Environmental Product Declaration

Styrofoam™ Brand XPS Products

DuPont™ Styrofoam™ Brand XPS Insulation products offer high, long-term thermal resistance, moisture resistance, and a wide variety of sizes and edge treatments for both residential and commercial applications.

The biggest sustainability problems can't be solved without big contributions from the building and construction industry. Solving these problems calls for sweeping transformation in today's building practices. As DuPont Performance Building Solutions, we're up to the challenge, and have charted a course to help make sustainability a reality in the building industry over the next decade. Inspired by the United Nations' Sustainable Development Goals (UN SDGs), and in support of the DuPont 2030 Sustainability Goals, we are committed to deliver solutions that help solve climate change, drive the circular economy, deliver safer solutions and help communities thrive.

Our Product Stewardship commitment drives us toward a vision that every product we bring to the market is safe for use across its life cycle, compliant, risk-managed, trusted, and contributing to a sustainable society. As part of this vision, we recognize the stakeholder need regarding product transparency beyond the Safety Data Sheet and are committed to providing transparency documents for products in our portfolio.

For additional details on our sustainability journey, please see:
https://www.dupont.com/building/sustainability.html

UL CERTIFIED
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UL.COM/EPD

Styrofoam™ Brand XPS Products

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.2.5 March 2020
Manufacturer Name and Address	DuPont de Nemours, Inc. Products are manufactured in plants located in Burley, ID, Channahon, IL, Dalton, GA, Pevely, MO, and Varennes, Canada. See address information in Section 1.1.
Declaration Number	4789559274.101.1
Declared Product & Functional Unit or Declared Unit	Styrofoam Brand XPS Products-Blue 1 m^2 of insulation with a thickness that gives an average thermal resistance RSI = 1 m^2K/W for a period of 75 years
Reference PCR and Version Number	Part A: LCA Calculation Rules and Report Requirements (UL, V3.2, 2018) Part B: Building Envelope Thermal Insulation EPD Requirements (UL V2.0, 2018)
Description of Product Application/Use	Insulation is used in a variety of applications including roofs, ceilings, interior and exterior walls, floors, basements, exterior insulation finishing systems, and composite panels.
Product RSL Description (if Appl.)	75 years
Markets of Applicability	North America
Date of Issue	January 1, 2021
Period of Validity	5 Years
EPD Type	Product Specific
Range of Dataset Variability	N/A
EPD Scope	Cradle-to-Grave
Year(s) of Reported Primary Data	2019
LCA Software & Version Number	GaBi v9.5.2.49
LCI Database(s) & Version Number	GaBi Service Pack 40
LCIA Methodology & Version Number	TRACI 2.1 and CML 2001-2016

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, 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.

1. Product Definition and Information

1.1. Description of Company/Organization

Grounded in science, DuPont™ Performance Building Solutions is working alongside those who also seek a sustainable tomorrow to help people thrive in homes and buildings in their communities for years to come. By developing solutions for managing the air, water and thermal performance of buildings and residences, we help our customers build energy-efficient, resilient, and durable shelters in a rapidly changing world. Backed by unmatched industry insight, building knowledge, and technical support, as well as world-class brands such as Styrofoam™ Brand, Thermax™ Brand, Tyvek®, and Great Stuff™, our products and services portfolio enables customers to focus on what they do best, no matter where and how they choose to build.

This Environmental Product Declaration is representative of products manufactured at the locations listed below.

BURLEY PLANT	JOLIET PLANT	DALTON PLANT	RIVERSIDE PLANT	VARENNES PLANT
Burley, ID 83318	Channahon, IL 60410	Dalton, GA 30721	Prevely, MO 63070	Varennes, Quebec J3X 1P3 Canada

