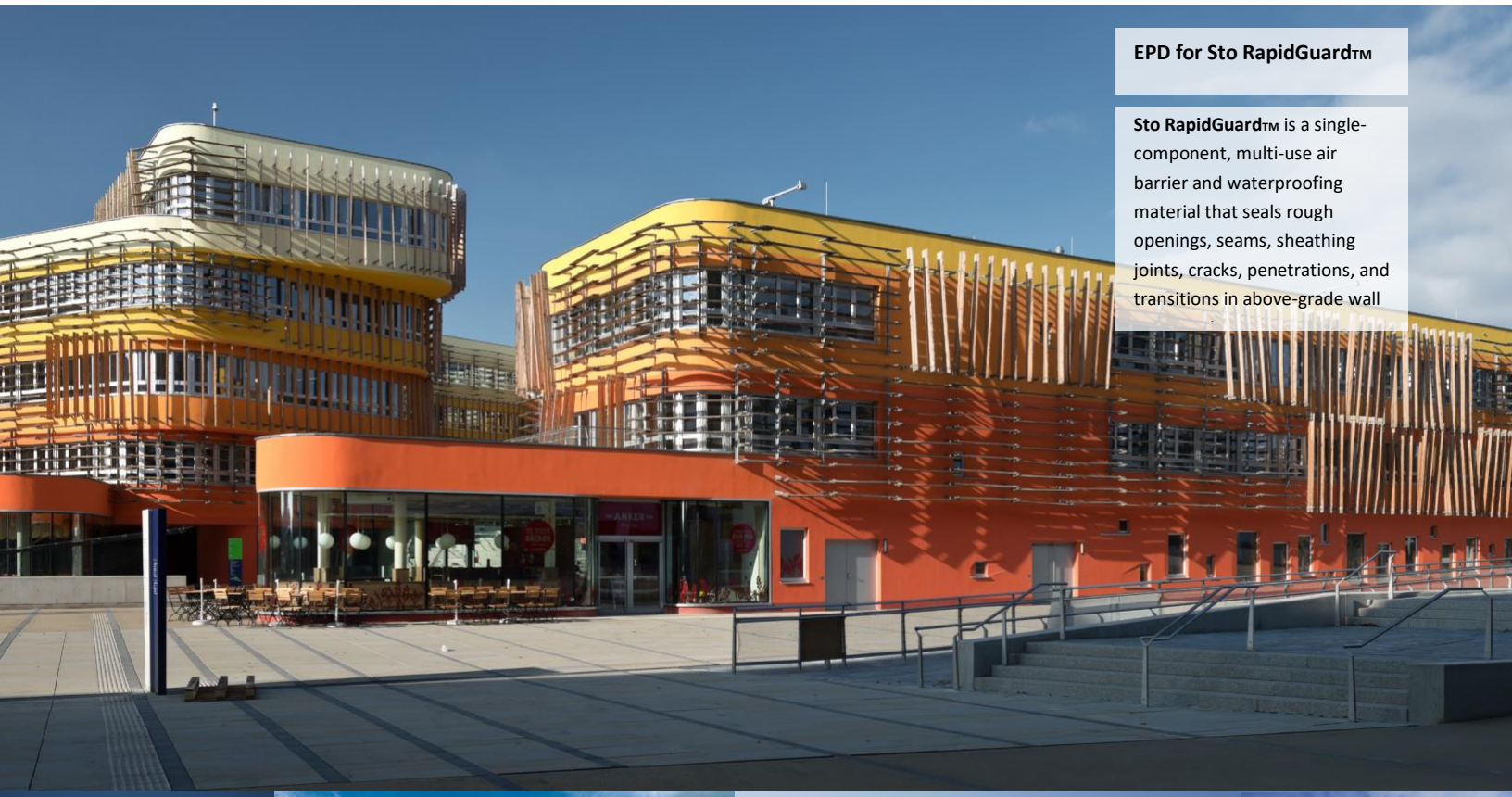
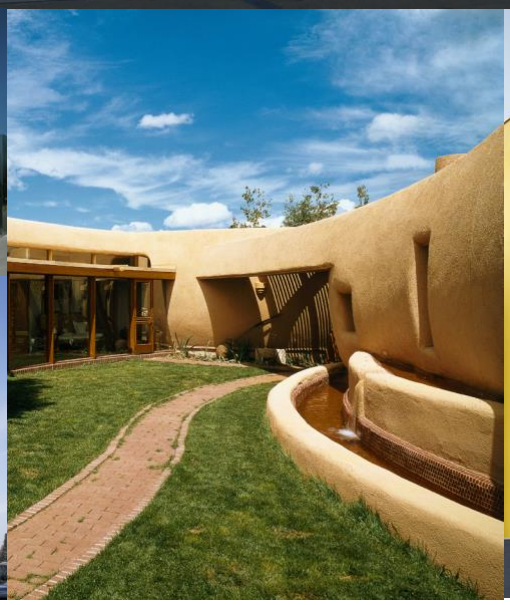


EPD for Sto RapidGuard™

Sto RapidGuard™ is a single-component, multi-use air barrier and waterproofing material that seals rough openings, seams, sheathing joints, cracks, penetrations, and transitions in above-grade wall



epstengroup Environmental Product Declaration

epstengroup Solutions for a Sustainable World

Manufacturer Name	Sto Corp. 3800 Camp Creek Parkway SW, Building 1400, Suite 120, Atlanta, GA 30331 www.stocorp.com | (800) 221-2397
EPD Program Operator	Epsten Group 101 Marietta St. Suite 2600, Atlanta, GA 30303 www.epstengroup.com
Compliance to ISO21930:2017	Yes
Product Name	Sto RapidGuard™
Product's Intended Application and Use	Air Barrier and Waterproofing Membrane
Declaration Number	01-006
Date of Certification	December 18th, 2019
Period of Validity	5 years from date of certification
Functional Unit	One square meter of covered substrate for 60 years
Reference Service Life used in assessment	10 Years
Overall Data Quality Assessment Score	Good
Manufacturing Location	Facility in Guelph, ON, Canada
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database, Service Pack 39
ISO 21930: 2017 serves as the core PCR Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External	Kate McFeaters kmcfeaters@epstengroup.com Kathrine McFeaters
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Kate McFeaters kmcfeaters@epstengroup.com Kathrine McFeaters

Comparability

In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the building level per ISO 21930 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Company

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That means ensuring that all building products are not only safe, effective and easy to install, but also environmentally responsible and sustainable. We know you're always looking for the smartest and newest technology to create energy efficient buildings with superior aesthetics.

That's exactly what our products help you achieve. Products like our wall systems, coatings and finishes are consistent favorites among design professionals, contractors and property owners alike. Whatever your needs or vision may be, we offer products for every type of building project; whether it's new construction, restoration or panelization, commercial or residential work.

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When you combine that commitment to product support and innovation with value-added offerings like consultative design and color services through Sto Studio or training in proper application techniques through the Sto Institute, you get an integrated exterior wall system solution unmatched in the industry.

Manufacturing Sites Covered in this EPD

Manufacturing location is Guelph, ON, Canada

Product Identification

RapidGuard™ is offered in two packaging options. Table 1 lists the products declared in this EPD.

Table 1: List of RapidGuard™ Products

Product Name	Product Number
Sto RapidGuard™ Cartridge	81571-740
Sto RapidGuard™ Sausage	81571-741

Product Description

Sto RapidGuard™ is a single-component, multi-use air barrier and waterproofing material that seals rough openings, seams, sheathing joints, cracks, penetrations, and transitions in above-grade wall construction.

Performance Features

Waterproof Material	No mesh/fabric/tapes needed at rough openings and sheathing joints	Cures in wet weather and on damp substrates
Vapor Permeable	Fast Cure	Gun Applied

Technical Details

Table 2： Technical Data

Performance*	Test Method	Test Criteria	Result
Water Penetration Resistance	AATCC-127 (waster column)	Resist 21.6" (55 cm) water for 5 hours	No water penetration
Tensile Strength	ASTM D412	n/a	250 psi (1724 kPa)
Elongation at Break	ASTM D412	n/a	400%
Durometer Hardness	ASTM D2240	Shore A	40-45 points
Adhesion (psi)	ASTM D4541	>50 psi (345 kPa) or substrate failure: OSB, Plywood, Concrete, CMU, Vinyl, Galvanized Steel, and Gypsum Sheathing	> 50 psi (345 kPa) > 20 psi (138 kPa) to gypsum sheathing (substrate failure)
Water Vapor Permeability (@DFT)	ASTM E96 (wet cup method)	n/a	6.18 perms @ 20 mils (353 ng/s•m^2•Pa) 5.37 perms @ 30 mils (307 ng/s•m^2•Pa)
Air Leakage Resistance	ASTM E2178	Less than 0.02 L/s/m^2	Pass
% Solids by Volume	n/a	n/a	98%
VOC Content	n/a	Compliant with EPA and South Coast AQMD requirements for Building Envelope Coatings	< 21 g/L
Building Code Compliance	Meets requirements of 2015 IBC, IRC, and IECC as an air barrier and joint treatment, ICC AC 212 and ASTM E 2570		

*Results are based on lab testing under controlled conditions. Results can vary between labs or from field tests.

Material Composition

The material composition of RapidGuard™ is listed below:

Table 3: Material composition of RapidGuard™

Ingredient	Mass %
Calcium Carbonate	45-55%
Plasticizers	25-30%
Silane Polymer	17-24%
Colorant	2-3%
Wax	1-2%
Silica	1-2%
Other Additives	<1%

Components related to Life Cycle Assessment

The functional unit for the LCA study was covering 1 square meter (m^2) of substrate for a period of 60 years—the assumed lifetime of a building. The reference flow required for the functional unit is calculated based on the product lifespan scenarios prescribed in ISO 21930:2017. The reference service life of the product is 10 years which is the warranty of Sto's wall system. The reference flow required for one functional unit is provided in Table 4.

Table 4: Reference flow and Functional Unit

Product	Functional Unit [1 m^2]	Reference Flow [kg]
RapidGuard™	1	7.68

Scope and Boundaries of the Life Cycle Assessment

The LCA was performed in accordance with ISO 14040 standards. The study is a cradle-to-grave LCA and includes the following life stages as prescribed in ISO 21930:2017.

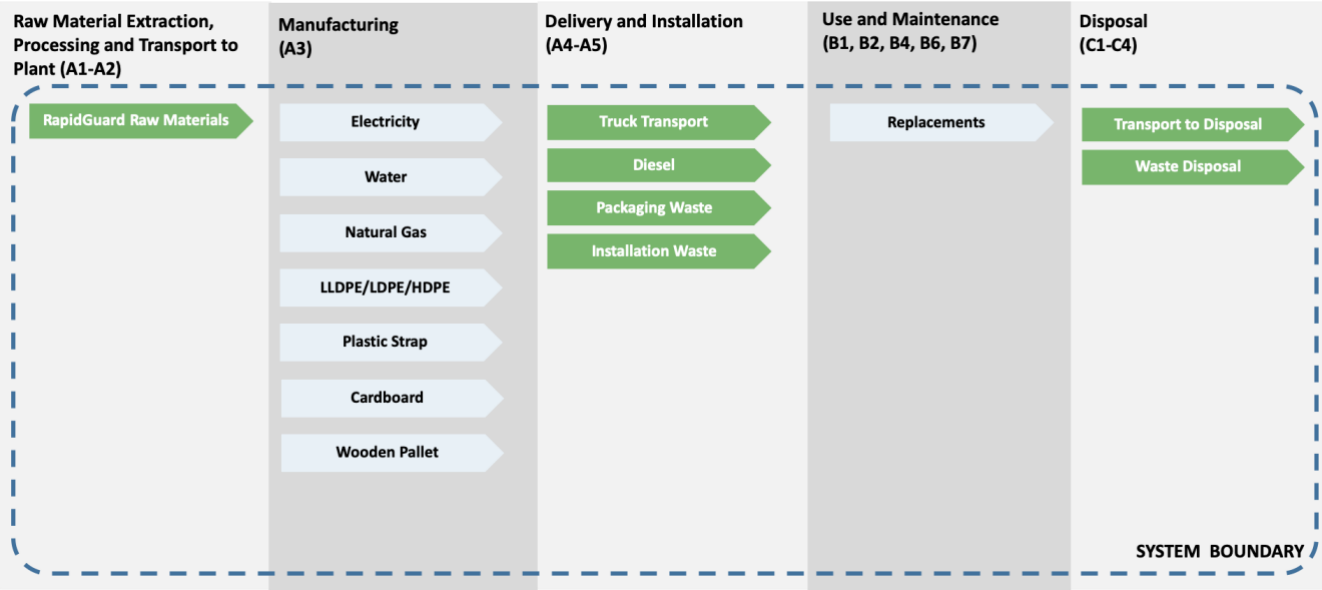


Figure 1: Life stages for the cradle-to-grave LCA

Cut-off Criteria

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

Data Quality

The overall data quality level was determined to be good. Primary data was collected from the manufacturing facility in Guelph, ON in Canada for the 2018 reference year. When primary data did not exist, secondary data were obtained from the Gabi V9.2.0.58 Database Service Pack 39. Overall, both primary and secondary data are considered good quality in terms of geographic, temporal and technological coverage.

Estimates and Assumption

Assumptions were made to represent the cradle-to-grave environmental performance of Sto's products. These assumptions include the transportation distances, the disposal of packaging material and the product at its end of life and use phase assumptions.

Allocation

General principles of allocation were based on ISO 14040/44. Where possible, allocation was avoided. When allocation was necessary it was done on a physical mass basis. To derive a per unit value for manufacturing inputs such as electricity, water, heating oil and natural gas, a series of allocation calculations were adopted. The facility level of utility data was allocated based on production values of different types of products in the same manufacturing facility. Then the data is further allocated among products of different packaging specifications based on the mass because it is believed the energy consumption and water consumption correlated better on a mass basis.

Production Stage (A1-A3)

RapidGuard™ is manufactured in Guelph, ON in Canada. This stage includes an aggregation of raw material extraction, supplier processing, delivery, manufacturing and packaging by the manufacturer. The raw materials used in the production manufacturing are sourced from the USA, Europe and China. After proper homogenization, the product is filled in 29-oz. (0.86-L) cartridges and 20-oz. (0.6-L) sausages ,and then further packaged in cartons and shipped on wooden pallets from Canada to facilities in the US for distribution.

Transport to Construction Site (A4)

RapidGuard™ is assumed to be shipped from the manufacturing facility in Canada to distribution facilities in the US via truck. From the distribution facilities, the product is shipped to construction sites. Table 5 gives the transportation details including the distances and the truck dataset used in the model. Transport distances are calculated based on the locations of the manufacturing facility, the distribution facilities, and customers' zip codes retrieved from the sales records.

Table 5: Transport Details

Parameter	Details	Unit
Type of transport	Truck	-
Fuel type	Diesel	-
Liters of fuel	39.0625	l/100km
Vehicle type	Heavy duty diesel truck/ 45,000 lb payload	-
Transport distance from the manufacturing facility to distribution facilities	1724.17	km
Transport distance from the distribution facilities to construction sites	782.21	km

Installation (A5)

RapidGuard™ is a one-component product without the need for mixing. The product can be applied with a caulking gun and spread with a dry joint knife, trowel or spatula while material is still wet. Detailed installation instructions can be found at Sto's website.

The installation process is manual. Thus, no energy or no material input other than the product is required. The LCA study considered a 10% of product loss in the installation process. Together with the product loss, the waste derived from the packaging material coming with the product are disposed of properly. In addition, the VOC emission from the curing of applied RapidGuard™ was also taken into account.

Table 6: Installation (A5)

Parameter	Value	Unit
Product loss per functional unit	7.68E-01	kg/ESL
Waste materials at the construction site before waste processing, generated by product installation	2.21E+00	kg/ESL
Plastic material recycled	1.77E-01	kg/ESL
Plastic material landfilled	1.47E+00	kg/ESL
Plastic material incinerated	3.02E-01	kg/ESL
Cardboard recycled	1.19E-01	kg/ESL
Cardboard landfilled	4.79E-02	kg/ESL
Cardboard incinerated	1.16E-02	kg/ESL
GWP based in biogenic carbon content of cardboard packaging	6.30E-01	kg CO2e/ESL
Wood material recycled	1.40E-02	kg/ESL
Wood material landfilled	5.85E-02	kg/ESL
Wood material incinerated	1.36E-02	kg/ESL
GWP based in biogenic carbon content of wood packaging	1.55E-01	kg CO2e/ESL
Direct emissions to ambient air	9.43E-02	kg/ESL

» Use Stage (B1-B5 & B6-B7)

Since the product is applied under a wall surface, there are no use phase inputs required to maintain the performance of the product other than the replacement needed through the estimated service life (ESL) of a whole building. The ESL in the study is assumed to be 60 years which is a standard established and used in many PCRs of similar product categories such as architectural coating. The RSL of the product is determined by the warranty of the product, which is ten years. Therefore, after initial installation on a building with a 60-year service life, there will be five replacements needed. Besides the emissions to the air disclosed in the above table, there are no other emissions to air, soil or water, including those of any regulated substances.

Table 7: Replacement (B4)

Parameter	Value	Unit
Reference Service Life (RSL)	10	Years
Estimated Service Life (ESL)	60	Years
Replacement cycle	5	(ESL/RSL)-1
Declared product properties	As per Product Identification section	-
Design application parameters	As per technical details in Table 2	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Industry Standard	-

» End-of-Life Stage (C1-C4)

In this stage, the product at its end of life is transported to the waste disposal facility and processed. Included in this stage are the following:

- Deconstruction – There are no impacts during this stage as the product is manually removed.
- Transportation to disposal – Estimated fuel requirements made based on weight of product and average distance to landfill.
- Waste processing for landfilling — This process is included in the landfilling process.
- Waste disposal — Due to the fact that all the products in study are installed as part of a wall system including the external coating/finish, and are not able to be dismantled based on their material type, it is reasonable to assume that the products at their end-of-life stage are landfilled.

Table 8: End-of-Life Parameters

	RapidGuard™	Unit
Collected with mixed construction waste	6.82	kg/ESL
Landfilling	100	%
Product for final deposition	6.82	kg/ESL

Life Cycle Assessment Results

As prescribed by ISO 21930:2017, TRACI 2.1 impact characterization methodology and IPCC 5th assessment report are adopted to calculate the environment impacts. Table 9 provides the acronym key of the impact indicators declared in this EPD.

Table 9: LCIA impact category and LCI Indicator keys

Abbreviation	Parameter	Unit
	TRACI 2.1	
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg N eq
GWP	Global warming potential including biogenic carbon emission	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg O_3 eq
ADP-Fossil Fuel	Abiotic depletion potential for fossil resources (An indicator derived from CML 2001-Jan 2016)	MJ, net calorific value
	Resource Use Parameters	
RPR_E	Renewable primary energy as energy carrier	MJ, net calorific value
RPR_M	Renewable primary energy resources as material utilization	MJ, net calorific value
$NRPR_E$	Non-renewable primary energy as energy carrier	MJ, net calorific value
$NRPR_M$	Non-renewable primary energy as material utilization	MJ, net calorific value
SM	Use of secondary material	kg
RSF	Use of renewable secondary fuels	MJ, net calorific value
NRSF	Use of non-renewable secondary fuels	MJ, net calorific value
RE	Recovered energy	MJ, net calorific value
FW	Use of fresh water	m^3
	Waste Parameters	
HWD	Disposed-of-hazardous waste	kg
NHWD	Disposed-of non-hazardous waste	kg
HLRW	High-level radioactive waste disposed	kg
ILLRW	Intermediate and low-level radioactive waste disposed	kg
	Carbon Removal and Emission Parameter	
BCRP	Biogenic Carbon Removal from Product	kg CO_2 eq
BCEP	Biogenic Carbon Emission from Product	kg CO_2 eq
BCRK	Biogenic Carbon Removal from Packaging	kg CO_2 eq
BCEK	Biogenic Carbon Emission from Packaging	kg CO_2 eq
BCEW	Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2 eq
CCE	Calcination Carbon Emissions	kg CO_2 eq
CCR	Carbonation Carbon Removals	kg CO_2 eq
CWNR	Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes	kg CO_2 eq

» Sto RapidGuard™ – Results

TRACI Results and ADP-Fossil Fuel

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
AP [kg SO_2 eq]	2.50E-02	1.45E-03	3.19E-04	0.00E+00	0.00E+00	0.00E+00	1.35E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.60E-06	0.00E+00	2.29E-04	MND
EP [kg N eq]	7.68E-04	1.20E-04	9.48E-05	0.00E+00	0.00E+00	0.00E+00	4.97E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.96E-07	0.00E+00	1.17E-05	MND
GWP [kg CO_2 eq]	4.49E+00	3.02E-01	1.64E-01	0.00E+00	0.00E+00	0.00E+00	2.50E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-03	0.00E+00	4.99E-02	MND
ODP [kg CFC 11 eq]	3.13E-13	-1.62E-15	-1.19E-15	0.00E+00	0.00E+00	0.00E+00	1.54E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.47E-17	0.00E+00	-2.62E-15	MND
POCP [kg O_3 eq]	1.94E-01	3.31E-02	2.61E-03	0.00E+00	0.00E+00	0.00E+00	1.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.93E-04	0.00E+00	4.59E-03	MND
ADP-fossil fuel [MJ]	8.28E+01	4.26E+00	3.13E-01	0.00E+00	0.00E+00	0.00E+00	4.41E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.85E-02	0.00E+00	7.77E-01	MND

Resource Use

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ]	1.80E+01	1.33E-01	2.14E-02	0.00E+00	0.00E+00	0.00E+00	9.11E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-03	0.00E+00	6.08E-02	MND
RPR_M [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
$NRPR_E$ [MJ]	8.96E+01	4.29E+00	3.22E-01	0.00E+00	0.00E+00	0.00E+00	4.75E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.87E-02	0.00E+00	7.97E-01	MND
$NRPR_M$ [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
FW [m_3]	3.84E-02	5.14E-04	2.70E-04	0.00E+00	0.00E+00	0.00E+00	1.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.64E-06	0.00E+00	9.46E-05	MND

Waste

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	1.85E-07	3.47E-08	1.11E-09	0.00E+00	0.00E+00	0.00E+00	1.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.14E-10	0.00E+00	2.79E-09	MND
NHWD [kg]	4.63E-01	1.62E-04	3.48E-01	0.00E+00	0.00E+00	0.00E+00	9.75E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-06	0.00E+00	1.14E+00	MND
HLRW [kg]	3.62E-06	1.15E-08	4.38E-09	0.00E+00	0.00E+00	0.00E+00	1.82E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-10	0.00E+00	9.70E-09	MND
ILLRW [kg]	2.70E-03	9.49E-06	3.52E-06	0.00E+00	0.00E+00	0.00E+00	1.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.56E-08	0.00E+00	7.72E-06	MND

Carbon Removal and Emission

Indicator	RapidGuard™
BCRP [kg CO2 eq]	7.80E-01
BCEP [kg CO2 eq]	7.85E-01
BCRK [kg CO2 eq]	1.36E-01
BCEK [kg CO2 eq]	6.26E-02
BCEW [kg CO2 eq]	0.00E+00
CCE [kg CO2 eq]	0.00E+00
CCR [kg CO2 eq]	0.00E+00
CWNR [kg CO2 eq]	0.00E+00

» Interpretation

In one reference service life of the product, the production stage, which includes raw material extraction, transportation from suppliers and manufacturing, is the highest contributor to all impact indicators. The impact from the remaining stages is negligible. From the perspective of a whole building lifespan, the vast majority of the impacts are derived from the number of replacements needed. This is directly related to the impacts associated with the manufacture of new products that are used to replace the original. Improving the relatively short lifespan of the product is essential to reducing the overall impact of the product.

