ENVIRONMENTAL
PRODUCT
DECLARATION

SBS-MODIFIED BITUMEN MEMBRANES

PANELIZED BASE SHEET

Specialized in the development and manufacturing of insulation, vegetated and soundproofing products and solutions for the roofing, building envelope and civil engineering fields worldwide, SOPREMA is pleased to present the environmental product declaration (EPD) of its panelized SBS-modified bitumen membranes.

This EPD presents the results of the life cycle assessment (LCA) of the panelized SBS-modified bitumen membranes, encompassing the raw materials supply, manufacturing, transport, installation, use, and end-of-life stages (i.e., cradle to grave).

The EPD was prepared by CT Consultant according to the prescribed product category rules (PCRs), ISO 14025:2006 and ISO 21930:2017, and verified by Marie Bellemare Consulting.

For more information about SOPREMA, visit https://www.soprema.ca/en/

ASTM INTERNATIONAL
Helping our world work better

1| GENERAL INFORMATION

Program operator	**ASTM International** 100 Barr Harbor Drive West Conshohocken, PA 19428 United States of America (USA) www.astm.org
General program instructions	ASTM International. General program instructions for environmental product declarations. https://www.astm.org/products-services/certification/environmental-product-declarations.html
EPD recipient organization, ownership and liability	**SOPREMA** 1688 Jean-Berchmans-Michaud Street Drummondville, Quebec Canada J2C8E9 www.soprema.ca/en
EPD registration number	EPD 970
Product	SBS-modified bitumen membranes – Panelized base sheet
Functional unit	100 m^2 [1076.4 ft^2] of installed SBS-modified bitumen membrane (base and cap sheets) including resurfacing and replacement for the 75-year estimated building service life.
Reference product category rules (PCR)	PCR Part A: UL Environment Building Related Products and Services. Life cycle assessment calculation rules and report requirements, v4.0. March 2022. Standard UL 10010. [1] PCR Part B: UL Environment Building Related Products and Services. Asphalt shingles, built-up asphalt membrane roofing and modified bituminous membrane roofing EPD requirements, v1.2. May 2021. Standard UL 10010-11. [2]
Product reference service life	25 years
Market of applicability	North America
Date of issue	May 8, 2025
Period of validity	May 2025 – May 2030
EPD type	Product-specific
Dataset variability	Not applicable
EPD scope	Cradle to grave
Reference period	2022
LCA software	openLCA v2.02 [3]
LCI database	Ecoinvent v3.9.1, Cut-off by classification [4]
LCIA method	IPCC 2013 [5], TRACI 2.1 [6] and CML-baseline 4.7 [7]
The sub-category PCR review was conducted by:	Thomas Gloria, PhD Industrial Ecology 35 Bracebridge Road, Newton United States of America (USA) (617) 533-4929 t.gloria@industrial-ecology.com
The life cycle assessment was independently verified in accordance with ISO 14044:2006 and the reference PCRs. This declaration was independently verified in accordance with ISO 14025:2006. The UL Environment "Part A: Life cycle assessment calculation rules and report requirements", v4.0 (March 2022), in conformance with ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017).	☐ INTERNAL ☒ EXTERNAL Marie Bellemare Consulting
This life cycle assessment was conducted in accordance with ISO 14044:2006, ISO 14025:2006 and the reference PCR by:	CT Consultant

LIMITATIONS: EPDs from different programs may not be comparable (ISO 14025:2006 [8]). Comparison of the environmental performance using EPD information shall consider all relevant information modules over the full life cycle of the products within the building. The PCRs allows EPD comparability only when the same functional requirements between products are ensured and the requirements of ISO 21930:2017 [9] Section 5.5 are met. It should be noted that different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.

2| PRESENTATION OF SOPREMA

2.1. Description of the company

Founded in 1908 in Strasbourg, France, SOPREMA is a manufacturing company established in over 90 countries. SOPREMA specializes in the manufacturing of waterproofing, insulating, greening and soundproofing products for the building and civil engineering sectors. With the environment at the heart of its corporate values, SOPREMA innovates in the field of sustainable construction materials through its 17 research and development centres around the world. SOPREMA offers a growing range of products for the sustainable building sector, positioning the company as a leader in the field.

2.2. Manufacturing site

SOPREMA's manufacturing plant dedicated to the panelized SBS-modified base sheets with a torch-applied cap sheet is located in Drummondville (Quebec, Canada).

3| DESCRIPTION OF THE PRODUCTS

3.1. Summary description and applications

The SBS-modified bitumen membranes manufactured by SOPREMA are trusted to protect against weather conditions, temperature extremes, impacts, and foot traffic. Moreover, they provide beauty, affordability and reliability. The membranes are used on low-slope roofs (with slopes less than 2:12). They are available in a wide range of thicknesses and mechanical properties, able to adapt to many roof design challenges. SBS-modified bitumen membranes are composed of two sheets (base and cap sheets) and can be installed in various application modes[1].

This EPD evaluates the two types of panelized SBS-modified bitumen membranes manufactured by SOPREMA: 1) a torch-applied (T) cap sheet with an asphalt board (P-A) base sheet and 2) a torch applied (T) cap sheet with a polyisocyanurate board (P-P) base sheet. To summarize, these panelized SBS-modified bitumen membranes are:

1. Base sheet (P-A) + Cap sheet (T)
2. Base sheet (P-P) + Cap sheet (T)

The panelized membranes are made up of fibreglass and/or polyester reinforcing mats, SBS-modified bitumen, mineral stabilizers, surfacing materials as well as an asphaltic or a polyisocyanurate board (base sheet).

[1] For more information about the installation mode, please read Section 3.9.

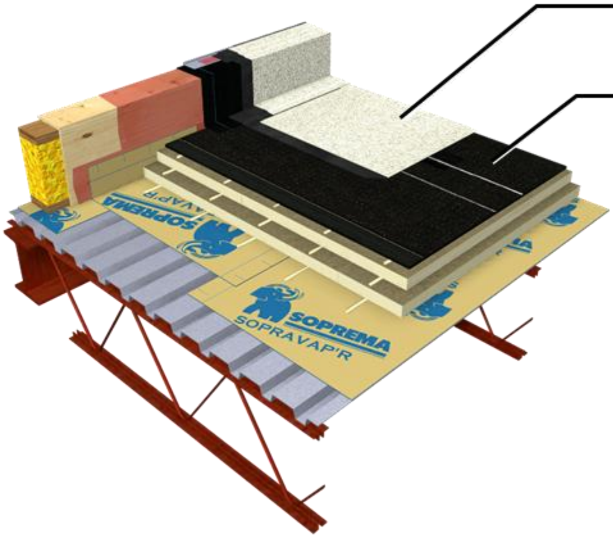

Figure 1. Visual representation of the panelized SBS-modified bitumen membranes

3.2. Products covered

SOPREMA's SBS-modified bitumen membrane sheets range covered by this EPD is presented at Table 1. The membrane sheets are classified by installation modes and installation order (base or cap sheet).

Table 1: Membrane sheets range – panelized

SHEET TYPE	PRODUCT NAME	
	BASE SHEET	CAP SHEET
P-A (ASPHALT BOARD)	2-1 SOPRASMART BOARD (all versions)	-
	2-1 SOPRASMART BOARD SANDED (all versions)	
P-P (POLYISOCYANURATE BOARD)	2-1 SOPRASMART ISO HD ½	-
	2-1 SOPRASMART ISO HD SANDED ½	
T (TORCH-APPLIED)	-	COLVENT FLAM GR (all versions)
		ELASTOPHENE FLAM GR (all versions)
		SOPRAFIX CAP 655
		SOPRALENE FLAM 180 GR (all versions)
		SOPRALENE FLAM 250 GR (all versions)
		SOPRALENE MAMMOUTH GR
		SOPRAPLY TRAFFIC CAP (all versions)
		SOPRASTAR FLAM GR (all versions)
		SOPRAWALK
		STARTER FLAM GR

3.3. Product average

The panelized SBS-modified bitumen membranes (P-A/T and P-P/T) are representative of SOPREMA's Drummondville manufacturing plant.

3.4. Material composition

The membranes are composed of a cap sheet as well as a panelized base sheet which is produced by lamination of an SBS-modified bitumen layer onto an asphalt or a polyisocyanurate board (Table 2). The SBS-modified bitumen layers are composed of mats made of polyester or a combination of fibreglass and polyester. The modified bitumen is made of a mixture of oxidized and non-oxidized bitumen, SBS (styrene-butadiene-styrene), limestone and other fillers. The role of the SBS in the bitumen mixture is to improve the flexibility and durability of the membrane sheets. Surfacing materials are applied to protect the membranes from UV radiation or as a parting material. The asphalt board is made of a fibreglass mat impregnated and coated with bitumen and limestone, whereas the polyisocyanurate board is made of a fibreglass facer and polyisocyanurate foam.