1.2. Product Description

Product Identification

This EPD is for representative products derived from DuPont's blue line of Styrofoam™ products produced at the facilities located in in the table above. The blue line of products under review include: Styrofoam™ Brand Ag Board, Styrofoam™ Brand Cavitymate™, Styrofoam™ Brand Cladmate™, Styrofoam™ Brand Deckmate™, Styrofoam™ Brand Duramate™, Styrofoam™ Brand Freezermate™, Styrofoam™ Brand Highload, Styrofoam™ Brand Panel Core, Styrofoam™ Brand Panelmate™, Styrofoam™ Brand Perimate™, Styrofoam™ Brand Plazamate™, Styrofoam™ Brand Recovermate, Styrofoam™ Brand Residential Sheathing, Styrofoam™ Brand Residing Board, Styrofoam™ Brand Roofmate™, Styrofoam™ Brand Scoreboard, Styrofoam™ Brand SM, Styrofoam™ Brand Square Edge, Styrofoam™ Brand Styrospan™, Styrofoam™ Brand Tongue and Groove, Styrofoam™ Brand Ultra, Styrofoam™ Brand UtilityFit™, Styrofoam™ Brand Wallmate™, and Styrofoam™ Brand Z-mate™.

DuPont's XPS insulation primarily consists of polystyrene foam and a blend of blowing agents. Additionally, some of the products under review are lined with films or facers that help prevent water and water vapor intrusion into the insulation foam, meaning less potential for mold and mildew in the building envelope. All of DuPont's XPS insulation products offer consistently high, long-term thermal resistance to reduce energy costs, are moisture resistant to increase resiliency, and are available in a variety of thicknesses and edge treatments to meet today's design demands.

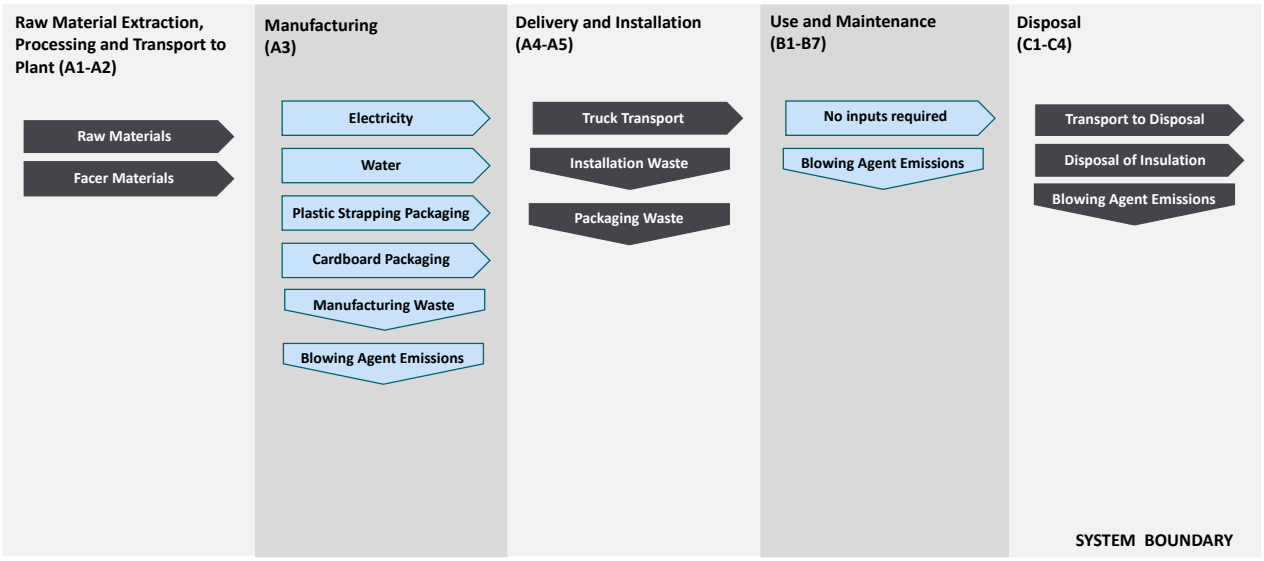
Product Specification

The UNSPSC code for this insulation product is 30141503 and the CSI code is 07 21 00.

Product Average

Results in this LCA are presented based on a representative product that is calculated based on the total materials purchased during 2019 and annual production data. The results in this study represent a weighted-average of the impacts from each product. The weighting is based on 2019 production volume of each product under review.

Flow Diagram



1.3. Application

DuPont Styrofoam™ Brand insulation products are commonly used on all six sides of the building envelope, including roofs, exterior walls, below grade, basements, exterior insulation finishing systems (EIFS), and composite panels.