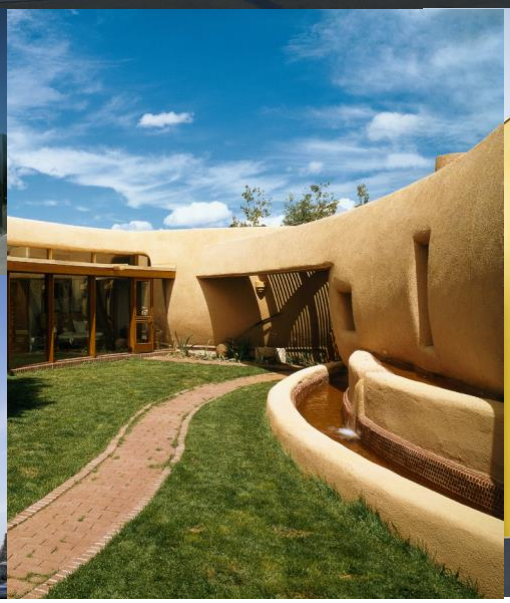
» Reference

- Life Cycle Assessment, LCA report for Sto Corp. WAP Sustainability, October 2019
- ISO14044:2006 Environmental Management–Life cycle assessment–Requirements and Guidelines.
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
- ISO 21930:2007 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
- Sto Studio. Sto Corp, 2019. Available at https://www.stocorp.com/sto-studio-us/
- Installation Guide, Sto RapidGuard. Sto Corp. Available at https://www.stocorp.com/wp-content/content/Systems_TechService/Air%20and%20Moisture%20Barriers/Installation%20and%20Repair/IG_Sto%20RapidGuard%20Installation%20Guide(HiRes).pdf

Building with conscience.

EPD for StoGuard® Transition Membrane

StoGuard® Transition Membrane is a flexible air barrier membrane for use on vertical above grade wall construction over properly prepared concrete, concrete masonry (CMU), glass mat gypsum sheathing and Exterior or Exposure I wood-based sheathing.



epstengroup Environmental Product Declaration

epstengroup Solutions for a Sustainable World

Manufacturer Name	Sto Corp. 3800 Camp Creek Parkway SW, Building 1400, Suite 120, Atlanta, GA 30331 www.stocorp.com | (800) 221-2397
EPD Program Operator	Epsten Group 101 Marietta St. Suite 2600, Atlanta, GA 30303 www.epstengroup.com
Compliance to ISO21930:2017	Yes
Product Name	StoGuard® Transition Membrane
Product's Intended Application and Use	Flexible air barrier membrane
Declaration Number	01-007
Date of Certification	December 18th, 2019
Period of Validity	5 years from date of certification
Functional Unit	One square meter of covered substrate for 60 years
Reference Service Life used in assessment	10 Years
Overall Data Quality Assessment Score	Good
Manufacturing Location	Wörschach, Austria
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database, Service Pack 39
ISO 21930: 2017 serves as the core PCR Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External	Kate McFeaters kmcfeaters@epstengroup.com Kathonie McFeaters
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Kate McFeaters kmcfeaters@epstengroup.com Kathonie McFeaters

Comparability

In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the building level per ISO 21930 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Company

We believe in '**Building with conscience**'.

That means ensuring that all building products are not only safe, effective and easy to install, but also environmentally responsible and sustainable. We know you're always looking for the smartest and newest technology to create energy efficient buildings with superior aesthetics.

That's exactly what our products help you achieve. Products like our wall systems, coatings and finishes are consistent favorites among design professionals, contractors and property owners alike. Whatever your needs or vision may be, we offer products for every type of building project; whether it's new construction, restoration or panelization, commercial or residential work.

An architect or specifier focuses on aesthetics and feasibility, a contractor needs products that are easy to work with, and a building owner requires high value and low costs on properties. Sto understands these unique needs, and delivers the smart, innovative materials and solutions that make this all possible. That's why Sto remains the innovative leader in integrated exterior wall systems.

When you combine that commitment to product support and innovation with value-added offerings like consultative design and color services through Sto Studio or training in proper application techniques through the Sto Institute, you get an integrated exterior wall system solution unmatched in the industry.

Manufacturing Sites Covered in this EPD

Manufacturing location is Wörschach, Austria.

Product Identification

StoGuard® Transition Membrane is offered in five different width options. It is a flexible air barrier membrane for use on vertical above grade wall construction over properly prepared concrete, concrete masonry (CMU), glass mat gypsum sheathing and Exterior or Exposure I wood-based sheathing.Table 1 lists the products declared in this EPD.

Table 1: List of StoGuard® Transition Membrane Products

Product Name	Product #	Width
StoGuard® Transition Membrane	81272	120 mm (4.75")
	81342	152 mm (6")
	81343	228 mm (9")
	81344	304 mm (12")
	81349	457 mm (18")

Product Description

StoGuard® Transition Membrane is applicator-friendly and cost-saving:

- StoGuard® Transition Membrane can be easily applied without the use of special tools or applicator training.
- Thanks to the durability of StoGuard® Transition Membrane, it will not tear or lose effectiveness while in service.
- Because StoGuard® Transition Membrane is a fully adhered product, it will not peel or suffer loss of adhesion along edges.
- StoGuard® Transition Membrane will not stain surfaces due to adhesive leaching or streaking.
- StoGuard® Transition Membrane does not require the use of primers or terminations mastics for proper installation.
- Because StoGuard® Transition Membrane is a flexible material, it can be used in a wide range of applications for both static and dynamic joint conditions. One product solves multiple job site conditions.
- StoGuard® Transition Membrane is compatible with all StoGuard® vapor permeable or vapor impermeable membranes.

Performance Features

Waterproof	Flexible	Fully adhered membrane	No adhesive leaching	Compatible with other StoGuard® products
Fast and easy to install	Durable	UV-resistant	Versatile	Sustainability

Technical Details

Table 2: Technical Data

Performance	Test Method	Test Criteria	Result
Elongation*	ASTM D412	Measure	260%
Tensile Strength*	ASTM D412	Measure	60 psi (.41 MPa)
Tear and Adhesion Properties at 25% Elongation	ASTM C1523	No tearing or loss of adhesion after conditioning	Pass after dry, wet, frozen, and heat aged conditioning
Water Vapor Permeance	ASTM E96		1.48 perms (85 ng/Pa•s•m2)
Air Leakage**	ASTM E2178	≤ 0.02 L/m2•s @ 75 Pa (≤ 0.004 cfm/ft2 @ 1.57 psf)	Passed
Water Column	AATCC 127 (modified)	No leakage for 5 hours miimum	Passed
Adhesion	ASTM D4541	≥ 60 psi (414 kPa)	Passed on plywood, OSB, concrete, and CMU sbustrates. Exceeded strength of glass mat facing attachment when adhered to glass mat gypsum sheathing
Cyclic Elongation	Lab Method	500 cycles at 0% to 50% elongation and return	No loss of continuity of membrane or loss of bond at joint

*Elongation and Tensile strength measured in transverse direction (perpendicular to length of roll).

** Based on extrapolation of similar E2178 test data.

Material Composition

The material composition of StoGuard® Transition Membrane is listed below:

Table 3: Material composition of StoGuard® Transition Membrane

Ingredient	Mass %
Polyester	20-25%
Thermoplastic Elastomer	75-80%
Colorant	0.04%

Components related to Life Cycle Assessment

The functional unit for the EPD was covering 1 square meter (m^2) of substrate for a period of 60 years—the assumed lifetime of a building. The reference flow required for the functional unit is calculated based on the product lifespan scenarios prescribed in ISO 21930:2017. The reference service life of the product is 10 years which is the warranty of Sto's wall system. Because the impacts of the product applied on different substrates differ by more than 10%. The results will be reported separately for application on plywood and CMU, which is respectively the lower and upper band of the amount of installation material. The reference flow required for one functional unit is provided in Table 4.

Table 4: Reference flow and Functional Unit

Substrate	FUnctional Unit [1 m^2]	Product	Reference Flow of product [kg]	Installation Material	Reference Flow of installation material [kg]
Plywood	1	StoGuard® Transition Membrane	2.4	Sto Gold Coat	5.6
CMU					12.06

Scope and Boundaries of the Life Cycle Assessment

The LCA was performed in accordance with ISO 14040 standards. The study is a cradle-to-grave LCA and includes the following life stages as prescribed in ISO 21930:2017.

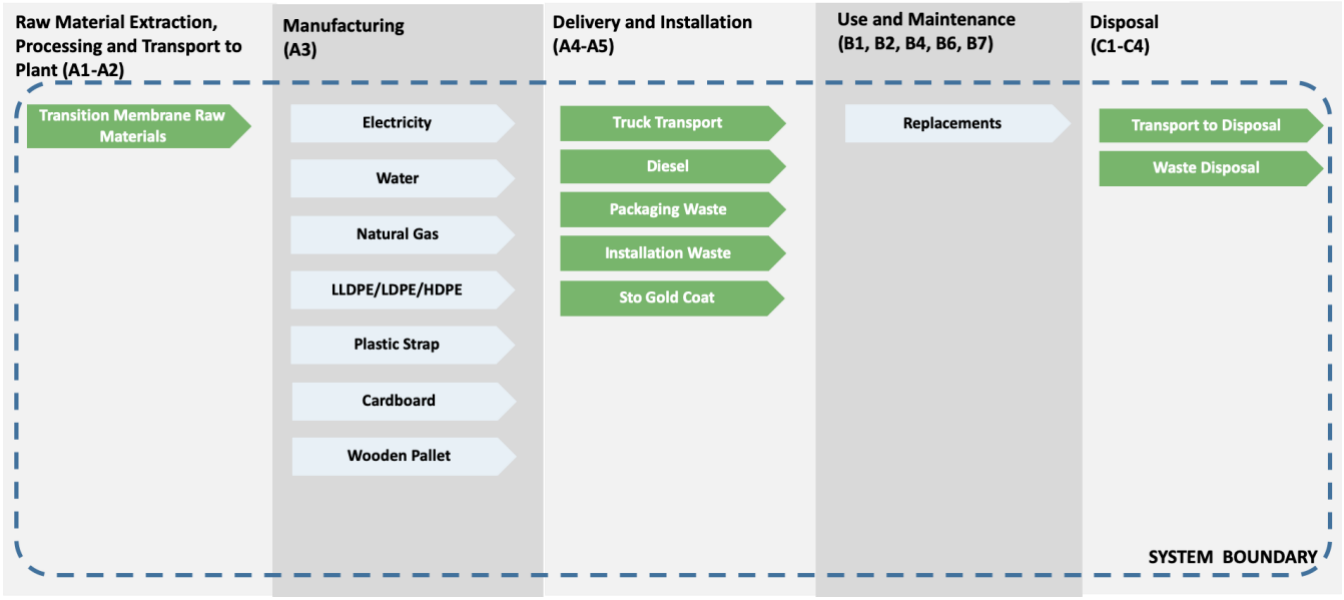


Figure 1: Life stages for the cradle-to-grave LCA

Cut-off Criteria

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

Data Quality

The overall data quality level was determined to be good. Primary data was collected from the manufacturing facility in Wörschach, Austria for the 2018 reference year. When primary data did not exist, secondary data were obtained from the Gabi V9.2.0.58 Database Service Pack 39. Overall, both primary and secondary data are considered acceptable quality in terms of geographic, temporal and technological coverage.

Estimates and Assumption

Assumptions were made to represent the cradle-to-grave environmental performance of Sto's products. These assumptions include up stream and downstream transportation distances, the disposal of packaging material, the method in which the product is disposed of at its end of life and relevant use phase assumptions.

Allocation

General principles of allocation were based on ISO 14040/44. Where possible, allocation was avoided. When allocation was necessary it was done on a physical mass basis. To derive a per unit value for manufacturing inputs such as electricity, water, and natural gas, a series of allocation calculations were adopted. The facility level of utility data was allocated based on production values of different types of products in the same manufacturing facility. Then the data is further allocated among products of different specifications based on the mass because it is believed the energy consumption and water consumption correlated better on a mass basis.

Production Stage (A1-A3)

StoGuard® Transition Membrane is manufactured in Wörschach, Austria. This stage includes an aggregation of raw material extraction, supplier processing, delivery, manufacturing and packaging by the manufacturer.

Transport to Construction Site (A4)

The product is assumed to be shipped from the manufacturing facility to distribution facilities in the US via truck and ocean freight transportation. From the distribution facilities, the product is shipped to construction sites by trucks. Table 5 gives the transportation details including the distances and the truck dataset used in the model. Transport distances are calculated based on the locations of the manufacturing facility, the distribution facilities, and customers' zip codes retrieved from the sales records.

Table 5: Transport Details

Parameter	Truck in US	Ocean Vessel	Truck in EU	Unit
Fuel type	Diesel	Heavy fuel oil	Diesel	-
Liters of fuel	39.0625	0.00023	33.1	l/100km
Vehicle type	Heavy duty diesel truck/ 50,000 lb payload	Container ship, 5,00 to 200, 000 dwt payload capacity, ocean going	Truck-trailer, Euro 0 - 6 mix, 34 - 40t gross weight / 27t payload capacity	-
Transport distance from the manufacturing facility to the departure port	n/a	n/a	441	km
Transport from EU to the USA	n/a	14127.62	n/a	km
Transport from arrival port to distribution facilities	446.59	n/a	n/a	km
Transport distance from the distribution facilities to construction sites	636.45	n/a	n/a	km

Installation (A5)

StoGuard® Transition Membrane is installed with any of the StoGuard® fluid-applied air barrier products: Sto Gold Coat, Sto Emerald Coat, Sto AirSeal or Sto VaporSeal. It also may be installed using Sto Extra Seal cementitious air barrier material. In this EPD, Sto Gold Coat is used as the complementary installation material due to the availability of its LCA data. Detailed application instructions are provided online.

The installation process is manual. Thus no energy or additional material other than the product and Sto Gold Coat is required. The use amount of Sto Gold Coat is calculated based on the coverages on two substrates: plywood and CMU, which give a lower and upper band of the coverage area. The LCA study considered a 10% of product loss as waste in the installation process. Together with the product loss, the waste was is also generated from the packaging material. In addition, VOC emissions from the curing of applied Sto Gold Coat was also taken into account.

Table 6: Installation (A5)

Parameter	Transition Membrane on Plywood	Transition Membrane on CMU	Unit
Product loss per functional unit	0.24		kg/ESL
Waste materials at the construction site before waste processing, generated by product installation	1.10E+00	2.07E+00	kg/ESL
Plastic material recycled	9.65E-02	1.82E-01	kg/ESL
Plastic material landfilled	7.99E-01	1.51E+00	kg/ESL
Plastic material incinerated	1.64E-01	3.10E-01	kg/ESL
Cardboard recycled	2.38E-03		kg/ESL
Cardboard landfilled	9.60E-04		kg/ESL
Cardboard incinerated	2.32E-04		kg/ESL
GWP based in biogenic carbon content of cardboard packaging	2.10E-4		kg CO_2e/ESL
Wood material recycled	2.64E-03		kg/ESL
Wood material landfilled	1.10E-02		kg/ESL
Wood material incinerated	2.56E-03		kg/ESL
GWP based in biogenic carbon content of wood packaging	2.92E-02		kg CO_2e/ESL
Steel material recycled	7.13E-03	1.54E-02	kg/ESL
Steel material landfilled	1.17E-02	2.53E-02	kg/ESL
Steel material incinerated	2.53E-03	5.44E-03	kg/ESL
Direct emissions to ambient air	2.04E-01	3.95E-01	kg/ESL

Use Stage (B1-B5 & B6-B7)

Since the product is applied under a wall surface, there are no use phase inputs required to maintain the performance of the product other than the replacement needed through the estimated service life (ESL) of a whole building. The ESL in the study is assumed to be 60 years which is a standard established and used in many PCRs of similar product categories such as architectural coating. The RSL of the product is determined by the warranty of the product, which is ten years. Therefore, after initial installation on a building with a 60-year service life, there will be five replacements needed. Besides the emissions to the air disclosed in the above table, there are no other emissions to air, soil or water, including those of any regulated substances.

Table 7: Replacement (B4)

Parameter	Value	Unit
Reference Service Life (RSL)	10	Years
Estimated Service Life (ESL)	60	Years
Replacement cycle	5	(ESL/RSL)-1
Declared product properties	As per Product Identification section	-
Design application parameters	As per technical details in Table 2	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Industry Standard	-

End-of-Life Stage (C1-C4)

In this stage, the product at its end of life is transported to the waste disposal facility and processed. Included in this stage are the following:

- Deconstruction – There are no impacts during this stage as the product is manually removed.
- Transportation to disposal – Estimated fuel requirements made based on weight of product and average distance to landfill.
- Waste processing for landfilling — This process is included in the landfilling process.
- Waste disposal — Due to the fact that all the products in study are installed as part of a wall system including the external coating/finish, and are not able to be dismantled based on their material type, it is reasonable to assume that the products at their end-of-life stage are landfilled.

Table 8: End-of-Life Parameters

Parameter	Transition Membrane on Plywood	Transition Membrane on CMU	Unit
Collected with mixed construction waste	6.98	12.6	kg/ESL
Landfilling	100	100	%
Product for final deposition	6.98	12.6	kg/ESL

Life Cycle Assessment Results

As prescribed by ISO 21930:2017, TRACI 2.1 impact characterization methodology and IPCC 5th assessment report are adopted to calculate the environment impacts. Table 9 provides the acronym key of the impact indicators declared in this EPD.