Table 2: Material composition of the SBS-modified bitumen membrane sheets – panelized

MATERIAL INPUT	MATERIAL COMPOSITION		
	Base sheet P-A	Base sheet P-P	Cap sheet T
Mat			
Polyester mat	2.3%	4.7%	4.0%
Polyester + fibreglass combination mat	0.0%	0.0%	1.2%
Reinforcement saturant			
Bitumen (oxidized)	4.7%	9.8%	15.3%
Asphaltic compound	22.3%	46.5%	54.2%
Bitumen (non oxidized)	Composition of asphaltic compound not disclosed for confidentiality purposes.		
Limestone filler			
SBS			
Plasticizing oil			
Surfacing materials			
Granules	0.0%	0.0%	25.3%
Sand	0.7%	1.4%	0.0%
Quartz powder (for lay lines)	0.1%	0.2%	0.0%
Plastic film	0.1%	0.2%	0.1%
Silicone-coated paper	0.0%	0.1%	0.0%
Asphalt board			
Fibreglass mat	2.4%	0.0%	0.0%
Bitumen (oxidized)	25.9%	0.0%	0.0%
Limestone filler	41.5%	0.0%	0.0%
Polyisocyanurate board			
Fibreglass facer	0.0%	18.6%	0.0%
TCPP Fire retardant	0.0%	0.6%	0.0%
Pentane blowing agent	0.0%	0.3%	0.0%
Methylene diphenyl diisocyanate	0.0%	11.9%	0.0%
Polyol polyester	0.0%	5.4%	0.0%
TOTAL	**100.0%**	**100.0%**	**100.0%**

3.5. Technical specifications

The membranes covered by this EPD belong to the following CSI Masterformat codes included in the PCR Part B: “07 52 16 SBS-Modified Bituminous Roofing”. The membrane sheets meet these test standards (Table 3).

Table 3: Standards met by SOPREMA’s SBS-modified bitumen membrane sheets

STANDARD	NAME OF THE STANDARD
ASTM D6162	Standard specification for SBS-modified bituminous sheet materials using a combination of polyester and glass fiber reinforcements
ASTM D6163	Standard specification for SBS-modified bituminous sheet materials using glass fiber reinforcements
ASTM D6164	Standard specification for SBS-modified bituminous sheet materials using polyester reinforcements
CSA A123.23	Product specification for polymer-modified bitumen sheet, prefabricated and reinforced

3.6. Product manufacturing

Membrane base sheets: Manufacture of a panelized base sheet involves the saturation of a non-woven polyester reinforcing mat and coating the mat with an SBS-modified asphalt. The SBS-modified asphalt is produced by mixing appropriate proportions of asphalt, SBS, and limestone or another suitable mineral stabilizer. Thin polyolefin film is applied as a parting agent to the top and bottom surfaces of the base sheet. The product is cooled and wound into jumbo rolls and transferred to a lamination operation. The base sheet is then laminated to a support panel, which can either be an asphalt board (P-A) or a high-density polyisocyanurate insulation board (P-P), using heat and pressure (Figure 3, Figure 4, Figure 5). Finally, the panelized base sheet is packaged for shipment.

Membrane cap sheets: As with the base sheets, manufacture of SBS-modified bitumen cap sheets involves the saturation of a reinforcing mat composed of fiberglass, non-woven polyester, or a combination of both, and coating of the mat with an SBS-modified asphalt. The SBS-modified asphalt is produced by mixing appropriate proportions of asphalt, SBS, and limestone or other suitable mineral stabilizer. An appropriate surfacing material is applied. Membrane cap sheets typically use a colored mineral granule top surfacing. A thin polyolefin film is applied as a parting agent to the bottom surface of the cap sheet. The product is cooled, wound into rolls, and packaged for shipment (Figure 2).

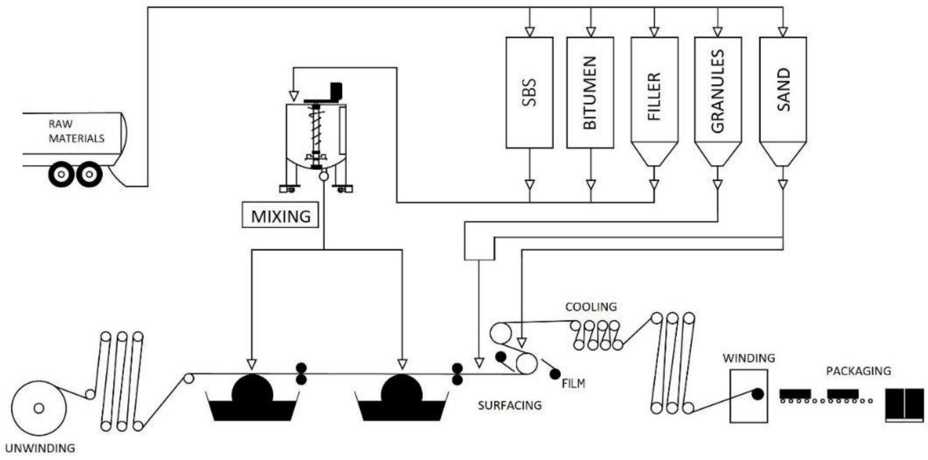

Figure 2: Production steps of the SBS-modified bitumen cap sheet at SOPREMA's manufacturing plant

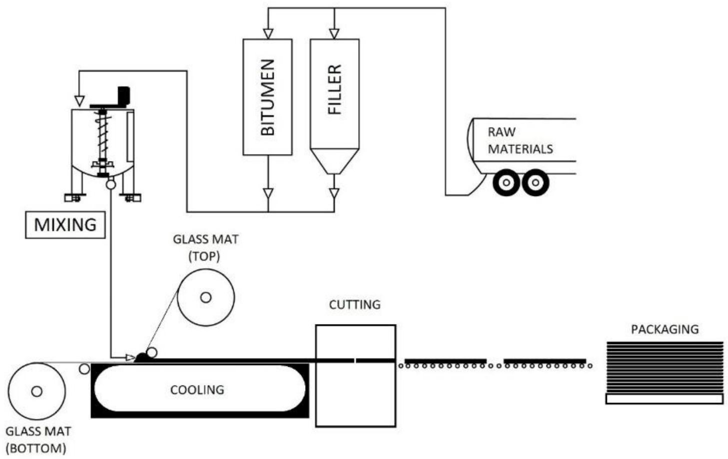

Figure 3: Production steps of the asphalt board for the P-A base sheets at SOPREMA's manufacturing plant

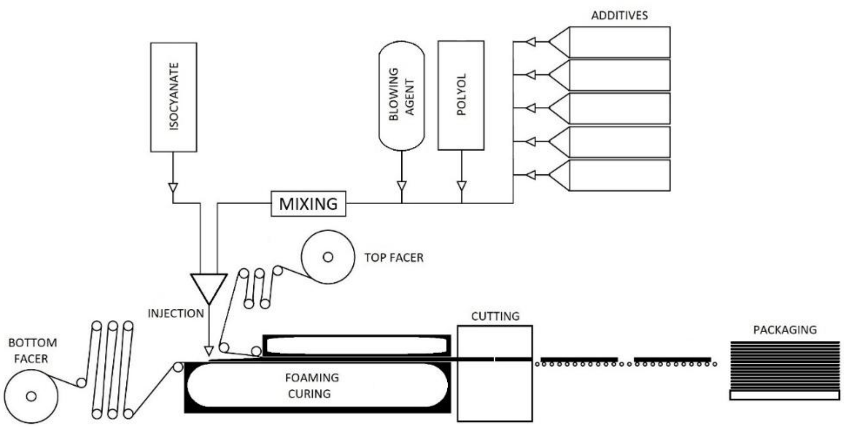

Figure 4: Production steps of the polyisocyanurate board for the P-P base sheets at SOPREMA's manufacturing plant

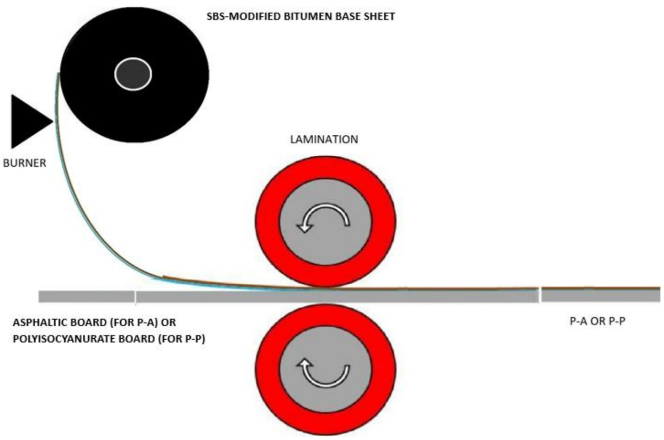

Figure 5: Lamination of the panelized SBS-modified bitumen base sheets at SOPREMA's manufacturing plant

3.7. Packaging

The SBS-modified bitumen cap sheets are wound into rolls with a cardboard core, packaged with plastic film, and placed on wood pallets for transport to the construction site. The panelized SBS-modified bitumen base sheets are packaged with cardboard, plastic film and wood pallets.