1.4. Declaration of Methodological Framework

This EPD is considered a Cradle-to-Grave study. The LCA for this study follows an attributional approach. Infrastructure flows have been excluded.

A summary of the life cycle stages included in this EPD is presented in Table 5. The reference service life is outlined in Table 8 and is only applicable if all manufacturing guidelines are followed regarding site-selection and installation, found online. No known flows are deliberately excldued from this EPD. Third party verified ISO 14040/44 secondary LCI datasetes contribute more than 67% of total impacts in all impacts categories required by the PCR.

1.5. Technical Requirements

Table 1 shows the technical specifications of various products under review, including any testing data as appropriate.

Table 1: Technical Details

PARAMETER	TEST METHOD	VALUE	UNIT
Thermal Conductivity	ASTM C518	5.6 at 1 inch	R-value
Compressive Strength	ASTM D1621	15-100	Psi, min
Water Absorption	ASTM C272	0.1	% by volume, max.
Dimentional Stability	ASTM D2126	2.0	% linear change, max
Water Vapor Permeance	ASTM E96	1.1-1.5	perm, max
Maximum Use Temperature	N/A	165	°F
Coefficient of Linear Thermal Expansion	ASTM D696	3.5 x 10-5	in/in•°F
Flexural Strength	ASTM C203	50	Psi, min.
Flame Spread	ASTM E84	<25	-
Smoke Development	ASTM E84	<450	-

1.6. Properties of Declared Product as Delivered

DuPont Styrofoam™ Brand insulation products are delivered in unit packaging as pallets with shrink wrap protection. Styrofoam™ Brand insulation products typically measure 8 feet in length and 4 feet in width upon delivery with varying thicknesses as required, though other sizes are available.

1.7. Material Composition

Products included in the study consist of two major components, thermoplastic resin and a blend of blowing agents. A flame retardant, colorant, and additives make up the remainder of the formula. Additionally, some products are faced with films or facers to help prevent water and water vapor intrusion into the insulation foam.

Table 2: Material Composition

COMPONENT	COMPOSITION (%)
Polystyrene (Virgin)	40%-60%
Polystyrene (Recycled)	15%-25%
Blowing Agent	8%-11%
Colorant	0-7%
Flame Retardant and Other Additives	0-3%
Film/Facer	0-8%

1.8. Manufacturing

The products under review are manufactured at the facilities described in section 1.1.

Styrofoam™ Brand products are manufactured in a continuous extrusion process with electricity as the main energy source. Polystyrene-acrylonitrile pellets are melted together with the additives in the extruder under high pressure. Blowing agents, which serve to expand the foam during the foaming process, are injected into the melted mass and dissolved into it. The melted mass is extruded through a flat die. The drop in pressure causes the polystyrene to foam, cool down and solidify. An endless board of homogenous closed-cell polystyrene foam is produced. This is cooled further and then cut to dimensions and trimmed, if necessary. A portion of the foam production trimmings and production waste is recycled directly back into the production facilities to manufacture extruded polystyrene foam. Thermoplastic resin can be recycled easily and economically by melting it.

Raw materials for the product were obtained from various parts of the United States.

1.9. Environment and Health During Manufacturing

During the manufacturing of the products covered in the EPD, all legal regulations regarding emissions to air, wastewater discharge, solid waste disposal and noise emissions are followed.

1.10. Packaging

Once the insulation is manufactured, it is packaged in plastic strapping and/or cardboard. The amount of packaging is detailed in Table 3.

Table 3: Packaging Inputs, per kg of Product

INPUT	VALUES	UNIT
Cardboard Belly Band	0.000846	kg
Plastic Spiral Wrapping	0.0127	kg
Plastic Hooding Film	0.000104	kg

1.11. Transportation

DuPont insulations are delivered to the customer via truck. The average distance from the manufacturing facilities to the construction site is 805 km.

1.12. Product Installation

Installation equipment is not required. Packaging and installation waste disposal have been modeled as per guidelines in section 2.8.5 of Part A: Life Cycle Assessment Calculation Rules and Report Requirements.

1.13. Environment and Health During Installation

All recommended personal protective equipment (PPE) should be utilized during installation.

