ENVIRONMENTAL PRODUCT DECLARATION

EXTRUDED POLYSTYRENE THERMAL INSULATION BOARD

SOPRA-XPS™

Specialised in the manufacturing of sealing, insulation, vegetative and soundproofing products and solutions for the roofing, building envelope and civil engineering fields worldwide, SOPREMA presents the environmental product declaration (EPD) of its extruded polystyrene thermal insulation board SOPRA-XPS™.

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

The EPD and LCA were prepared by CT Consultant according to EN 15804, ISO 14025 and ISO 21930, and verified by Marie Bellemare (Marie Bellemare Consulting).

For further information about the products manufactured by SOPREMA, visit https://www.soprema.ca/

Period of validity: December 2021 – December 2026

ASTM INTERNATIONAL

1 | GENERAL INFORMATION

Program operator	**ASTM International** 100 Barr Harbor Drive West Conshohocken, PA 19428 United States of America (USA) www.astm.org
Declaration holder	**SOPREMA** 1688 Jean-Berchmans-Michaud Street Drummondville, Quebec Canada J2C 8E9 (819) 478-8163 www.soprema.ca
Declared product	SOPRA-XPS™ extruded polystyrene thermal insulation board
Functional unit	1 m^2 of installed extruded polystyrene thermal insulation board with a thickness that gives an average thermal resistance RSI = 1 m^2K/W.
Declaration number	EPD-283
Date of issue	16 December 2021
Period of validity	16 December 2021 – 15 December 2026
EPD type	Product-specific
EPD scope	Cradle to grave
Reference period	May 2020 – April 2021
Region covered	North America
LCA Software	OpenLCA version 1.10.3 [1]
Life cycle inventory database	ecoinvent version 3.6 [2]
Life cycle impact assessment method	TRACI version 2.1 [3]
Product Category Rules (PCR)	PCR Part A: UL Environment Building Related Products and Services. v3.1. May 2018 [4] PCR Part B: UL Environment. Building Related Products and Services. Building Envelope Thermal Insulation EPD requirements. v2.0. April 2018 [5]
PCR Part B review	PCR Part B peer review panel Thomas Gloria, PhD, Industrial Ecology, Chairman of the peer review panel t.gloria@industrial-ecology.com

2 | PREPARATION AND VERIFICATION

- This EPD and the LCA were prepared by:

  CT CONSULTANT
  Expertise in environmental life cycle assessment
  266 Hickson Street
  Montreal, Quebec
  Canada H4G 2J6
  www.ctconsultant.ca

- This EPD and the LCA were verified by:

  This verification was carried out in accordance with ISO 14025:2006 [6], ISO 14044:2006 [7], and the reference PCR.

  ☐ INTERNAL ☒ EXTERNAL

  MB Consulting
  Marie Bellemare Consulting
  5687 5th Avenue
  Montreal, Quebec
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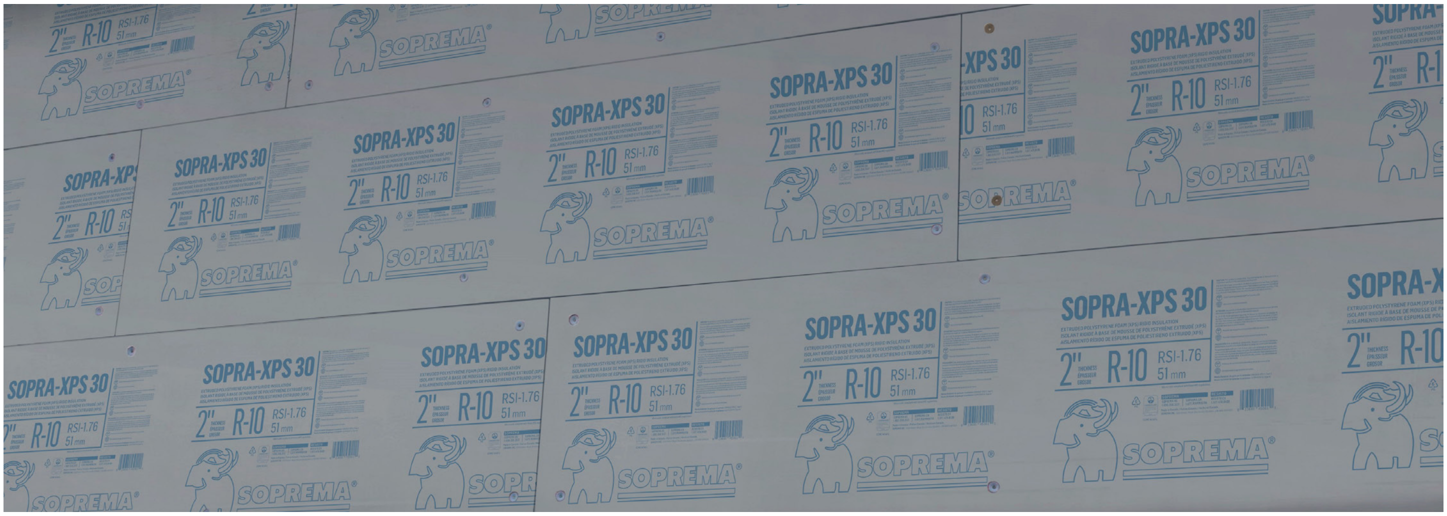
- The PCR "UL Environment, Building Related Products and Services, Part A v3.1, May 2018" [4] based on ISO 21930:2017 [8] and EN 15804:2013 [9] serves as the core PCR, with additional considerations for the USGBC/UL Environment Part A Enhancement (2017) and "UL Environment. Building Related Products and Services. Part B : Building Envelope Thermal Insulation EPD requirements. v2.0. April 2018" [5].