3.8. Transport to the construction site

The membrane sheets are deemed to be transported to the construction site by semi-trailer truck.

3.9. Product installation

For this EPD, the panelized SBS-modified bitumen membrane consists in one laminated panel base and one torch-applied cap sheet. The panelized base sheet is installed onto the roof surface using mechanical fastening: fasteners (screws and plates) are inserted into the longitudinal seam of the base sheet to attach it to the structural decking using an electric screwdriver, and a propane torch is used to weld the overlap and membrane seams. The SBS-modified bitumen cap sheet is then torched directly on top of the panelized base sheet by using a propane torch to melt the bitumen on the underside of the sheet as it is being unrolled. Mineral granules are applied to the asphalt bleed-out (the portion that has migrated out of the cap sheet seams) to protect it from UV and for aesthetic reasons. There are no specific noise reduction measures during installation.

3.10. Reference service life and use stage

The reference service life (RSL) of the SBS-modified membranes is deemed to be 25 years. The estimated service life (ESL) of the building on which the membranes are installed is set to 75 years [2]. Thus, the SBS-modified membrane undergoes two 'replacement' steps over the ESL:

- **Step 1 – Membrane resurfacing after 25 years.** This process consists in the installation of a new cap sheet on top of the existing membrane (base sheet and cap sheet) that remains in place. This new cap sheet is installed with the use of a torch.
- **Step 2 – Membrane replacement after 50 years.** This process consists in the removal of the membrane (base sheet and cap sheet) plus the cap sheet added after 25 years and the installation of a new base and cap sheets using the same installation modes.

The membrane resurfacing and replacement steps include the manufacturing and transport of the new base and cap sheets and associated packaging, auxiliary materials and waste treatment. The membrane replacement also includes the use of a gasoline roof ripper to remove the base and cap sheets. No other maintenance, refurbishment or repair operations occur during the service life of the membranes.

3.11. End of life

When the building in which the membranes are installed reaches its end of life, it is assumed that it is demolished without any sorting or recycling of materials. The membranes will be incorporated into the rest of the demolition waste and sent to a landfill site.

4| METHODOLOGY USED FOR THE LIFE CYCLE ASSESSMENT

4.1. Functional unit

The functional unit (FU) defined according to the PCR Part B [2] and the associated mass of membranes required to fulfill the functional unit are presented in Table 4. This includes membrane overlap, installation losses and auxiliary materials, but excludes packaging.

Table 4: Functional unit and associated mass of SBS-modified bitumen membranes

FUNCTIONAL UNIT	100 m^2 [1076.4 ft^2] of installed SBS-modified bitumen membrane (base and cap sheets) including resurfacing and replacement for the 75-year estimated building service life.				
MEMBRANE TYPE	Unit	Initial membrane	Resurfacing after 25 years	Replacement after 50 years	Total after 75 years
		Cap sheet + base sheet	Cap sheet added over the initial membrane	Cap sheet + base sheet	
P-A/T	kg	1426.92	551.81	1426.92	3405.66
P-P/T	kg	1001.93	551.81	1001.93	2555.67

4.2. System boundary

The cradle-to-grave LCA includes the following life cycle stages and modules (ISO 21930:2017 [9]):

- Production (A1 - A3)
- Construction (A4 - A5)
- Use (B1 - B7)
- End of life (C1 - C4)

As SOPREMA declared a 100% landfill scenario and because the product isn't destined to be recycled, module D (regarding benefits associated with recycling) is considered to be zero and thus excluded from the LCA (Table 5, Figure 6).

Table 5: Life cycle stages and modules included and excluded from the LCA

PRODUCTION STAGE (A1 - A3)			CONSTRUCTION STAGE (A4 - A5)		USE STAGE (B1 - B7)							END-OF-LIFE STAGE (C1 - C4)				BEYOND THE SYSTEM BOUNDARY
Production of raw materials	Transport of raw materials	Manufacturing of base and cap sheets	Transport to the construction site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Energy use	Water use	Deconstruction / Demolition	Transport to waste treatment site	Waste treatment	Disposal	Benefits associated with reuse/recycling/energy recovery
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ME

Legend

X: Module included

ME: Module excluded

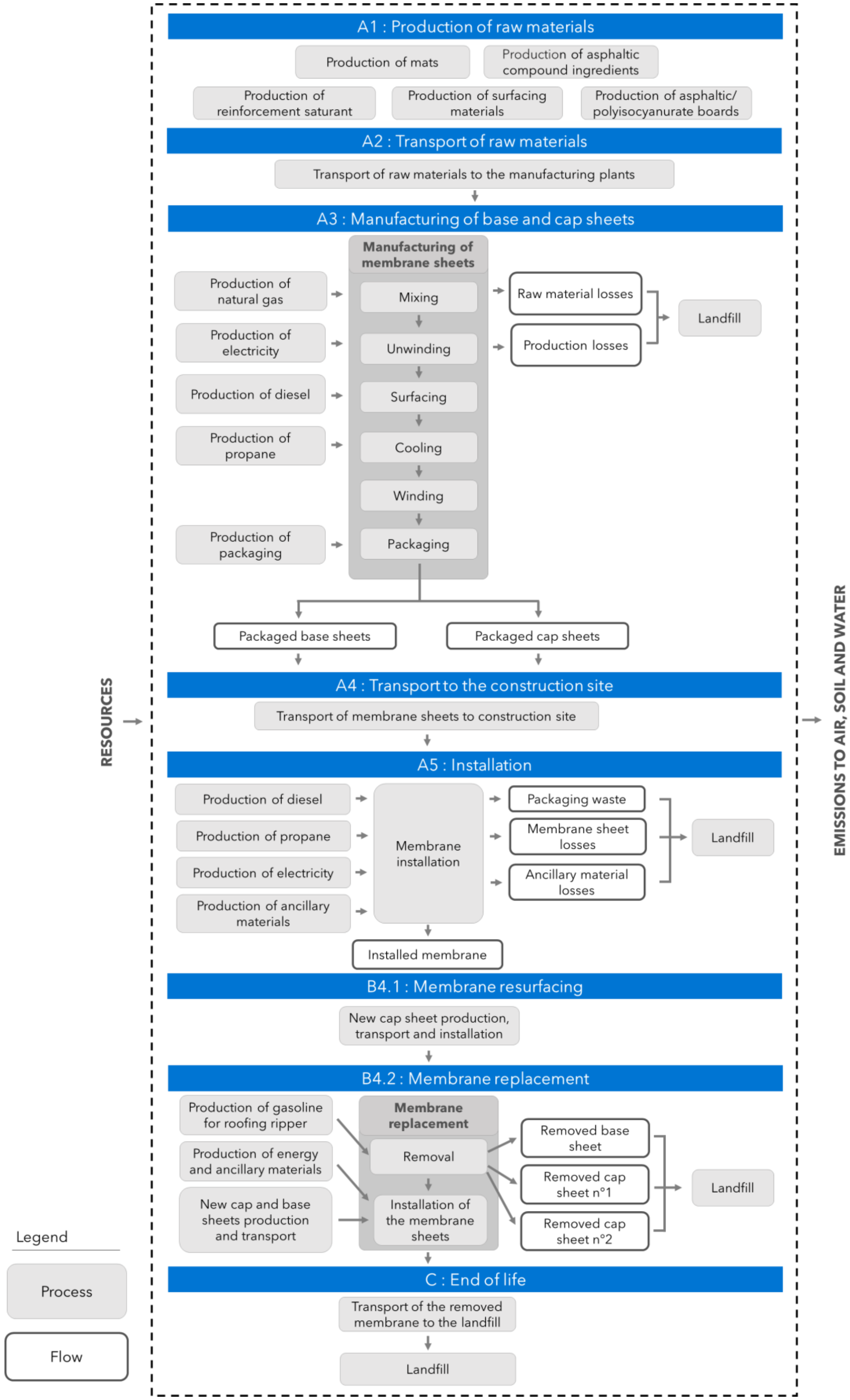

Figure 6: System boundary - SBS-modified bitumen membranes - panelized

4.3. Reference period

The reference period is the calendar year 2022 (from 1 January 2022 to 31 December 2022).

4.4. Assumptions

Carrying out an LCA involves making assumptions when data is incomplete or missing. The following assumptions were applied with respect to the present LCA:

- **Production of non-oxidized bitumen and SBS (A1).** In the absence of appropriate secondary data to model the non-oxidized bitumen and the SBS in Ecoinvent v3.9.1, these materials were modelled from the Asphalt Institute's LCA report [10].
- **Production of oxidized bitumen (A1).** Oxidized bitumen is bitumen that has been subjected to a controlled reaction with air or oxygen at elevated temperatures to improve thermal and aging properties [11]. Since no oxidized bitumen production process was available, the oxidized bitumen production is modelled as non-oxidized bitumen.
- **Packaging end of life (A5).** Based on the PCR Part A [1], the plastic packaging is assumed to be 78% recycled and 22% landfilled, and the other product packaging (wood pallets, cardboard) to be 20% recycled and 80% landfilled at the end of their life (mass ratio).