1.14. Use

As required in the PCR, the results are based on the estimated service life (ESL) of the building of 75 years. Since insulation typically lasts as long as the building itself, the RSL of the building is assumed to be 75 years. Hence, no replacements are necessary during the service life of the building.

1.15. Reference Service Life and Estimated Building Service Life

According to Part A of the PCR, the Estimated Service Life (ESL) of the building is assumed to be 75 years. Since insulation is expected to last as long as the building itself, the Reference Service Life (RSL) of insulation is taken to be 75 years.

1.16. Reuse, Recycling, and Energy Recovery

Styrofoam™ Brand insulation can be reused if the product is not damaged during disassembly. The insulation can also be recycled or incinerated for energy recovery if local facilities are available.

1.17. Disposal

All end-of-life product waste has been modeled according to the requirements laid out in Section 2.8.6 in Part A: Life Cycle Assessment Calculation rules and Report Requirements from UL Environment. Specifically, the product is modeled to be 100% landfilled at end-of-life.

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

The functional unit is 1 m2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W for a period of 75 years. Table 4 shows additional details related to the functional unit.

Table 4: Functional Unit – Average of Products Under Review

NAME	VALUE	UNIT
Functional Unit	1 m2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W for a period of 75 years	
Mass	0.681	kg
Thickness to achieve Functional Unit	0.0253	m

2.2. System Boundary

This EPD is considered a Cradle-to-Grave study. A summary of the life cycle modules included in this EPD is presented in Table 5. Infrastructure flows have been excluded.

Table 5: System Boundary

MODULE NAME	DESCRIPTION	ANALYSIS PERIOD	SUMMARY OF INCLUDED ELEMENTS
A1	Product Stage: Raw Material Supply	2019	Raw Material sourcing and processing as defined by secondary data.
A2	Product Stage: Transport	2019	Shipping from supplier to manufacturing site. Fuel use requirements estimated based on product weights and measured and calculated distance.
A3	Product Stage: Manufacturing	2019	Energy and material inputs required for manufacturing products from raw materials. Packaging materials, blowing agent emissions, and manufacturing waste are included as well.
A4	Construction Process Stage: Transport	2019	Shipping from manufacturing site to project site. Fuel use requirements estimated based on measured and calculated distance.
A5	Construction Process Stage: Installation	2019	Installation waste and packaging material waste.
B1	Use Stage: Use	2019	No inputs are required for the use of the product however, this stage includes additional blowing agent emissions.
B2	Use Stage: Maintenance	2019	No inputs required for maintenance as minimal resources are used in the rare occasion that maintenance is necessary.
B3	Use Stage: Repair	2019	No inputs required for repairs as minimal resources are used in the rare occasion that a repair is necessary.
B4	Use Stage: Replacement	2019	No inputs required for replacement manufacturing as minimal resources are used in the rare occasion that a replacement is necessary.
B5	Use Stage: Refurbishment	2019	DuPont insulation lasts as long as the building and generally, does not need refurbishment.
B6	Operational Energy Use	2019	No Operational Energy Use of Building Integrated System During Product Use
B7	Operational Water Use	2019	No Operational Water Use of Building Integrated System During Product Use
C1	EOL: Deconstruction	2019	No inputs required for deconstruction.
C2	EOL: Transport	2019	Shipping from project site to landfill, incineration, and recycling. Fuel use requirements estimated based on product weight and assumed distance recommended by the PCR (Part B).
C3	EOL: Waste Processing	2019	Waste processing included for landfill.
C4	EOL: Disposal	2019	Assumes all products are sent to landfill, per PCR Part A. This stage includes additional blowing agent emissions.
D	Benefits beyond system	MND	Module Not Declared

2.3. Estimates and Assumptions

All estimates and assumptions are within the requirements of ISO 14040/44. The majority of the estimations are within the primary data. Some assumptions made in the study that may have affected the results are:

- The primary data was collected as annual totals including all utility usage and production information. For the LCA, the usage information was divided by the production mass to create energy, water, and waste consumption/generation per kg of product. Energy, water and waste inputs were weighted based on annual production at each facility.
- The disposal pathways and the corresponding transportation distances of unused product waste, packaging waste, and post-consumer product waste are assumed in accordance with the PCR.
- The use and selection of secondary datasets from GaBi – The selection of which generic dataset to use to represent an aspect of a supply chain is a significant value choice. Collaboration between LCA practitioner, DuPont associates and GaBi data experts was valuable in determining best-case scenarios in the selection of data. However, no generic data can be a perfect fit. Improved supply chain specific data would improve the accuracy of results, however budgetary and time constraints have to be taken into account.

