EverGuard® TPO Roofing Membrane

Smooth Back

Environmental Product Declaration

Program Operator	NSF Certification, LLC 789 N. Dixboro Ann Arbor, MI 48105 www.nsf.org			
General Program instructions and Version Number	PCR for Single Ply Roofing Membranes, Version 2, NSF International and ASTM International			
Manufacturer Name	GAF			
Declaration Number	EPD10289			
Declared Product and Functional Unit	EverGuard® TPO Smooth Back Membrane 1000 m_2 of installed roofing membrane for 75 years, with a thickness of 45 mils (1.14 mm), 60 mils (1.52 mm) or 80 mils (2.03 mm).			
Facilities Included	Gainesville Facility 1301 Corporate Dr, Gainesville, TX 76240	Mt Vernon Facility 901 Givens Rd, Mt Vernon, IN 47620	Cedar City Facility 5080 UT-56 Cedar City, UT 84721	New Columbia Facility 2093 Old Rte 15, New Columbia, PA 17856
Reference PCR and Version Number	PCR for Single Ply Roofing Membranes, Version 2, NSF International			
Product's intended Application and Use	Roofing			
Product RSL	25 Years			
Markets of Applicability	North America			
Date of Issue	December 11th, 2019			
Period of Validity	5 years from date of issue			
EPD Type	Product Specific			
Range of Dataset Variability	N/A			
EPD Scope	Cradle to Grave			
Year of reported manufacturer primary data	2018			
LCA Software and Version Number	GaBi 9.2.0.58			
LCI Database and Version Number	GaBi Database, Service Pack 39			
LCIA Methodology and Version Number	TRACI 2.1 CML 2001-Jan 2016			
The sub-category PCR review was conducted by:	Review Panel chaired by Dr. Thomas Gloria			
This declaration was independently verified in accordance with ISO 14025: 2006 and the reference PCR: PCR for Single Ply Roofing Membranes, Version 2, NSF International and ASTM International ☐ Internal ☐ External	Jenny Oorbeck joorbeck@nsf.org			
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:	Angela Fisher Aspire Sustainability angela@aspiresustainability.com			

Limitations:
Environmental declarations from different programs (ISO 14025) may not be comparable.
Comparison of the environmental performance of Single Ply Membranes 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 Single Ply Membranes 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.

Company Description

Founded in 1886, GAF is the leading roofing manufacturer in North America. As a member of the Standard Industries family of companies, GAF is part of the largest roofing and waterproofing business in the world. The company's products include a comprehensive portfolio of roofing and waterproofing solutions for residential and commercial properties as well as for civil engineering applications. The full GAF portfolio of solutions is supported by an extensive national network of factory-certified contractors. GAF continues to be the leader in quality and offers comprehensive warranty protection on its products and systems. The company's success is driven by a commitment to empowering its people to deliver advanced quality and purposeful innovation. For more information about GAF, visit www.gaf.com.

Product Description

EverGuard® TPO membrane is a single-ply roofing product and is designed to be used as an outer roof layer, either in new construction or re-covering applications. It is made of two layers of thermoplastic polyolefin (TPO) bonded to a layer of polyester scrim in the middle. This configuration meets all the inherent properties and performance which TPO is known for, including excellent seam strength, long-term weathering, natural resistance to fungi, energy savings, and more.

Application

EverGuard® TPO membrane can be installed using various methods, including mechanically attached, RhinoBond®, or adhesive adhered. Acceptable deck types include steel, wood, structural concrete & gypsum, light weighted insulating concrete and cementitious wood fiber.

Technical Data

Table 1: Product Performance Properties

Product	Everguard TPO Smooth Back Membrane			ASTM D6878 Minimum	Test Method
Product Form	Dual layers of TPO reinforced with a layer of PET scrim				-
Nominal Thickness	1.14 mm (45 mil)	1.52 mm (60 mil)	2.03 mm (80 mil)	0.99 mm	ASTM D751
Thickness over Scrim	0.40 mm (15.8 mil)	0.56 mm (22.1 mil)	0.80 mm (31.4 mil)	n/a	ASTM D7635
Breaking Strength	1245.5 x 1201.0 N	1356.7 x 1290.0 N	1490.2 x 1423.4 N	979.6 N	ASTM D751 Grab Method
Factory Seam Strength	489.3 N	600.5 N	711.7 N	293.6 N	ASTM D751
Elongation at Break	30%			15%	ASTM D751
Heating Aging	100% Retention of Breaking Strength & Elongation at Break			90%	ASTM D573
Tear Strength	444.82 x 533.8 N	333.6 x 578.3 N	289.1 x 711.7 N	244.7 N	ASTM D751 8" x 8" Sample
Puncture Resistance	131 kg	172 kg		n/a	FTM 101C Method 2031
Cold Brittleness	-40 °C			-40 °C	ASTM D2137
Permeance	0.08 Perms			n/a	ASTM E96
Dimensional Change	0.4%			+/-1%	ASTM D1204 @ 70°C, 6 hrs
Water Absorption	0.7%			+/-3%	ASTM D471 @ 70 °C, 1 week
Hydrostatic Resistance	380 psi	430 psi		n/a	ASTM D751 Method D
Ozone Resistance	No visible deterioration @7 x magnification				ASTM D1149
Reflectivity (White) Initial/Aged	0.76/0.68			n/a	ASTM C1549
Emissivity (White) Initial/Aged*	0.90/0.83			n/a	ASTM C1371
Weather Resistance	>20,000 KJ/(m²*nm) at 340 nm	>25,000 KJ/(m²*nm) at 340 nm		10080 KJ/(m2,nm) at 340 nm	ASTM G155/D6878
Heating Aging	60 weeks			115 °C for 32 weeks	ASTM D573