4.5. Cut-off criteria

As defined in ISO 21930:2017 [9], all input and output processes whose mass and/or energy flow account for more than 1% of the total mass and/or cumulative energy of the SBS-modified bitumen membranes were included. Also in line with the standard, at least 95% of all mass and energy flows were included. The packaging of raw materials is excluded, as this flow represents less than 1% of the mass of inputs and does not represent a significant environmental impact. The production and maintenance of equipment and infrastructure, administration activities, transport of employees and removal of debris from the roof drains during use were not included. No known mass or energy flows were deliberately excluded from this EPD.

4.6. Allocation

When a process in the life cycle of a product generates several outputs (multifunctional processes) or is linked to another system (life cycle of a product outside the boundary of the system studied), the environmental impact of the process must be allocated to the different products, co-products and systems. The allocation methods considered for this study are:

- **Allocation for end-of-life processes.** The "cut-off" approach was chosen in accordance with ISO 21930:2017 [9]. This approach specifies that the impacts associated with secondary materials entering the system are attributable to the system that generated them, and the benefits associated with recycling materials leaving the system are not included. In this study, the only impacts associated the recycled polyester are those of its processing and transport to the manufacturing plant. Using the same principle, no environmental benefits associated with the part of packaging materials sent for recycling (cardboard, plastic film, wood pallet) were accounted for.
- **Allocation for multi-functional processes.** There are no multifunctional processes involved in the life cycle of the membranes.
- **Allocation approach for Ecoinvent datasets**. The Ecoinvent datasets used the "Allocation, cut-off by classification" allocation approach, which attributes the impacts of secondary materials entering the system to those that generated them, and excludes the benefits associated with recycling materials. This is in line with the cut-off rule specified in ISO 21930:2017.

4.7. Data sources and quality

Table 6: Inventory data sources for SBS-modified bitumen membranes

DATA TYPE	SOURCE
Foreground data	Primary foreground data was provided by SOPREMA regarding: ● measured data regarding the raw materials and transport; ● measured data regarding the manufacturing of the sheets and their packaging; ● data based on realistic scenarios supported by technical information regarding the auxiliary materials and losses during the installation of the membranes; ● data based on realistic scenarios regarding the membrane resurfacing and replacement during the estimated building service life.
Foreground data	Secondary foreground data regarding the transport distance of the sheets to the construction site and of the removed membrane to the waste treatment site at its end of life was obtained from the PCR Part B [2].
Background data	The background data was obtained from the following sources: ● technical reports (LCA of the bitumen and SBS [10][12]); ● Ecoinvent database v3.9.1 [4], a transparent and internationally recognized life cycle inventory database.

Table 7: Data quality assessment

CRITERION	EVALUATION
Temporal representativeness	The primary foreground data supplied by SOPREMA is representative of the reference period (year 2022). The secondary foreground data comes from the PCR Part B (2021) and technical reports issued in 2019 and 2023. As for the Ecoinvent database, the 3.9.1 version (2022) is based on version 3.0, which has been released annually since 2013. It should be noted that some of the data in version 3.0 comes from earlier versions (1991-2012). The foreground and background data are considered to have a high temporal representativeness.
Geographical representativeness	The primary foreground data related to the life cycle stages of the membranes represents the specific context of SOPREMA. The data based on realistic assumptions regarding the installation and the use of the membranes are supported by technical information from SOPREMA. The secondary foreground data is based on the PCR Part B (North American context). The background data used to model the bitumen and SBS is based on a report from the Asphalt Institute and is representative of the North American context. The electricity used at the manufacturing plant is representative of the regional grid mix. The background datasets were selected according to geographical representativeness. The foreground and background data are considered to have a high geographical representativeness.

CRITERION	EVALUATION
Technological representativeness	The primary foreground data relating to the manufacturing of the membranes are based on material fact sheets and measurements carried out by SOPREMA. The primary foreground data regarding the other life cycle stages are based on realistic scenarios. In the absence of suitable data in the Ecoinvent database, the bitumen and SBS was based on the Asphalt Institute's LCA report. The oxidized bitumen is modelled as non-oxidized bitumen. The background datasets were chosen according to technological representativeness. The foreground and background data are considered to have a satisfactory technological representativeness.
Precision	The primary foreground data relating to the production of the membranes are based on measurements carried out by SOPREMA. The primary foreground data regarding the installation and use of the membranes are based on realistic scenarios supported by technical information. The secondary foreground data used for the scenarios for the product transport to the construction site and the waste transport were retrieved from the PCR Part B. The level of precision for the primary and secondary data is considered satisfactory.
Completeness	All processes whose mass and energy are above the cut-off criteria (1%) were included in the LCA in accordance with the PCR Part A. No known flows were deliberately excluded. The study is considered to have a satisfactory level of completeness.
Consistency	For all methodological aspects (e.g., assumptions, allocation methodology, impact assessment method, data sources and modelling approaches), maximum consistency was aimed for. The only lack of methodological consistency observed, although justified by the absence of suitable data in the Ecoinvent database, is that surrounding the use of data from the Asphalt Institute's LCA which is based on the GaBi database. The study is considered to have a sufficient level of consistency.
Reproducibility	Information on the methodology, main assumptions and data sources is provided in the LCA report. The reproducibility level is considered to be high.
Reliability	The primary foreground data relating to the production of the membranes are based on measurements carried out by SOPREMA. The primary foreground data regarding the installation and use of the membranes are based on realistic scenarios supported by technical information. The secondary foreground data used for the scenarios for the product transport to the construction site and the waste transport were retrieved from the PCR Part B. The level of reliability for the primary and secondary data is considered high.

4.8. Scenarios used beyond the manufacturing stage

4.8.1 Transport to the construction site (A4)

Table 8: Scenarios for the transport of SBS-modified bitumen membranes from the manufacturing plant to the construction site – P-A/T, P-P/T

PARAMETER	VALUE / SPECIFICATION		UNIT
	P-A/T	P-P/T	
Fuel type	Diesel	Diesel	-
Liters of fuel[1]	35	35	L/100km
Vehicle type	Semi-trailer truck with a load capacity of 32 tons or more	Semi-trailer truck with a load capacity of 32 tons or more	-
Transport distance[2]	800	800	km
Capacity utilization[3]	Unknown	Unknown	-
Gross density of products transported[4]	1364.51	958.81	kg/100 m^2
Weight of products transported (if gross density not reported)	-	-	kg
Volume of products transported (if gross density not reported)	-	-	m^3
Capacity utilization volume factor (factor: =1 or <1 or ≥1 for compressed or nested products)	1	1	-

[1] Fuel consumption is calculated considering the average mass transported per vehicle type according to Ecoinvent v3.9.1.

[2] Generic data from Table 3 of the PCR Part B [2].

[3] Information about the truck's capacity utilization is not available. The information provided in the Ecoinvent v3.9.1 database concerns the total mass of the truck and its content and not the maximum mass that the vehicle can contain, thus it is not possible to determine the capacity utilization.

[4] The unit of gross density is changed from kg/m^3 to kg/100 m^2 based on the functional unit due to calculation constraints. This value includes packaging and membrane overlap, but excludes installation losses and auxiliary materials.

4.8.2 Installation (A5)

Table 9: Scenario for the installation of SBS-modified bitumen membranes – P-A/T

PARAMETER	WEIGHT OF MATERIAL (kg/100 m^2)	EFFECTIVE COVERAGE (m^2 of material/ m^2 of roof)	SCRAP RATE	REQUIRED QUANTITY per 100 m^2 of roof (effective coverage, scrap included)	UNIT
SBS-modified bitumen sheets					
Cap sheet T	468.91	1.10	5%	543.81	kg
Base sheet P-A	819.20	1.00	5%	862.31	kg
Ancillary materials					
Granules (at seams)	-	-	0%	8.00	kg
Fasteners (screws and plates)	-	-	0%	12.80	kg
Resources					
Propane (torching)	-	-	0%	557.52	MJ
Diesel (crane)	-	-	0%	458.30	MJ
Electricity	-	-	0%	0.37	kWh
Waste and emissions					
VOC emissions [1]	-	-	-	0.60	kg
Direct emissions to ambient air, soil and water	-	-	-	-	kg
Waste - Product loss	-	-	-	70.31	kg
Waste - Ancillary materials	-	-	-	-	kg
Waste - Cardboard packaging	-	-	-	7.73	kg
Waste - Wood packaging	-	-	-	21.68	kg
Waste - Plastic packaging	-	-	-	1.25	kg
Waste - Paper packaging	-	-	-	2.1E-3	kg
Output materials resulting from on-site waste processing (recycling, energy recovery and disposal)	-	-	-	-	kg

[1] Emissions from the heating of the bitumen, excluding combustion emissions from propane torching. The combustion emissions are included in the dataset. The unit of VOC emissions is changed from µg/m^3 to kg/100 m^2 based on the functional unit due to calculation constraints.