Although the PCR for these products does not specify assumptions that need to be made related to blowing agent emissions, which make a significant contribution to the GWP results, a worst-case scenario has been assumed such that all blowing agents incorporated into the products during the foaming process are released into the atmosphere across the product life cycle.

2.4. 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. No known flows are deliberately excluded from this EPD.

2.5. Data Sources

Primary data was collected by DuPont associates for onsite energy, water and waste during the course of manufacturing. Whenever available, supplier data was used for raw materials used in the production process. When primary data did not exist, secondary data for raw material production was used from GaBi Software Version 9.5 and database Service Pack 40. All calculation procedures adhere to ISO14044.

2.6. Data Quality

The geographical scope of the manufacturing portion of the life cycle is North America. All primary data were collected from the manufacturer. The geographic coverage of primary data is considered excellent. Primary data were provided by the manufacturer and represent all information for calendar year 2019. Primary data provided by the manufacturer is specific to the technology that the company uses in manufacturing their product. It is site-specific and considered of good quality. Data used to allocate energy, water, and waste on a per unit of product produced includes overhead energy such as lighting, heating and sanitary use of water. Sub-metering was not available to extract process only energy and water use from the total energy use. Sub-metering would improve the technological coverage of data quality.

2.7. Period under Review

The period under review is calendar year 2019.

2.8. Allocation

General principles of allocation were based on ISO 14040/44.

To derive a per-unit value for the manufacturing inputs/outputs, mass allocation based on total production at each Styrofoam™ facility was adopted. For all Styrofoam™ plants, the total consumption during 2019 was divided by the total production mass during 2019 to derive a weighted-average use-per-production unit value. DuPont associates determined the best way to allocate inputs. This allocation methodology was used for the following inputs:

- Electricity
- Thermal Energy from Natural Gas
- Gasoline
- Propane
- Diesel Fuel
- DPO (Heat Transfer Fluid)
- Steam from Natural Gas
- Liquified Petroleum Gas
- Water
- Recycled Waste
- Waste for Energy Recovery
- Incinerated Hazardous Waste
- Incinerated Non-Hazardous Waste
- Landfilled Hazardous Waste
- Landfilled Non-Hazardous Waste

Discussions with DuPont staff divulged this was a more representative way to allocate the manufacturing inputs/outputs due to the fact that all products created at the facilities are similar in nature. As a default, secondary GaBi datasets use a physical mass basis for allocation.

2.9. Comparability and Benchmarking

The user of the EPD should take care when comparing EPDs from different companies. Assumptions, data sources, and assessment tools may all impact the variability of the final results and make comparisons misleading. Without understanding the specific variability, the user is therefore, not encouraged to compare EPDs. Even for similar products, differences in use and end-of-life stage assumptions, and data quality may produce incomparable results. Comparison of the environmental performance of thermal insulation products using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR. Full conformance with the PCR for thermal insulation products 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.

3. Life Cycle Assessment Scenarios

Table 6: Transport to the building site (A4)

NAME	VALUE	UNIT
Fuel type	Diesel	
Liters of fuel	39.06	l/100km
Vehicle type	Truck-trailer, Euro 0 - 6 mix, 34 - 40t gross weight / 27t payload capacity	
Transport distance	805	km
Capacity utilization (including empty runs, mass based)	65	%
Average weight of products transported (if gross density not reported)	0.681	kg
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)	1	-

Table 7: Installation into the building (A5)

NAME	VALUE	UNIT
Waste materials at the construction site before waste processing, generated by product installation	0.02369	kg

Table 8: 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	DuPont insulations can be exposed to the exterior during normal construction cycles. If exposed for extended periods of time, some mold and mildew may begin to grow. It is best if the product is covered within 180 days to minimize degradation.
Indoor environment, (if relevant for indoor applications), e.g. temperature, moisture, chemical exposure)	Typically, to comply with building codes, all foam plastics must be covered with a 15- minute thermal barrier unless specific industry recognized testing is completed for approved exception by building application per local building code. ½" thick gypsum board 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 9: End of life (C1-C4)

NAME		VALUE	UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)	Although reuse and recycling of extruded polystyrene 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	Collected with mixed construction waste	0.681	kg
Disposal to Landfill	Product or material for final deposition	0.681	kg
Removals of biogenic carbon (excluding packaging)		0	kg CO_2

Tables for modules B2-B7 are not provided as they are not applicable to this product, as shown in Table 5.

