



EverGuard® Extreme TPO Roofing Membrane

Smooth Back

Environmental Product Declaration



| | | | |
|--|--|---|---|
| Program Operator | NSF Certification, LLC 789 N. Dixboro Ann Arbor, MI 48105 www.nsf.org | | Certified Environmental Product Declaration 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 | EPD10290 | | |
| Declared Product and Functional Unit | EverGuard® Extreme TPO Smooth Back Membrane 1000 m ² of installed roofing membrane for 75 years, with a thickness of 50 mils (1.27 mm), 60 mils (1.52 mm), 70 mils (1.78 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 11 th , 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@aspireustainability.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® Extreme 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® Extreme 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® Extreme TPO Smooth Back Membrane | | | | ASTM D6878 Minimum | Test Method |
|-----------------------------------|---|--------------------|--------------------|-------------------|-----------------------------|---------------------------|
| Product Form | Dual layers of Extreme TPO reinforced with a layer of PET scrim | | | | | - |
| Nominal Thickness | 1.27 mm (50 mil) | 1.52 mm (60 mil) | 1.78 mm (70 mil) | 2.03 mm (80 mil) | 0.99 mm | ASTM D751 |
| Thickness over Scrim | 0.45 mm (17.9 mil) | 0.55 mm (21.5 mil) | 0.65 mm (25.7 mil) | 0.8 mm (31.5 mil) | n/a | ASTM D7635 |
| Breaking Strength | 1356.7 x 1290.0 N | | 1490.2 x 1423.4 N | | 979.6 N | ASTM D751 Grab Method |
| Factory Seam Strength | 667.2 N | | 734.0 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 | 311.4 x 489.3 N | 289.1 x 578.3 N | 266.9 x 667.2 N | | 244.7 N | ASTM D751 8" x 8" Sample |
| Puncture Resistance | 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 | 430 psi | | | | n/a | ASTM D751 Method D |
| Ozone Resistance | No visible deterioration @ 7 x magnification | | | | | ASTM D1149 |
| Reflectivity (White) Initial/Aged | 0.835/0.72 | | | | n/a | ASTM C1549 |
| Emissivity (White) Initial/Aged* | 0.84/0.91 | | | | n/a | ASTM C1371 |
| Weather Resistance | >46,000 KJ/(m2*nm) at 340 nm | | | | 10080 KJ/(m2, nm) at 340 nm | ASTM G155/D6878 |
| Heating Aging | 128 weeks | | | | 115 °C for 32 weeks | ASTM D573 |

*White Membrane Only



Delivery Status

EverGuard® Extreme TPO membrane is delivered in various roll sizes. 50-mil and 60-mil membranes are in 1.21 m (4'), 1.52 m (5'), 2.44 m (8') or 3.05 m (10') in width and 30.5 m (100') in length. 70-mil and 80-mil membranes are in 1.52 m (5') or 3.05 m (10') in width and 30.5 m (100') in length.

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

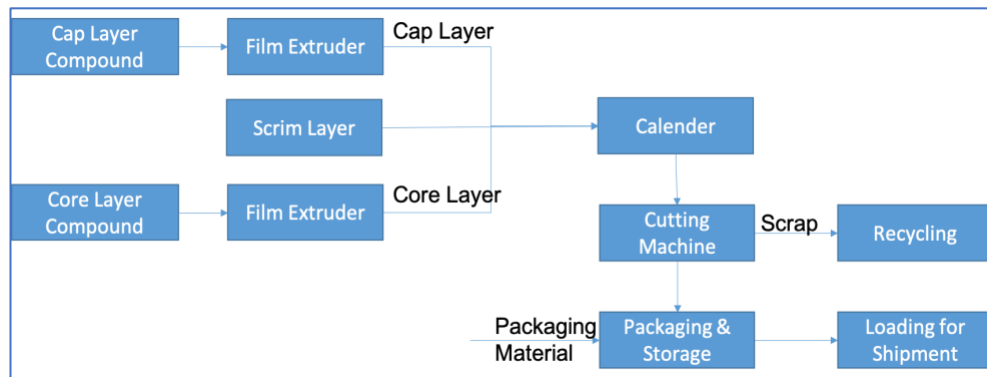
Table 2: Composition

| Material | Mass % |
|---------------------------|--------|
| Thermoplastic Olefin | 90-96 |
| Proprietary Additives | |
| Polyester | 4-8 |
| Internal Recycled Content | 0-2 |

Manufacturing

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

EverGuard® Extreme 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® Extreme 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® Extreme 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® Extreme 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® Extreme TPO membrane.