Table 9: LCIA impact category and LCI Indicator keys

Abbreviation	Parameter	Unit
	TRACI 2.1	
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg N eq
GWP	Global warming potential including biogenic carbon emission	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg O_3 eq
ADP-Fossil Fuel	Abiotic depletion potential for fossil resources (An indicator derived from CML 2001-Jan 2016)	MJ, net calorific value
	Resource Use Parameters	
RPR_E	Renewable primary energy as energy carrier	MJ, net calorific value
RPR_M	Renewable primary energy resources as material utilization	MJ, net calorific value
$NRPR_E$	Non-renewable primary energy as energy carrier	MJ, net calorific value
$NRPR_M$	Non-renewable primary energy as material utilization	MJ, net calorific value
SM	Use of secondary material	kg
RSF	Use of renewable secondary fuels	MJ, net calorific value
NRSF	Use of non-renewable secondary fuels	MJ, net calorific value
RE	Recovered energy	MJ, net calorific value
FW	Use of fresh water	m^3
	Waste Parameters	
HWD	Disposed-of-hazardous waste	kg
NHWD	Disposed-of non-hazardous waste	kg
HLRW	High-level radioactive waste disposed	kg
ILLRW	Intermediate and low-level radioactive waste disposed	kg
	Carbon Removal and Emission Parameter	
BCRP	Biogenic Carbon Removal from Product	kg CO_2 eq
BCEP	Biogenic Carbon Emission from Product	kg CO_2 eq
BCRK	Biogenic Carbon Removal from Packaging	kg CO_2 eq
BCEK	Biogenic Carbon Emission from Packaging	kg CO_2 eq
BCEW	Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2 eq
CCE	Calcination Carbon Emissions	kg CO_2 eq
CCR	Carbonation Carbon Removals	kg CO_2 eq
CWNR	Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes	kg CO_2 eq

StoGuard® Transition Membrane on Plywood -- Results

TRACI Results

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
AP [kg SO_2 eq]	1.75E-03	1.69E-03	9.76E-03	0.00E+00	0.00E+00	0.00E+00	6.73E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.54E-06	0.00E+00	2.54E-04	MND
EP [kg N eq]	1.71E-04	6.90E-05	3.44E-04	0.00E+00	0.00E+00	0.00E+00	2.99E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.83E-07	0.00E+00	1.30E-05	MND
GWP [kg CO_2 eq]	1.17E+00	9.20E-02	1.96E+00	0.00E+00	0.00E+00	0.00E+00	1.64E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-03	0.00E+00	5.53E-02	MND
ODP [kg CFC 11 eq]	-1.52E-13	-3.88E-16	1.74E-11	0.00E+00	0.00E+00	0.00E+00	8.62E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.63E-17	0.00E+00	-2.91E-15	MND
POCP [kg O_3 eq]	3.17E-02	3.38E-02	7.11E-02	0.00E+00	0.00E+00	0.00E+00	7.09E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-04	0.00E+00	5.09E-03	MND
ADP-fossil fuel [MJ]	3.18E+01	1.20E+00	3.81E+01	0.00E+00	0.00E+00	0.00E+00	3.60E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.27E-02	0.00E+00	8.62E-01	MND

Resource Use

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ]	3.00E+00	2.55E-02	1.74E+00	0.00E+00	0.00E+00	0.00E+00	2.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-03	0.00E+00	6.74E-02	MND
RPR_M [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
$NRPR_E$ [MJ]	3.33E+01	1.21E+00	4.09E+01	0.00E+00	0.00E+00	0.00E+00	3.82E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.29E-02	0.00E+00	8.84E-01	MND
$NRPR_M$ [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
FW [m_3]	4.74E-03	7.57E-05	1.06E-02	0.00E+00	0.00E+00	0.00E+00	7.74E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.15E-06	0.00E+00	1.05E-04	MND

Waste

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	2.54E-08	1.22E-08	3.95E-08	0.00E+00	0.00E+00	0.00E+00	4.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-10	0.00E+00	3.10E-09	MND
NHWD [kg]	1.18E-02	3.43E-05	2.61E-01	0.00E+00	0.00E+00	0.00E+00	7.68E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-06	0.00E+00	1.26E+00	MND
HLRW [kg]	7.91E-07	2.76E-09	1.30E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-10	0.00E+00	1.08E-08	MND
ILLRW [kg]	5.92E-04	2.06E-06	1.08E-03	0.00E+00	0.00E+00	0.00E+00	8.43E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.50E-08	0.00E+00	8.56E-06	MND

StoGuard® Transition Membrane on CMU – Results

TRACI Results

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
AP [kg SO_2 eq]	1.75E-03	1.69E-03	1.89E-02	0.00E+00	0.00E+00	0.00E+00	1.14E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-05	0.00E+00	4.24E-04	MND
EP [kg N eq]	1.71E-04	6.90E-05	6.56E-04	0.00E+00	0.00E+00	0.00E+00	4.60E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-06	0.00E+00	2.16E-05	MND
GWP [kg CO_2 eq]	1.17E+00	9.20E-02	3.77E+00	0.00E+00	0.00E+00	0.00E+00	2.57E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.04E-03	0.00E+00	9.23E-02	MND
ODP [kg CFC 11 eq]	-1.52E-13	-3.88E-16	3.37E-11	0.00E+00	0.00E+00	0.00E+00	1.68E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.72E-17	0.00E+00	-4.85E-15	MND
POCP [kg O_3 eq]	3.17E-02	3.38E-02	1.37E-01	0.00E+00	0.00E+00	0.00E+00	1.06E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.57E-04	0.00E+00	8.49E-03	MND
ADP-fossil fuel [MJ]	3.18E+01	1.20E+00	7.38E+01	0.00E+00	0.00E+00	0.00E+00	5.42E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.12E-02	0.00E+00	1.44E+00	MND

Resource Use

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ]	3.00E+00	2.55E-02	3.36E+00	0.00E+00	0.00E+00	0.00E+00	3.25E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.22E-03	0.00E+00	1.13E-01	MND
RPR_M [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
$NRPR_E$ [MJ]	3.33E+01	1.21E+00	7.91E+01	0.00E+00	0.00E+00	0.00E+00	5.76E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.16E-02	0.00E+00	1.48E+00	MND
$NRPR_M$ [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
FW [m_3]	4.74E-03	7.57E-05	2.04E-02	0.00E+00	0.00E+00	0.00E+00	1.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.59E-06	0.00E+00	1.75E-04	MND

Waste

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	2.54E-08	1.22E-08	7.64E-08	0.00E+00	0.00E+00	0.00E+00	5.99E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.81E-10	0.00E+00	5.17E-09	MND
NHWD [kg]	1.18E-02	3.43E-05	4.65E-01	0.00E+00	0.00E+00	0.00E+00	1.29E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-06	0.00E+00	2.11E+00	MND
HLRW [kg]	7.91E-07	2.76E-09	2.51E-06	0.00E+00	0.00E+00	0.00E+00	1.66E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.91E-10	0.00E+00	1.80E-08	MND
ILLRW [kg]	5.92E-04	2.06E-06	2.10E-03	0.00E+00	0.00E+00	0.00E+00	1.35E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-07	0.00E+00	1.43E-05	MND

Carbon removal and Emission

Indicator	Tranisition Membrane on plywood	Transition Membrane on CMU
BCRP [kg CO2 eq]	5.86E-02	6.10E-02
BCEP [kg CO2 eq]	5.95E-02	6.13E-02
BCRK [kg CO2 eq]	5.51E-03	5.96E-03
BCEK [kg CO2 eq]	2.05E-03	2.37E-03
BCEW [kg CO2 eq]	0.00E+00	0.00E+00
CCE [kg CO2 eq]	0.00E+00	0.00E+00
CCR [kg CO2 eq]	0.00E+00	0.00E+00
CWNR [kg CO2 eq]	0.00E+00	0.00E+00

Interpretation

In one reference service life of the product, the stage that contributes the most enviornmental impact is the installation stage. Unlike many products, the impact derived from the production of the declared product is exceeded by those from the installation of Sto Transition Membrane. This also explains the significant differences in impacts between substrate types. From the perspective of a whole building lifespan, the vast majority of the impacts are derived from the number of replacements needed. This is directly related to the impacts associated with the manufacture of new installation material and new products that are used to replace the original. Improving the relatively short lifespan of the products is essential to reducing the overall impact of the product.

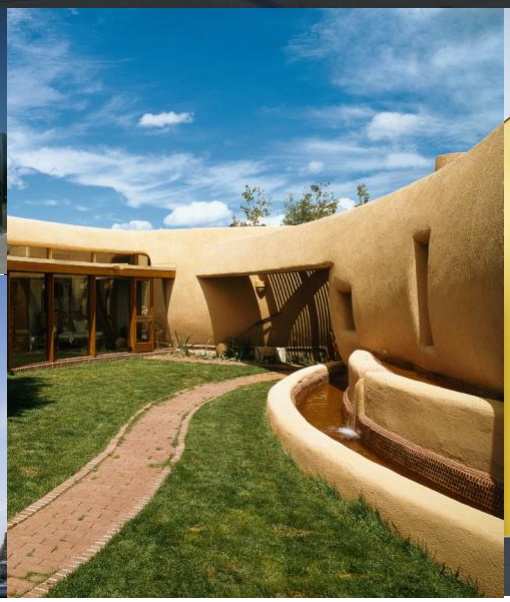
Reference

- Life Cycle Assessment, LCA report for Sto Corp. WAP Sustainability, October 2019
- ISO14044:2006Environmental Management–Life cycle assessment–Requirements and Guidelines.
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
- ISO 21930:2007 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
- Sto Studio. Sto Corp, 2019. Available at https://www.stocorp.com/sto-studio-us/
- Product Bulletin – StoGuard Transition Membrane. Sto Corp. Available at https://www.stocorp.com/wp-content/content/Products_TechService/Air%20Moisture%20Barriers/Product%20Bulletins/PB_81272_StoGuard_Transition_Membrane_EN.pdf

Building with conscience.

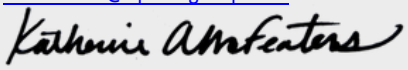
EPD for BTS® Plus

Sto BTS® Plus is a one-component, polymer-modified, cement based, dry powder material used as an adhesive and base coat in Sto Wall Claddings, including StoTherm ci Classic and StoTherm ci Lotusan Systems.



epstengroup Environmental Product Declaration

epstengroup Solutions for a Sustainable World

PCR Identification	PCR for Architectural Coatings: NAICS 325510 on the basis of ISO 21930:2007, NSF International, 2017. Valid through June 23, 2022
Compliance to ISO 14040/44, ISO 14025 and ISO 21930	Yes
Product Category	Exterior Coating
Manufacturer's name	Sto Corp. 3800 Camp Creek Parkway SW, Building 1400, Suite 120 Atlanta, GA 30331 www.stocorp.com | (800) 221-2397
EPD program operator	Epsten Group 101 Marietta St. Suite 2600, Atlanta, GA 30303 www.epstengroup.com
Declaration Number	01-004
Date of Certification	December 18th, 2019
Period of Validity	5 years from date of certification
Functional Unit	One square meter of covered and protected substrate for 60 years
Market-base life used in assessment	10 Years
Design life used in assessment	N/A
Test method employed for determination of design life	N/A
Amount of colorant needed	See table 3
Overall Data Quality Assessment Score	Good
Site(s) in which the results of the LCA are representative	STO manufacturing sites in Atlanta, Georgia; and Glendale, Arizona.
Information on where explanatory material can be obtained	See references at the end of this document.
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database Version 8.7, Service Pack 39
This declaration was independently verified in accordance with ISO 14025: 2006 and the reference PCR: PCR for Architectural Coatings: NAICS 325510 ☐ Internal ☒ External	Kate McFeaters kmcfeaters@epstengroup.com 
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14040/44 and the reference PCR by:	Kate McFeaters kmcfeaters@epstengroup.com 

Comparability

In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the building level per ISO 21930 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Company

We believe in '**Building with conscience**'.

That means ensuring that all building products are not only safe, effective and easy to install, but also environmentally responsible and sustainable. We know you're always looking for the smartest and newest technology to create energy efficient buildings with superior aesthetics.

That's exactly what our products help you achieve. Products like our wall systems, coatings and finishes are consistent favorites among design professionals, contractors and property owners alike. Whatever your needs or vision may be, we offer products for every type of building project; whether it's new construction, restoration or panelization, commercial or residential work.

An architect or specifier focuses on aesthetics and feasibility, a contractor needs products that are easy to work with, and a building owner requires high value and low costs on properties. Sto understands these unique needs, and delivers the smart, innovative materials and solutions that make this all possible. That's why Sto remains the innovative leader in integrated exterior wall systems.

When you combine that commitment to product support and innovation with value-added offerings like consultative design and color services through Sto Studio or training in proper application techniques through the Sto Institute, you get an integrated exterior wall system solution unmatched in the industry.

Manufacturing Sites Covered in this EPD

Atlanta Plant

Glendale Plant

Product Identification

Sto BTS® Plus is offered in 47-lb bags and used as an undercoater. Thus, there are no finish or color base options provided.

Table 1: BTS® Plus Identification

Product Name	Product Number	Base Type	Finish Type
Sto BTS® Plus	80130	n/a	n/a

Product Description

Sto BTS® Plus is a one-component, polymer-modified, cement based, dry powder material used as an adhesive, skim coat and base coat in Sto Wall Claddings, including StoTherm ci Classic and StoTherm ci Lotusan Systems. According to the classification scheme developed by American Coating Association (ACA), BTS® Plus is treated in the study as an undercoater and as per PCR, it should only utilize the market-based lifetime (10 years for exterior undercoater).

Performance Features

One-component	High Polymer/ Cement Ratio	Vapor Permeable	Pre-blended
Polymer Modified	Creamy Smooth Consistency	High Build	Low Cement Ratio

Material Composition

The material compositions of BTS® Plus are listed below:

Table 2: Material composition for BTS® Plus

Ingredient	BTS® Plus
Additives	0-1%
Cement	40-45%
Colorant	0-1%
Polymer	2-3%
Silica	54-55%
Silicate	0-1%

Components related to Life Cycle Assessment

The functional unit for the LCA study was covering and protecting 1 square meter (m2) of substrate for a period of 60 years—the assumed lifetime of a building. The reference flow required for the functional unit is calculated based on the product lifespan scenarios prescribed in the PCR. The market-based lifetime is 10 years. By default, BTS® Plus has a 5-year warranty. In case it is applied on Sto's wall systems, the warranty is extended to 10 years. The reference flow required for one functional unit is provided in Table 3.

Table 3: Market-based lifetime and reference flow

	Functional Unit [1 m^2]	Reference Flow [kg]	Tint needed* [kg]
Lifespan		Market-based Lifetime [10 years]	
BTS® Plus – Adhesive over Rough Masonry	1	40.39	N/A
BTS® Plus – Average		14.12	N/A

Scope and Boundaries of the Life Cycle Assessment

The LCA was performed in accordance with ISO 14040 standards. The study is a cradle-to-grave LCA and includes the following life stages as prescribed in the PCR.

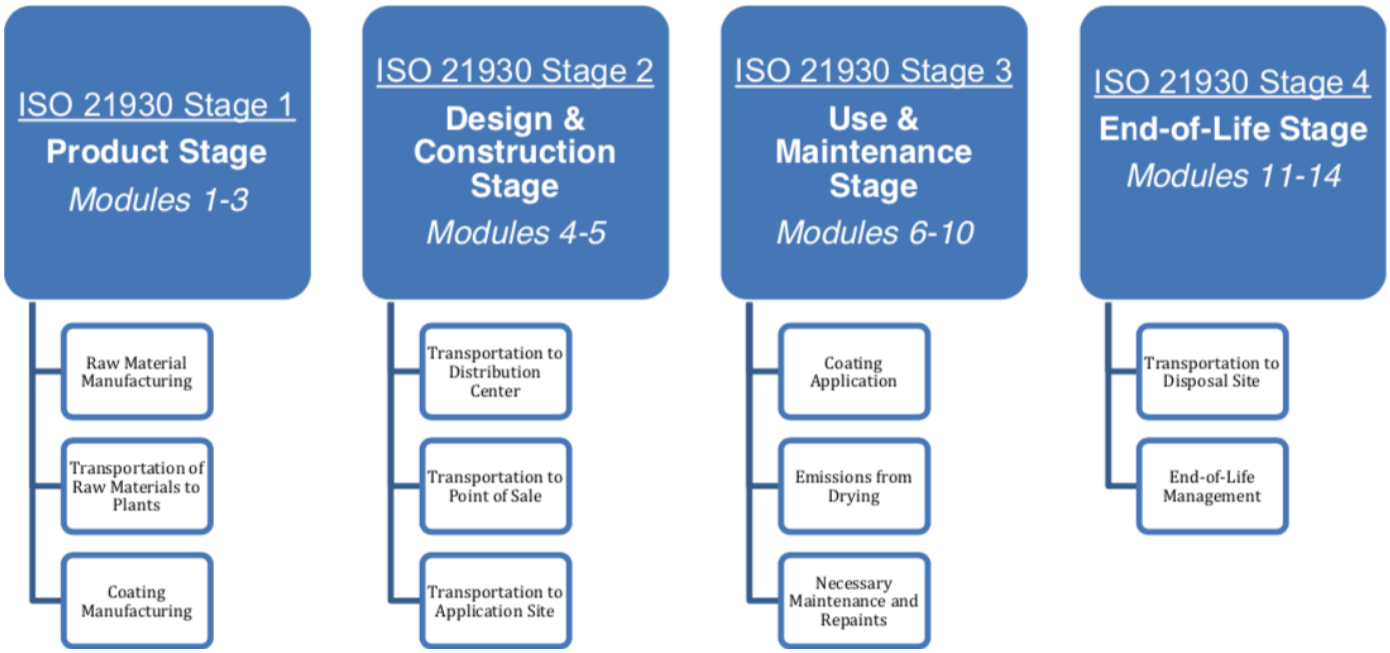


Figure 1: Life stages for the cradle-to-grave LCA

Cut-off Criteria

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

Data Quality

The overall data quality level was determined to be good. Primary data was collected from Sto's facilities in Atlanta, GA, and Glendale, AZ for the 2018 reference year. When primary data did not exist, secondary data were obtained from the Gabi V8.7 Database Service Pack 39. Overall, both primary and secondary data are considered good quality in terms of geographic, temporal and technological coverage.

Estimates and Assumption

Assumptions were made to represent the cradle-to-grave environmental performance of Sto's products. These assumptions were made in accordance with the PCR and include the transportation distances, the disposal of packaging material and the product at its end of life and use phase assumptions.

Allocation

General principles of allocation were based on ISO 14040/44. Where possible, allocation was avoided. When allocation was necessary it was done on a physical mass basis.

Product Stage

BTS® Plus is a dry-powder product. It is manufactured in both the Atlanta, GA and Glendale, AZ facilities. The facility in Atlanta also supplies BTS® concentrate to Glendale facility, based on which BTS® Plus is produced. BTS® Plus is packaged in a paper bag at 47 pounds (21.3 kgs) per bag. This stage includes an aggregation of raw material extraction, supplier processing, delivery, manufacturing and packaging by Sto.

Design and Construction Stage

The design and construction process stage starts with the packaged product leaving the production site and ends with being delivered to the application site.

During this stage, the finished product is moved from a shipping dock for distribution. The end gate is the application site after the purchaser acquires the finished product and transports it to the application site.

Use and Maintenance Stage

The use stage begins when the user prepares the product before applying it to a substrate and ends with any leftover coating and discarded packaging entering the end-of-life stage. Detailed application instructions are provided online. The application procedure includes mixing and applying. In the mixing process, BTS® Plus requires the addition of water at an average rate of 5.45 kg of water per 21.3-kg bag. As recommended, an electric drill/mixer and a spray pump are assumed to be used for mixing and application. The equipment is not included in the study as these are multi-use tools and the impacts per declared unit is considered negligible, but electricity to power application tools has been included.

As prescribed in the PCR, 10% of the wet mass of BTS® Plus is assumed to be unused and properly disposed of.

End-of-Life Stage

Table 4: End-of_life Disposal Scenarios

Waste Flow	Recycling	Incineration	Landfilling
Paper Packaging	66.6%	6.01%	27.39%
Unused Product	0%	0%	100%
Post-Consumer Product	0%	0%	100%

In this stage, the disposal of installation waste, packaging waste and product waste at its end of life is included. The disposal pathway of each waste stream is modeled based on the recommendation of PCR and US EPA's latest waste management fact sheet.

Life Cycle Assessment Results

As prescribed by the PCR, TRACI 2.1 impact characterization methodology and IPCC 5th assessment report are adopted to calculate the environment impacts. Table 5 provides the acronym key of the impact indicators declared in this EPD.

Table 5: LCIA impact category and LCI Indicator keys

Abbreviation	Parameter	Unit
	TRACI 2.1	
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg N eq
GWP	Global warming potential including biogenic carbon emission	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg O_3 eq
	Resource Use Parameters	
RPR	Use of renewable primary energy	MJ, net calorific value (LHV)
RMR	Use of renewable Material Resources	kg
NRER	Depletion of Non-Renewable Energy Resources	MJ, net calorific value
NRMR	Depletion of Non-Renewable Material Resources	kg
FW	Consumption of Freshwater	m^3
	Waste Parameters	
HWD	Disposed-of-hazardous waste	kg
NHWD	Disposed-of non-hazardous waste	kg
	Biogenic Carbon Parameter	
BC	Biogenic Carbon	kg CO_2 eq
	Energy Differentiation Parameters	
HWP	Hydro/wind Power	MJ, net calorific value (LHV)
FE	Fossil Energy	MJ, net calorific value (LHV)
BE	Bio-energy	MJ, net calorific value (LHV)
NE	Nuclear Energy	MJ, net calorific value (LHV)
OE	Other Energy	MJ, net calorific value (LHV)

BTS® Plus – Adhesive over Rough Masonry

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	8.90E-02	1.56E-02	6.73E-04	1.07E-02
	EP [kg N eq]	9.00E-03	1.27E-03	3.03E-05	1.52E-03
	GWP [kg CO_2 eq]	3.86E+01	3.04E+00	2.42E-01	1.94E+00
	ODP [kg CFC 11 eq]	3.82E-12	2.89E-16	8.03E-16	6.57E-15
	POCP [kg O_3 eq]	1.61E+00	3.57E-01	5.67E-03	1.79E-01
	RPRE [MJ]	4.35E+01	1.33E+00	5.23E-01	2.22E+00
	NRPRE [MJ]	4.64E+02	4.30E+01	3.85E+00	2.99E+01
	FW [m3]	1.09E-01	5.13E-03	1.18E-02	3.47E-03
	RMR [kg]	2.05E-01	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	4.04E+01	0.00E+00	0.00E+00	0.00E+00
	HWD [kg]	7.01E-07	3.49E-07	1.73E-09	1.11E-07
	NHWD [kg]	4.33E+00	1.62E-03	3.30E-03	4.09E+01
	BC [kg CO_2 eq]	4.21E+00			
	HWP [MJ]	2.67E+00			
	FE [MJ]	3.97E+01			
	BE [MJ]	1.29E+00			
	NE [MJ]	1.04E+01			
	OE [MJ]	1.04E+00			

BTS® Plus – Average Substrate

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	3.11E-02	5.46E-03	2.35E-04	3.73E-03
	EP [kg N eq]	3.15E-03	4.45E-04	1.06E-05	5.30E-04
	GWP [kg CO_2 eq]	1.35E+01	1.06E+00	8.44E-02	6.78E-01
	ODP [kg CFC 11 eq]	1.34E-12	1.01E-16	2.81E-16	2.30E-15
	POCP [kg O_3 eq]	5.62E-01	1.25E-01	1.98E-03	6.26E-02
	RPRE [MJ]	1.52E+01	4.66E-01	1.83E-01	7.74E-01
	NRPRE [MJ]	1.62E+02	1.51E+01	1.35E+00	1.04E+01
	FW [m3]	3.82E-02	1.79E-03	4.12E-03	1.21E-03
	RMR [kg]	7.16E-02	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.41E+01	0.00E+00	0.00E+00	0.00E+00
	HWD [kg]	2.45E-07	1.22E-07	6.07E-10	3.88E-08
	NHWD [kg]	1.51E+00	5.68E-04	1.15E-03	1.43E+01
	BC [kg CO_2 eq]	1.47E+00			
	HWP [MJ]	9.34E-01			
	FE [MJ]	1.39E+01			
	BE [MJ]	4.51E-01			
	NE [MJ]	3.64E+00			
	OE [MJ]	3.65E-01			

Interpretation

Overall, the Product Stage is the major contributor to many impact categories including GWP. This is understandable as cement is a major ingredient of BTS® Plus and it is an energy-intensive material.