*White Membrane Only

Delivery Status
EverGuard® TPO membrane is delivered in rolls with a width of 1.52m (5'), 1.83m (6'), 2.44m (8'), 3.05m (10"), or 3.65m (12'), and a length of 30.5m (100').

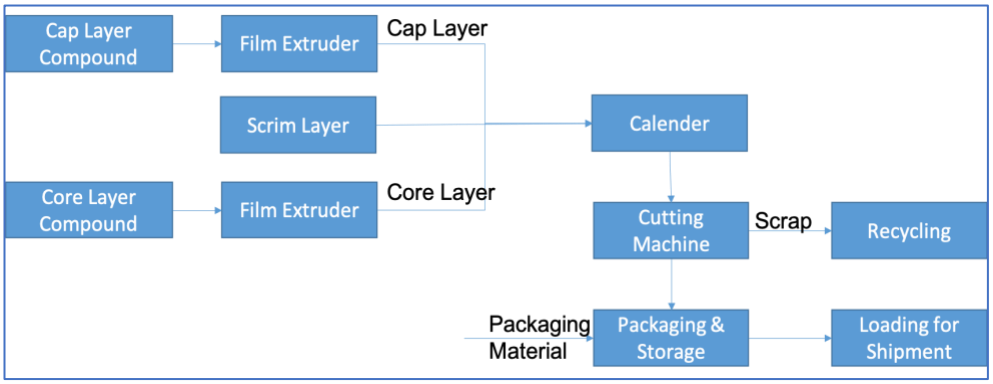
Declaration of Methodological Framework
The type of EPD is cradle-to-grave. All LCA modules are included and are summarized in Table 10.

Material Composition

Table 2: Composition

Material	Mass %
Thermoplastic Olefin	90-96
Proprietary additives	
Polyester	4-8
Internal recycled content	0-8

Manufacturing
This stage includes an aggregation of raw material extraction, supplier processing, delivery, manufacturing and packaging by GAF.



EverGuard® TPO membrane is constructed of three layers, as shown in the table above. The cap and core layers are made of TPO-based compounds and are processed on site. The scrim is purchased in its ready-to-use form from an off-site supplier. To produce the cap and core layers, pre-mixed compounds are fed into extruders, heated and pressurized and then extruded through a die to form films of a required thickness. The cap layer and core layer will join the scrim layer between a series of heated rollers. In this manner, the layers are bound together to form the final membrane. Once bound, the membrane will go through the cutter where it will be cut into specified dimensions. The finished membrane is reeled to a roll, packaged, labelled and moved into storage until it shipped to a job site for customer use.

Environment and Health During Manufacturing
During the manufacturing of EverGuard® TPO membrane, all legal regulations regarding emissions to air, wastewater discharge, solid waste disposal and noise emissions are followed.

Packaging
After manufacturing, the product is prepared for shipment to the customer. The membrane is reeled on a cardboard core and wrapped in plastic film. Additional packaging materials include product labels, a cardboard protective sheet and steel strap. The product is then shipped on wooden pallets to the customer.

Product Installation
There are multiple installation options for EverGuard® TPO membrane. These options include mechanical fasteners, adhesive and RhinoBond®. This EPD provides an average of the installation options. For additional environmental information regarding the specific installation options for your project, please contact GAF.

Some equipment may be necessary during the installation phase. This includes weld seaming adjacent membranes using a hot-air welder. Such installation equipment is required though not included in the study as these are multi-use tools and the impacts per declared unit are assumed to be negligible. However, electricity used to power this equipment during the installation process was evaluated.

Condition of Use
With professional installation and proper use, the condition and material content of EverGuard® TPO membrane remains unchanged throughout the service life.

Environment and Health During Use
No impacts to the environment or the health of the users during the use phase is expected.