4. Life Cycle Assessment Results

Table 10: 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
EPD Type Cradle to Grave	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND

4.1. Life Cycle Impact Assessment Results

All results are given per functional unit, which is 1 m^2 of insulation material with a thickness that gives an average thermal resistance RSI = 1 m^2K/W over 75 years.

Table 11: North American Impact Assessment Results

TRACI v2.1	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
GWP 100 [kg CO_2 eq]	2.94E+01	7.13E-02	6.84E-01	3.14E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.78E-03	0.00E+00	3.85E+01
ODP [kg CFC-11 eq]	2.01E-09	9.11E-18	2.01E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.95E-19	0.00E+00	1.11E-16
AP [kg SO_2 eq]	6.14E-03	1.18E-04	7.08E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-05	0.00E+00	1.50E-04
EP [kg N eq]	5.60E-04	1.86E-05	7.87E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E-06	0.00E+00	8.47E-06
POCP [kg O_3 eq]	1.22E-01	2.59E-03	1.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-04	0.00E+00	2.65E-03
Resources [MJ]	9.01E+00	1.34E-01	9.33E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-02	0.00E+00	6.73E-02

Table 12: EU Impact Assessment Results

CML v4.2	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
GWP 100 [kg CO_2 eq]	2.94E+01	7.13E-02	6.84E-01	3.14E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.78E-03	0.00E+00	3.85E+01
ODP [kg CFC-11 eq]	1.69E-08	9.11E-18	1.69E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.95E-19	0.00E+00	1.11E-16
AP [kg SO_2 eq]	5.30E-03	9.04E-05	5.73E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.86E-06	0.00E+00	1.37E-04
EP [kg PO_4^{-3} eq]	8.00E-04	2.46E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-06	0.00E+00	1.71E-05
POCP [kg ethene eq]	5.85E-04	-2.21E-05	7.51E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.41E-06	0.00E+00	1.21E-06
$ADP_{element}$ [kg Sb-eq]	1.24E-06	1.21E-08	1.27E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-09	0.00E+00	6.92E-09
ADP_{fossil} [MJ, LHV]	6.71E+01	1.00E+00	6.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-01	0.00E+00	5.19E-01

4.2. Life Cycle Inventory Results

All results are given per functional unit, which is 1 m^2 of insulation material with a thickness that gives an average thermal resistance RSI = 1 m^2K/W over 75 years.

Table 13: Resource Use

Parameter	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
RPR_E [MJ, LHV]	2.16E+00	4.26E-02	2.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.65E-03	0.00E+00	4.29E-02
RPR_M [MJ, LHV]	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
RPR_T [MJ, LHV]	2.16E+00	4.26E-02	2.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.65E-03	0.00E+00	4.29E-02
$NRPR_E$ [MJ, LHV]	4.54E+01	1.01E+00	4.78E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-01	0.00E+00	5.30E-01
$NRPR_M$ [MJ, LHV]	2.41E+01	0.00E+00	2.41E-01	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
$NRPR_T$ [MJ, LHV]	6.94E+01	1.01E+00	7.19E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-01	0.00E+00	5.30E-01
SM [kg]	3.37E-01	0.00E+00	3.37E-03	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
RSF [MJ, LHV]	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
NRSF [MJ, LHV]	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
RE [MJ, LHV]	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
FW [m^3]	1.23E-02	1.90E-04	1.34E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-05	0.00E+00	7.53E-05