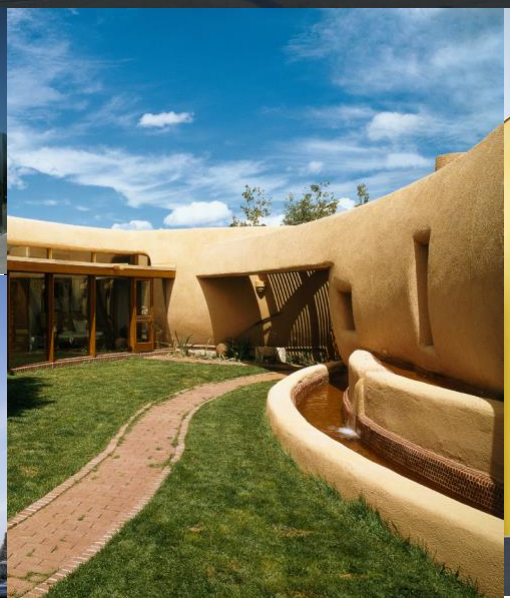
Reference

- Life Cycle Assessment, LCA report for Sto Corp. WAP Sustainability, September 2019
- PCR for Architectural Coatings: NAICS 325510. NSF International, 2017
- ISO14044:2006 Environmental Management–Life cycle assessment–Requirements and Guidelines.
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
- ISO 21930:2007 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
- Advancing Sustainable Materials Management: 2015 Fact Sheet. US EPA. Available at https://www.epa.gov/sites/production/files/2018-07/documents/2015_smm_msw_factsheet_07242018_fnl_508_002.pdf
- Product Bulletin – Sto BTS® Plus. Sto Corp. Available at https://www.stocorp.com/wp-content/content/Products_TechService/Base%20Coats%20and%20Adhesives/Product%20Bulletins/PB_80727_Sto_BTS_Plus_EN.pdf

Building with conscience.

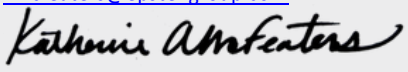
EPD for Sto TurboStick®

Sto TurboStick®
Sto TurboStick® is a ready-to-use, single component polyurethane foam adhesive for installing Sto insulation boards in StoTherm® exterior wall claddings.
Compared to cementitious adhesives, Sto TurboStick delivers unparalleled convenience and installation



epstengroup Environmental Product Declaration

epstengroup
Solutions for a Sustainable World

Manufacturer Name	Sto Corp. 3800 Camp Creek Parkway SW, Building 1400, Suite 120, Atlanta, GA 30331 www.stocorp.com | (800) 221-2397
EPD Program Operator	Epsten Group 101 Marietta St. Suite 2600, Atlanta, GA 30303 www.epstengroup.com
Compliance to ISO21930:2017	Yes
Product Name	Sto TurboStick®
Product's Intended Application and Use	Foam adhesive for securing insulation boards
Declaration Number	01-008
Date of Certification	December 18th, 2019
Period of Validity	5 years from date of certification
Functional Unit	One square meter of covered substrate for 60 years
Reference Service Life used in assessment	10 Years
Overall Data Quality Assessment Score	Good
Manufacturing Location	Wilmington, IL, USA
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database, Service Pack 39
ISO 21930: 2017 serves as the core PCR Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External	Kate McFeaters kmcfeaters@epstengroup.com 
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Kate McFeaters kmcfeaters@epstengroup.com 

Comparability

In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the building level per ISO 21930 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Company

We believe in '**Building with conscience**'.

That means ensuring that all building products are not only safe, effective and easy to install, but also environmentally responsible and sustainable. We know you're always looking for the smartest and newest technology to create energy efficient buildings with superior aesthetics.

That's exactly what our products help you achieve. Products like our wall systems, coatings and finishes are consistent favorites among design professionals, contractors and property owners alike. Whatever your needs or vision may be, we offer products for every type of building project; whether it's new construction, restoration or panelization, commercial or residential work.

An architect or specifier focuses on aesthetics and feasibility, a contractor needs products that are easy to work with, and a building owner requires high value and low costs on properties. Sto understands these unique needs, and delivers the smart, innovative materials and solutions that make this all possible. That's why Sto remains the innovative leader in integrated exterior wall systems.

When you combine that commitment to product support and innovation with value-added offerings like consultative design and color services through Sto Studio or training in proper application techniques through the Sto Institute, you get an integrated exterior wall system solution unmatched in the industry.

Manufacturing Sites Covered in this EPD

Manufacturing location is Wilmington, IL, USA.

Product Identification

Sto TurboStick® is offered in a 31-lb gross weight pressurized cylinder. Sto TurboStick® is a ready-to-use, single component polyurethane foam adhesive for securing Sto EPS Insulation Boards in StoTherm exterior wall claddings including StoTherm® ci XPS.

Table 1: List of TurboStick® Products

Product Name	Product Number
Sto TurboStick®	81181

Product Description

The leader in innovation, Sto offers an entirely new PU-foam adhesive system that outperforms traditional adhesives across the board. Sto TurboStick® requires no mixing, goes on easier, cures in just one hour, and can even be used for other applications, such as filling voids between insulation boards. It is also lightweight, so it requires no heavy lifting to get it up the scaffolding like cementitious adhesives.

- Ready-to-apply: Go straight to the wall as there is no mixing required compared to traditional cementitious adhesives;
- Cures in one hour: Rasp, cut joints and apply basecoat and mesh the same day instead of waiting until the following day;
- Small packaging: Easier to handle the material on scaffolding. Requires less space on the ground for staging compared to bag material; and
- Lightweight: The product weighs significantly less than a bag of basecoat. In addition, its compact size makes it easier to carry and handle, for example on scaffolding.

Performance Features

Convenient and Ready-to-Use	Pre-pressurized Container	Minimal preparation time
Compact and Lightweight High coverage rate	Fast	VOC Compliant

Technical Details

Table 2: Technical Data*

Performance	Test Method	Test Criteria	Result
Surface Burning	ASTM E-84-10 (UL 723, UBC 8-1, NFPA 255)	Flame Spread: ≤25 Smoke Developed: ≤450	Flame Spread: 10 Smoke Developed: 5
Tensile Strength	ASTM C-297	Greater than 15 psi	> 15 psi; cohesive failure of EPS insulation board
VOC (g/L)	This product contains no VOC's. Complies with US EPA (40 CFR 59) VOC emission standards for architectural coatings.		

*Results are based on lab testing under controlled conditions. Results can vary between labs or from field tests.

Material Composition

The material composition of TurboStick® is listed below:

Table 3: Material composition of TurboStick®

	TurboStick®
Polymethylenepolyphenl polyisocyanate, polypropyleneglycol copolymer	30-60%
1,1,1,2-Tetrafluoroethane	10-30%
Diphenylmethane Diisocyanate, isomers and homologues	10-30%
4,4'-Diphenylmethane diisocyanate	7-13%
N,N'-Dimorpholinodiethylether	1-5%

Components related to Life Cycle Assessment

The functional unit for the EPD was covering 1 square meter (m^2) of substrate for a period of 60 years—the assumed lifetime of a building. The reference flow required for the functional unit is calculated based on the product lifespan scenarios prescribed in ISO 21930:2017. The reference service life of the product is 10 years which is the warranty of Sto's wall system. The reference flow required for one functional unit is provided in Table 4.

Table 4: Reference flow and Functional Unit

Product	Functional Unit [1 m^2]	Reference Flow [kg]
TurboStick®	1	0.81

Scope and Boundaries of the Life Cycle Assessment

The LCA was performed in accordance with ISO 14040 standards. The study is a cradle-to-grave LCA and includes the following life stages as prescribed in ISO 21930:2017.

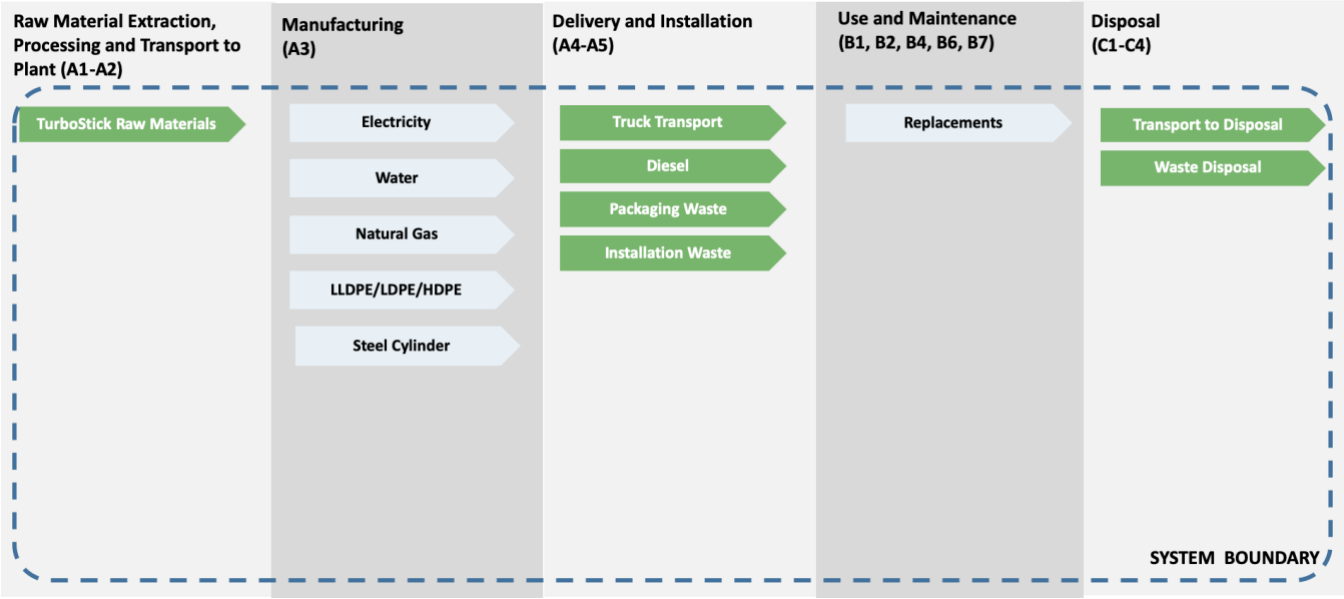


Figure 1: Life stages for the cradle-to-grave LCA

Cut-off Criteria

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

Data Quality

The overall data quality level was determined to be good. Primary data was collected from the manufacturing facility in Illinois, USA for the 2018 reference year. When primary data did not exist, secondary data were obtained from the Gabi V9.2.0.58 Database Service Pack 39. Overall, both primary and secondary data are considered acceptable quality in terms of geographic, temporal and technological coverage.

Estimates and Assumption

Assumptions were made to represent the cradle-to-grave environmental performance of Sto's products. These assumptions include up stream and downstream transportation distances, the disposal of packaging material, the method in which the product is disposed of at its end of life and relevant use phase assumptions.

Allocation

General principles of allocation were based on ISO 14040/44. Where possible, allocation was avoided. When allocation was necessary it was done on a physical mass basis. To derive a per unit value for manufacturing inputs such as electricity, water, and natural gas, a series of allocation calculations were adopted. The facility level of utility data was allocated based on production values of different types of products in the same manufacturing facility. Then the data is further allocated among products of different specifications based on the mass because it is believed the energy consumption and water consumption correlated better on a mass basis.

Production Stage (A1-A3)

TurboStick® is manufactured in Illinois, US. All the raw materials are supplied from the US. The product is a mixture of four types of substances: polyols, isocyanates, catalysts, and blowing agent, filled and shipped in a steel cylinder.

Transport to Construction Site (A4)

The product is assumed to be shipped from the manufacturing facility to distribution facilities in the US via truck. From the distribution facilities, the product is shipped to construction sites. Table 5 gives the transportation details including the distances and the truck dataset used in the model. Transport distances are calculated based on the locations of the manufacturing facility, the distribution facilities, and customers' zip codes retrieved from the sales records.

Table 5: Transport Details

Name	Details	Unit
Type of transport	Truck	-
Fuel type	Diesel	-
Liters of fuel	39.0625	l/100km
Vehicle type	Heavy duty diesel truck/ 45,000 lb payload	-
Transport distance from the manufacturing facility to distribution facilities	1437.95	km
Transport distance from the distribution facilities to construction sites	880.69	km

Installation (A5)

TurboStick® can be applied directly from the cylinder through a dispensing pistol without any additional steps. Hence, no specific installation materials are required. The reference flow is calculated on the basis of the coverage rates on TurboStick®'s product data sheets and a 10% installation waste was considered to account for the possibility of some unused amount left in the product containers. The disposal of the pressure cylinder is modeled to be landfilled as it is a standard practice to deal with pressure cylinder potentially containing unused adhesive polymer, while the installation waste disposal is modeled in accordance with EPA's Advancing Sustainable Materials Management: 2015 Fact Sheet. For TurboStick® which uses HFC-134a as the blowing agent, HFC-134a is modeled as the VOC emission flow. As the tools (dispensing pistol) used during the installation of the product are multi-use tools and can be reused after each installation, the per-functional unit impacts are considered negligible and therefore are not included. Detailed installation instructions are provided online. Packaging waste is generated and disposed of in this stage.

Table 6: Installation (A5)

Name	Value	Unit
Product loss per functional unit	8.09E-02	kg/ ESL
Waste materials at the construction site before waste processing, generated by product installation	0.362	kg/ ESL
Steel waste, packaging	0.281	kg/ ESL
VOC Emissions	0.154	Kg/ESL

Use Stage (B1-B5 & B6-B7)

Since the product is installed as part of the wall assembly, there are no use phase inputs required to maintain the product. The RSL of the product is 10 years, so five replacements are required to cover the estimated service life (ESL). The product requires no maintenance once installed. It is assumed that the product requires no repairs or refurbishments if it is properly applied. Besides the emissions to the air disclosed in the above table, there are no other emissions to air, soil or water, including those of any regulated substances.

Table 7: Replacement (B4)

Name	Value	Unit
Reference Service Life (RSL)	10	Years
Estimated Service Life (ESL)	60	Years
Replacement cycle	5	(ESL/RSL)-1
Declared product properties	As per Product Identification section	-
Design application parameters	As per technical details in Table 2	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Industry Standard	-

End-of-Life Stage (C1-C4)

In this stage, the product is transported to the waste disposal facility and processed. Due to the fact that TurboStick® is applied as part of a wall system including the external coating/finish and are not able to be dismantled based on their material type, it is reasonable to assume that the products at their end-of-life stage are landfilled.

Table 8: End-of-Life Parameters

	TurboStick®	Unit
Collected with mixed construction waste	0.574	kg/ESL
Landfilling	100	%
Product for final deposition	0.574	kg/ESL

Life Cycle Assessment Results

As prescribed by ISO 21930:2017, TRACI 2.1 impact characterization methodology and IPCC 5th assessment report are adopted to calculate the environment impacts. Table 9 provides the acronym key of the impact indicators declared in this EPD.

Table 9: LCIA impact category and LCI Indicator keys

Abbreviation	Parameter	Unit
	TRACI 2.1	
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg N eq
GWP	Global warming potential including biogenic carbon emission	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg O_3 eq
ADP-Fossil Fuel	Abiotic depletion potential for fossil resources (An indicator derived from CML 2001-Jan 2016)	MJ, net calorific value
	Resource Use Parameters	
RPR_E	Renewable primary energy as energy carrier	MJ, net calorific value
RPR_M	Renewable primary energy resources as material utilization	MJ, net calorific value
$NRPR_E$	Non-renewable primary energy as energy carrier	MJ, net calorific value
$NRPR_M$	Non-renewable primary energy as material utilization	MJ, net calorific value
SM	Use of secondary material	kg
RSF	Use of renewable secondary fuels	MJ, net calorific value
NRSF	Use of non-renewable secondary fuels	MJ, net calorific value
RE	Recovered energy	MJ, net calorific value
FW	Use of fresh water	m^3
	Waste Parameters	
HWD	Disposed-of-hazardous waste	kg
NHWD	Disposed-of non-hazardous waste	kg
HLRW	High-level radioactive waste disposed	kg
ILLRW	Intermediate and low-level radioactive waste disposed	kg
	Carbon Removal and Emission Parameter	
BCRP	Biogenic Carbon Removal from Product	kg CO_2 eq
BCEP	Biogenic Carbon Emission from Product	kg CO_2 eq
BCRK	Biogenic Carbon Removal from Packaging	kg CO_2 eq
BCEK	Biogenic Carbon Emission from Packaging	kg CO_2 eq
BCEW	Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2 eq
CCE	Calcination Carbon Emissions	kg CO_2 eq
CCR	Carbonation Carbon Removals	kg CO_2 eq
CWNR	Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes	kg CO_2 eq

Sto TurboStick® -- Results

TRACI Results and ADP-Fossil

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
AP [kg SO_2 eq]	2.54E-03	1.60E-04	2.43E-05	0.00E+00	0.00E+00	0.00E+00	1.37E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.44E-07	0.00E+00	1.98E-05	MND
EP [kg N eq]	1.89E-04	1.32E-05	5.09E-06	0.00E+00	0.00E+00	0.00E+00	1.04E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.88E-08	0.00E+00	1.01E-06	MND
GWP [kg CO_2 eq]	1.23E+00	3.34E-02	3.30E+01	0.00E+00	0.00E+00	0.00E+00	1.71E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-04	0.00E+00	4.31E-03	MND
ODP [kg CFC 11 eq]	1.30E-08	-1.80E-16	-1.58E-16	0.00E+00	0.00E+00	0.00E+00	6.48E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.27E-18	0.00E+00	-2.27E-16	MND
POCP [kg O_3 eq]	3.82E-02	3.66E-03	3.23E-04	0.00E+00	0.00E+00	0.00E+00	2.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-05	0.00E+00	3.97E-04	MND
ADP-fossil fuel [MJ]	1.72E+01	4.71E-01	5.24E-02	0.00E+00	0.00E+00	0.00E+00	8.88E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.33E-03	0.00E+00	6.72E-02	MND

Resource Use

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ]	5.53E-01	1.47E-02	3.60E-03	0.00E+00	0.00E+00	0.00E+00	2.88E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-04	0.00E+00	5.26E-03	MND
RPR_M [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
$NRPR_E$ [MJ]	1.80E+01	4.74E-01	5.36E-02	0.00E+00	0.00E+00	0.00E+00	9.28E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.35E-03	0.00E+00	6.89E-02	MND
$NRPR_M$ [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
FW [m_3]	4.94E-03	5.68E-05	1.54E-05	0.00E+00	0.00E+00	0.00E+00	2.51E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.01E-07	0.00E+00	8.18E-06	MND

Waste

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	2.25E-07	3.84E-09	2.24E-10	0.00E+00	0.00E+00	0.00E+00	1.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.71E-11	0.00E+00	2.42E-10	MND
NHWD [kg]	5.21E-02	1.79E-05	6.09E-02	0.00E+00	0.00E+00	0.00E+00	1.06E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-07	0.00E+00	9.86E-02	MND
HLRW [kg]	3.60E-07	1.27E-09	5.93E-10	0.00E+00	0.00E+00	0.00E+00	1.82E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.94E-12	0.00E+00	8.39E-10	MND
ILLRW [kg]	3.00E-04	1.05E-06	4.74E-07	0.00E+00	0.00E+00	0.00E+00	1.51E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-09	0.00E+00	6.67E-07	MND

Carbon Removal and Emission

Indicator	TurboStick®
BCRP [kg CO2 eq]	1.16E-02
BCEP [kg CO2 eq]	1.70E-02
BCRK [kg CO2 eq]	1.38E-03
BCEK [kg CO2 eq]	1.41E-03
BCEW [kg CO2 eq]	0.00E+00
CCE [kg CO2 eq]	0.00E+00
CCR [kg CO2 eq]	0.00E+00
CWNR [kg CO2 eq]	0.00E+00

Interpretation

In one reference service life of the product, the production stage, which includes the raw material extraction, transportation from suppliers and manufacturing, is the highest contributor to all impact indicators with the exception of GWP. The GWP impacts from the installation stage are dominant because of the remarkably high GWP intensity of the blowing agent. From the perspective of a whole building lifespan, the vast majority of the impacts are derived from the number of replacements needed. This is directly related to the impacts associated with the manufacture of new products that are used to replace the original. Improving the relatively short lifespan of the products is essential to reducing the overall impact of the product.