Extraordinary Effects Mechanical Destruction

EverGuard® Extreme TPO membrane has excellent mechanical strength. The breaking strength and elongation at break performance are measured by ASTM D751 and test results confirm Everguard® Extreme TPO has a breaking strength of > (1356.7 x 1290.0) N and an elongation at break of 25%. The ASTM minimums for these properties are 979.6 N and 15%, respectively.

Re-Use Phase and Disposal

In general, EverGuard® Extreme TPO membrane can be recycled if local recycling facilities are available. Re-use after service is not recommended. In this EPD, the impacts of a 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

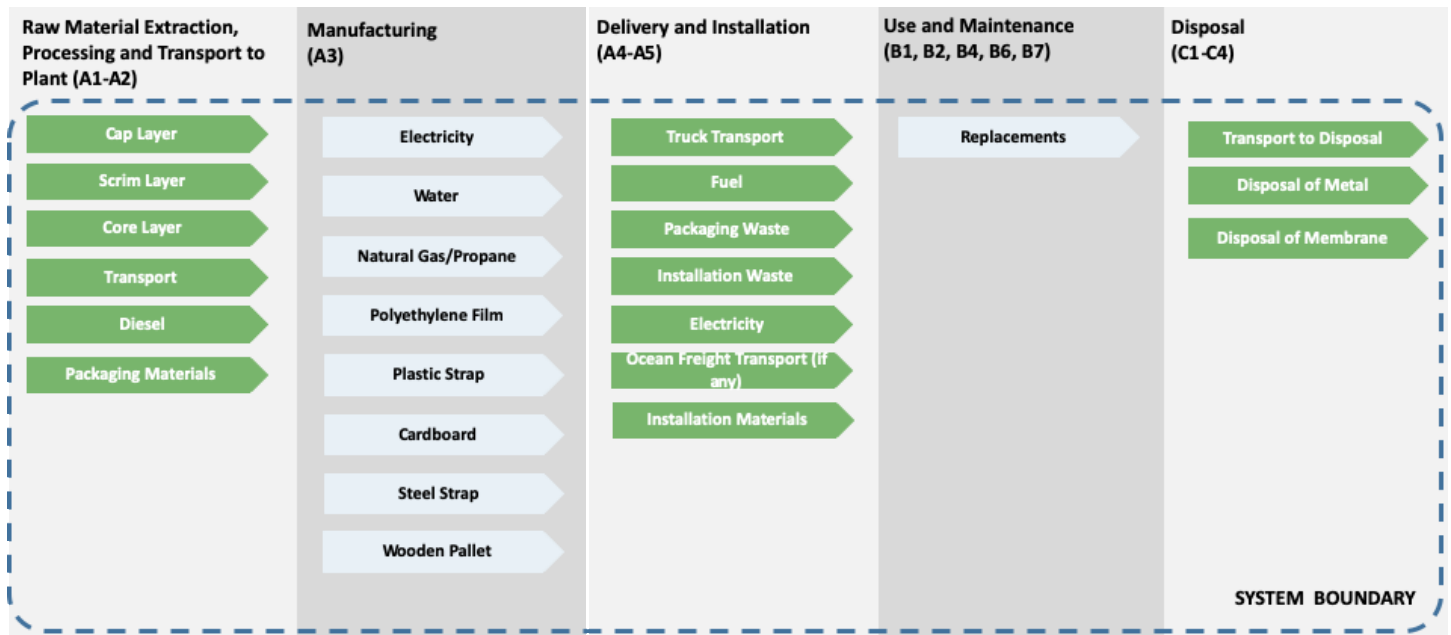
The environmental impacts are declared based on 1000 m² of installed EverGuard® Extreme TPO membrane over 75 years.