Table 14: Output Flows and Waste Categories

Parameter	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
HWD [kg]	4.45E-05	1.73E-08	4.45E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-09	0.00E+00	3.54E-09
NHWD [kg]	2.00E-02	7.24E-05	1.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.90E-06	0.00E+00	7.94E-01
HLRW [kg]	1.08E-06	2.74E-09	1.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.99E-10	0.00E+00	5.23E-09
ILLRW [kg]	9.00E-04	2.27E-06	9.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-07	0.00E+00	4.49E-06
CRU [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
MR [kg]	4.85E-02	0.00E+00	2.51E-03	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
MER [kg]	2.45E-05	0.00E+00	1.76E-03	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
EEE [MJ]	1.56E-04	0.00E+00	9.28E-03	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
EET [MJ]	3.39E-05	0.00E+00	3.72E-03	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

Table 15: Carbon Emissions and Removals

Parameter	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
BCRP [kg CO2]	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
BCEP [kg CO2]	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
BCRK [kg CO2]	1.09E-03	0.00E+00	-8.09E-04	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
BCEK [kg CO2]	0.00E+00	0.00E+00	2.73E-04	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
BCEW [kg CO2]	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
CCE [kg CO2]	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
CCR [kg CO2]	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
CWNR [kg CO2]	2.67E-04	0.00E+00	2.67E-06	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

5. LCA Interpretation

Overall for DuPont's Styrofoam™ Brand XPS products, Global Warming (GWP) and Abiotic Depletion of fossil fuels are the impact categories of most significance. The largest contributor to the Abiotic Depletion of fossil fuels impacts in A1-A3 is the extraction and use of polymer resin material (76%) during manufacturing. Transport to customer (A4) has the second largest ADP – Fossils impact, mainly due to the transportation via truck to customer. Installation (A5) and end-of-life module (C4) have lesser overall ADP-fossil impacts, which is a result of the materials used for installation and resources used to landfill the product at end-of-life, respectively.

For GWP, the impacts are almost equally distributed across the raw material sourcing and manufacturing process (A1-A3), use phase (B1), and end of life disposal (C4), with the largest contributions resulting from the blowing agent emissions in these stages.

The exact product SKU purchased can affect the final results of the LCA due to the functional unit being highly dependent on the R-value of the product sold. If product-specific results are required beyond what is available in this EPD, please contact a DuPont representative.

6. Additional Environmental Information

6.1. Building Use Stage Benefits

Styrofoam™ brand insulation provides a significant reduction in the energy burden associated with heating and cooling of a building during its entire use phase, relative to the base non-insulated wall [Mazor, 2011]. The energy savings delivered by the insulation, and related GHG savings, can be estimated through mathematical modeling of heat transfer through the non-insulated wall and through the insulated wall, and calculating the difference in heat flow between the two. The energy savings can then be translated into GHG savings using an energy emissions factor, which provides a quantified estimate of life cycle GHG emissions associated with a unit of energy consumption. By comparing the total GHG savings enabled by the use of Styrofoam™ brand insulation to the life cycle GHG emissions (as described by the Life Cycle Impact Assessment GWP 100 values provided in Table 11), the user can better understand the relative benefit in terms of carbon savings overall, and GHG "payback" time.

Examples are provided below that show estimated carbon savings for 4 different example regions in the United States, selected to represent a wide range in ASHRAE climate zones. For this case study, only savings in heating energy required to heat the building in cooler months were considered, as a conservative estimate for understanding the relative size of the GHG savings compared to the life cycle product emissions. Adding in the savings in energy required to cool the building during warmer months would lead to even larger savings estimate and shorter payback times but is not included in this analysis. 'Heating degree days' (HDD) data for each region was taken from a 5 year average of weather data, using the tool provided at www.degreedays.com. An energy emissions factor, providing the GHG emissions associated with a unit consumption of energy, for each region was taken from 2016 data as supplied by the U.S. Energy Information Administration (EIA), which reports the average life cycle GHG emissions (per million BTU) for the total energy consumption of each region including both direct/primary and upstream/secondary contributions.

For this case study, a decrease in the GHG intensity of energy over time, reflective of the urgent action that is needed to address climate change, was incorporated into the analysis. For example, the Science-Based Targets Initiative (SBTi) outlines that an aggressive 85% reduction in carbon intensity of the power sector needs to happen by 2035 to support the 1.5°C pathway of the Paris Agreement on climate change. Incorporating this type of reduction in the energy emissions factor used in the modeling exercise leads to a more realistic estimate of the actual GHG savings that will occur far into the future as the world does what is needed to manage GHG emissions in response to climate change.