Reference

- Life Cycle Assessment, LCA report for Sto Corp. WAP Sustainability, October 2019
- ISO14044:2006 Environmental Management–Life cycle assessment–Requirements and Guidelines.
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
- ISO 21930:2007 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
- Sto Studio. Sto Corp, 2019. Available at https://www.stocorp.com/sto-studio-us/
- Product Bulletin – Sto TurboStick. Sto Corp. Available at https://www.stocorp.com/wp-content/content/Products_TechService/Base%20Coats%20and%20Adhesives/Product%20Bulletins/PB_81181_Sto_Turbostick_EN.pdf

Environmental Product Declaration

FOAMULAR® 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. It uses a decision framework for managing the company as a sustainable enterprise. It is the foundation of the company's strategy of building market-leading businesses, global in scope – human in scale, and reflects the company's purpose: our people and products make the world a better place.

Owens Corning is committed to balancing economic growth with social progress and sustainable solutions to its building materials and composite customers around the world.

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

sustainability.owenscorning.com

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

FOAMULAR® XPS Insulation

According to ISO 14025,
EN 15804 and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfingsten Road Northbrook, IL 60611 https://www.ul.com/ https://spot.ul.com/
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.4 July 2018
MANUFACTURER NAME AND ADDRESS	Owens Corning, One Owens Corning Parkway, Toledo, OH, USA
DECLARATION NUMBER	4788721182.101.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	1 m^2 insulation at R_{SI}-1
REFERENCE PCR AND VERSION NUMBER	Part B: Building Envelope Thermal Insulation EPD Requirements, UL 10010-1
DESCRIPTION OF PRODUCT APPLICATION/USE	FOAMULAR® XPS is a type of rigid foam board insulation used in a variety of building applications, both residential and commercial, requiring the use of thermal
PRODUCT RSL DESCRIPTION (IF APPL.)	75 years
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	January 1, 2019
PERIOD OF VALIDITY	5 Years
EPD TYPE	Product-specific
RANGE OF DATASET VARIABILITY	Product-specific
EPD SCOPE	Cradle to gate with options (A4, A5, B1, C1-C4)
YEAR(S) OF REPORTED PRIMARY DATA	2017
LCA SOFTWARE & VERSION NUMBER	SimaPro 8.5.2.0
LCI DATABASE(S) & VERSION NUMBER	ecoinvent 3.4
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1 v1.04; Cumulative Energy Demand (CED) V1.10

This PCR Review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria Thomas P. Gloria, Industrial Ecology Consultants

LIMITATIONS

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; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

FOAMULAR® XPS Insulation

According to ISO 14025,
EN 15804 and ISO 21930:2017

1. Product Definition and Information

1.1. Description of Company/Organization

Founded in 1938, Owens Corning has been a leader in insulation, roofing and fiberglass composites. It has a global presence with 19,000 people in 37 countries. This Environmental Product Declaration is representative of product produced at the locations listed below.

Tallmadge Plant Tallmadge, OH 44278	Rockford Plant Rockford, IL 61109	Gresham Plant Gresham, OR 97080	Valleyfield Plant Valleyfield, QC, Canada J65 0A7	Monterrey Plant Santa Catarina, Nuevo Leon 66350, Mexico

1.2. Product Description

Product Identification

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 has third-party certified recycled content - certified by SCS Global Services - and, in addition to the only XPS foam that is GREENGUARD Gold certified, offers the 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.owenscorningcommercial.com*

Product Specification

	FOAMULAR® 150	FOAMULAR® 250	FOAMULAR® 400	FOAMULAR® 600	FOAMULAR® 1000
ASTM C578 Classification	Type X	Type IV	Type VI	Type VII	Type V
Compressive resistance at yield or 10 % deformation, whichever occurs first min, psi	15	25	40	60	100
Density, min, lb/ft^3	1.3	1.55	1.8	2.2	3
Thermal resistance of 1.00-in. thickness, min, hr·ft^2·°F/Btu Mean temperature: 75°F ± 2°F	5	5	5	5	5
Flexural strength, min, psi	40	50	60	75	100
Water vapor permeance of 1.00-in. thickness, max, perm	1.5	1.5	1.1	1.1	1.1
Water absorption by total immersion, max, volume	0.3	0.3	0.3	0.3	0.3

Product Average

The results of this declaration represent an average performance for the listed products and manufacturing locations. Reported densities for included products and production locations were taken from quality control data to create a production-BDFT-weighted average, which was used to determine the mass of the functional unit for the LCA.

1.3. Application

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, residing, foundation, under slab, commercial walls, commercial roofing, plaza decks and under roads.

1.4. Declaration of Methodological Framework

This declaration is a product-specific EPD and is cradle-to-installation with end-of-life. The underlying LCA upon which this EPD is based included the following life cycle modules: *Raw Material supply* (A1); *Inbound Transportation* (A2); *Manufacturing* (A3); *Distribution* (A4); *Installation* (A5); *Use* (B1); *End-of-life, Transport* (C2) and *End-of-life, Disposal* (C4). No known flows have been deliberately excluded. The product is expected to perform as claimed for the 75-year reference service life.

1.5. Technical Requirements

FOAMULAR® XPS Insulation boards are manufactured at minimum densities of 1.30, 1.45, 1.80, 2.20, and 3.00 lb/ft^3 and have ASTM C578 designations of Type X, Type IV, Type VI, Type VII, and Type V respectively.

1.6. Properties of Declared Product as Delivered

FOAMULAR® XPS Insulation meets the performance requirements of ASTM C578 and CAN/ULC-S701. When installed in typical building and construction assemblies according to all applicable Owens Corning specifications, recommendations and guidelines, FOAMULAR® XPS Insulation retains at least 90% of its advertised R-value.*

1.7. Material Composition

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, a brominated polymeric flame retardant, and colorant. Each of these minor components is less than 1% by mass of the total material composition.

Material Component	Material Component%
Additives	<1%
Blowing Agent	5% - 15%
Colorant	<1%
Flame retardant	<1%
Polystyrene (recycled)	<30%
Polystyrene (virgin)	65% - 75%

**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.owenscorningcommercial.com*

1.8. Manufacturing

Manufacturing Locations

Owens Corning North American manufacturing locations can be found across the United States, Canada and Mexico. Primary data from these five manufacturing facilities were used for the underlying life cycle assessment. Results provided in this declaration are based on a BDFT-weighted average production of these five manufacturing facilities.

Tallmadge Plant Tallmadge, OH 44278	Rockford Plant Rockford, IL 61109	Gresham Plant Gresham, OR 97080	Valleyfield Plant Valleyfield, QC, Canada J65 0A7	Monterrey Plant Santa Catarina, Nuevo Leon 66350, Mexico

Manufacturing Process

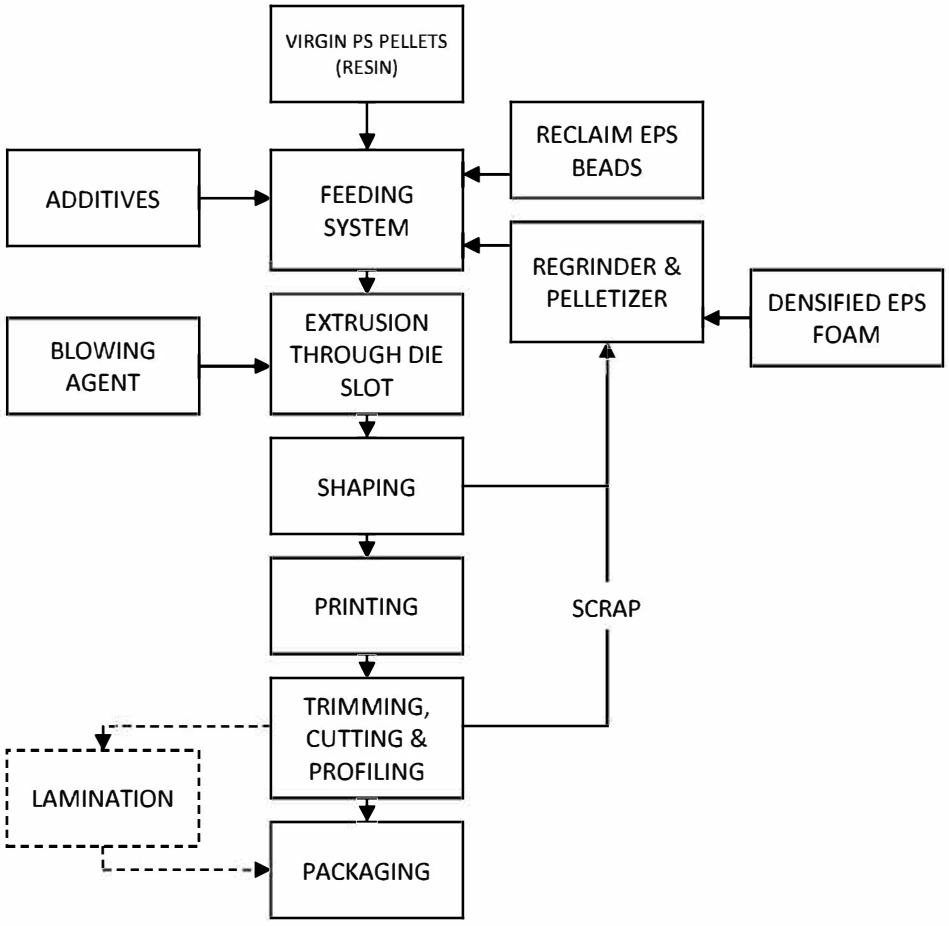


Figure 1. Process Flow Diagram for Manufacturing of XPS Insulation

The diagram above for FOAMULAR® XPS Insulation is representative of the processes used among the manufacturing facilities. Although minor differences exist due to the availability of specific suppliers for materials, there are no significant process differences among manufacturing locations.

1.9. Packaging

FOAMULAR® XPS Insulation is packaged and shipped in units (typically 3,072 board-feet per unit) with two stretch-wrap bands per bundle. Regional disposal scenarios for the U.S. and Canada were used as a default assumption for the packaging waste generated during installation. Disposal rates used by material type and waste treatment method are shown in the table below.

Country/Region	Material Type	Recycling Rate	Landfill Rate	Incineration Rate
Canada	Plastics	78%	22%	0%
	Other materials	20%	80%	0%
United States	Plastics	15%	68%	17%
	Metals	57%	34%	9%
	Pulp (cardboard, paper)	75%	20%	5%

1.10. Transportation

The product outbound transportation from manufacturing facility is by diesel-truck. The average distance from manufacturing facility to construction site is 1,194 km.

1.11. Product 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

1.12. Use

Due to its nature, FOAMULAR® XPS Insulation is a passive device requiring no utilities or maintenance over its useful life. 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.

1.13. Reference Service Life and Estimated Building Service Life

The product is assumed to remain in service for the life of the building, 75 years.

1.14. Reuse, Recycling, and Energy Recovery

FOAMULAR® XPS insulation may be reused. Although recycling programs do not currently exist for XPS insulation, energy content from the material may be recovered.

1.15. Disposal

The End of Life stage modeled for XPS insulation consisted of the transportation by tractor-trailer truck of the foam for an assumed distance of 100 miles to a landfill and the subsequent disposal of the used XPS insulation in the landfill including releases to air of all remaining, residual blowing agents.

2. Life Cycle Assessment Background Information

2.1. Function and Functional Unit

The functional unit is 1 m^2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W and with a building service life of 75 years. FOAMULAR® Insulating Sheathing and FOAMULAR® PROPink® additionally have 1 m^2 of a laminate material on each side of the XPS insulation material. For laminate materials, the declared unit amount is 1 m^2, and the amount of the declared unit required for the functional unit is 2 m^2.

Table 1. Functional Unit Properties of FOAMULAR® XPS insulation

	FOAMULAR® XPS Insulation
Functional unit	1 m^2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W
Mass of Functional unit	7.77E-01 kg
Thickness to achieve Functional unit	2.88E-02 m

Table 2. Declared Unit Properties of Laminate Addons for FOAMULAR® INSULATING SHEATHING and FOAMULAR® PROPINK®

	Laminate Addon for FOAMULAR® Insulating Sheathing
Declared unit	1 m^2 of Laminate Addon
Mass of Declared unit	3.51E-02 kg
Amount of Declared unit to achieve Functional unit	2 m^2
	Laminate Addon for FOAMULAR® PROPINK®
Declared unit	1 m^2 of Laminate Addon
Mass of Declared unit	8.71E-02 kg
Amount of Declared unit to achieve Functional unit	2 m^2

2.2. System Boundary

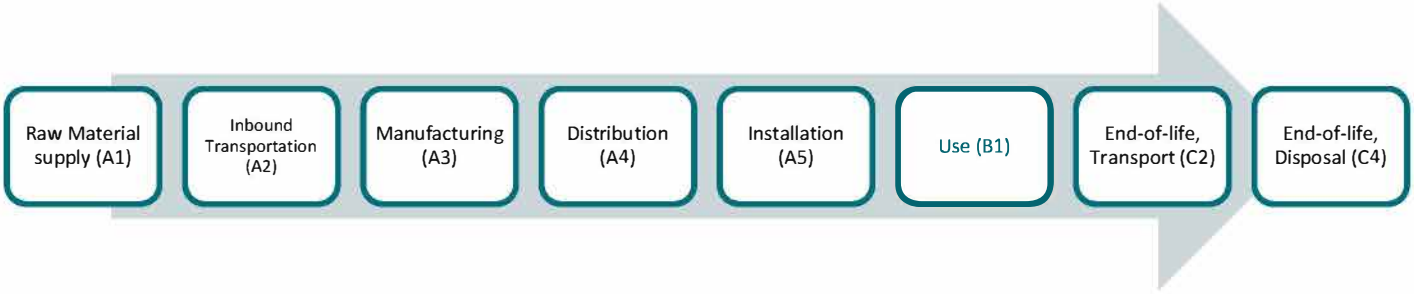


Figure 2. System Boundary of FOAMULAR® XPS Insulation

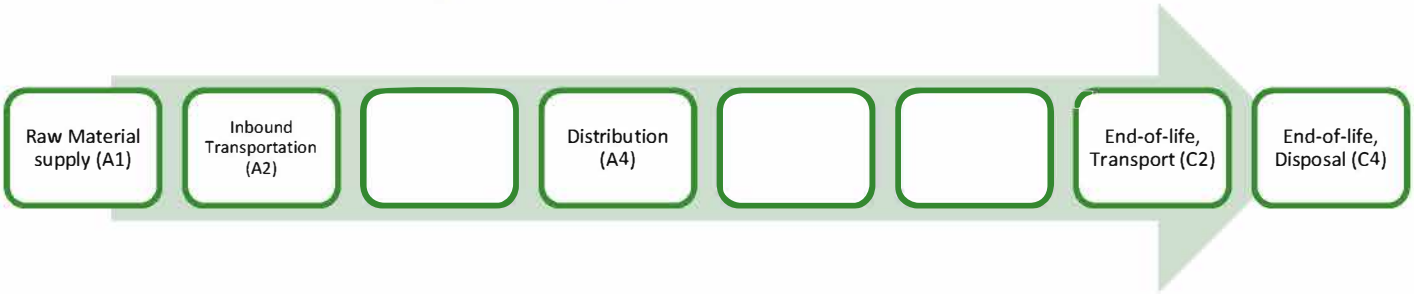


Figure 3. System Boundary of Laminate Addons for FOAMULAR® Insulating Sheathing FOAMULAR® PROPink®

The system boundaries for this study include inputs and outputs for the following life cycle stages for XPS foam insulation:

- Raw Material supply (A1) – *applicable to* FOAMULAR® XPS Insulation and Laminate Addons
  - 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
- Inbound Transportation (A2) – *applicable to* FOAMULAR® XPS Insulation and Laminate Addons
  - transportation of all input materials to manufacturing facilities
- Manufacturing (A3) – *applicable to* FOAMULAR® XPS Insulation
  - electricity, natural gas combustion and LPG combustion (consumption and associated emissions)
  - water usage
  - blowing agent emissions from the trimming, cutting and profiling of the XPS boards as well as from the regrinding process and curing process and other releases to environmental media[1]
- Distribution (A4) – *applicable to* FOAMULAR® XPS Insulation and Laminate Addons
  - transportation from manufacturing facilities to distribution centers
  - transportation from distribution centers to construction site
- Installation (A5) – *applicable to* FOAMULAR® XPS Insulation
  - transportation and disposal of packaging waste
- Use (B1) – *applicable to* FOAMULAR® XPS Insulation
  - blowing agent emissions during distribution and installation of XPS insulation and its diffusion from the XPS insulation board over 75-year reference service life
- End-of-life, Transport (C2) – *applicable to* FOAMULAR® XPS Insulation and Laminate Addons

[1] All manufacturing waste (i.e., scrap and trim) is recycled internally; there is no manufacturing waste to landfill from the manufacturing process.

- transportation from building deconstruction site to landfill
- End-of-life, Disposal (C4) – *applicable to* FOAMULAR® XPS Insulation and Laminate Addons
  - disposal in landfill
  - blowing agent emissions released from XPS insulation during disposal

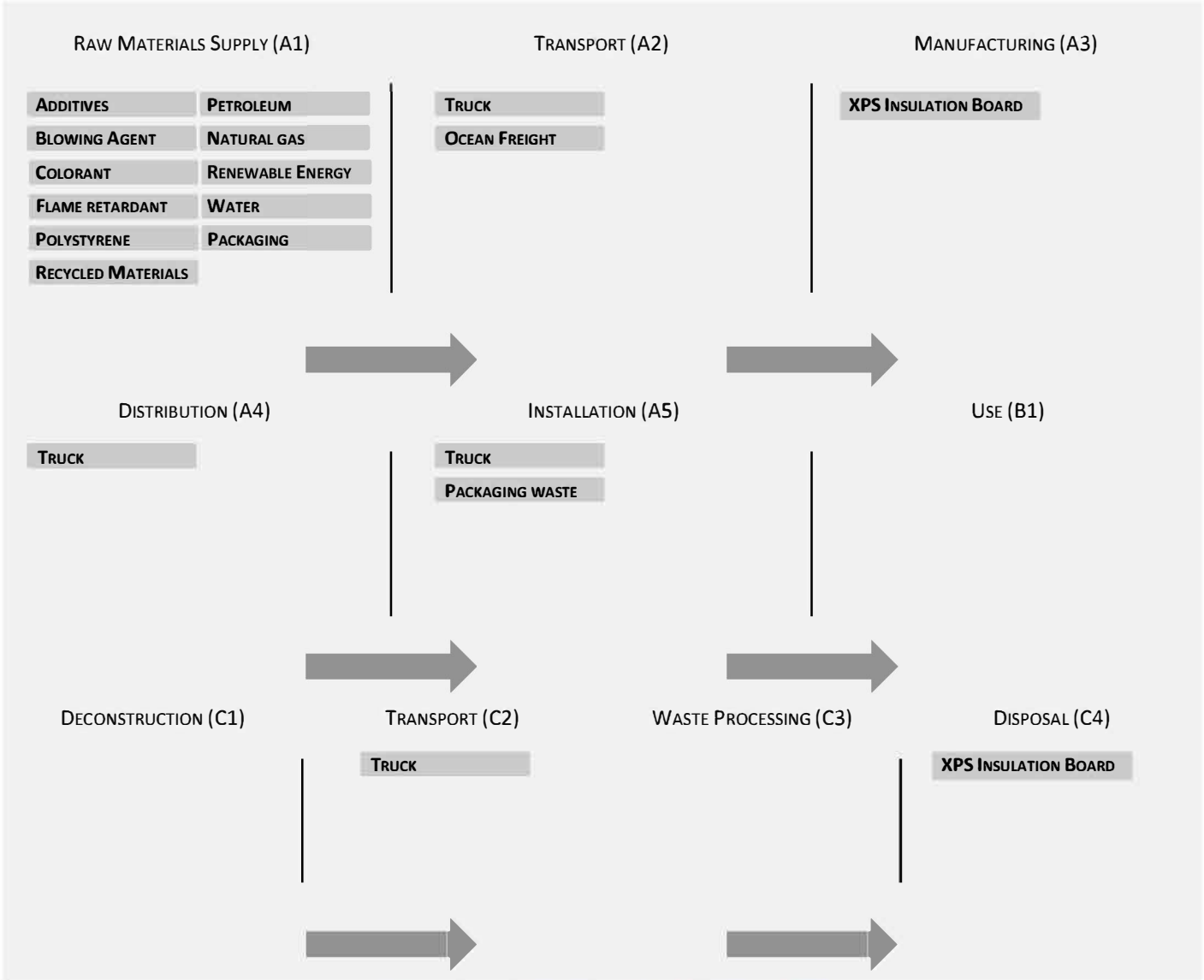


Figure 4. Flow Diagram of FOAMULAR® XPS Insulation

2.3. Estimates and Assumptions

FOAMULAR® XPS Insulation is a passive device requiring no utilities or maintenance over its useful life; it is assumed that the product remains in service for the 75-year reference service.