Table 10: Scenario for the installation of SBS-modified bitumen membranes – P-P/T

PARAMETER	WEIGHT OF MATERIAL (kg/100 m^2)	EFFECTIVE COVERAGE (m^2 of material/ m^2 of roof)	SCRAP RATE	REQUIRED QUANTITY per 100 m^2 of roof (effective coverage, scrap included)	UNIT
SBS-modified bitumen sheets					
Cap sheet T	468.91	1.10	5%	543.81	kg
Base sheet P-P	415.45	1.00	5%	437.32	kg
Ancillary materials					
Granules (at seams)	-	-	0%	8.00	kg
Fasteners (screws and plates)	-	-	0%	12.80	kg
Resources					
Propane (torching)	-	-	0%	557.52	MJ
Diesel (crane)	-	-	0%	458.30	MJ
Electricity	-	-	0%	0.37	kWh
Waste and emissions					
VOC emissions[1]	-	-	-	0.60	kg
Direct emissions to ambient air, soil and water	-	-	-	-	kg
Waste - Product loss	-	-	-	49.06	kg
Waste - Ancillary materials	-	-	-	-	kg
Waste - Cardboard packaging	-	-	-	9.81	kg
Waste - Wood packaging	-	-	-	17.78	kg
Waste - Plastic packaging	-	-	-	1.11	kg
Waste - Paper packaging	-	-	-	2.1E-3	kg
Output materials resulting from on-site waste processing (recycling, energy recovery and disposal)	-	-	-	-	kg

[1] Emissions from the heating of the bitumen, excluding combustion emissions from propane torching. The combustion emissions are included in the dataset. The unit of VOC emissions is changed from μg/m^3 to kg/100 m^2 based on the functional unit due to calculation constraints.

4.8.3 Use (B1-B7)

Table 11: Scenarios for the use of SBS-modified bitumen membranes – P-A/T, P-P/T

<table>
<tr><th colspan="2" rowspan="2">PARAMETER</th><th colspan="2">VALUE</th><th rowspan="2">UNIT</th></tr>
<tr><th>P-A/T</th><th>P-P/T</th></tr>
<tr><td colspan="2">Estimated building service life</td><td>75</td><td>75</td><td>years</td></tr>
<tr><td colspan="2">Reference service life (product)</td><td>25</td><td>25</td><td>years</td></tr>
<tr><td colspan="2">Replacement cycle</td><td>2</td><td>2</td><td>(ESL/RSL) - 1</td></tr>
<tr><td colspan="5">Membrane resurfacing after 25 years (B4.1)</td></tr>
<tr><td rowspan="2">Energy inputs</td><td>Propane for torching</td><td>464.60</td><td>464.60</td><td>MJ</td></tr>
<tr><td>Diesel for crane</td><td>229.15</td><td>229.15</td><td>MJ</td></tr>
<tr><td>Ancillary materials</td><td>Granules</td><td>8.00</td><td>8.00</td><td>kg</td></tr>
<tr><td colspan="2">New cap sheet added</td><td>543.81</td><td>543.81</td><td>kg</td></tr>
<tr><td colspan="2">VOC emissions[1]</td><td>0.50</td><td>0.50</td><td>kg</td></tr>
<tr><td colspan="2">Direct emissions to ambient air, soil and water</td><td>-</td><td>-</td><td>kg</td></tr>
<tr><td colspan="5">Membrane replacement after 50 years (B4.2)</td></tr>
<tr><td rowspan="4">Energy inputs</td><td>Propane for torching</td><td>557.52</td><td>557.52</td><td>MJ</td></tr>
<tr><td>Diesel for crane</td><td>458.30</td><td>458.30</td><td>MJ</td></tr>
<tr><td>Electricity</td><td>0.37</td><td>0.37</td><td>kWh</td></tr>
<tr><td>Gasoline for the roofing ripper</td><td>37.05</td><td>37.05</td><td>MJ</td></tr>
<tr><td rowspan="2">Ancillary materials</td><td>Fasteners</td><td>12.80</td><td>12.80</td><td>kg</td></tr>
<tr><td>Granules</td><td>8.00</td><td>8.00</td><td>kg</td></tr>
<tr><td colspan="2">New base sheet added</td><td>862.31</td><td>437.32</td><td>kg</td></tr>
<tr><td colspan="2">New cap sheet added</td><td>543.81</td><td>543.81</td><td>kg</td></tr>
<tr><td colspan="2">VOC emissions[1]</td><td>0.60</td><td>0.60</td><td>kg</td></tr>
<tr><td colspan="2">Direct emissions to ambient air, soil and water</td><td>-</td><td>-</td><td>kg</td></tr>
<tr><td colspan="5">Use (B1)</td></tr>
<tr><td colspan="2">Emissions of blowing agent to air (pentane)</td><td>-</td><td>0.77</td><td>kg</td></tr>
</table>

[1] Emissions from the heating of the bitumen, excluding combustion emissions from propane torching. The combustion emissions are included in the dataset. The unit of VOC emissions is changed from µg/m^3 to kg/100 m^2 based on the functional unit due to calculation constraints.

Table 12: Reference service life and use conditions of the SBS-modified bitumen membranes – P-A/T, P-P/T

PARAMETER	VALUE / SPECIFICATION	UNIT
Reference service life	25	years
Declared product properties	Waterproofing of building roofing	-
Design application parameters and an assumed quality of work, when installed in accordance with the manufacturer's instructions	Design and installation according to SOPREMA's instructions.	-
Outdoor environment	The SBS-modified bitumen membrane is subject to weathering, exposed to rainwater, hail, snow, wind and solar radiation.	-
Indoor environment	Not applicable	-
Use conditions	Regular maintenance, including removing debris from the roof drains is recommended	-
Replacement	● After 25 years, membrane resurfacing (installation of a new cap sheet on top of the membrane) is required; ● After 50 years, membrane replacement (removal of the base sheet and cap sheets, removal of the resurfacing cap sheet and installation of new base and cap sheets) is required.	-

4.8.4 End of life (C1-C4)

Table 13: Scenarios for the end of life of SBS-modified bitumen membranes – P-A/T, P-P/T

PARAMETER	VALUE / SPECIFICATION		UNIT
	P-A/T	P-P/T	
Assumptions for scenario development	When the building in which the membrane is installed reaches its end of life, it is assumed that it is demolished without any sorting or recycling of materials. Therefore, the membranes will be incorporated into the rest of the demolition waste and sent to a landfill site.		-
Transport distance[1]	161	161	km
Vehicle type	Truck with a load capacity between 16 and 32 tons	Truck with a load capacity between 16 and 32 tons	-
Collection process - Mixed construction waste[2]	1426.92	1001.93	kg
Emissions of blowing agent to air (pentane)	-	0.26	kg
Elimination - Landfill[2]	1426.92	1001.93	kg
Recovery	0.00	0.00	kg

[1] Generic data from Table 3 of the PCR Part B [2].
[2] This value includes membrane overlap, installation losses and auxiliary materials, but excludes packaging.

5| ENVIRONMENTAL IMPACTS AND INVENTORY RESULTS

5.1. Environmental life cycle impacts

The environmental life cycle impacts are reported for the functional unit, i.e. "100 m² [1076.4 ft²] of installed SBS-modified bitumen membrane (base and cap sheets) including resurfacing and replacement for the 75-year estimated building service life" (Table 14). These were calculated for the impact category *Climate change – GWP 100* from the IPCC 2013 impact assessment method [5], four impact categories (*Acidification, Eutrophication, Smog formation* and *Ozone depletion*) from the TRACI 2.1 impact assessment method [6], and the impact category *Abiotic resource depletion (fossil fuels)* from the CML impact assessment method [7]. The results for the two types of panelized SBS-modified bitumen membranes (P-A/T, P-P/T) are reported for each declared life cycle module [9]. The term "potential" means that the impact scores do not represent actual measured impacts but are the results of theoretical modelling using an impact assessment method. For simplicity, the term «potential» will not be used in the explanatory text in the rest of the EPD.

It should be noted that the life cycle impact assessment results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, EPD users should not use additional measures for comparative purposes [1].