3 | NOTES ON EPD COMPARISON

For products from the same category but from different programs, environmental declarations may not be comparable. When EPDs are used to compare the environmental performance of different building envelope thermal insulation products, it is essential to take into account the products' use and their impacts on the building. Therefore, EPDs cannot be used for comparison purposes when the building's energy consumption is not considered [5]. Furthermore, in order to allow comparability, all the life cycle stages of a thermal insulation product must have been considered. The same standards and the same reference PCR must be used, and the product installation scenarios must be equivalent [5]. It should also be noted that the use of different LCA software packages and databases may affect the reliability of the EPD comparison.



4 | PRODUCT AND COMPANY DESCRIPTION

4.1. Company description

Specialised in the manufacturing of products for waterproofing, soundproofing, insulating and greening buildings and civil engineering structures, SOPREMA manufactures several types of insulation products including an extruded polystyrene insulation board, the SOPRA-XPS™. 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. The SOPRA-XPS™ insulation board is manufactured in an ISO 9001-certified plant [10] (see section 10.1.) located at 5255 Robert-Boyd Street in Sherbrooke, Quebec, Canada.

4.2. Product description and applications

The SOPRA-XPS™ is a rigid, closed-cell extruded polystyrene foam insulation board used for thermal insulation in residential and commercial buildings and civil engineering structures. This versatile insulation product can be used in a variety of applications such as foundation systems, walls, parking decks and inverted roof systems, including plaza decks and green roofs. The insulation board is manually installed in one or more layers flat on or against the surface being insulated. All the products of the line have an initial and long-term RSI (thermal performance) equal to 0.8805 m²K/W [11]. Its high density and closed cell structure give the SOPRA-XPS™ one of the highest compressive strengths on the market, and make it exceptionally resistant to water and moisture. It is also resistant to climatic variations and freeze-thaw cycles. The product's formulation limits the formation of mould and the proliferation of bacteria, even in the presence of moisture. In addition, the SOPRA-XPS™ is made of up to 70% recycled and recovered content, as well as a new HFO-type blowing agent with a low global warming potential (1 kg CO_2 eq [12]). The SOPRA-XPS™ is GREENGUARD GOLD certified, which demonstrates that the product line complies with very strict criteria and considers the most demanding safety factors regarding volatile organic compound (VOC) emissions. The SOPRA-XPS™ insulation boards comply with the CAN/ULC-S701.1 [13] and ASTM C578 [14] standards in their respective classifications. The SOPRA-XPS™ is sold in grey boards measuring 8 feet long by 2 or 4 feet wide, and are available in several thicknesses, with grooved, shiplap or butt edges.

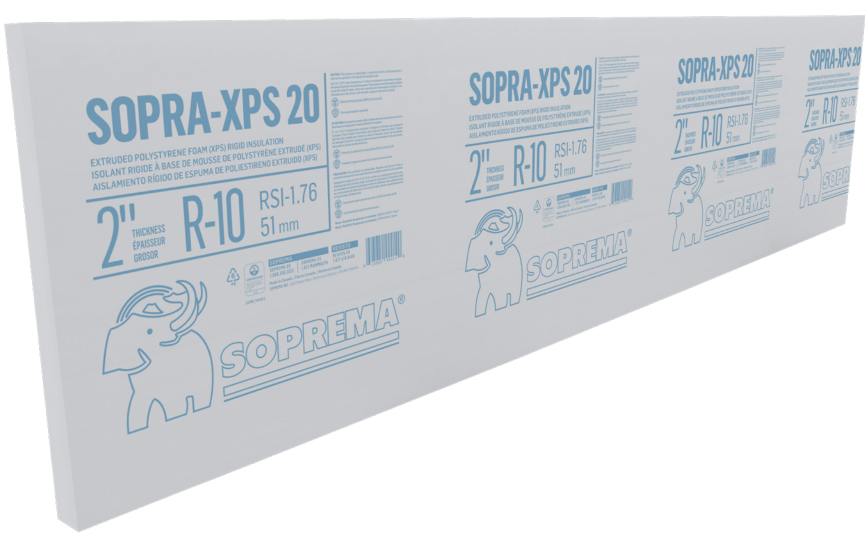


Photo 1. SOPRA-XPS™ insulation board

4.3. Products covered by the EPD

All the products of the SOPRA-XPS™ product line are covered by this EPD:

- SOPRA-XPS™ 20
- SOPRA-XPS™ 25 CW
- SOPRA-XPS™ 30
- SOPRA-XPS™ 35
- SOPRA-XPS™ 35 DC
- SOPRA-XPS™ 40
- SOPRA-XPS™ 60
- SOPRA-XPS™ 100

4.4. Reference product

The reference product considered here is representative of the entire SOPRA-XPS™ line. It corresponds to a weighted average of the composition and densities based on the total quantity of raw materials purchased and tonnage produced for each of the products of the SOPRA-XPS™ line manufactured during the reference year (May 2020 - April 2021). The thermal resistance and processes included in the life cycle of the insulation board (manufacturing process, transport, installation, use and end of life) are identical for each product of the line, and only the density and thickness differ from one product to another.

In 2020, SOPREMA replaced the HFC-based blowing agent previously used in the manufacturing of its insulation board by HFO-1234ze. As HFO-1234ze was used for 7 of the 12 months of the reference year considered, the quantity of HFO-1234ze used in the study was determined by extrapolation to the full year. For conciseness, HFO-1234ze is hereafter referred to simply as HFO.

4.5. Material composition

Table 1. Material composition of the SOPRA-XPSTM insulation board

Material	Mass (% of the board)	Production site	Distance travelled to SOPREMA's manufacturing plant
Recycled polystyrene	68%	Multiple (Canada and USA)	1 837
Virgin Polystyrene	20%	Multiple (USA, Taiwan and South Korea)	9 206
HFO	3%	Baton Rouge (Louisiana, USA)	2 850
Carbon dioxide	3%	Pointe-aux-Trembles and Varennes (Quebec, Canada)	165
Flame retardant	3%	Israel	9 893
		China	26 004
Co-agent	2%	Chatham (Ontario, Canada)	970
		Shreveport (Louisiana, USA)	2 800
Talc	1%	Israel	9 893
Colorant	<1%	Israel	9 893
Stearic acid	<1%	Spain	6197

4.6. Thermal performance of the product

Table 2. Thermal performance of the SOPRA-XPSTM insulation board

Standard	Title	Result	Verification laboratory
ASTM C518-21 [11]	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	0.8805 $m^2K/W/cm$ (5 $ft^2°Fhr/BTU/in$)	R&D Services Inc., Watertown (Tennessee, USA)

4.7. Density and sizes of the product

Table 3. Density and sizes of the SOPRA-XPSTM insulation board upon delivery

Property	Value	Unit
Density	32.8	kg/m^3
Length	8	ft
	243.84	cm
Width	2	ft
	60.96	cm
Thickness	1 - 4	in
	2.54 - 10.16	cm

4.8. Manufacturing

The insulation board consists of polystyrene, additives and a blowing agent. For the definitions of the terms, please refer to the glossary. During the manufacturing process at SOPREMA's plant in Sherbrooke, the polystyrene (virgin, recycled and recovered materials, which are scrap materials and non-compliant insulation boards) is mixed with the additives. The mixture is then extruded using a blowing agent made up of HFO and carbon dioxide and a co-agent to obtain a foam. After cooling, the foam is cut into boards. A descriptive print is added to the surface of the insulation boards before they are stacked on a polystyrene wedge and packaged for delivery to the user. During insulation board storage at the SOPREMA plant, a portion of the HFO is considered to be emitted to the air as presented in the scenario described in Section 5.3