2.4. Cut-off Criteria

Per section 2.9 of the governing PCR, the procedure detailed in ISO 21930, section 7.1.8 was followed regarding the exclusion of inputs and outputs. For energy, mass and environmental impacts, the cut-off criteria were 1% per the standard. Per the standard "the total of neglected input flows per module shall be a maximum of 5% of energy usage, mass and environmental impacts." Flows excluded for this study include infrastructure, capital goods and workforce burdens. Inputs and outputs associated with infrastructure (construction, maintenance and demolition of buildings/plants, road surfaces, transport equipment, etc.) are not included. This choice is based on experience from previous LCAs where the contribution from these items was negligible due to the long lifetime of the equipment compared to the high production volume of material during that lifetime. Although pallets are used in the transportation of packaged, finished XPS insulation boards, pallets have been excluded due to their high reuse rates since they would have a negligible impact if otherwise included.

2.5. Data Sources

Primary data was collected from the locations listed in the Manufacturing section. Life-cycle modeling and calculation of potential environmental impacts were conducted using the LCA software SimaPro 8, version 8.5.2.0, developed by PRé Consultants bv. The LCI database used for secondary data was the ecoinvent 3.4 database, provided with the Developer version of the software. 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.

2.6. Data Quality

To determine how representative the data used to model the life-cycle of Owens Corning® FOAMULAR® XPS Insulation manufactured in 2017 is, the temporal, geographical and technological aspects of the data were assessed. For the five Owens Corning facilities analyzed in the underlying LCA study, the data used adequately represents the technology used in 2017 in the United States, Canada and Mexico.

2.7. Period under Review

For the manufacturing facilities considered in the LCA, Owens Corning primary data was collected for the 2017 calendar year.

2.8. Allocation

The products studied in this analysis are all members of the FOAMULAR® XPS insulation product family. Plants reported the total board-foot amount of FOAMULAR® XPS insulation produced as well as the board-foot amount produced of each individual product. In general, the characteristics that differentiate one product from another within the family are its compressive strength, density and thickness. Particular product application can be considered another differentiating characteristic; however, 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 and FOAMULAR® CC High-R, which have a slightly higher R-value per unit thickness, and two sheathing (i.e., laminated) products, FOAMULAR® Insulating Sheathing and PROPINK®. For each of these four products, it was possible to avoid allocation.

The incremental amount of thermal resistance per inch provided by FOAMULAR® High-R CW Plus and FOAMULAR® CC High-R is approximately R = 0.129 hr·ft^2·°F/BTU, and the amount of FOAMULAR® High-R CW Plus and FOAMULAR® CC High-R produced was less than 0.5% of total production. It is on these bases, allocation was avoided for these particular products. 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 are 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. This would have been ideal; 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.

3. Life Cycle Assessment Scenarios

Table 3. Transport to the building site (A4)

	FOAMULAR® XPS Insulation (1 m², R_{SI}-1)	Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)	Laminate Addon for FOAMULAR® PROPink® (1 m²)	
Name	Value	Value	Value	Unit
Fuel type	diesel, low-sulfur	diesel, low-sulfur	diesel, low-sulfur	
Liters of fuel	3.53E-03	1.59E-04	3.96E-04	l/100km
Vehicle type	Transport, freight, lorry 16-32 metric ton, EURO3	Transport, freight, lorry 16-32 metric ton, EURO3	Transport, freight, lorry 16-32 metric ton, EURO3	
Transport distance	1.19E+03	1.08E+03	1.14E+03	km
Capacity utilization (including empty runs, mass based)‡	63%	63%	63%	%
Gross density of products transported	2.69E+01	9.20E+02	1.03E+03	kg/m³
Weight of products transported (if gross density not reported)	7.77E-01	3.51E-02	8.71E-02	kg
Volume of products transported (if gross density not reported)	2.88E-02	3.81E-05	8.46E-05	m³
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)	1	1	1	-

‡ EcoTransIT. World. Ecological Transport Information Tool for Worldwide Transports Methodology and Data - Update 4th December 2014. (https://www.ecotransit.org/download/EcoTransIT_World_Methodology_Report_2014-12-04.pdf)

Table 4. Installation into the building (A5)

Name	Value	Unit
Ancillary materials	0.00E+00	kg
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	0.00E+00	m³
Other resources	0.00E+00	kg
Electricity consumption	0.00E+00	kWh
Other energy carriers	0.00E+00	MJ
Product loss per functional unit	0.00E+00	kg
Waste materials at the construction site before waste processing, generated by product installation	1.93E-02	kg
Output materials resulting from on-site waste processing (specified by route; e.g. for recycling, energy recovery and/or disposal)	0.00E+00	kg
Biogenic carbon contained in packaging	0.00E+00	kg CO_2
Direct emissions to ambient air, soil and water	0.00E+00	kg
VOC content‡	0.00E+00	µg/m³

‡ VOC content determined in accordance to "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers - version 1.2." CA Specification 01350.

Table 5. Reference Service Life

Name	Value
RSL	75 years
Declared product properties (at the gate) and finishes, etc.	Not applicable (Insulation properties require installation into a building.)
Design application parameters (if instructed by the manufacturer), including references to the appropriate practices and application codes)	Install per instructions
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Will meet R-value (Installer should install per manufacturer instructions)
Outdoor environment, (if relevant for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, building orientation, shading, temperature	FOAMULAR® XPS Insulation can be exposed to the exterior during normal construction cycles. During that time some fading of color may begin due to UV exposure, and, if exposed for extended periods of time, some degradation or "dusting" of the polystyrene surface may begin. It is best if the product is covered within 60 days to minimize degradation. Once covered, the deterioration stops, and damage is limited to the thin top surface layers of cells. Cells below are generally unharmed and still useful insulation.
Indoor environment, (if relevant for indoor applications), e.g. temperature, moisture, chemical exposure)	To comply with building codes, all foam plastics must be covered with a 15-minute thermal barrier. Gypsum board, ½" thick is a common covering.
Use conditions, e.g. frequency of use, mechanical exposure.	Not applicable (Insulation is a passive product which is not used directly during life)
Maintenance, e.g. required frequency, type and quality of replacement components	None needed (Insulation does not need maintenance during its use)

Table 6. End-of-life, Transport (C2)

		FOAMULAR® XPS Insulation (1 m², R_{SI}-1)	Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)	Laminate Addon for FOAMULAR® PROPink® (1 m²)	
Name		Value	Value	Value	Unit
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)	Although reuse and recycling of XPS insulation at its end of life is possible, there are no formal programs for collection and transport. It is assumed that all product is sent to landfill at end of life.				
Collection process (specified by type)	Collected separately	0.00E+00	0.00E+00	0.00E+00	kg
	Collected with mixed construction waste	7.77E-01	3.51E-02	8.71E-02	kg
Recovery (specified by type)	Reuse	0.00E+00	0.00E+00	0.00E+00	kg
	Recycling	0.00E+00	0.00E+00	0.00E+00	kg
	Landfill	0.00E+00	0.00E+00	0.00E+00	kg
	Incineration	0.00E+00	0.00E+00	0.00E+00	kg
	Incineration with energy recovery	0.00E+00	0.00E+00	0.00E+00	kg
	Energy conversion efficiency rate	0.00E+00	0.00E+00	0.00E+00	
Disposal (specified by type)	Product or material for final deposition	0.00E+00	0.00E+00	0.00E+00	kg
Removals of biogenic carbon (excluding packaging)		0.00E+00	0.00E+00	0.00E+00	kg CO2

Table 7. End-of-life, Disposal (C4)

		FOAMULAR® XPS Insulation (1 m^2, R_{SI}-1)	Laminate Addon for FOAMULAR® Insulating Sheathing (1 m^2)	Laminate Addon for FOAMULAR® PROPink® (1 m^2)	
Name		Value	Value	Value	Unit
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)	Although reuse and recycling of XPS insulation at its end of life is possible, there are no formal programs for collection and transport. It is assumed that all product is sent to landfill at end of life.				
Collection process (specified by type)	Collected separately	0.00E+00	0.00E+00	0.00E+00	kg
	Collected with mixed construction waste	0.00E+00	0.00E+00	0.00E+00	kg
Recovery (specified by type)	Reuse	0.00E+00	0.00E+00	0.00E+00	kg
	Recycling	0.00E+00	0.00E+00	0.00E+00	kg
	Landfill	0.00E+00	0.00E+00	0.00E+00	kg
	Incineration	0.00E+00	0.00E+00	0.00E+00	kg
	Incineration with energy recovery	0.00E+00	0.00E+00	0.00E+00	kg
	Energy conversion efficiency rate	0.00E+00	0.00E+00	0.00E+00	
Disposal (specified by type)	Product or material for final deposition	7.77E-01	3.51E-02	8.71E-02	kg
Removals of biogenic carbon (excluding packaging)		0.00E+00	0.00E+00	0.00E+00	kg CO2

4. Life Cycle Assessment Results

Table 8. Description of the system boundary modules

	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY	
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential	Reference Service Life
FOAMULAR® XPS Insulation (1 m^2, R_{SI}-1)	x	x	x	x	x	x	MND	MND	MND	MND	MND	MND	MND	x	MND	x	MND	75 years
Laminate Addon for FOAMULAR® Insulating Sheathing (1 m^2)	x	x	MND	x	MND	MND	MND	MND	MND	MND	MND	MND	MND	x	MND	x	MND	75 years
Laminate Addon for FOAMULAR® PROPink® (1 m^2)	x	x	MND	x	MND	MND	MND	MND	MND	MND	MND	MND	MND	x	MND	x	MND	75 years
EPD Type: Cradle to installation with end of life	Required					Optional (Based on scenarios)							Required					Required

4.1. Life Cycle Impact Assessment Results

Table 9. LCIA Results for North America (TRACI) for FOAMULAR® XPS Insulation (1 m², R_{SI}-1)

FOAMULAR® XPS Insulation (1 m², RSI-1)									
TRACI v2.1	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
GWP 100 [kg CO2 eq]	2.19E+01	1.54E-01	2.10E-03	2.86E+01	MND	MND	2.07E-02	MND	7.39E+00
ODP [kg CFC-11 eq]	3.35E-05	3.75E-08	1.46E-10	0.00E+00	MND	MND	5.05E-09	MND	1.83E-09
AP [kg SO2 eq]	1.37E-02	9.55E-04	3.82E-06	0.00E+00	MND	MND	1.28E-04	MND	3.54E-05
EP [kg N eq]	6.45E-03	1.85E-04	1.12E-06	0.00E+00	MND	MND	2.50E-05	MND	7.58E-06
POCP [kg O3 eq]	1.79E-01	2.57E-02	1.03E-04	3.39E-04	MND	MND	3.46E-03	MND	8.50E-04
ADP_{fossil} [MJ, LHV]	9.41E+00	3.37E-01	1.32E-03	0.00E+00	MND	MND	4.53E-02	MND	1.71E-02

[GWP 100 - Global Warming Potential]; [ODP - Ozone Depletion Potential]; [AP - Acidification Potential]; [EP - Eutrophication Potential];
[POCP - Smog Formation Potential]; [ADP_{fossil} - Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources]

Table 10. LCIA Results for North America (TRACI) for Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)

Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)									
TRACI v2.1	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
GWP 100 [kg CO2 eq]	1.05E-01	6.29E-03	MND	MND	MND	MND	9.33E-04	MND	1.86E-04
ODP [kg CFC-11 eq]	3.40E-09	1.54E-09	MND	MND	MND	MND	2.28E-10	MND	8.25E-11
AP [kg SO2 eq]	4.27E-04	3.91E-05	MND	MND	MND	MND	5.79E-06	MND	1.60E-06
EP [kg N eq]	1.17E-04	7.59E-06	MND	MND	MND	MND	1.13E-06	MND	3.42E-07
POCP [kg O3 eq]	5.66E-03	1.05E-03	MND	MND	MND	MND	1.56E-04	MND	3.80E-05
ADP_{fossil} [MJ, LHV]	3.93E-01	1.38E-02	MND	MND	MND	MND	2.04E-03	MND	7.70E-04

[GWP 100 - Global Warming Potential]; [ODP - Ozone Depletion Potential]; [AP - Acidification Potential]; [EP - Eutrophication Potential];
[POCP - Smog Formation Potential]; [ADP_{fossil} - Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources]

Table 11. LCIA Results for North America (TRACI) for Laminate Addon for FOAMULAR® PROPink® (1 m²)

Laminate Addon for FOAMULAR® PROPink® (1 m²)									
TRACI v2.1	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
GWP 100 [kg CO2 eq]	2.89E-01	1.64E-02	MND	MND	MND	MND	2.32E-03	MND	4.62E-04
ODP [kg CFC-11 eq]	1.53E-08	4.01E-09	MND	MND	MND	MND	5.66E-10	MND	2.05E-10
AP [kg SO2 eq]	1.20E-03	1.02E-04	MND	MND	MND	MND	1.44E-05	MND	3.97E-06
EP [kg N eq]	4.75E-04	1.98E-05	MND	MND	MND	MND	2.80E-06	MND	8.49E-07
POCP [kg O3 eq]	1.66E-02	2.75E-03	MND	MND	MND	MND	3.88E-04	MND	9.46E-05
ADP_{fossil} [MJ, LHV]	9.79E-01	3.60E-02	MND	MND	MND	MND	5.08E-03	MND	1.91E-03

[GWP 100 - Global Warming Potential]; [ODP - Ozone Depletion Potential]; [AP - Acidification Potential]; [EP - Eutrophication Potential];
[POCP - Smog Formation Potential]; [ADP_{fossil} - Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources]

4.2. Life Cycle Inventory Results

Table 12. Resource Use for FOAMULAR® XPS Insulation (1 m², R_{SI}-1)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
RPRE [MJ, LHV]	1.88E+00	2.98E-02	1.35E-04	0.00E+00	MND	MND	4.01E-03	MND	3.03E-03
RPRM [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
NRPRE [MJ, LHV]	3.87E+01	2.51E+00	9.84E-03	0.00E+00	MND	MND	3.37E-01	MND	1.26E-01
NRPRM [MJ, LHV]	3.84E+01	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
SM [kg]	9.51E-02	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
RSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
NRSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
RE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
FW [m³]	5.13E-02	4.26E-04	3.29E-06	0.00E+00	MND	MND	5.73E-05	MND	1.31E-04

[RPRE - Renewable primary energy used as energy carrier (fuel)]; [RPRM - Renewable primary resources with energy content used as material]; [RPRT - Total use of renewable primary resources with energy content]; [NRPRE - Non-renewable primary resources used as an energy carrier (fuel)]; [NRPRM - Non-renewable primary resources with energy content used as material]; [NRPRT - Total use of non-renewable primary resources with energy content]; [SM - Secondary materials]; [RSF - Renewable secondary fuels]; [NRSF - Non-renewable secondary fuels]; [RE - Recovered energy]; [FW - Use of net fresh water resources]

Table 13. Resource Use for Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
RPRE [MJ, LHV]	1.19E-01	1.22E-03	MND	MND	MND	MND	1.81E-04	MND	1.37E-04
RPRM [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
NRPRE [MJ, LHV]	1.67E+00	1.03E-01	MND	MND	MND	MND	1.52E-02	MND	5.67E-03
NRPRM [MJ, LHV]	1.56E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
SM [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
RSF [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
NRSF [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
RE [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
FW [m³]	1.41E-03	1.74E-05	MND	MND	MND	MND	2.58E-06	MND	5.91E-06

Table 14. Resource Use for Laminate Addon for FOAMULAR® PROPink® (1 m²)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
RPRE [MJ, LHV]	3.01E-01	3.18E-03	MND	MND	MND	MND	4.49E-04	MND	3.40E-04
RPRM [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
NRPRE [MJ, LHV]	4.87E+00	2.68E-01	MND	MND	MND	MND	3.78E-02	MND	1.41E-02
NRPRM [MJ, LHV]	3.24E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
SM [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
RSF [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
NRSF [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
RE [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
FW [m³]	3.93E-03	4.55E-05	MND	MND	MND	MND	6.42E-06	MND	1.47E-05

Table 15. Output Flows and Waste Categories for FOAMULAR® XPS Insulation (1 m², R_{SI}-1)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
HWD [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
NHWD [kg]	0.00E+00	0.00E+00	1.93E-02	0.00E+00	MND	MND	0.00E+00	MND	7.77E-01
HLRW [kg] or [m³]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
ILLRW [kg] or [m³]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
MR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
EE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00

[HWD - Hazardous waste disposed]; [NHWD - Non-hazardous waste disposed]; [HLRW - High-level radioactive waste, conditioned, to final repository]; [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository]; [CRU - Components for re-use]; [MR - Materials for recycling]; [MER - Materials for energy recovery]; [EE - Exported energy];

Table 16. Output Flows and Waste Categories for Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
HWD [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
NHWD [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	3.51E-02
HLRW [kg] or [m³]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
ILLRW [kg] or [m³]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CRU [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
MR [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
MER [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
EE [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00

[HWD - Hazardous waste disposed]; [NHWD - Non-hazardous waste disposed]; [HLRW - High-level radioactive waste, conditioned, to final repository]; [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository]; [CRU - Components for re-use]; [MR - Materials for recycling]; [MER - Materials for energy recovery]; [EE - Exported energy];

Table 17. Output Flows and Waste Categories for Laminate Addon for FOAMULAR® PROPink® (1 m²)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
HWD [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
NHWD [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	8.71E-02
HLRW [kg] or [m³]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
ILLRW [kg] or [m³]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CRU [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
MR [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
MER [kg]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
EE [MJ, LHV]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00

[HWD - Hazardous waste disposed]; [NHWD - Non-hazardous waste disposed]; [HLRW - High-level radioactive waste, conditioned, to final repository]; [ILLRW - Intermediate- and low-level radioactive waste, conditioned, to final repository]; [CRU - Components for re-use]; [MR - Materials for recycling]; [MER - Materials for energy recovery]; [EE - Exported energy];

Table 18. Carbon Emissions and Removals for FOAMULAR® XPS Insulation (1 m², R_{SI}-1)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
BCRP [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
BCEP [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
BCRK [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
BCEK [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
BCEW [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
CCE [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
CCR [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00
CWNR [kg CO2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND	MND	0.00E+00	MND	0.00E+00

[BCRP - Biogenic Carbon Removal from Product]; [BCEP - Biogenic Carbon Emission from Product]; [BCRK - Biogenic Carbon Removal from Packaging]; [BCEK - Biogenic Carbon Emission from Packaging]; [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes]; [CCE - Calcination Carbon Emissions]; [CCR - Carbonation Carbon Removals]; [CWNR - Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes]

Table 19. Carbon Emissions and Removals for Laminate Addon for FOAMULAR® Insulating Sheathing (1 m²)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
BCRP [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCEP [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCRK [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCEK [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCEW [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CCE [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CCR [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CWNR [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00

[BCRP - Biogenic Carbon Removal from Product]; [BCEP - Biogenic Carbon Emission from Product]; [BCRK - Biogenic Carbon Removal from Packaging]; [BCEK - Biogenic Carbon Emission from Packaging]; [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes]; [CCE - Calcination Carbon Emissions]; [CCR - Carbonation Carbon Removals]; [CWNR - Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes]

Table 20. Carbon Emissions and Removals for Laminate Addon for FOAMULAR® PROPink® (1 m²)

Parameter	A1 - A3	A4	A5	B1	B2 - B7	C1	C2	C3	C4
BCRP [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCEP [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCRK [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCEK [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
BCEW [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CCE [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CCR [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00
CWNR [kg CO2]	0.00E+00	0.00E+00	MND	MND	MND	MND	0.00E+00	MND	0.00E+00

[BCRP - Biogenic Carbon Removal from Product]; [BCEP - Biogenic Carbon Emission from Product]; [BCRK - Biogenic Carbon Removal from Packaging]; [BCEK - Biogenic Carbon Emission from Packaging]; [BCEW - Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes]; [CCE - Calcination Carbon Emissions]; [CCR - Carbonation Carbon Removals]; [CWNR - Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes]

4.3. Calculating Impact Category Results for Products with Specific Performance Properties

The impact category values found in Table 9 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 $hr \cdot ft^2 \cdot °F/BTU$ (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:

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

where Impact_{AD} is the adapted impact category value, Impact_{FU} is the impact category value of the functional unit found in Table 9, 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	0.773
25	0.921
40	1.070
60	1.308
100	1.783

Thermal Resistance, $hr \cdot ft^2 \cdot °F/Btu$ (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 calculate 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:

$$\text{Impact}_{AD} = 58.1\ CO_{2\,eq} \times 0.921 \times 1.761 = 94.3\ CO_{2\,eq}$$

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

FOAMULAR® 250 XPS Insulation (1 m^2, R-10)	
TRACI v2.1	**A1 - C4**
GWP 100 [kg CO2 eq]	9.43E+01
ODP [kg CFC-11 eq]	5.44E-05
AP [kg SO2 eq]	2.41E-02
EP [kg N eq]	1.08E-02
POCP [kg O3 eq]	3.39E-01
ADP_{fossil} [MJ, LHV]	1.59E+01

The FOAMULAR® XPS Insulation product family has two sheathing products, FOAMULAR® PROPINK 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								
			$Impact_{FU}$		d_{factor}		$Impact_{lamination}$	
$Impact_{AD}$	=	GWP 100	5.81E+01	X	0.440 (½ in)	+	2.25E-01	kg CO2 eq
		ODP	3.35E-05				1.05E-08	kg CFC-11 eq
		AP	1.48E-02		0.660 (¾ in)		9.48E-04	kg SO2 eq
		EP	6.67E-03				2.52E-04	kg N eq
		POCP	2.09E-01		0.881 (1 in)		1.38E-02	kg O3 eq
		ADP_{fossil}	9.81E+00				8.20E-01	MJ, LHV

PROPINK®								
			$Impact_{FU}$		d_{factor}		$Impact_{lamination}$	
$Impact_{AD}$	=	GWP 100	5.81E+01	X	0.440 (½ in)	+	1.16E+02	kg CO2 eq
		ODP	3.35E-05				6.71E-05	kg CFC-11 eq
		AP	1.48E-02		0.660 (¾ in)		3.06E-02	kg SO2 eq
		EP	6.67E-03				1.36E-02	kg N eq
		POCP	2.09E-01		0.881 (1 in)		4.32E-01	kg O3 eq
		ADP_{fossil}	9.81E+00				2.04E+01	MJ, LHV

5. LCA Interpretation

The underlying LCA upon which this EPD is based considered the following six environmental impact categories: Global Warming Potential (GWP 100); Ozone Depletion Potential (ODP); Acidification Potential (AP); Eutrophication Potential (EP); Smog Formation Potential (POCP); and Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources (ADP_{fossil}). The impact assessment results indicate that among the life cycle modules declared for FOAMULAR® XPS Insulation, the *Raw Materials supply* (A1) life cycle module, which represents both batch materials and packaging materials, accounted for the majority of the potential environmental impact in four of these six impact categories.