Reference Service Life
For this study, the reference service life is assumed to be 25 years, but may vary based on the method of attachment of the membrane. Therefore, after initial installation on a building with a reference service life of 75 years, there will be two replacements needed for this study. Customers should refer to www.gaf.com or their sales representative for more accurate warranty and lifetime information on the product, based on their specific needs.

Extraordinary Effects Fire
Resistance by the roofing system to fire applied to the exterior roof surface is important. Typically, a UL Class A or B rating is required by building code. Occasionally, depending on the use of the building, special resistance to fire applied from within the building is required. This is normally expressed in the form of hourly ratings, and usually requires the use of a specialized roof assembly. Refer to current EverGuard® listings in the appropriate UL directory to verify roof assembly requirements for specific fire ratings.

Extraordinary Effects Water
No environmental impacts are expected due to water exposure of properly installed EverGuard® TPO membrane.

Extraordinary Effects Mechanical Destruction
EverGuard® TPO membrane has excellent mechanical strength. The breaking strength and elongation at break performance are measured by ASTM D751 and test results confirm Everguard® TPO has a breaking strength of > (1245.5 x 1201.0) N and an elongation at break of 30%. The ASTM minimums for these properties are 979.6 N and 15%, respectively.

Re-Use Phase and Disposal
In general, EverGuard® TPO membrane can be recycled if local recycling facilities are available. Re-use after service is not recommended. In this EPD, the impacts in landfilling scenario is declared as the most common disposal option.

Further information

More information about GAF and its products can be found at www.gaf.com.

Functional Unit

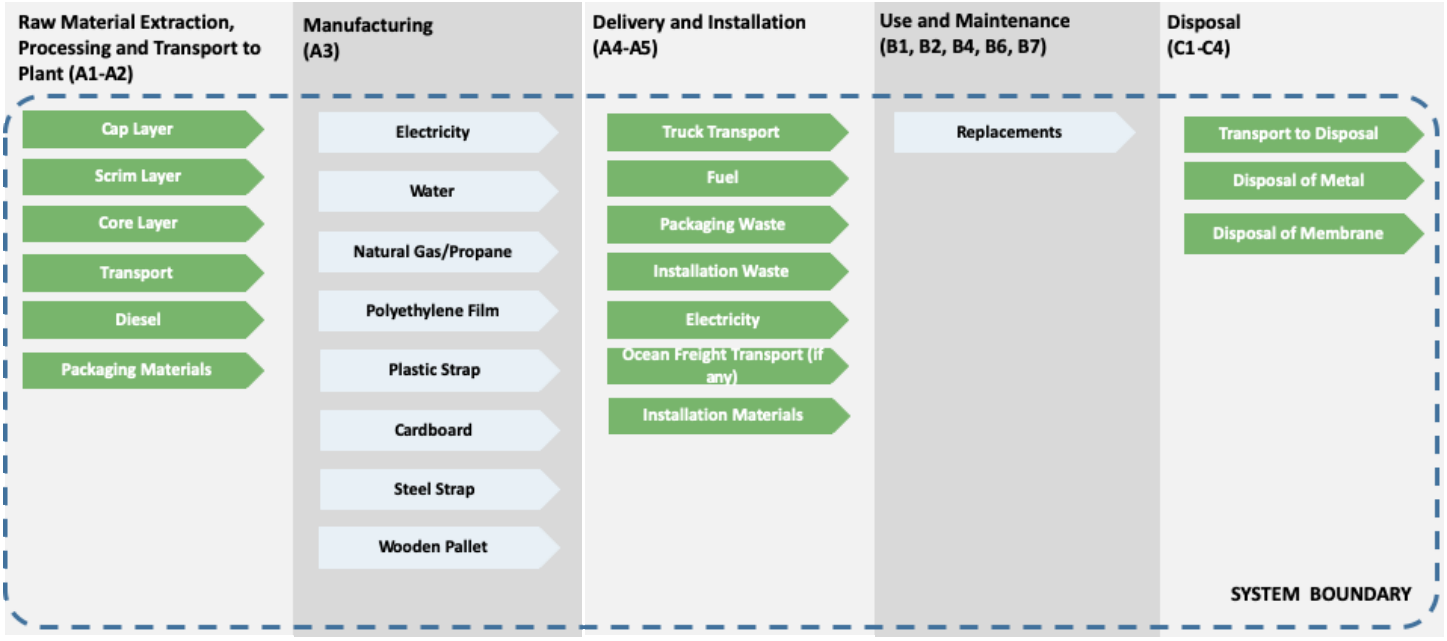
The environmental impacts are declared based on 1000 m_2 of installed EverGuard® TPO membrane over 75 years.