Table 14: Environmental life cycle impacts – 100 m² of SBS-modified bitumen membrane – P-A/T

IMPACT CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Global warming potential	kg CO_2 eq	3.28E+3	7.94E+2	5.15E+1	1.15E+2	1.14E+2	2.14E+2	0.00E+0	1.92E+3	0.00E+0	0.00E+0	4.17E+1	0.00E+0	2.72E+1
Acidification of soil and water sources potential	kg SO_2 eq	1.17E+1	2.60E+0	4.22E-1	1.42E-1	4.48E-1	9.17E-1	0.00E+0	6.84E+0	0.00E+0	0.00E+0	1.64E-1	0.00E+0	1.03E-1
Eutrophication potential	kg N eq	1.40E+0	3.35E-1	2.80E-2	2.32E-2	4.17E-2	1.10E-1	0.00E+0	8.24E-1	0.00E+0	0.00E+0	1.52E-2	0.00E+0	2.00E-2
Smog formation potential	kg O_3 eq	2.48E+2	4.55E+1	1.02E+1	2.84E+0	1.13E+1	2.46E+1	0.00E+0	1.46E+2	0.00E+0	0.00E+0	4.14E+0	0.00E+0	2.61E+0
Ozone depletion potential	kg CFC-11 eq	1.70E-3	6.21E-4	8.80E-7	1.04E-6	2.06E-6	3.62E-5	0.00E+0	1.04E-3	0.00E+0	0.00E+0	7.24E-7	0.00E+0	4.10E-7
Abiotic resource depletion potential of non-renewable (fossil) energy resources	MJ (LHV)	3.85E+4	8.53E+3	6.90E+2	1.66E+3	1.65E+3	2.49E+3	0.00E+0	2.25E+4	0.00E+0	0.00E+0	5.82E+2	0.00E+0	3.36E+2

Table 15: Environmental life cycle impacts – 100 m² of SBS-modified bitumen membrane – P-P/T

IMPACT CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Global warming potential	kg CO_2 eq	3.91E+3	1.11E+3	7.97E+1	1.06E+2	8.03E+1	2.32E+2	0.00E+0	2.24E+3	0.00E+0	0.00E+0	2.93E+1	0.00E+0	2.82E+1
Acidification of soil and water sources potential	kg SO_2 eq	1.54E+1	4.26E+0	7.06E-1	1.59E-1	3.15E-1	1.01E+0	0.00E+0	8.70E+0	0.00E+0	0.00E+0	1.15E-1	0.00E+0	7.33E-2
Eutrophication potential	kg N eq	3.12E+0	1.12E+0	4.64E-2	3.79E-2	2.93E-2	1.56E-1	0.00E+0	1.69E+0	0.00E+0	0.00E+0	1.07E-2	0.00E+0	2.64E-2
Smog formation potential	kg O_3 eq	3.05E+2	6.81E+1	1.74E+1	4.82E+0	7.94E+0	2.60E+1	1.02E+0	1.74E+2	0.00E+0	0.00E+0	2.91E+0	0.00E+0	2.18E+0
Ozone depletion potential	kg CFC-11 eq	1.79E-3	6.63E-4	1.34E-6	1.33E-6	1.45E-6	3.84E-5	0.00E+0	1.09E-3	0.00E+0	0.00E+0	5.09E-7	0.00E+0	2.88E-7
Abiotic resource depletion potential of non-renewable (fossil) energy resources	MJ (LHV)	5.16E+4	1.53E+4	1.05E+3	1.49E+3	1.16E+3	2.82E+3	0.00E+0	2.91E+4	0.00E+0	0.00E+0	4.09E+2	0.00E+0	2.36E+2

5.2. Life cycle inventory categories

The life cycle inventory categories comprise use of resources as well as waste and output flows. For the sake of simplicity, inventory categories related to biogenic carbon are not presented as none of the membranes contain biogenic carbon and the biogenic carbon contained in the packaging is below the cut-off criteria. Furthermore, inventory categories associated with emissions from combustion of waste and from calcination, as well as removals from carbonation are not presented as the system contains no incinerated materials, calcination or carbonation processes.

5.2.1 Use of resources

Table 16: Resource use inventory categories – 100 m² of SBS-modified bitumen membrane – P-A/T

INVENTORY CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Renewable primary resources used as energy carrier (fuel)[1]	MJ (LHV)	3.58E+3	4.23E+2	1.17E+1	1.06E+3	2.12E+1	1.30E+2	0.00E+0	1.92E+3	0.00E+0	0.00E+0	7.51E+0	0.00E+0	5.93E+0
Renewable primary resources with energy content used as material[2]	MJ (LHV)	3.78E+2	0.00E+0	0.00E+0	1.65E+2	0.00E+0	7.35E+0	0.00E+0	2.05E+2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary resources	MJ (LHV)	3.96E+3	4.23E+2	1.17E+1	1.23E+3	2.12E+1	1.37E+2	0.00E+0	2.13E+3	0.00E+0	0.00E+0	7.51E+0	0.00E+0	5.93E+0
Non-renewable primary resources used as an energy carrier (fuel)[3]	MJ (LHV)	5.36E+4	1.46E+4	7.02E+2	1.43E+3	1.67E+3	2.71E+3	0.00E+0	3.15E+4	0.00E+0	0.00E+0	5.90E+2	0.00E+0	3.44E+2
Non-renewable primary resources with energy content used as material[2]	MJ (LHV)	6.49E+4	2.59E+4	0.00E+0	1.05E+2	0.00E+0	1.30E+3	0.00E+0	3.76E+4	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary resources	MJ (LHV)	1.18E+5	4.04E+4	7.02E+2	1.54E+3	1.67E+3	4.01E+3	0.00E+0	6.91E+4	0.00E+0	0.00E+0	5.90E+2	0.00E+0	3.44E+2
Renewable secondary fuels	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Non-renewable secondary fuels	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Secondary materials	kg	3.48E+0	1.11E+0	0.00E+0	0.00E+0	0.00E+0	5.55E-2	0.00E+0	2.31E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Recovered energy[4]	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of net freshwater resources[5]	m^3	1.18E+3	4.25E+2	1.02E-1	4.99E+0	2.39E-1	2.31E+1	0.00E+0	7.23E+2	0.00E+0	0.00E+0	7.44E-2	0.00E+0	3.49E-1

Table 17: Resource use inventory categories – 100 m^2 of SBS-modified bitumen membrane – P-P/T

INVENTORY CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Renewable primary resources used as energy carrier (fuel)[1]	MJ (LHV)	3.94E+3	7.35E+2	1.95E+1	9.13E+2	1.49E+1	1.38E+2	0.00E+0	2.11E+3	0.00E+0	0.00E+0	5.28E+0	0.00E+0	4.26E+0
Renewable primary resources with energy content used as material[2]	MJ (LHV)	4.55E+2	0.00E+0	0.00E+0	2.04E+2	0.00E+0	9.09E+0	0.00E+0	2.42E+2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary resources	MJ (LHV)	4.39E+3	7.35E+2	1.95E+1	1.12E+3	1.49E+1	1.48E+2	0.00E+0	2.35E+3	0.00E+0	0.00E+0	5.28E+0	0.00E+0	4.26E+0
Non-renewable primary resources used as an energy carrier (fuel)[3]	MJ (LHV)	6.03E+4	1.83E+4	1.07E+3	1.29E+3	1.17E+3	2.87E+3	0.00E+0	3.49E+4	0.00E+0	0.00E+0	4.15E+2	0.00E+0	2.42E+2
Non-renewable primary resources with energy content used as material[2]	MJ (LHV)	5.15E+4	1.95E+4	0.00E+0	9.16E+1	0.00E+0	9.81E+2	0.00E+0	3.09E+4	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary resources	MJ (LHV)	1.12E+5	3.79E+4	1.07E+3	1.38E+3	1.17E+3	3.85E+3	0.00E+0	6.58E+4	0.00E+0	0.00E+0	4.15E+2	0.00E+0	2.42E+2
Renewable secondary fuels	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Non-renewable secondary fuels	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Secondary materials	kg	3.48E+0	1.11E+0	0.00E+0	0.00E+0	0.00E+0	5.55E-2	0.00E+0	2.31E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Recovered energy[4]	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of net freshwater resources[5]	m^3	1.21E+3	4.42E+2	1.59E-1	4.52E+0	1.68E-1	2.40E+1	0.00E+0	7.41E+2	0.00E+0	0.00E+0	5.23E-2	0.00E+0	2.45E-1

[1] Category meeting the requirements of ISO 21930:2017 and the PCR. The results of this indicator were calculated using the "Renewable, biomass", "Renewable, water" and "Renewable, wind, solar, geothermal" from the Cumulative Energy Demand (LHV) method [7] following the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [13].

[2] Categories meeting the requirements of ISO 21930:2017. The results of these inventory categories were calculated with the CED LHV method following the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [13].

[3] Category meeting the requirements of ISO 21930:2017 and the PCR. The results of this indicator were calculated using the "Non renewable, fossil", "Non renewable, biomass" and "Non renewable, nuclear" indicators from the Cumulative Energy Demand (LHV) method [7].

[4] There is no energy recovered from disposal of waste in previous systems.

[5] Category meeting the requirements of ISO 21930:2017 and the PCR. The results of this indicator were calculated using the "Water consumption" indicator from the ReCiPe 2016 Midpoint (H) impact assessment method [7].