The only impact categories for which the *Raw Materials supply* (A1) life cycle module was not the greatest contributor were the GWP and EP impact categories. For the global warming potential impact category, the *Use* (B1) life cycle module was the major contributor. Diffusion of the blowing agent from installed XPS insulation during the 75-year use phase is the cause for this life cycle module's being the greatest contributor to the GWP. Although the intended application of XPS foam is for building envelope thermal insulation, the affected reductions in a building's energy consumption when the XPS foam is used for this purpose were not included in the *Use* life cycle stage. The reason that blowing agent emissions were included within the *Use* (B1) life cycle module is because these emissions occur regardless of the end use application. For the eutrophication potential impact catgory, the *Manufacturing* (A3) life cycle module was the greatest source of impact. Electricity is the predominate energy carrier used for extrusion in the manufacture XPS insulation; upstream processes used to generate electricity indicate their signifcant impact on eutrophication.

6. Additional Environmental Information

6.1. Environment and Health During Manufacturing

Owens Corning manufacturing facilities of FOAMULAR® XPS Insulation maintain quality management systems.

6.2. 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 Used in Building	MJ saved/year for Insulated Building	Net MJ Saved (first year)	Payback Time (years)	MJ Saved Over 75-year use phase
Cinder Block	692,777	872,779	180,002	0.8	6.48E+07
Steel Stud	738,880	1,049,086	310,206	0.7	7.79E+07
Phoenix - Arizona Energy Savings					
Cinder Block	600,569	519,848	-80,722	1.2	3.84E+07
Steel Stud	604,258	668,195	63,937	0.9	4.95E+07

When properly installed, due to the savings it affords in an otherwise non-insulated building, the energy resource impact from the life cycle of insulation has a payback period of 0.7 to 1.2 years. Based on the US EPA's Greenhouse Gas Equivalencies Calculator, the annual avoided GHGs from the energy saved by the insulation in the Chicago steel-stud structure is equivalent to the GHGs emitted annually by 42 automobiles over 75 years. For the Phoenix steel-stud structure, the annual avoided GHGs from the energy saved by the insulation is equivalent to the GHGs emitted annually by 27 automobiles over 75 years.

Greenhouse Gas Avoidance

Chicago - Illinois CO2 eq Savings	Life cycle kg CO2 eq for Insulation Used in Building	kg CO2 eq saved/year for Insulated Building	Net kg CO2 eq Saved (first year)	Payback Time (years)	Net kg CO2 eq Saved Over 75-year use phase
Cinder Block	192,305	148,962	-43,342	1.3	1.10E+07
Steel Stud	205,102	182,841	-22,262	1.1	1.35E+07
Phoenix - Arizona CO2 eq Savings					
Cinder Block	166,709	67,180	-99,529	2.5	4.87E+06
Steel Stud	167,733	86,325	-81,408	1.9	6.31E+06

Note: CO_2 equivalents due to electricity generation were calculated using the U.S. EPA's eGRID2012 Version 1.0, Year 2009 GHG annual Output Emission Rates. The CO_2 equivalent factor of 117.08 lb CO_2 eq/MMBTU 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 13,508 metric tonnes of CO_2. This represents an annual greenhouse gas avoidance of 180 metric tonnes per year for the 75-year life of the building. The greenhouse gas avoidance for the steel-stud Phoenix building is equal to 6,307 metric tonnes over the 75-year life of the structure. This represents an annual greenhouse gas avoidance of 84.1 metric tonnes over the 75-year life of the building.

6.3. Environment and Health During Installation

This product is considered an article. 29 CFR 1910.1200(c) definition of an article is as follows: "Article" means a manufactured item other than a fluid or particle: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which under normal conditions of use does not release more than very small quantities, e.g., minute or trace amounts of a hazardous chemical (as determined under paragraph (d) of this section), and does not pose a physical hazard or health risk to employees WHMIS Regulatory Status This product is considered an article per the Canadian Hazardous Products Regulation SOR/2015-17.

Manufactured articles which meet the definition of the Canadian Hazardous Products Act (any article that is formed to a specific shape or design during manufacture, the intended use of which when in that form is dependent in whole or in part on its shape or design, and that, when being installed, if the intended use of the article requires it to be installed, and under normal conditions of use, will not release or otherwise cause an individual to be exposed to a hazardous product) are not regulated by the Canadian Hazardous Products Regulation SOR/2015-17. The product's Safe Use Instruction Sheet includes exposure guidelines, engineering controls and individual potection measures.

6.4. Extraordinary Effects

No extraordinary effects or environmental impacts are expected due to destruction of the product by fire, water or mechanical means.

6.5. Delayed Emissions

No delayed emissions are expected from this product.

6.6. Environmental Activities and Certifications

- 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.
- 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.

6.7. Further Information

Additional information may be found at www.owenscorning.com

6.8. Indoor Environmental

FOAMULAR® XPS Insulation has achieved GREENGUARD Gold Certification.

7. References

Product Category Rules (PCR) Guidance for Building-Related Products and Services - Part B: Building Envelope Thermal Insulation EPD Requirements, UL 10010-1 Version 2.0, Second Edition, UL Environment, April 10, 2018.

Product Category Rules for Building Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, UL 10010 Version 3.2, Fifth Edition, UL Environment, December 12, 2018.

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

BS EN 15804:2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

ISO 21930:2017(E), Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services

PRé Consultants: SimaPro 8.5.2.0 LCA Software. 2018. The Netherlands.

ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM C578-18: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

ASTM C518-17: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

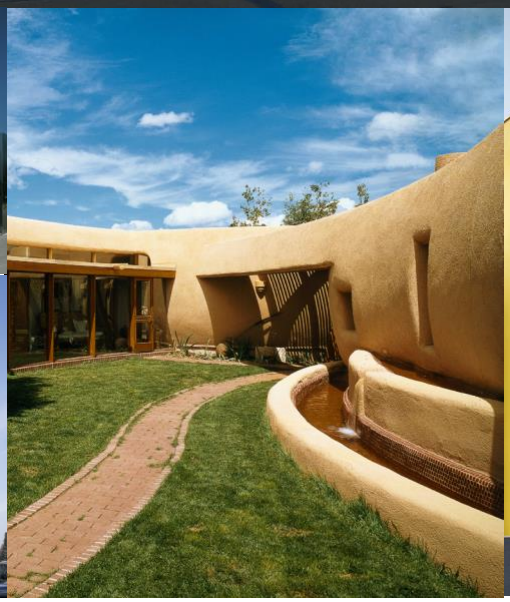
Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers - version 1.2, CA Specification 01350, January 2017.

Building with conscience.

EPD for Stolit®
in varied textures

Product Textures: 1.0, 1.0 Dark, 1.5, 1.5 Dark, Freeform, Freeform Dark, R1.5, R1.5 Dark

Stolit ® is a ready-mixed premium acrylic based exterior or interior textured wall finish enhanced with advanced polymer technology, designed for use as a finish coat over prepared vertical concrete, masonry or plaster substrates and in StoTherm® ci wall



epstengroup Environmental Product Declaration

epstengroup
Solutions for a Sustainable World

PCR Identification	PCR for Architectural Coatings: NAICS 325510 on the basis of ISO 21930:2007, NSF International, 2017. Valid through June 23, 2022
Compliance to ISO1 4040/44, ISO 14025 and ISO 21930	Yes
Product Category	Exterior Coating
Manufacturer's name	Sto Corp. 3800 Camp Creek Parkway SW, Building 1400, Suite 120 Atlanta, GA 30331 www.stocorp.com | (800) 221-2397
EPD program operator	Epsten Group 101 Marietta St. Suite 2600, Atlanta, GA 30303 www.epstengroup.com
Declaration Number	01-001
Date of Certification	December 18th, 2019
Period of Validity	5 years from date of certification
Functional Unit	One square meter of covered and protected substrate for 60 years
Market-base life used in assessment	10 Years
Design life used in assessment	5 Years
Test method employed for determination of design life	Product default warranty
Amount of colorant needed	See Table 3
Overall Data Quality Assessment Score	Good
Site(s) in which the results of the LCA are representative	STO manufacturing sites in Atlanta, Georgia; Glendale, Arizona; and Rutland, Vermont
Information on where explanatory material can be obtained	See references at the end of this document.
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database Version 8.7, Service Pack 39
This declaration was independently verified in accordance with ISO 14025: 2006 and the reference PCR: PCR for Architectural Coatings: NAICS 325510 ☐ Internal ☒ External	Kate McFeaters kmcfeaters@epstengroup.com Kathrine McFeaters
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14040/44 and the reference PCR by:	Kate McFeaters kmcfeaters@epstengroup.com Kathrine McFeaters

Comparability

In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the building level per ISO 21930 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Company

We believe in '**Building with conscience**'.

That means ensuring that all building products are not only safe, effective and easy to install, but also environmentally responsible and sustainable. We know you're always looking for the smartest and newest technology to create energy efficient buildings with superior aesthetics.

That's exactly what our products help you achieve. Products like our wall systems, coatings and finishes are consistent favorites among design professionals, contractors and property owners alike. Whatever your needs or vision may be, we offer products for every type of building project; whether it's new construction, restoration or panelization, commercial or residential work.

An architect or specifier focuses on aesthetics and feasibility, a contractor needs products that are easy to work with, and a building owner requires high value and low costs on properties. Sto understands these unique needs, and delivers the smart, innovative materials and solutions that make this all possible. That's why Sto remains the innovative leader in integrated exterior wall systems.

When you combine that commitment to product support and innovation with value-added offerings like consultative design and color services through Sto Studio or training in proper application techniques through the Sto Institute, you get an integrated exterior wall system solution unmatched in the industry.

Manufacturing Sites Covered in this EPD

Atlanta Plant

Glendale Plant

Rutland Plant

Product Identification

Stolit® finishes are offered in various coarseness and color bases that allow more freedom in building exterior designing and finishing. Table 1 lists the products declared in this EPD.

Table 1: List of Stolit® Products

Product Name	Product Number	Base Type	Finish Type
Stolit® 1.0	80130	Tintable White	Fine
Stolit® 1.0 Dark Colors	82130	Deep	Fine
Stolit® 1.5	80131	Tintable White	Medium
Stolit® 1.5 Dark Colors	82131	Deep	Medium
Stolit® Freeform	80156	Tintable White	Freeform
Stolit® Freeform Dark Colors	82156	Deep	Freeform
Stolit® R1.5	80141	Tintable White	Swirl
Stolit® R1.5 Dark Colors	82141	Deep	Swirl

Product Description

Stolit® is a series of ready-mixed, acrylic-based exterior or interior textured wall finishes. Stolit® is used as a decorative and protective wall coating over prepared vertical above grade concrete, masonry and plaster substrates, and in StoTherm® ci Systems. In this study, Stolit® 1.0, 1.5, R1.5 and Freeform are included. Two tint bases are offered: standard and dark colors which respectively can be transcribed to tintable white base and deep base in the PCR.

Performance Features

Mildew Resistance	Ready Mixed	Moisture Resistance	Low VOC & Odor
Vapor Permeable	Integral Color	Water-based	

Material Composition

The material compositions of Stolit® are listed below:

Table 2: Material composition for Stolit®

Product	Additives	Colorant	Limestone	Acrylic resin	Silica	Silicate	Surfactant	Water
Stolit® R1.5 Dark Colors	0.77%	0.60%	47.76%	5.03%	26.66%	2.69%	0.08%	15.75%
Stolit® R1.5	0.77%	0.60%	47.69%	5.03%	26.60%	2.69%	0.08%	15.88%
Stolit® 1.0 Dark Colors	0.77%	0.60%	49.20%	5.04%	25.26%	2.69%	0.07%	15.71%
Stolit® 1.0	0.77%	0.60%	49.16%	5.03%	25.20%	2.69%	0.07%	15.80%
Stolit® 1.5 Dark Colors	0.59%	0.61%	64.85%	6.95%	7.91%	2.46%	0.18%	15.65%
Stolit® 1.5	0.59%	0.80%	64.55%	6.95%	8.01%	2.46%	0.18%	15.66%
Stolit® Freeform Dark Colors	0.77%	0.58%	67.26%	4.84%	8.18%	2.59%	0.07%	15.08%
Stolit® Freeform	0.74%	0.58%	67.23%	4.84%	8.18%	2.58%	0.07%	15.13%

Components related to Life Cycle Assessment

The functional unit for the LCA study was covering and protecting 1 square meter (m^2) of substrate for a period of 60 years—the assumed lifetime of a building. The reference flow required for the functional unit is calculated based on the product lifespan scenarios prescribed in the PCR. The market-based lifetime is 10 years, and the design lifetime is determined either based on quality determined by ASTM tests or on the product warrant. By default, Stolit® finishes have a 5-year warranty. In case a finish is applied on Sto's wall systems, the warranty is extended to 10 years. In this EPD, default warranty is adopted as the design lifetime. The reference flow required for one functional unit is provided in Table 3.

Table 3: Market-based lifetime and reference flow

	Functional Unit	Reference Flow [kg]	Tint needed* [kg]	Reference Flow [kg]	Tint needed* [kg]
Lifespan		Design Lifetime [5 years]		Market-based Lifetime [10 years]	
Stolit® R1.5 Dark Colors	1	30.59	2.69	15.29	1.35
Stolit® R1.5	1	30.59	0.79	15.29	0.40
Stolit® 1.0 Dark Colors	1	29.58	2.60	14.80	1.30
Stolit® 1.0	1	29.58	0.77	14.80	0.38
Stolit® 1.5 Dark Colors	1	34.05	3.00	17.03	1.50
Stolit® 1.5	1	34.05	0.88	17.03	0.44
Stolit® Freeform Dark Colors	1	53.08	4.66	26.53	2.33
Stolit® Freeform	1	53.08	1.37	26.53	0.69

Scope and Boundaries of the Life Cycle Assessment

The LCA was performed in accordance with ISO 14040 standards. The study is a cradle-to-grave LCA and includes the following life stages as prescribed in the PCR.

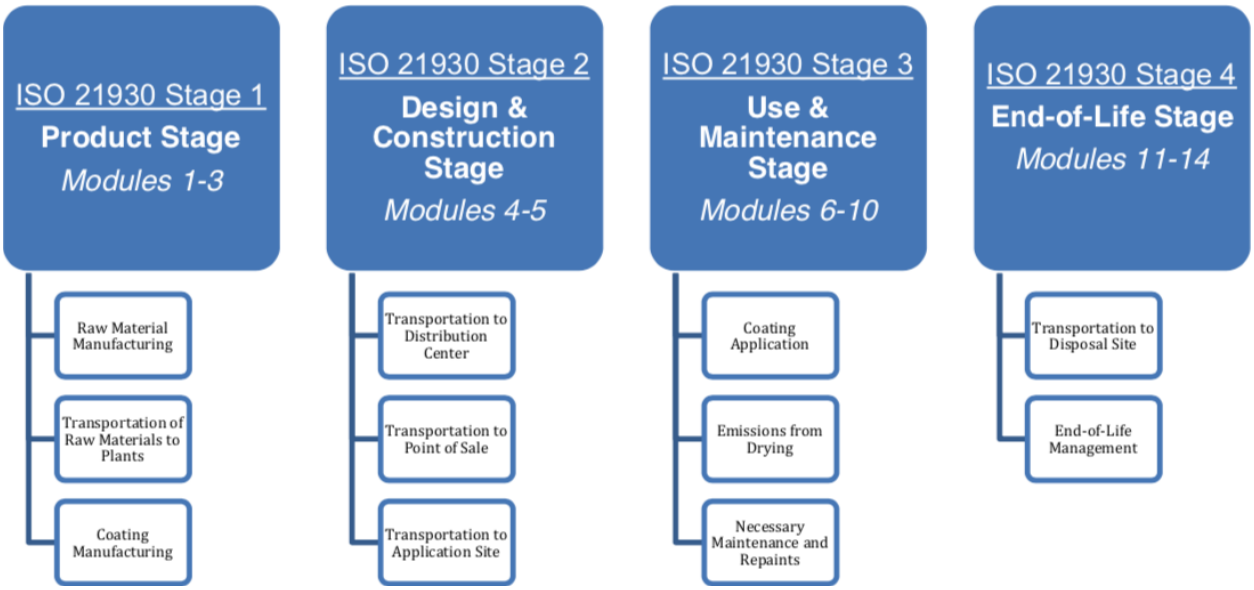


Figure 1: Life stages for the cradle-to-grave LCA

Cut-off Criteria

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

Data Quality

The overall data quality level was determined to be good. Primary data was collected from Sto's facilities in Atlanta, GA, Glendale, AZ and Rutland, VT for the 2018 reference year. When primary data did not exist, secondary data were obtained from the Gabi V8.7 Database Service Pack 39. Overall, both primary and secondary data are considered good quality in terms of geographic, temporal and technological coverage.

Estimates and Assumption

Assumptions were made to represent the cradle-to-grave environmental performance of Sto's products. These assumptions were made in accordance with the PCR and include the transportation distances, the disposal of packaging material and the product at its end of life and use phase assumptions.

Allocation

General principles of allocation were based on ISO 14040/44. Where possible, allocation was avoided. When allocation was necessary it was done on a physical mass basis.

Product Stage

Stolit® is produced at Sto's Atlanta, GA, Glendale, AZ and Rutland, VT facilities. This stage includes an aggregation of raw material extraction, supplier processing, delivery, manufacturing and packaging by Sto. Stolit® is supplied in 5-gallon pails.

Design and Construction Stage

The design and construction process stage starts with the packaged product leaving the production site and ends with being delivered to the application site.

During this stage, the finished product is moved from a shipping dock for distribution. The end gate is the application site after the purchaser acquires the finished product and transports it to the application site.

Use and Maintenance Stage

The use stage begins when the user prepares the product before applying it to a substrate and ends with any leftover coating and discarded packaging entering the end-of-life stage. Detailed application instructions are provided online. The application procedure includes mixing and applying. As recommended, an electric drill/mixer and a spray pump are assumed to be used for mixing and application. The equipment is not included in the study as these are multi-use tools and the impacts per declared unit is considered negligible, but electricity to power application tools has been included.

As prescribed in the PCR, 10% of the wet mass of Stolit® is assumed to be unused and properly disposed of.

End-of-Life Stage

Table 4: End-of-life Disposal Scenarios

Waste Flow	Recycling	Incineration	Landfilling
Paper Packaging	66.6%	6.01%	27.39%
Steel Packaging	33.3%	12.01%	54.69%
Plastic Packaging	9.1%	16.36%	74.54%
Unused Product	0%	0%	100%
Post-Consumer Product	0%	0%	100%

In this stage, the disposal of installation waste, packaging waste and product waste at its end of life is included. The disposal pathway of each waste stream is modeled based on the recommendation of PCR and US EPA's latest waste management fact sheet.

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Life Cycle Assessment Results

As prescribed by the PCR, TRACI 2.1 impact characterization methodology and IPCC 5th assessment report are adopted to calculate the environment impacts. Table 5 provides the acronym key of the impact indicators declared in this EPD.