Table 3: Reference Flow for 75 Years

EverGuard® TPO Smooth Back Membrane			
Functional Unit	1000 m_2 of installed roofing membrane for 75 years with a thickness of 45 mils, 60 mils or 80 mils		
Specification	45 mils	60 mils	80 mils
Thickness [mm]	1.14	1.52	2.03
Installation Option	Average*	Average*	Average*
Mass [kg]	1343.56	1712.93	2261.39
Fasteners [kg]	80.22		
Adhesive [kg]	215.05		
* Average indicates that 4 types of installation configurations were considered. These include two mechanical options, an adhered option and a RhinoBond® option.			

System Boundary

The overall system boundary is identified in the flow chart below. This EPD discloses impacts from cradle to grave, including the replacement needed for a use of 75 years.



Cut-Off Rules
All inputs for which data were available were included. 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. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit. Some raw materials were excluded. This was due to lack of adequate representative secondary data within GaBi. However, the excluded materials were significantly below the cut off criteria and include minor additives such as proprietary binders.

Estimates and Assumptions
The compositional data of EverGuard® TPO membrane is based upon typical product performance and is subject to normal manufacturing tolerance and variance. The LCA study is based on nominal values.

Background data
Primary data was collected onsite by GAF associates. This includes electrical and thermal energy, water consumption, waste generation, bill of materials and suppliers. Secondary data including those used to complete the upstream material LCI background data was sourced from GaBi Database, Service Pack 39 and eGRID.

Data Quality
The geographical scope of the manufacturing portion of the life cycle is Gainesville of Texas, Cedar City of Utah, Mount Vernon of Indiana, and New Columbia of Pennsylvania. Site-specific data are collected, and the average are weighted based on the production at each facility. All primary data were collected by the manufacturing facilities. The geographic coverage of primary data is considered excellent. The primary data provided by the manufacturer represent all information for calendar year 2018. Using this data meets the PCR requirements. Time coverage of this data is considered good. Primary data provided by the manufacturer is specific to the technology that GAF uses in manufacturing their product. It is site-specific and considered of good quality. It is worth noting that the energy and water used in manufacturing the product includes overhead energy such as lighting, heating and sanitary use of water. Sub-metering would improve the technological coverage of data quality. Data necessary to model cradle-to-gate unit processes was sourced from GaBi LCI datasets.

Period under Review
Data used in this study was representative of production in calendar year 2018.

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.

Comparability
The user of the EPD should take care when comparing EPDs from different companies. Assumptions, data sources, and assessment tools may all impact the uncertainty of the final results and make comparisons misleading. Even for similar products, differences in use and end-of-life stage assumptions and data quality may produce incomparable results. The user should not compare EPDs unless they are experts in the nuances of Life Cycle Assessment (LCA) practice and methodology and follow comparability best practices.

Scenarios and Additional Technical Information

Transportation to the Construction Site (A4)

Table 4: Transportation Details

Name	Value	Unit
Shipping to Customer	1160.34	km
Shipping to Landfill	32.19	km
Fuel Type	Diesel	-
Liters of Fuel	39.0625	l/100km
Vehicle Type	Truck – Trailer, basic enclosed/45000 lb. payload	
Capacity Utilization	78	%
Gross Density of Products Transported	175.75	Kg/m_3
Weight of Products Transported	20,411.657	Kg
Volume of Products Transported	116.14	M_3
Capacity Utilization Volume Factor	1	-

Installation into the Building (A5)

Table 5: Installation Parameters

Name	Value for Average Installation Option	Unit
Metal Fasteners	80.22	kg
Water Consumption	0	kg
Adhesive	215.05	kg
Electricity Consumption	6.71	kWh
Other Energy Carriers	0	MJ
Material Loss	0	kg
Output Substances Following Waste Treatment on Site	0	kg
Dust in the Air	0	kg
Installation Losses	134.35 (45 mils) 171.29 (60 mils) 226.14 (80 mils)	kg
VOC in adhesive	611	g/L
Overlap (membrane)	3.16%	%

Table 6: A5 Product Packaging Waste

Module	Parameter	Unit	Value
A5	Mass of plastic packaging	kg	5.11
	GWP based in biogenic carbon content of plastic packaging	kg CO2e	0
	Mass of cardboard and paper packaging	kg	30.19
	GWP based in biogenic carbon content of cardboard and paper packaging	kg CO2e	96.03
	Mass of steel packaging	kg	0.43
	GWP based in biogenic carbon content of steel packaging	kg CO2e	0
	Mass of wood packaging	kg	48.14
	GWP based in biogenic carbon content of wood packaging	kg CO2e	78.2

Reference Service Life

Table 7: Product Reference Service Life

Name	Value	Unit
RSL	25	years
Declared product properties (at the gate) and finishes, etc.	See Table 1	-
Design application	Installation per recommendation by manufacturer	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Accepted industry standard	-
Indoor environment (if relevant for indoor applications)	Normal building operating conditions	-
Use conditions, e.g. frequency of use, mechanical exposure	Normal building operating conditions	-