5.2.2 Waste and output flows

Table 18: Waste and output flows inventory categories – 100 m² of SBS-modified bitumen membrane – P-A/T

INVENTORY CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Hazardous waste disposed[1,2]	kg	0.00E+0	0.00E+0	2.07E-1	0.00E+0	1.95E-1	0.00E+0	0.00E+0	3.77E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.30E+0
Non-hazardous waste disposed[1,2]	kg	0.00E+0	0.00E+0	6.88E+1	0.00E+0	9.45E+1	0.00E+0	0.00E+0	2.18E+3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.40E+3
Intermediate- and low-level radioactive waste[2,3]	m^3	1.08E-6	5.23E-8	1.76E-7	1.03E-7	2.99E-7	0.00E+0	1.08E-6	2.50E-6	0.00E+0	0.00E+0	3.36E-8	0.00E+0	3.07E-8
High-level radioactive waste[2,3]	m^3	2.14E-7	9.82E-9	1.66E-7	1.97E-8	7.37E-8	0.00E+0	2.14E-7	6.73E-7	0.00E+0	0.00E+0	6.53E-9	0.00E+0	5.64E-9
Components for re-use[4]	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	6.45E+0	0.00E+0	0.00E+0	9.75E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for energy recovery[4]	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Exported energy[4]	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

Table 19: Waste and output flows inventory categories – 100 m² of SBS-modified bitumen membrane – P-P/T

INVENTORY CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Hazardous waste disposed[1,2]	kg	3.03E+1	0.00E+0	0.00E+0	1.09E+1	0.00E+0	7.39E-1	0.00E+0	1.52E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.48E+0
Non-hazardous waste disposed[1,2]	kg	2.86E+3	0.00E+0	0.00E+0	4.86E+1	0.00E+0	7.19E+1	0.00E+0	1.74E+3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	9.96E+2
Intermediate- and low-level radioactive waste[2,3]	m^3	6.63E-6	2.20E-6	8.54E-8	1.85E-7	7.27E-8	3.55E-7	0.00E+0	3.68E-6	0.00E+0	0.00E+0	2.36E-8	0.00E+0	2.21E-8
High-level radioactive waste[2,3]	m^3	1.59E-6	4.35E-7	1.60E-8	1.51E-7	1.38E-8	8.39E-8	0.00E+0	8.86E-7	0.00E+0	0.00E+0	4.59E-9	0.00E+0	4.06E-9
Components for re-use[4]	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	kg	1.53E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.98E+0	0.00E+0	9.28E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for energy recovery[4]	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Exported energy[4]	MJ (LHV)	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

[1] The results of these indicators were calculated according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [13] using foreground data provided by the manufacturer.

[2] The life cycle inventory data used to generate waste indicators for LCAs and EPDs currently have significant limitations. The waste indicators were calculated following the requirements of ISO 21930:2017 [9] but these results represent rough estimates and are for informational purposes only.

[3] The results of these indicators were calculated according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [13] using background inventory data. It is important to note that the foreground data in this LCA does not include radioactive waste, i.e. the SBS-modified bitumen membrane manufacturing process does not directly generate radioactive waste. According to ISO 2d1930:2017, radioactive waste, when generated for electricity production, consists mainly of spent fuel from reactors (high-level radioactive waste) and routine maintenance and operation of the facilities (low- and medium-level radioactive waste).

[4] The SBS-modified bitumen membranes are considered to be landfilled without energy generation, so these inventory categories are zero.

5.3. Interpretation of life cycle impacts

The life cycle impacts are interpreted by means of a contribution analysis. The purpose of the contribution analysis is to determine the share of impacts associated with the different life cycle modules in order to identify the main contributors.

Table 20: Share of impacts associated with life cycle modules – 100 m² of SBS-modified bitumen membrane – P-A/T

IMPACT CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Global warming potential	kg CO_2 eq	100.0%	24.2%	1.6%	3.5%	3.5%	6.5%	0.0%	58.6%	0.0%	0.0%	1.3%	0.0%	0.8%
Acidification of soil and water sources potential	kg SO_2 eq	100.0%	22.4%	3.6%	1.2%	3.8%	7.9%	0.0%	58.8%	0.0%	0.0%	1.4%	0.0%	0.9%
Eutrophication potential	kg N eq	100.0%	24.0%	2.0%	1.7%	3.0%	7.9%	0.0%	59.0%	0.0%	0.0%	1.1%	0.0%	1.4%
Smog formation potential	kg O_3 eq	100.0%	18.4%	4.1%	1.1%	4.6%	9.9%	0.0%	59.1%	0.0%	0.0%	1.7%	0.0%	1.1%
Ozone depletion potential	kg CFC-11 eq	100.0%	36.5%	0.1%	0.1%	0.1%	2.1%	0.0%	61.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Abiotic resource depletion potential of non-renewable (fossil) energy resources	MJ (LHV)	100.0%	22.2%	1.8%	4.3%	4.3%	6.5%	0.0%	58.6%	0.0%	0.0%	1.5%	0.0%	0.9%

Table 21: Share of impacts associated with life cycle modules – 100 m² of SBS-modified bitumen membrane – P-P/T

IMPACT CATEGORY	UNIT	TOTAL	PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE			END-OF-LIFE STAGE			
			A1-A3			A4-A5		B1-B7			C1-C4			
			A1	A2	A3	A4	A5	B1-B3	B4	B5-B7	C1	C2	C3	C4
Global warming potential	kg CO_2 eq	100.0%	28.5%	2.0%	2.7%	2.1%	5.9%	0.0%	57.3%	0.0%	0.0%	0.8%	0.0%	0.7%
Acidification of soil and water sources potential	kg SO_2 eq	100.0%	27.8%	4.6%	1.0%	2.1%	6.6%	0.0%	56.7%	0.0%	0.0%	0.8%	0.0%	0.5%
Eutrophication potential	kg N eq	100.0%	36.0%	1.5%	1.2%	0.9%	5.0%	0.0%	54.2%	0.0%	0.0%	0.3%	0.0%	0.8%
Smog formation potential	kg O_3 eq	100.0%	22.3%	5.7%	1.6%	2.6%	8.5%	0.3%	57.2%	0.0%	0.0%	1.0%	0.0%	0.7%
Ozone depletion potential	kg CFC-11 eq	100.0%	37.0%	0.1%	0.1%	0.1%	2.1%	0.0%	60.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Abiotic resource depletion potential of non-renewable (fossil) energy resources	MJ (LHV)	100.0%	29.7%	2.0%	2.9%	2.2%	5.5%	0.0%	56.5%	0.0%	0.0%	0.8%	0.0%	0.5%

The environmental impacts of the two types of membranes under study are dominated by the life cycle module B - Use, representing between 54.2% and 61.1% % of the total impacts for all categories. This module represents the highest contributor because it includes the membrane resurfacing at 25 years (production, transport and installation of a new cap sheet) and membrane replacement at 50 years (end of life of the base and cap sheets plus the resurfacing cap sheet and production, transport and installation of a new base and cap sheets). Indeed, these processes together represent approximately 1.5 times the impacts of the rest of the life cycle (A1-A5 + C2-C4), as they involve the production, transport, installation and end of life of one base sheet and two cap sheets. Module A1 - Production of raw materials is the second highest contributor (between 18.4% and 37.0% of the total impacts for all categories).

6| ADDITIONAL ENVIRONMENTAL INFORMATION

6.1. Regulated hazardous substances

There are no regulated hazardous substances associated with the panelized membranes.

6.2. Health and environmental quality during product manufacturing and installation

The panelized SBS-modified bitumen roofing membranes do not have any adverse effect on the health of the workers during manufacturing and installation, and do not emit any substances that could significantly affect health or the environment.

6.3. Environmental certifications and activities

The panelized SBS-modified bitumen roofing membranes are manufactured in SOPREMA's plant located in Drummondville (Quebec, Canada) which complies with these standards:

- ISO 9001:2015 - Quality management systems [14];
- ISO 45001:2018 - Occupational health and safety management systems [15];
- ISO 14001:2015 - Environmental management systems [16].

The certificates of these standards can be found at:
https://www.soprema.ca/en/documentation/document/search?q=__empty__&type=Plants%20Certifications

6.4. Delayed emissions and unexpected adverse events

No delayed emissions are expected from the SBS-modified bitumen roofing membranes. There are no unexpected adverse effects from the combustion, water damage or mechanical alteration of the product.