Table 5: LCIA impact category and LCI Indicator keys

Abbreviation	Parameter	Unit
	TRACI 2.1	
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg N eq
GWP	Global warming potential including biogenic carbon emission	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg O_3 eq
	Resource Use Parameters	
RPR	Use of renewable primary energy	MJ, net calorific value (LHV)
RMR	Use of renewable Material Resources	kg
NRER	Depletion of Non-Renewable Energy Resources	MJ, net calorific value
NRMR	Depletion of Non-Renewable Material Resources	kg
FW	Consumption of Freshwater	m^3
	Waste Parameters	
HWD	Disposed-of-hazardous waste	kg
NHWD	Disposed-of non-hazardous waste	kg
	Biogenic Carbon Parameter	
BC	Biogenic Carbon	kg CO_2 eq
	Energy Differentiation Parameters	
HWP	Hydro/wind Power	MJ, net calorific value (LHV)
FE	Fossil Energy	MJ, net calorific value (LHV)
BE	Bio-energy	MJ, net calorific value (LHV)
NE	Nuclear Energy	MJ, net calorific value (LHV)
OE	Other Energy	MJ, net calorific value (LHV)

Stolit® R1.5 Dark Colors

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	4.73E-02	6.12E-03	6.31E-03	4.41E-03
	EP [kg N eq]	2.75E-03	4.98E-04	2.30E-04	7.14E-04
	GWP [kg CO_2 eq]	1.36E+01	1.19E+00	2.99E+00	9.16E-01
	ODP [kg CFC 11 eq]	1.71E-09	1.13E-16	1.89E-14	2.49E-15
	POCP [kg O_3 eq]	5.46E-01	1.40E-01	8.05E-01	7.33E-02
	RPRE [MJ]	1.64E+01	5.22E-01	3.20E+00	7.57E-01
	NRPRE [MJ]	2.99E+02	1.69E+01	7.97E+01	1.11E+01
	FW [m3]	7.08E-02	2.01E-03	1.79E-02	1.42E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.59E+01	0.00E+00	1.35E+00	0.00E+00
	HWD [kg]	4.77E-06	1.37E-07	1.13E-08	4.58E-08
	NHWD [kg]	8.46E-01	6.36E-04	9.48E-03	1.70E+01
	BC [kg CO_2 eq]		1.53E+00		
	HWP [MJ]		9.79E-01		
	FE [MJ]		1.48E+01		
	BE [MJ]		4.84E-01		
	NE [MJ]		3.89E+00		
	OE [MJ]		3.90E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	9.46E-02	1.22E-02	1.26E-02	8.82E-03
	EP [kg N eq]	5.50E-03	9.96E-04	4.60E-04	1.43E-03
	GWP [kg CO_2 eq]	2.72E+01	2.38E+00	5.98E+00	1.83E+00
	ODP [kg CFC 11 eq]	3.42E-09	2.26E-16	3.78E-14	4.98E-15
	POCP [kg O_3 eq]	1.09E+00	2.80E-01	1.61E+00	1.47E-01
	RPRE [MJ]	3.28E+01	1.04E+00	6.40E+00	1.51E+00
	NRPRE [MJ]	5.98E+02	3.38E+01	1.59E+02	2.22E+01
	FW [m3]	1.42E-01	4.02E-03	3.58E-02	2.84E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.18E+01	0.00E+00	2.70E+00	0.00E+00
	HWD [kg]	9.54E-06	2.74E-07	2.26E-08	9.16E-08
	NHWD [kg]	1.69E+00	1.27E-03	1.90E-02	3.40E+01
	BC [kg CO_2 eq]		3.07E+00		
	HWP [MJ]		1.96E+00		
	FE [MJ]		2.97E+01		
	BE [MJ]		9.68E-01		
	NE [MJ]		7.78E+00		
	OE [MJ]		7.81E-01		

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	6.36E-02	6.11E-03	1.93E-03	4.23E-03
	EP [kg N eq]	2.83E-03	4.98E-04	7.06E-05	7.05E-04
	GWP [kg CO_2 eq]	1.39E+01	1.19E+00	9.06E-01	8.76E-01
	ODP [kg CFC 11 eq]	1.71E-09	1.13E-16	5.66E-15	2.35E-15
	POCP [kg O_3 eq]	5.62E-01	1.40E-01	7.78E-01	6.97E-02
	RPRE [MJ]	1.67E+01	5.22E-01	9.95E-01	7.11E-01
	NRPRE [MJ]	3.03E+02	1.69E+01	2.38E+01	1.04E+01
	FW [m3]	7.24E-02	2.01E-03	5.40E-03	1.34E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.59E+01	0.00E+00	4.00E-01	0.00E+00
	HWD [kg]	4.77E-06	1.37E-07	3.48E-09	4.35E-08
	NHWD [kg]	8.54E-01	6.36E-04	2.91E-03	1.62E+01
	BC [kg CO_2 eq]		1.40E+00		
	HWP [MJ]		9.78E-01		
	FE [MJ]		1.48E+01		
	BE [MJ]		4.84E-01		
	NE [MJ]		3.89E+00		
	OE [MJ]		3.90E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	1.27E-01	1.22E-02	3.86E-03	8.46E-03
	EP [kg N eq]	5.66E-03	9.96E-04	1.41E-04	1.41E-03
	GWP [kg CO_2 eq]	2.78E+01	2.38E+00	1.81E+00	1.75E+00
	ODP [kg CFC 11 eq]	3.42E-09	2.26E-16	1.13E-14	4.70E-15
	POCP [kg O_3 eq]	1.12E+00	2.80E-01	1.56E+00	1.39E-01
	RPRE [MJ]	3.34E+01	1.04E+00	1.99E+00	1.42E+00
	NRPRE [MJ]	6.06E+02	3.38E+01	4.76E+01	2.08E+01
	FW [m3]	1.45E-01	4.02E-03	1.08E-02	2.68E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.18E+01	0.00E+00	8.00E-01	0.00E+00
	HWD [kg]	9.54E-06	2.74E-07	6.96E-09	8.70E-08
	NHWD [kg]	1.71E+00	1.27E-03	5.82E-03	3.24E+01
	BC [kg CO_2 eq]		2.80E+00		
	HWP [MJ]		1.96E+00		
	FE [MJ]		2.97E+01		
	BE [MJ]		9.68E-01		
	NE [MJ]		7.77E+00		
	OE [MJ]		7.80E-01		

Stolit® 1.0 Dark Colors

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	4.91E-02	5.91E-03	6.11E-03	4.27E-03
	EP [kg N eq]	2.80E-03	4.82E-04	2.23E-04	6.91E-04
	GWP [kg CO_2 eq]	1.42E+01	1.15E+00	2.90E+00	8.86E-01
	ODP [kg CFC 11 eq]	2.06E-09	1.09E-16	1.83E-14	2.41E-15
	POCP [kg O_3 eq]	5.64E-01	1.35E-01	7.79E-01	7.09E-02
	RPRE [MJ]	1.77E+01	5.05E-01	3.10E+00	7.33E-01
	NRPRE [MJ]	3.09E+02	1.63E+01	7.69E+01	1.07E+01
	FW [m3]	7.34E-02	1.94E-03	1.73E-02	1.37E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.54E+01	0.00E+00	1.30E+00	0.00E+00
	HWD [kg]	5.67E-06	1.32E-07	1.09E-08	4.43E-08
	NHWD [kg]	9.34E-01	6.12E-04	9.13E-03	1.65E+01
	BC [kg CO_2 eq]		1.57E+00		
	HWP [MJ]		9.48E-01		
	FE [MJ]		1.44E+01		
	BE [MJ]		4.69E-01		
	NE [MJ]		3.76E+00		
	OE [MJ]		3.78E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	9.82E-02	1.18E-02	1.22E-02	8.54E-03
	EP [kg N eq]	5.60E-03	9.64E-04	4.46E-04	1.38E-03
	GWP [kg CO_2 eq]	2.84E+01	2.30E+00	5.80E+00	1.77E+00
	ODP [kg CFC 11 eq]	4.12E-09	2.18E-16	3.66E-14	4.82E-15
	POCP [kg O_3 eq]	1.13E+00	2.70E-01	1.56E+00	1.42E-01
	RPRE [MJ]	3.54E+01	1.01E+00	6.20E+00	1.47E+00
	NRPRE [MJ]	6.18E+02	3.26E+01	1.54E+02	2.14E+01
	FW [m3]	1.47E-01	3.88E-03	3.46E-02	2.74E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.08E+01	0.00E+00	2.60E+00	0.00E+00
	HWD [kg]	1.13E-05	2.64E-07	2.18E-08	8.86E-08
	NHWD [kg]	1.87E+00	1.22E-03	1.83E-02	3.30E+01
	BC [kg CO_2 eq]		3.13E+00		
	HWP [MJ]		1.90E+00		
	FE [MJ]		2.87E+01		
	BE [MJ]		9.37E-01		
	NE [MJ]		7.53E+00		
	OE [MJ]		7.56E-01		

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	6.54E-02	5.91E-03	1.86E-03	4.09E-03
	EP [kg N eq]	2.89E-03	4.82E-04	6.83E-05	6.82E-04
	GWP [kg CO_2 eq]	1.46E+01	1.15E+00	8.76E-01	8.48E-01
	ODP [kg CFC 11 eq]	2.06E-09	1.09E-16	5.47E-15	2.27E-15
	POCP [kg O_3 eq]	5.81E-01	1.35E-01	7.52E-01	6.74E-02
	RPRE [MJ]	1.81E+01	5.05E-01	9.63E-01	6.88E-01
	NRPRE [MJ]	3.13E+02	1.63E+01	2.31E+01	1.01E+01
	FW [m3]	7.53E-02	1.94E-03	5.22E-03	1.30E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.54E+01	0.00E+00	3.80E-01	0.00E+00
	HWD [kg]	5.65E-06	1.32E-07	3.37E-09	4.20E-08
	NHWD [kg]	9.41E-01	6.15E-04	2.81E-03	1.56E+01
	BC [kg CO_2 eq]		1.44E+00		
	HWP [MJ]		9.47E-01		
	FE [MJ]		1.44E+01		
	BE [MJ]		4.68E-01		
	NE [MJ]		3.76E+00		
	OE [MJ]		3.78E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	1.31E-01	1.18E-02	3.72E-03	8.18E-03
	EP [kg N eq]	5.78E-03	9.64E-04	1.37E-04	1.36E-03
	GWP [kg CO_2 eq]	2.92E+01	2.30E+00	1.75E+00	1.70E+00
	ODP [kg CFC 11 eq]	4.12E-09	2.18E-16	1.09E-14	4.54E-15
	POCP [kg O_3 eq]	1.16E+00	2.70E-01	1.50E+00	1.35E-01
	RPRE [MJ]	3.62E+01	1.01E+00	1.93E+00	1.38E+00
	NRPRE [MJ]	6.26E+02	3.26E+01	4.62E+01	2.02E+01
	FW [m3]	1.51E-01	3.88E-03	1.04E-02	2.60E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.08E+01	0.00E+00	7.60E-01	0.00E+00
	HWD [kg]	1.13E-05	2.64E-07	6.74E-09	8.40E-08
	NHWD [kg]	1.88E+00	1.23E-03	5.62E-03	3.12E+01
	BC [kg CO_2 eq]		2.88E+00		
	HWP [MJ]		1.89E+00		
	FE [MJ]		2.87E+01		
	BE [MJ]		9.37E-01		
	NE [MJ]		7.52E+00		
	OE [MJ]		7.55E-01		

Stolit® 1.5 Dark Colors

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	5.54E-02	6.81E-03	7.02E-03	4.91E-03
	EP [kg N eq]	3.14E-03	5.55E-04	2.56E-04	7.95E-04
	GWP [kg CO_2 eq]	1.61E+01	1.32E+00	3.33E+00	1.02E+00
	ODP [kg CFC 11 eq]	1.90E-09	1.26E-16	2.11E-14	2.77E-15
	POCP [kg O_3 eq]	6.28E-01	1.55E-01	8.97E-01	8.16E-02
	RPRE [MJ]	2.01E+01	5.81E-01	3.56E+00	8.44E-01
	NRPRE [MJ]	3.51E+02	1.88E+01	8.86E+01	1.23E+01
	FW [m3]	8.38E-02	2.24E-03	1.99E-02	1.58E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.77E+01	0.00E+00	1.50E+00	0.00E+00
	HWD [kg]	5.30E-06	1.52E-07	1.25E-08	5.10E-08
	NHWD [kg]	1.06E+00	7.07E-04	1.05E-02	1.90E+01
	BC [kg CO_2 eq]		1.78E+00		
	HWP [MJ]		1.09E+00		
	FE [MJ]		1.65E+01		
	BE [MJ]		5.39E-01		
	NE [MJ]		4.33E+00		
	OE [MJ]		4.35E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	1.11E-01	1.36E-02	1.40E-02	9.82E-03
	EP [kg N eq]	6.28E-03	1.11E-03	5.12E-04	1.59E-03
	GWP [kg CO_2 eq]	3.22E+01	2.64E+00	6.66E+00	2.04E+00
	ODP [kg CFC 11 eq]	3.80E-09	2.52E-16	4.22E-14	5.54E-15
	POCP [kg O_3 eq]	1.26E+00	3.10E-01	1.79E+00	1.63E-01
	RPRE [MJ]	4.02E+01	1.16E+00	7.12E+00	1.69E+00
	NRPRE [MJ]	7.02E+02	3.76E+01	1.77E+02	2.46E+01
	FW [m3]	1.68E-01	4.48E-03	3.98E-02	3.16E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.54E+01	0.00E+00	3.00E+00	0.00E+00
	HWD [kg]	1.06E-05	3.04E-07	2.50E-08	1.02E-07
	NHWD [kg]	2.12E+00	1.41E-03	2.10E-02	3.80E+01
	BC [kg CO_2 eq]		3.56E+00		
	HWP [MJ]		2.18E+00		
	FE [MJ]		3.31E+01		
	BE [MJ]		1.08E+00		
	NE [MJ]		8.66E+00		
	OE [MJ]		8.70E-01		

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	7.53E-02	6.81E-03	2.14E-03	4.71E-03
	EP [kg N eq]	3.32E-03	5.55E-04	7.86E-05	7.84E-04
	GWP [kg CO_2 eq]	1.67E+01	1.32E+00	1.01E+00	9.75E-01
	ODP [kg CFC 11 eq]	1.90E-09	1.26E-16	6.30E-15	2.61E-15
	POCP [kg O_3 eq]	6.69E-01	1.55E-01	8.66E-01	7.76E-02
	RPRE [MJ]	2.05E+01	5.81E-01	1.11E+00	7.92E-01
	NRPRE [MJ]	3.59E+02	1.88E+01	2.65E+01	1.16E+01
	FW [m3]	8.63E-02	2.24E-03	6.01E-03	1.50E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	1.77E+01	0.00E+00	4.40E-01	0.00E+00
	HWD [kg]	5.33E-06	1.52E-07	3.88E-09	4.84E-08
	NHWD [kg]	1.07E+00	7.07E-04	3.23E-03	1.80E+01
	BC [kg CO_2 eq]		1.64E+00		
	HWP [MJ]		1.09E+00		
	FE [MJ]		1.65E+01		
	BE [MJ]		5.39E-01		
	NE [MJ]		4.33E+00		
	OE [MJ]		4.35E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	1.51E-01	1.36E-02	4.28E-03	9.42E-03
	EP [kg N eq]	6.64E-03	1.11E-03	1.57E-04	1.57E-03
	GWP [kg CO_2 eq]	3.34E+01	2.64E+00	2.02E+00	1.95E+00
	ODP [kg CFC 11 eq]	3.80E-09	2.52E-16	1.26E-14	5.22E-15
	POCP [kg O_3 eq]	1.34E+00	3.10E-01	1.73E+00	1.55E-01
	RPRE [MJ]	4.10E+01	1.16E+00	2.22E+00	1.58E+00
	NRPRE [MJ]	7.18E+02	3.76E+01	5.30E+01	2.32E+01
	FW [m3]	1.73E-01	4.48E-03	1.20E-02	3.00E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	3.54E+01	0.00E+00	8.80E-01	0.00E+00
	HWD [kg]	1.07E-05	3.04E-07	7.76E-09	9.68E-08
	NHWD [kg]	2.14E+00	1.41E-03	6.46E-03	3.60E+01
	BC [kg CO_2 eq]		3.29E+00		
	HWP [MJ]		2.18E+00		
	FE [MJ]		3.31E+01		
	BE [MJ]		1.08E+00		
	NE [MJ]		8.66E+00		
	OE [MJ]		8.69E-01		

Stolit® Freeform Dark Colors

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	8.88E-02	1.06E-02	1.10E-02	7.66E-03
	EP [kg N eq]	4.96E-03	8.64E-04	3.99E-04	1.24E-03
	GWP [kg CO_2 eq]	2.51E+01	2.06E+00	5.20E+00	1.59E+00
	ODP [kg CFC 11 eq]	-8.37E-13	1.96E-16	3.28E-14	4.32E-15
	POCP [kg O_3 eq]	1.01E+00	2.42E-01	1.40E+00	1.27E-01
	RPRE [MJ]	2.98E+01	9.05E-01	5.56E+00	1.32E+00
	NRPRE [MJ]	5.54E+02	2.93E+01	1.38E+02	1.92E+01
	FW [m3]	1.29E-01	3.49E-03	3.10E-02	2.46E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	2.76E+01	0.00E+00	2.33E+00	0.00E+00
	HWD [kg]	7.85E-07	2.37E-07	1.95E-08	7.95E-08
	NHWD [kg]	1.47E+00	1.10E-03	1.64E-02	2.96E+01
	BC [kg CO_2 eq]		2.71E+00		
	HWP [MJ]		1.70E+00		
	FE [MJ]		2.58E+01		
	BE [MJ]		8.40E-01		
	NE [MJ]		6.75E+00		
	OE [MJ]		6.77E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	1.78E-01	2.12E-02	2.20E-02	1.53E-02
	EP [kg N eq]	9.92E-03	1.73E-03	7.98E-04	2.48E-03
	GWP [kg CO_2 eq]	5.02E+01	4.12E+00	1.04E+01	3.18E+00
	ODP [kg CFC 11 eq]	-1.67E-12	3.92E-16	6.56E-14	8.64E-15
	POCP [kg O_3 eq]	2.02E+00	4.84E-01	2.80E+00	2.54E-01
	RPRE [MJ]	5.96E+01	1.81E+00	1.11E+01	2.64E+00
	NRPRE [MJ]	1.11E+03	5.86E+01	2.76E+02	3.84E+01
	FW [m3]	2.58E-01	6.98E-03	6.20E-02	4.92E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	5.51E+01	0.00E+00	4.66E+00	0.00E+00
	HWD [kg]	1.57E-06	4.74E-07	3.90E-08	1.59E-07
	NHWD [kg]	2.94E+00	2.20E-03	3.28E-02	5.92E+01
	BC [kg CO_2 eq]		5.42E+00		
	HWP [MJ]		3.40E+00		
	FE [MJ]		5.15E+01		
	BE [MJ]		1.68E+00		
	NE [MJ]		1.35E+01		
	OE [MJ]		1.35E+00		

	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Market-based lifetime	AP [kg SO_2 eq]	1.20E-01	1.06E-02	3.34E-03	7.35E-03
	EP [kg N eq]	5.13E-03	8.64E-04	1.23E-04	1.22E-03
	GWP [kg CO_2 eq]	2.58E+01	2.06E+00	1.57E+00	1.52E+00
	ODP [kg CFC 11 eq]	-8.35E-13	1.96E-16	9.82E-15	4.08E-15
	POCP [kg O_3 eq]	1.05E+00	2.42E-01	1.35E+00	1.21E-01
	RPRE [MJ]	3.05E+01	9.05E-01	1.73E+00	1.23E+00
	NRPRE [MJ]	5.63E+02	2.93E+01	4.14E+01	1.81E+01
	FW [m3]	1.33E-01	3.49E-03	9.37E-03	2.33E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	2.76E+01	0.00E+00	6.90E-01	0.00E+00
	HWD [kg]	7.89E-07	2.37E-07	6.04E-09	7.54E-08
	NHWD [kg]	1.49E+00	1.10E-03	5.04E-03	2.81E+01
	BC [kg CO_2 eq]		2.49E+00		
	HWP [MJ]		1.70E+00		
	FE [MJ]		2.58E+01		
	BE [MJ]		8.40E-01		
	NE [MJ]		6.74E+00		
	OE [MJ]		6.77E-01		
	Indicator	1. Product Stage	2. Design & Construction Stage	3. Use & Maintenance Stage	4. End-of-Life Stage
Design lifetime	AP [kg SO_2 eq]	2.40E-01	2.12E-02	6.68E-03	1.47E-02
	EP [kg N eq]	1.03E-02	1.73E-03	2.46E-04	2.44E-03
	GWP [kg CO_2 eq]	5.16E+01	4.12E+00	3.14E+00	3.04E+00
	ODP [kg CFC 11 eq]	-1.67E-12	3.92E-16	1.96E-14	8.16E-15
	POCP [kg O_3 eq]	2.10E+00	4.84E-01	2.70E+00	2.42E-01
	RPRE [MJ]	6.10E+01	1.81E+00	3.46E+00	2.46E+00
	NRPRE [MJ]	1.13E+03	5.86E+01	8.28E+01	3.62E+01
	FW [m3]	2.66E-01	6.98E-03	1.87E-02	4.66E-03
	RMR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRMR [kg]	5.51E+01	0.00E+00	1.38E+00	0.00E+00
	HWD [kg]	1.58E-06	4.74E-07	1.21E-08	1.51E-07
	NHWD [kg]	2.98E+00	2.20E-03	1.01E-02	5.62E+01
	BC [kg CO_2 eq]		4.98E+00		
	HWP [MJ]		3.39E+00		
	FE [MJ]		5.15E+01		
	BE [MJ]		1.68E+00		
	NE [MJ]		1.35E+01		
	OE [MJ]		1.35E+00		

Interpretation

For all the products in study, the majority of the environmental impacts come from the Product Stage, which includes raw material sourcing, transportation and manufacturing. The only exception is POCP whose dominant source is Use & Maintenance Stage because of VOC emission in the curing process. From a functional unit perspective, the lifetime of the product and the coverage rate play a major role in scaling the impacts. This explains why products of coarse finishes have a higher impact than those of fine finishes.

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