Replacement (B4)

Table 8: Replacement Parameters

Name	Value	Unit
Replacement cycle	0	Number/ RSL
Replacement cycle	2	Number/ ESL
Energy input to power drills and hot-air welders	2.24	kWh/replacement
Net freshwater consumption specified by water source and fate	0	m3/replacement
Adhesive	71.68	kg/replacement

End-of-Life Stage (C1-C4)

Table 9: Disposal Parameters

Product	45 Mils	60 Mils	80 Mils	45 Mils	60 Mils	80 Mils	Unit
	Membrane			Fasteners			
Reuse*	0			0			kg
Recycling*	0			0			kg
Landfilling	1424.26	1756.69	2250.31	80.22			kg
Energy Recovery*	0			0			kg
* The products can also be recycled or incinerated for energy recovery, though only the most common disposal option of landfilling is declared in this EPD.							

LCA Results

All results are given per functional unit, which is 1000 m_2 of installed TPO membrane for 75 years with a thickness of 45 mils (1.14 mm), 60 mils (1.52 mm) or 80 mils (2mm). Environmental impacts were calculated using the GaBi software platform. Impact results have been calculated using both TRACI 2.1 and CML 2001-Jan 2016 characterization factors.

Table 10: Description of the System Boundary

Product Stage			Construction Process Stage		Use Stage							End of Life Stage			
Raw Material Supply	Transportation	Manufacturing	Transportation	Installation	Use	Maintenance	Repair	Refurbishment	Replacement	Operational Energy Use	Operational Water Use	De-construction	Transportation	Waste Processing	Disposal
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Impact Category Keys

Table 11: LCIA Indicators

Abbreviation	Parameter	Unit
CML 2001-Jan 2016		
ADP-elements*	Abiotic depletion potential for non-fossil resources	kg Sb eq
ADP-fossil	Abiotic depletion potential for fossil resources	MJ, net calorific value
AP	Acidification potential of soil and water	kg SO_2 eq
EP	Eutrophication potential	kg Phosphate eq
GWP	Global warming potential	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
POCP	Photochemical ozone creation potential	kg Ethene eq
TRACI 2.1		
AP	Acidification potential of soil and water	kg N eq
EP	Eutrophication potential	kg SO_2 eq
GWP	Global warming potential	kg CO_2 eq
ODP	Depletion of stratospheric ozone layer	kg CFC 11 eq
Resources	Depletion of non-renewable fossil fuels	MJ, surplus energy
POCP	Photochemical ozone creation potential	kg O_3 eq

*Table 12: Life Cycle Inventory Indicators**

Abbreviation	Parameter	Unit
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
RPR_T	Total use of renewable primary energy resources	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
$NRPR_T$	Total use of non-renewable primary energy resources	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
Output Flows and Waste Parameters		
HWD	Hazardous waste disposed	kg
NHWD	Non-hazardous waste disposed	kg
HLRW	High-level radioactive waste disposed	kg
ILLRW	Intermediate and low-level radioactive waste disposed	kg
CRU	Components for reuse	kg
MFR	Materials for recycling	kg
MER	Materials for energy recovery	kg
EE	Exported energy	MJ

*Emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in above categories in Table 11 and Table 12.

1 EverGuard® TPO 45-mil Smooth Back Membrane

1.1 CML Results

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
ADP-elements [kg Sb eq]	6.92E-04	2.12E-05	1.49E-02	0.00E+00	0.00E+00	0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.88E-07	0.00E+00	2.73E-05
ADP-fossil fuel [MJ]	7.41E+04	1.57E+03	2.24E+04	0.00E+00	0.00E+00	0.00E+00	1.98E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.09E+01	0.00E+00	1.03E+03
AP [kg SO2 eq]	6.91E+00	4.19E-01	2.00E+00	0.00E+00	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.51E-03	0.00E+00	8.75E-01
EP [kg Phosphate eq]	6.15E-01	1.16E-01	3.19E-01	0.00E+00	0.00E+00	0.00E+00	2.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E-03	0.00E+00	3.90E-01
GWP [kg CO2 eq]	2.54E+03	1.12E+02	9.96E+02	0.00E+00	0.00E+00	0.00E+00	7.43E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.61E+00	0.00E+00	6.64E+01
ODP [kg CFC 11 eq]	3.21E-11	1.05E-14	1.65E-09	0.00E+00	0.00E+00	0.00E+00	3.36E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-16	0.00E+00	2.41E-13
POCP [kg Ethene eq]	4.57E-01	-1.59E-01	3.21E-01	0.00E+00	0.00E+00	0.00E+00	2.03E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.90E-03	0.00E+00	3.97E-01