To account for this anticipated change, we modeled an exponential reduction in carbon intensity for the electricity portion of the energy consumption, assuming an overall reduction in electricity carbon intensity of 85% reduction from 2020 to 2035 in alignment with SBTi. The fraction of the energy grid that is supplied by electricity was also taken from EIA (Table C1. Total Energy Consumption by Major Fuel, 2012). For the fuel component of the energy consumption, the carbon intensity was held constant until the year 2035. For years beyond 2035, we assumed a further reduction of 2% per year applied to the total energy grid (heat + power), so that the overall energy emissions factor was assumed to continue to decrease beyond 2035.

The annual carbon emissions savings was calculated for the case of 2" of Styrofoam™ brand insulation (R value of 10 °F ft^2 hr/Btu) relative to a non-insulated wall (base R value of 2 °F ft^2 hr/Btu). Each individual year used the corresponding energy emissions factor value as described above. The cumulative carbon emissions savings was calculated as a function of time and a 'carbon payback time' was determined by identifying when the cumulative carbon savings equaled the life cycle GHG emissions associated with the insulation product. Note that the life cycle GHG emissions for the insulation used in this calculation were calculated for a thickness of 2" to achieve an R value of 10 °F ft^2 hr/Btu, based on the value reported in this EPD for R = 1 m^2 K/W (equivalent to 5.678 ft^2 °F hr/BTU). Therefore, the GWP per 1m^2 of 2" insulation is 10/5.678 (or 1.76) times the sum of all GWP impact assessment results reported in Table 11. This GWP value for 2" insulation is reported in the notes beneath Table 16.

Table 16: Use Phase Benefits

Location	HDD [Day °F]	Energy Saved in Heating Annually from 1M^2 of 2" insulation, R=10°F*FT*H/BTU	Starting Energy Emissions Factor [lb CO_2E/MBTU]	CO_2E Saved Over 75 Year Use Phase of a Building [kg]	Carbon Payback Time [Years]
Austin, TX	1,818	201	119.02	265 – 908	14.6 – 33
Nashville, TN	3,260	360	109.78	477 – 1,501	8.8 – 14
Saginaw, MI	6,672	736	118.58	1,275 – 3,318	4.0 – 4.5
Minneapolis, MN	7,253	800	111.1	1,189 – 3,380	3.9 – 4.5

Notes: 2" of a Styrofoam product in the blue line would have a GWP of 176.2 kg CO_2e per 1 m^2, which is (10/5.678), or 1.76 times the sum of all GWP values reported in Table 11; MBTU = million Btu; The range in values for CO2 saved and payback time reflect the constant-energy-emissions-factor and decreasing-energy-emissions-factor scenarios.

6.2. Extraordinary Effects

No extraordinary effects are expected during fire, water, or mechanical destruction events. More information on test results can be found in Section 1.5.

7. References

1. BS EN 15804:2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
2. ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
3. ISO 14025: 2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.

4. ISO 14044: 2006 Environmental Management – Life cycle assessment – Requirements and Guidelines.
5. ISO 14044: 2006/ Amd 1:2017 Environmental Management – Life cycle assessment – Requirements and Guidelines – Amendment 1.
6. Life Cycle Assessment, LCA Report for DuPont Styrofoam™. WAP Sustainability Consulting. October 2020.
7. Mazor et al.; Life Cycle Greenhouse Gas Emissions Reduction From Rigid Thermal Insulation Use in Buildings. J Ind Eco 2011, 15(2), 284-299.
8. Part B: Building Envelope Thermal Insulation EPD Requirements (UL Environment V2.0, 2018
9. Product Category Rule (PCR) for Building-Related Products and Services, Part A: Life Cycle Assessment Calculation Rules and Report Requirements UL 10010. Version 3.2, December 12, 2018.
10. UL General Program Rules v.2.5 March 2020

Upon written request to DuPont, additional explanatory material can be provided to facilitate understanding of the data contained in this declaration.