Table 3: Reference Flow for 75 Years

| EverGuard® Extreme 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 | 50 mils | 60 mils | 70 mils | 80 mils |
| Thickness [mm] | 1.27 | 1.52 | 1.78 | 2.03 |
| Installation Option | Average* | | | |
| Mass [kg] | 1435.04 | 1721.96 | 2008.89 | 2273.32 |
| Fasteners [kg] | 81.38 | | | |
| 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® Extreme 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 | 81.38 | kg |
| Water Consumption | 0 | kg |
| Adhesive | 215.05 | kg |
| Electricity Consumption | 7.14 | 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 | 143.51 (50 mils) 172.19 (60 mils) 200.89 (70 mils) 227.34 (80 mils) | kg |
| VOC in adhesive | 611 | g/L |
| Overlap (membrane) | 3.70% | % |

Table 6: A5 Product Packaging Waste

| Module | Parameter | Unit | Value |
|--------|---|----------------------|-------|
| A5 | Mass of plastic packaging | kg | 5.14 |
| | GWP based in biogenic carbon content of plastic packaging | kg CO ₂ e | 0 |
| | Mass of cardboard and paper packaging | kg | 30.35 |
| | GWP based in biogenic carbon content of cardboard and paper packaging | kg CO ₂ e | 96.53 |
| | Mass of steel packaging | kg | 0.43 |
| | GWP based in biogenic carbon content of steel packaging | kg CO ₂ e | 0 |
| | Mass of wood packaging | kg | 48.52 |
| | GWP based in biogenic carbon content of wood packaging | kg CO ₂ e | 78.6 |



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 | 2.38 | 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

| Name | 50 Mils | 60 Mils | 70 Mils | 80 Mils | 50 Mils | 60 Mils | 70 Mils | 80 Mils | Unit |
|------------------|----------|---------|---------|---------|-----------|---------|---------|---------|------|
| | Membrane | | | | Fasteners | | | | |
| Reuse* | 0 | | | | 0 | | | | kg |
| Recycling* | 0 | | | | 0 | | | | kg |
| Landfilling | 1506.58 | 1764.82 | 2023.05 | 2261.03 | 81.38 | | | | kg |
| Energy Recovery* | 0 | | | | 0 | | | | kg |

* Though the products can also be recycled or incinerated for energy recovery, only the most common disposal option of landfilling is declared in the EPD.



LCA Results

All results are given per functional unit, which is 1000 m² of installed Extreme TPO membrane for 75 years with a thickness of 50 mils (1.27 mm), 60 mils (1.52 mm), 70 mils (1.78 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® Extreme TPO 50-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] | 7.52E-04 | 2.26E-05 | 1.51E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.19E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.27E-07 | 0.00E+00 | 2.88E-05 |
| ADP-fossil fuel [MJ] | 7.67E+04 | 1.67E+03 | 2.27E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.04E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.38E+01 | 0.00E+00 | 1.09E+03 |
| AP [kg SO2 eq] | 8.16E+00 | 4.46E-01 | 2.15E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.34E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.98E-03 | 0.00E+00 | 9.25E-01 |
| EP [kg Phosphate eq] | 5.80E-01 | 1.23E-01 | 3.19E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.88E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.55E-03 | 0.00E+00 | 4.13E-01 |
| GWP [kg CO2 eq] | 2.62E+03 | 1.19E+02 | 1.01E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.64E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.81E+00 | 0.00E+00 | 7.01E+01 |
| ODP [kg CFC 11 eq] | 3.27E-11 | 1.12E-14 | 1.66E-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 | 3.61E-16 | 0.00E+00 | 2.55E-13 |
| POCP [kg Ethene eq] | 6.23E-01 | -1.69E-01 | 3.40E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.42E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -3.06E-03 | 0.00E+00 | 4.20E-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] | 9.20E+00 | 6.09E-01 | 2.42E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.66E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.20E-02 | 0.00E+00 | 1.06E+00 |
| EP [kg N eq] | 3.87E-01 | 4.96E-02 | 1.78E-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 | 1.11E-03 | 0.00E+00 | 4.02E-01 |
| GWP [kg CO2 eq] | 2.59E+03 | 1.18E+02 | 9.99E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.57E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.80E+00 | 0.00E+00 | 6.97E+01 |
| ODP [kg CFC 11 eq] | -3.71E-10 | -6.36E-13 | 1.70E-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 | -2.05E-14 | 0.00E+00 | -3.66E-12 |
| Resources [MJ] | 1.04E+04 | 2.23E+02 | 2.88E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.73E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.20E+00 | 0.00E+00 | 1.40E+02 |
| POCP [kg O3 eq] | 8.01E+01 | 1.39E+01 | 3.61E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.79E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.69E-01 | 0.00E+00 | 9.11E+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] | 5.46E+03 | 5.19E+01 | 1.05E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.33E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.67E+00 | 0.00E+00 | 8.50E+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] | 5.46E+03 | 5.19E+01 | 1.05E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.33E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.67E+00 | 0.00E+00 | 8.50E+01 | |
| NRPR _E [MJ] | 8.03E+04 | 1.68E+03 | 2.33E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.13E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.41E+01 | 0.00E+00 | 1.11E+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] | 8.03E+04 | 1.68E+03 | 2.33E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.13E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.41E+01 | 0.00E+00 | 1.11E+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] | 1.25E+01 | 2.01E-01 | 4.67E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.50E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.49E-03 | 0.00E+00 | 1.32E-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] | 3.22E-05 | 1.36E-05 | 1.25E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.25E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.38E-07 | 0.00E+00 | 3.90E-06 | |
| NHWD [kg] | 2.76E+01 | 6.33E-02 | 1.97E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.62E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.04E-03 | 0.00E+00 | 1.58E+03 | |
| HLRW [kg] | 1.93E-03 | 4.49E-06 | 3.39E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.58E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.45E-07 | 0.00E+00 | 1.36E-05 | |
| ILLRW [kg] | 1.41E+00 | 3.72E-03 | 2.57E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.36E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.20E-04 | 0.00E+00 | 1.08E-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 | 2.58E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.17E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |



2 EverGuard® Extreme 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] | 8.82E-04 | 2.68E-05 | 1.52E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.22E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.45E-07 | 0.00E+00 | 3.35E-05 |
| ADP-fossil fuel [MJ] | 9.11E+04 | 1.98E+03 | 2.42E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.37E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.25E+01 | 0.00E+00 | 1.26E+03 |
| AP [kg SO2 eq] | 9.73E+00 | 5.31E-01 | 2.33E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.74E+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] | 6.76E-01 | 1.47E-01 | 3.38E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.29E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.97E-03 | 0.00E+00 | 4.83E-01 |
| GWP [kg CO2 eq] | 3.11E+03 | 1.41E+02 | 1.06E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.79E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.43E+00 | 0.00E+00 | 8.15E+01 |
| ODP [kg CFC 11 eq] | 3.58E-11 | 1.33E-14 | 1.66E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.39E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.20E-16 | 0.00E+00 | 2.96E-13 |
| POCP [kg Ethene eq] | 7.27E-01 | -2.01E-01 | 3.54E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.74E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -3.56E-03 | 0.00E+00 | 4.92E-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] | 1.10E+01 | 7.24E-01 | 2.62E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.40E-02 | 0.00E+00 | 1.24E+00 |
| EP [kg N eq] | 4.47E-01 | 5.90E-02 | 1.92E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.34E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.29E-03 | 0.00E+00 | 4.70E-01 |
| GWP [kg CO2 eq] | 3.08E+03 | 1.41E+02 | 1.05E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.71E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.42E+00 | 0.00E+00 | 8.10E+01 |
| ODP [kg CFC 11 eq] | -4.42E-10 | -7.56E-13 | 1.69E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.49E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -2.38E-14 | 0.00E+00 | -4.26E-12 |
| Resources [MJ] | 1.23E+04 | 2.66E+02 | 3.08E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.17E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.37E+00 | 0.00E+00 | 1.63E+02 |
| POCP [kg O3 eq] | 9.39E+01 | 1.65E+01 | 3.79E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.18E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.13E-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] | 6.12E+03 | 6.18E+01 | 1.12E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.48E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.95E+00 | 0.00E+00 | 9.88E+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] | 6.12E+03 | 6.18E+01 | 1.12E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.48E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.95E+00 | 0.00E+00 | 9.88E+01 | |
| NRPR _E [MJ] | 9.52E+04 | 2.00E+03 | 2.49E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.47E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.29E+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] | 9.52E+04 | 2.00E+03 | 2.49E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.47E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.29E+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 | 2.39E-01 | 4.89E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.98E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.54E-03 | 0.00E+00 | 1.54E-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] | 3.79E-05 | 1.62E-05 | 1.33E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.45E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.10E-07 | 0.00E+00 | 4.54E-06 | |
| NHWD [kg] | 3.09E+01 | 7.52E-02 | 2.24E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.19E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.37E-03 | 0.00E+00 | 1.84E+03 | |
| HLRW [kg] | 2.23E-03 | 5.33E-06 | 3.69E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.25E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.68E-07 | 0.00E+00 | 1.58E-05 | |
| ILLRW [kg] | 1.63E+00 | 4.42E-03 | 2.80E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.86E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.39E-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 | 2.58E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.17E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |



3 EverGuard® Extreme TPO 70-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] | 1.01E-03 | 3.11E-05 | 1.52E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.25E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.63E-07 | 0.00E+00 | 3.82E-05 |
| ADP-fossil fuel [MJ] | 1.05E+05 | 2.30E+03 | 2.57E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.70E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.13E+01 | 0.00E+00 | 1.44E+03 |
| AP [kg SO2 eq] | 1.13E+01 | 6.15E-01 | 2.51E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.13E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.19E-02 | 0.00E+00 | 1.24E+00 |
| EP [kg Phosphate eq] | 7.73E-01 | 1.70E-01 | 3.58E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.71E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.38E-03 | 0.00E+00 | 5.53E-01 |
| GWP [kg CO2 eq] | 3.60E+03 | 1.64E+02 | 1.11E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.94E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.05E+00 | 0.00E+00 | 9.29E+01 |
| ODP [kg CFC 11 eq] | 3.89E-11 | 1.54E-14 | 1.66E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.39E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.79E-16 | 0.00E+00 | 3.37E-13 |
| POCP [kg Ethene eq] | 8.31E-01 | -2.33E-01 | 3.69E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.05E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -4.06E-03 | 0.00E+00 | 5.64E-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] | 1.28E+01 | 8.39E-01 | 2.83E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.57E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.59E-02 | 0.00E+00 | 1.42E+00 |
| EP [kg N eq] | 5.08E-01 | 6.83E-02 | 2.06E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.65E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.47E-03 | 0.00E+00 | 5.39E-01 |
| GWP [kg CO2 eq] | 3.56E+03 | 1.63E+02 | 1.10E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.85E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.04E+00 | 0.00E+00 | 9.23E+01 |
| ODP [kg CFC 11 eq] | -5.14E-10 | -8.77E-13 | 1.69E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.33E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -2.72E-14 | 0.00E+00 | -4.85E-12 |
| Resources [MJ] | 1.43E+04 | 3.08E+02 | 3.28E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.61E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.54E+00 | 0.00E+00 | 1.85E+02 |
| POCP [kg O3 eq] | 1.08E+02 | 1.91E+01 | 3.97E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.58E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.57E-01 | 0.00E+00 | 1.21E+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] | 6.78E+03 | 7.16E+01 | 1.19E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.63E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E+00 | 0.00E+00 | 1.13E+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] | 6.78E+03 | 7.16E+01 | 1.19E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.63E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E+00 | 0.00E+00 | 1.13E+02 | |
| NRPR _E [MJ] | 1.10E+05 | 2.31E+03 | 2.64E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.81E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.17E+01 | 0.00E+00 | 1.48E+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] | 1.10E+05 | 2.31E+03 | 2.64E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.81E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.17E+01 | 0.00E+00 | 1.48E+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] | 1.67E+01 | 2.77E-01 | 5.11E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.46E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.59E-03 | 0.00E+00 | 1.75E-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] | 4.36E-05 | 1.87E-05 | 1.42E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.65E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.81E-07 | 0.00E+00 | 5.17E-06 | |
| NHWD [kg] | 3.43E+01 | 8.72E-02 | 2.50E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.76E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.70E-03 | 0.00E+00 | 2.10E+03 | |
| HLRW [kg] | 2.53E-03 | 6.18E-06 | 4.00E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.91E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.92E-07 | 0.00E+00 | 1.80E-05 | |
| ILLRW [kg] | 1.86E+00 | 5.12E-03 | 3.03E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.36E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.59E-04 | 0.00E+00 | 1.43E-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 | 2.58E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.17E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |



4 EverGuard® Extreme TPO 80-mil Smooth Back Membrane

4.1 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] | 1.13E-03 | 3.50E-05 | 1.52E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.28E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.07E-06 | 0.00E+00 | 4.25E-05 |
| ADP-fossil fuel [MJ] | 1.19E+05 | 2.59E+03 | 2.70E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.00E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.93E+01 | 0.00E+00 | 1.60E+03 |
| AP [kg SO2 eq] | 1.27E+01 | 6.93E-01 | 2.67E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.50E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.33E-02 | 0.00E+00 | 1.38E+00 |
| EP [kg Phosphate eq] | 8.62E-01 | 1.91E-01 | 3.75E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.10E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.77E-03 | 0.00E+00 | 6.18E-01 |
| GWP [kg CO2 eq] | 4.05E+03 | 1.84E+02 | 1.16E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.62E+00 | 0.00E+00 | 1.03E+02 |
| ODP [kg CFC 11 eq] | 4.18E-11 | 1.74E-14 | 1.66E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.40E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.33E-16 | 0.00E+00 | 3.75E-13 |
| POCP [kg Ethene eq] | 9.27E-01 | -2.62E-01 | 3.82E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.34E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -4.51E-03 | 0.00E+00 | 6.30E-01 |

4.2 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] | 1.44E+01 | 9.45E-01 | 3.02E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.99E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.77E-02 | 0.00E+00 | 1.59E+00 |
| EP [kg N eq] | 5.64E-01 | 7.70E-02 | 2.18E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.93E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.64E-03 | 0.00E+00 | 6.02E-01 |
| GWP [kg CO2 eq] | 4.01E+03 | 1.84E+02 | 1.15E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.09E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.61E+00 | 0.00E+00 | 1.03E+02 |
| ODP [kg CFC 11 eq] | -5.80E-10 | -9.87E-13 | 1.68E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.18E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -3.02E-14 | 0.00E+00 | -5.40E-12 |
| Resources [MJ] | 1.61E+04 | 3.47E+02 | 3.46E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.02E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.06E+01 | 0.00E+00 | 2.06E+02 |
| POCP [kg O3 eq] | 1.20E+02 | 2.16E+01 | 4.13E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.94E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.97E-01 | 0.00E+00 | 1.35E+01 |



4.3 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] | 7.39E+03 | 8.06E+01 | 1.25E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.77E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.47E+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] | 7.39E+03 | 8.06E+01 | 1.25E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.77E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.47E+00 | 0.00E+00 | 1.25E+02 | |
| NRPR _E [MJ] | 1.24E+05 | 2.60E+03 | 2.78E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.98E+01 | 0.00E+00 | 1.64E+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] | 1.24E+05 | 2.60E+03 | 2.78E+04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.98E+01 | 0.00E+00 | 1.64E+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 | 3.12E-01 | 5.31E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.90E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.57E-03 | 0.00E+00 | 1.95E-01 | |

4.4 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] | 4.88E-05 | 2.11E-05 | 1.51E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.83E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-07 | 0.00E+00 | 5.76E-06 | |
| NHWD [kg] | 3.74E+01 | 9.82E-02 | 2.74E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.29E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.01E-03 | 0.00E+00 | 2.33E+03 | |
| HLRW [kg] | 2.80E-03 | 6.96E-06 | 4.27E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.52E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.13E-07 | 0.00E+00 | 2.00E-05 | |
| ILLRW [kg] | 2.06E+00 | 5.77E-03 | 3.23E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.82E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.77E-04 | 0.00E+00 | 1.59E-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 | 2.58E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.17E+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 | Extreme TPO Smooth Back 50 mil | Extreme TPO Smooth Back 60 mil | Extreme TPO Smooth Back 70 mil | Extreme TPO Smooth Back 80 mil | Unit |
|------|---|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------|
| BCRP | Biogenic Carbon Removal from Product | 9.46E+01 | 1.10E+02 | 1.26E+02 | 1.41E+02 | [kg CO ₂] |
| BCEP | Biogenic Carbon Emission from Product | 1.01E+02 | 1.18E+02 | 1.35E+02 | 1.50E+02 | [kg CO ₂] |
| BCRK | Biogenic Carbon Removal from Packaging | 1.80E+02 | 1.81E+02 | 1.82E+02 | 1.82E+02 | [kg CO ₂] |
| BCEK | Biogenic Carbon Emission from Packaging | 7.34E+01 | 7.39E+01 | 7.44E+01 | 7.49E+01 | [kg CO ₂] |



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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