1.2 TRACI Results

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
AP [kg SO2 eq]	7.82E+00	5.72E-01	2.26E+00	0.00E+00	0.00E+00	0.00E+00	2.33E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-02	0.00E+00	1.01E+00
EP [kg N eq]	3.94E-01	4.66E-02	1.75E-01	0.00E+00	0.00E+00	0.00E+00	1.99E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-03	0.00E+00	3.80E-01
GWP [kg CO2 eq]	2.51E+03	1.11E+02	9.85E+02	0.00E+00	0.00E+00	0.00E+00	7.36E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+00	0.00E+00	6.60E+01
ODP [kg CFC 11 eq]	-3.61E-10	-5.98E-13	1.69E-09	0.00E+00	0.00E+00	0.00E+00	2.65E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.94E-14	0.00E+00	-3.47E-12
Resources [MJ]	1.00E+04	2.10E+02	2.84E+03	0.00E+00	0.00E+00	0.00E+00	2.65E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.82E+00	0.00E+00	1.33E+02
POCP [kg O3 eq]	8.31E+01	1.31E+01	3.61E+01	0.00E+00	0.00E+00	0.00E+00	2.82E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-01	0.00E+00	8.63E+00

1.3 Resource Use

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
RPR_E [MJ]	5.32E+03	4.88E+01	1.03E+03	0.00E+00	0.00E+00	0.00E+00	1.30E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E+00	0.00E+00	8.05E+01
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
RPR_T [MJ]	5.32E+03	4.88E+01	1.03E+03	0.00E+00	0.00E+00	0.00E+00	1.30E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E+00	0.00E+00	8.05E+01
$NRPR_E$ [MJ]	7.75E+04	1.58E+03	2.30E+04	0.00E+00	0.00E+00	0.00E+00	2.06E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.12E+01	0.00E+00	1.06E+03
$NRPR_M$ [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
$NRPR_T$ [MJ]	7.75E+04	1.58E+03	2.30E+04	0.00E+00	0.00E+00	0.00E+00	2.06E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.12E+01	0.00E+00	1.06E+03
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
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
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
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
FW [m3]	1.18E+01	1.89E-01	4.60E+00	0.00E+00	0.00E+00	0.00E+00	3.35E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.14E-03	0.00E+00	1.25E-01

1.4 Waste

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
HWD [kg]	3.85E-05	1.28E-05	1.29E-05	0.00E+00	0.00E+00	0.00E+00	1.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.15E-07	0.00E+00	3.70E-06
NHWD [kg]	2.61E+01	5.95E-02	1.89E+02	0.00E+00	0.00E+00	0.00E+00	3.43E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.93E-03	0.00E+00	1.50E+03
HLRW [kg]	1.85E-03	4.22E-06	3.30E-04	0.00E+00	0.00E+00	0.00E+00	4.40E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-07	0.00E+00	1.28E-05
ILLRW [kg]	1.35E+00	3.49E-03	2.50E-01	0.00E+00	0.00E+00	0.00E+00	3.22E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-04	0.00E+00	1.02E-02
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
MFR [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
MER [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
EE [MJ]	0.00E+00	0.00E+00	2.57E+01	0.00E+00	0.00E+00	0.00E+00	5.14E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

2 EverGuard® TPO 60-mil Smooth Back Membrane

2.1 CML Results

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
ADP-elements [kg Sb eq]	8.54E-04	2.67E-05	1.49E-02	0.00E+00	0.00E+00	0.00E+00	3.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.40E-07	0.00E+00	3.34E-05
ADP-fossil fuel [MJ]	9.31E+04	1.97E+03	2.43E+04	0.00E+00	0.00E+00	0.00E+00	2.42E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.22E+01	0.00E+00	1.26E+03
AP [kg SO2 eq]	8.70E+00	5.28E-01	2.21E+00	0.00E+00	0.00E+00	0.00E+00	2.51E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-02	0.00E+00	1.08E+00
EP [kg Phosphate eq]	7.59E-01	1.46E-01	3.45E-01	0.00E+00	0.00E+00	0.00E+00	3.47E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.95E-03	0.00E+00	4.81E-01
GWP [kg CO2 eq]	3.19E+03	1.40E+02	1.07E+03	0.00E+00	0.00E+00	0.00E+00	8.96E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.41E+00	0.00E+00	8.11E+01
ODP [kg CFC 11 eq]	3.62E-11	1.33E-14	1.65E-09	0.00E+00	0.00E+00	0.00E+00	3.37E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-16	0.00E+00	2.94E-13
POCP [kg Ethene eq]	5.52E-01	-2.00E-01	3.36E-01	0.00E+00	0.00E+00	0.00E+00	2.35E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.54E-03	0.00E+00	4.90E-01