6.5. Sustainable roofing

Some stakeholders of the building industry have promoted sustainable roofing by focusing on green roofs and reflective roofs only. Roof design for sustainability entails more than membrane selection. It means incorporating materials and details that extend the service life of the roof system beyond its currently accepted service life expectancy and provide future rehabilitation options to minimize consumption of new resources and delay demolition. Design for sustainable recovery from premature failure must be part of the original concept. It has to be realistically expected that a portion of a roof will eventually fail at some point for some reason. Sustainable recovery minimizes damage impact, reduces material waste and consumption of new materials. It also facilitates repair and renews roof performance. SBS-modified bitumen membranes allow for resurfacing and replacement at the end of their service life. Once the waterproof integrity of the membrane in place has been verified, or minor repairs to it have been performed if needed, the addition of an SBS-modified cap sheet to the system can be done easily. That is not to say that "cool roof" principles should be overlooked. Mitigation of urban heat islands should guide the design and specification of roof assemblies, as should energy conservation, durability, resiliency, raw materials consumption and waste reduction. There are reflective roof options available for virtually any roof and any building. Because of their longevity, SBS-modified bitumen membranes provide excellent value for building owners. They provide options for varying levels of reflectivity and have proven to retain high reflectivity levels over their service life (according to the Cool Roof Rating Council, www.coolroofs.org).

6.6. Further information

Additional information can be found at: www.soprema.ca/en

7| IMPACT AND INVENTORY INDICATORS DEFINITIONS

Table 22: Impact categories, definitions and units used in the study

IMPACT ASSESSMENT METHOD	IMPACT CATEGORY	DEFINITION	UNIT
IPCC 2013	Global warming potential	This indicator measures the impact of an increase in global average temperature caused by greenhouse gas emissions on the world's climate. The main greenhouse gases are CO_2, CH_4, and N_2O [5].	kg CO_2 eq
TRACI 2.1	Acidification of soil and water sources potential	This indicator measures the impact of an increase in the concentration of hydrogen ions (H^+) in soil or water environments caused by emissions of acidifying substances (for example, sulfuric acid) [6].	kg SO_2 eq
TRACI 2.1	Eutrophication potential	This indicator measures the consequences of an enrichment of water by nutrients (nitrates and phosphates), thus increasing the growth of algae that deteriorate the aquatic ecosystem [6].	kg N eq
TRACI 2.1	Smog formation potential	This indicator measures the formation of smog (ground-level ozone (O_3)), which is a pollutant that impacts the respiratory system. Smog is produced by the exposure of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) to solar radiation [6].	kg O_3 eq
TRACI 2.1	Ozone depletion potential	This indicator measures the impact of the depletion of the ozone layer, which protects living organisms from solar radiation. Ozone depletion is mainly caused by chlorofluorocarbon (CFC) and halon emissions [6].	kg CFC-11 eq
CML	Abiotic resource depletion potential of non-renewable (fossil) energy resources	This indicator measures the depletion of abiotic (fossil) energy resources and represents the excess energy required to extract these resources in the future [7].	MJ (LHV)

Table 23: Inventory categories, definitions and units used in the study [1]

INDICATOR CATEGORY	DEFINITION	UNIT
Renewable primary energy used as energy carrier/material	Use of renewable primary energy as a source of energy (hydroelectric, solar, wind) or as a material (wood, paper).	MJ (LHV)
Non-renewable primary energy used as energy carrier/material	Use of non-renewable primary energy (peat, oil, gas, coal) as a source of energy or as a material (plastics).	MJ (LHV)
Hazardous, non-hazardous and radioactive disposed waste	Generation of hazardous (solvents, engine oil, acids), non-hazardous (concrete, plastic, glass) or radioactive (radioactive fuels, products contaminated by radioactive substances) disposed waste.	kg, m^3
Use of freshwater resources	Freshwater that is consumed, i.e., by evaporation (cooling towers), evapotranspiration, freshwater embedded in the product or drainage of water into the ocean.	m^3
Removals and emissions of biogenic carbon	Biogenic carbon input (removal during biomass formation) and output (emissions) related to the product and packaging.	kg CO_2

8| ABBREVIATIONS, ACRONYMS AND CHEMICAL FORMULAE

CFC	Chlorofluorocarbon
CFC-11	Trichlorofluoromethane
CH_4	Methane
CO_2	Carbon dioxide
EPD	Environmental product declaration
eq	Equivalent
LCA	Life cycle assessment
LHV	Lower heating value
N	Nitrogen
NO_x	Nitrogen oxides
O_3	Ozone
PCR	Product category rules
SO_2	Sulphur dioxide
VOCs	Volatile organic compounds

9| GLOSSARY

- **Cut-off threshold.** Criteria for excluding inputs and outputs based on their contribution (%) to the total mass and energy. If this contribution is lower than a certain threshold (cut-off), these flows can be ignored [9].

- **Ecoinvent.** Life cycle inventory database for materials, chemicals, power generation systems, transport and waste treatment processes [4].

- **Environmental impact.** Any negative or beneficial modification of the environment, resulting wholly or in part from environmental aspects [17] that is to say elements of the activities, products or services of an organization that can interact with the environment [18].

- **Environmental product declaration (EPD).** Environmental declaration providing quantified environmental data for a product using predetermined parameters based on the ISO 14040:2006 and ISO 14044:2006 standards related to life cycle assessment [18,19] as well as the ISO 14025:2006 standard related to type III environmental declarations [8].

- **Functional unit (FU).** Quantified performance of a product system intended to be used as a reference unit in a life cycle assessment [18].

- **Life cycle assessment (LCA).** Compilation and evaluation of the inputs and outputs (inventory) as well as the assessment of potential environmental impacts of a product during its life cycle [18].

- **Product category rules (PCR).** A set of specific rules, requirements and guidelines for the development of EPDs [9].

10| REFERENCES

[1] UL Environment (2022) Product category rules for building-related products and services. Part A: Life cycle assessment calculation rules and report requirements. Standard UL 10010. Version 4.0. Available at: https://www.shopulstandards.com/ProductDetail.aspx?productId=ULE10010_6_S_20220328

[2] UL Environment (2021) Product category rules for building-related products and services. Part B: Asphalt shingles, built-up asphalt membrane roofing and modified bituminous membrane roofing EPD requirements. Standard UL 10010-11. Version 1.2. Available at: https://www.shopulstandards.com/ProductDetail.aspx?productId=ULE10010-11_3_S_20210524

[3] GreenDelta (2024) OpenLCA 2.0.2. Available at: https://www.openlca.org/

[4] Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E. and Weidema, B. (2016) The ecoinvent database version 3 (part I): overview and methodology. *The International Journal of Life Cycle Assessment* 21, 1218–1230. Available at: https://link.springer.com/article/10.1007/s11367-016-1087-8

[5] IPPC and WG2 (2013) IPCC Fifth Assessment Report (AR5). *Climate Change 2014: Impacts, Adaptation, and Vulnerability*

[6] U.S. Environmental Protection Agency (2012) Tool for the reduction and assessment of chemical and other environmental impacts (TRACI) TRACI version 2.1 - User's guide. Available at: https://nepis.epa.gov/Adobe/PDF/P100HN53.pdf

[7] Hischier, R., Weidema, B., Althaus, H.-J., Bauer, C., Doka, G., Dones, R., Frischknecht, R., Hellweg, S., Humbert, S., Jungbluth, N., Köllner, T., Loerincik, Y., Margni, M. and Nemecek, T. (2010) Implementation of life cycle impact assessment methods data v2.2 (2010). *ecoinvent Report No. 3* 176. Available at: https://www.researchgate.net/publication/263239305_Implementation_of_Life_Cycle_Impact_Assessment_Methods_ecoinvent_report_No_3_v22

[8] International organization for standardization (2006) ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures

[9] International organization for standardization (2017) ISO 21930:2017 Sustainability in buildings and civil engineering works - core rules for environmental product declarations of construction products and services

[10] Asphalt Institute (2019) Life cycle assessment of asphalt binder. Available at: https://www.asphaltinstitute.org/engineering/sustainability/life-cycle-assessment-of-asphalt-binder/

[11] Petro-Acc (2023) What is oxidized bitumen. Available at: https://www.petroacc.com/what-is-oxidized-bitumen

[12] Vertima (Unknown year) Extract from the report : Life cycle assessment of SOPREMA's air barriers

[13] Flanagan, B. and Steckel, D. (2019) ACLCA guidance to calculating non-LCIA inventory metrics in accordance with ISO 21930:2017. Available at: https://aclca.org/wp-content/uploads/ISO-21930-Final.pdf

[14] International organization for standardization (2015) ISO 9001:2015 Quality management systems - requirements

[15] International organization for standardization (2018) ISO 45001:2018 Occupational health and safety management systems - Requirements with guidance for use

[16] International organization for standardization (2015) ISO 14001:2015 Environmental management systems - Requirements with guidance for use

[17] International organization for standardization (2010) ISO 21931-1 Sustainability in building construction - framework for methods of assessment of the environmental performance of construction works - part 1: buildings

[18] International organization for standardization (2006) ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework

[19] International organization for standardization (2006) ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines

EPD FOR SBS-MODIFIED BITUMEN MEMBRANES - PANELIZED BASE SHEET

SOPREMA

1688 Jean-Berchmans-Michaud Street,
Drummondville, Quebec,
Canada J2C8E9

https://www.soprema.ca/en