2.2 TRACI Results

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
AP [kg SO2 eq]	9.87E+00	7.20E-01	2.50E+00	0.00E+00	0.00E+00	0.00E+00	2.87E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-02	0.00E+00	1.24E+00
EP [kg N eq]	4.80E-01	5.87E-02	1.94E-01	0.00E+00	0.00E+00	0.00E+00	2.40E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-03	0.00E+00	4.68E-01
GWP [kg CO2 eq]	3.16E+03	1.40E+02	1.05E+03	0.00E+00	0.00E+00	0.00E+00	8.88E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.40E+00	0.00E+00	8.06E+01
ODP [kg CFC 11 eq]	-4.58E-10	-7.52E-13	1.68E-09	0.00E+00	0.00E+00	0.00E+00	2.44E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.37E-14	0.00E+00	-4.24E-12
Resources [MJ]	1.26E+04	2.64E+02	3.11E+03	0.00E+00	0.00E+00	0.00E+00	3.24E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.32E+00	0.00E+00	1.62E+02
POCP [kg O3 eq]	1.03E+02	1.64E+01	3.86E+01	0.00E+00	0.00E+00	0.00E+00	3.38E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.11E-01	0.00E+00	1.06E+01

2.3 Resource Use

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
RPR_E [MJ]	6.19E+03	6.14E+01	1.12E+03	0.00E+00	0.00E+00	0.00E+00	1.49E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.94E+00	0.00E+00	9.83E+01
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
RPR_T [MJ]	6.19E+03	6.14E+01	1.12E+03	0.00E+00	0.00E+00	0.00E+00	1.49E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.94E+00	0.00E+00	9.83E+01
$NRPR_E$ [MJ]	9.73E+04	1.99E+03	2.50E+04	0.00E+00	0.00E+00	0.00E+00	2.51E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E+01	0.00E+00	1.29E+03
$NRPR_M$ [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
$NRPR_T$ [MJ]	9.73E+04	1.99E+03	2.50E+04	0.00E+00	0.00E+00	0.00E+00	2.51E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E+01	0.00E+00	1.29E+03
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
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
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
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
FW [m3]	1.46E+01	2.38E-01	4.88E+00	0.00E+00	0.00E+00	0.00E+00	3.97E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.50E-03	0.00E+00	1.53E-01

2.4 Waste

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
HWD [kg]	4.83E-05	1.61E-05	1.43E-05	0.00E+00	0.00E+00	0.00E+00	1.67E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.07E-07	0.00E+00	4.52E-06
NHWD [kg]	3.04E+01	7.48E-02	2.22E+02	0.00E+00	0.00E+00	0.00E+00	4.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.36E-03	0.00E+00	1.83E+03
HLRW [kg]	2.24E-03	5.31E-06	3.69E-04	0.00E+00	0.00E+00	0.00E+00	5.26E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-07	0.00E+00	1.57E-05
ILLRW [kg]	1.64E+00	4.39E-03	2.80E-01	0.00E+00	0.00E+00	0.00E+00	3.87E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-04	0.00E+00	1.25E-02
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
MFR [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
MER [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
EE [MJ]	0.00E+00	0.00E+00	2.57E+01	0.00E+00	0.00E+00	0.00E+00	5.14E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

3 EverGuard® TPO 80-mil Smooth Back Membrane

3.1 CML Results

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
ADP-elements [kg Sb eq]	1.10E-03	3.48E-05	1.50E-02	0.00E+00	0.00E+00	0.00E+00	3.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-06	0.00E+00	4.23E-05
ADP-fossil fuel [MJ]	1.21E+05	2.58E+03	2.73E+04	0.00E+00	0.00E+00	0.00E+00	3.06E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.89E+01	0.00E+00	1.59E+03
AP [kg SO2 eq]	1.14E+01	6.89E-01	2.53E+00	0.00E+00	0.00E+00	0.00E+00	3.19E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-02	0.00E+00	1.37E+00
EP [kg Phosphate eq]	9.74E-01	1.90E-01	3.85E-01	0.00E+00	0.00E+00	0.00E+00	4.33E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.75E-03	0.00E+00	6.15E-01
GWP [kg CO2 eq]	4.16E+03	1.83E+02	1.17E+03	0.00E+00	0.00E+00	0.00E+00	1.12E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.59E+00	0.00E+00	1.03E+02
ODP [kg CFC 11 eq]	4.24E-11	1.73E-14	1.65E-09	0.00E+00	0.00E+00	0.00E+00	3.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E-16	0.00E+00	3.74E-13
POCP [kg Ethene eq]	6.93E-01	-2.61E-01	3.57E-01	0.00E+00	0.00E+00	0.00E+00	2.82E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.49E-03	0.00E+00	6.27E-01

3.2 TRACI Results

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
AP [kg SO2 eq]	1.29E+01	9.40E-01	2.86E+00	0.00E+00	0.00E+00	0.00E+00	3.66E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.76E-02	0.00E+00	1.58E+00
EP [kg N eq]	6.08E-01	7.66E-02	2.22E-01	0.00E+00	0.00E+00	0.00E+00	3.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-03	0.00E+00	5.99E-01
GWP [kg CO2 eq]	4.12E+03	1.83E+02	1.16E+03	0.00E+00	0.00E+00	0.00E+00	1.11E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.58E+00	0.00E+00	1.02E+02
ODP [kg CFC 11 eq]	-6.01E-10	-9.82E-13	1.67E-09	0.00E+00	0.00E+00	0.00E+00	2.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.01E-14	0.00E+00	-5.38E-12
Resources [MJ]	1.65E+04	3.45E+02	3.50E+03	0.00E+00	0.00E+00	0.00E+00	4.11E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E+01	0.00E+00	2.05E+02
POCP [kg O3 eq]	1.33E+02	2.15E+01	4.24E+01	0.00E+00	0.00E+00	0.00E+00	4.21E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.95E-01	0.00E+00	1.34E+01

3.3 Resource Use

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
RPR_E [MJ]	7.49E+03	8.02E+01	1.25E+03	0.00E+00	0.00E+00	0.00E+00	1.79E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E+00	0.00E+00	1.25E+02
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
RPR_T [MJ]	7.49E+03	8.02E+01	1.25E+03	0.00E+00	0.00E+00	0.00E+00	1.79E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E+00	0.00E+00	1.25E+02
$NRPR_E$ [MJ]	1.27E+05	2.59E+03	2.81E+04	0.00E+00	0.00E+00	0.00E+00	3.18E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.94E+01	0.00E+00	1.63E+03
$NRPR_M$ [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
$NRPR_T$ [MJ]	1.27E+05	2.59E+03	2.81E+04	0.00E+00	0.00E+00	0.00E+00	3.18E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.94E+01	0.00E+00	1.63E+03
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
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
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
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
FW [m3]	1.87E+01	3.11E-01	5.30E+00	0.00E+00	0.00E+00	0.00E+00	4.89E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.52E-03	0.00E+00	1.94E-01

3.4 Waste

	Product Stage	Construction Stage		Use Stage							End of Life Stage			
Impact Category	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**
HWD [kg]	6.27E-05	2.10E-05	1.64E-05	0.00E+00	0.00E+00	0.00E+00	2.13E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.43E-07	0.00E+00	5.73E-06
NHWD [kg]	3.66E+01	9.77E-02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	5.26E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.99E-03	0.00E+00	2.32E+03
HLRW [kg]	2.82E-03	6.93E-06	4.27E-04	0.00E+00	0.00E+00	0.00E+00	6.55E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-07	0.00E+00	1.99E-05
ILLRW [kg]	2.07E+00	5.74E-03	3.23E-01	0.00E+00	0.00E+00	0.00E+00	4.83E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.76E-04	0.00E+00	1.58E-02
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
MFR [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
MER [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
EE [MJ]	0.00E+00	0.00E+00	2.57E+01	0.00E+00	0.00E+00	0.00E+00	5.14E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Biogenic Carbon Removals and Emissions

	Parameter	TPO Smooth Back 45 mil	TPO Smooth Back 60 mil	TPO Smooth Back 80 mil	Unit
BCRP	Biogenic Carbon Removal from Product	9.16E+01	1.13E+02	1.44E+02	[kg CO2]
BCEP	Biogenic Carbon Emission from Product	9.70E+01	1.19E+02	1.52E+02	[kg CO2]
BCRK	Biogenic Carbon Removal from Packaging	1.79E+02	1.80E+02	1.81E+02	[kg CO2]
BCEK	Biogenic Carbon Emission from Packaging	7.28E+01	7.35E+01	7.45E+01	[kg CO2]

Interpretation

Abiotic Depletion of fossil fuels, Acidification Potential, and Global Warming Potential share a similar pattern that the production stages (A1-A3) contribute the most to the impacts followed by installation stage (A5). This is because the major ingredient of the product, polyolefin resin, is a fossil fuel-based material and the installation involves the using of adhesive that is also made of fossil fuel-based material. The extraction of fossil fuel and the production of polyolefin resin is positively related to fossil fuel depletion, acidification and global warming. This is a consistent finding across all different thickness. From the angle of a 75-year period, the impact from replacement stage (B4) is largest, but in one reference service life of the products, the vast majority of impacts are related to the sourcing, raw material transportation and manufacturing phases of the life cycle of the product. The third largest impactful life cycle stage is the installation of the product and the need for installation materials.

Since the replacement is responsible for the largest portion of the overall impact, product performance and durability are important. By improving the durability and prolong the reference service life, the impact across the building service life will be alleviated.

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