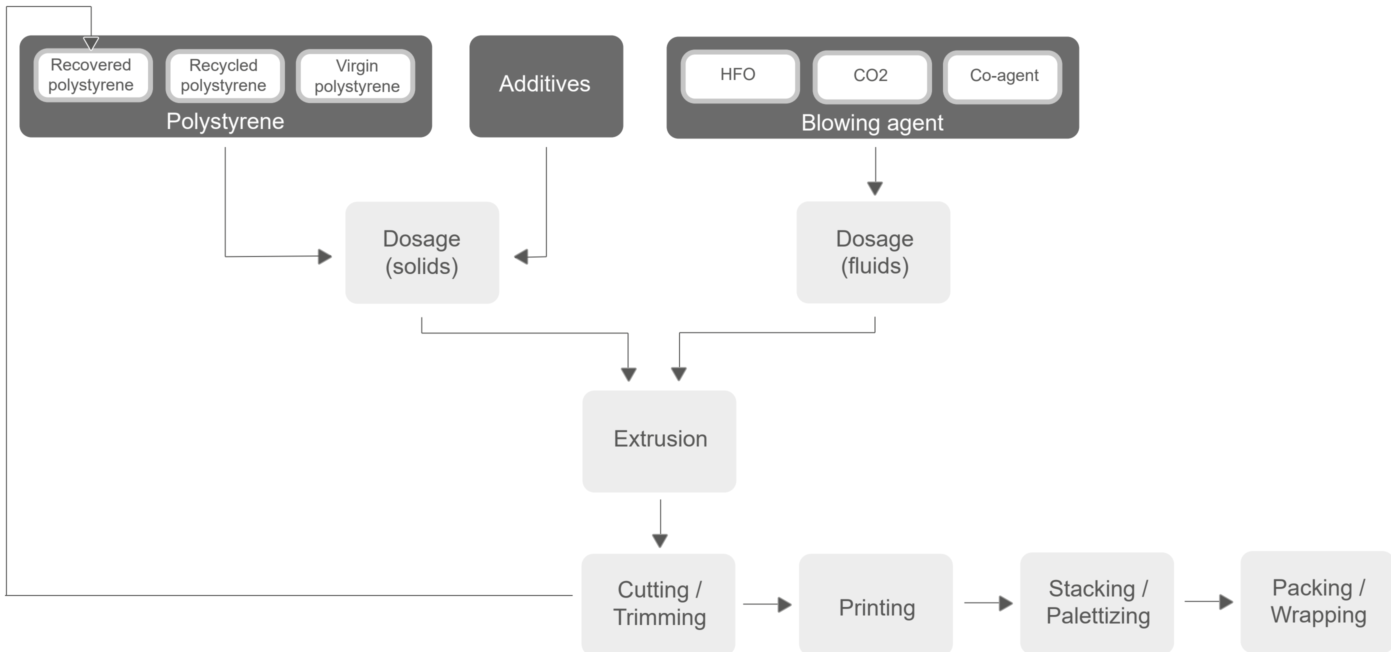


Figure 1. Steps for the production of the SOPRA-XPS™ insulation board (Sherbrooke, Quebec, Canada)

4.9. Manufacturing losses

- Scrap material, as well as non-compliant or misshapen insulation boards, are reground and recovered by reintroducing them into the insulation board manufacturing process.
- Contaminated or poor quality insulation boards that cannot be reused in the process are sent to landfill.
- Raw materials that are non-compliant or were inadvertently not used in the manufacturing process are sent to landfill.

4.10. Packaging

The insulation board is delivered to the user in bundles of 12 to 88 boards on polystyrene wedges. The stacked boards are wrapped with a heat-shrinked film for UV protection and an additional plastic packaging film.

4.11. Transport

The insulation board is delivered to the user following four transport scenarios:

- Direct shipment to the user by truck-trailer;
- Shipment via a distributor by truck-trailer;
- Direct shipment to the user by train and trailer-truck;
- Shipment via a distributor by train and trailer-truck;

The transport to the user stage includes storage of the insulation board in a heated space. No specific transport to the storage space was added to the LCA model.

4.12. Installation

The insulation board is installed manually on horizontal surfaces such as roofs, or mechanically attached with fasteners (screws or pins with plastic washers) or adhesive to walls and other surfaces. There are no insulation board losses during installation, because scraps are re-used to insulate other parts of the building. The waste generated during installation, i.e. the polystyrene wedge and the plastic packaging films, is either sent to landfill, recycling or incineration depending on the installation location according to the scenario presented in Table 2, PCR Part A [4].

4.13. Use

Once installed, the insulation board does not require any maintenance, repair or replacement. Part of the HFO (blowing agent) diffuses out of the insulation board during use in the building, according to the scenario described in Section 5.3.

4.14. Reference service life

The reference service life is considered equivalent to that of the building, set to 75 years as the default value in the PCR Part B [5].

4.15. End of life

Although the insulation board is recyclable and is identified as such, there is no product recovery system currently in place to enable its recycling. When the building (in which the SOPRA-XPS™ insulation board is installed) reaches its end of life, it is assumed that it is demolished without any sorting or recycling of materials. Therefore, the insulation board will be incorporated into the rest of the demolition waste and sent to a landfill site.The HFO still remaining in the polystyrene foam at its end-of-life is considered to be emitted in the years following the insulation board's landfill, according to the scenario described in Section 5.3.

5 | METHODOLOGY USED FOR THE LIFE CYCLE ASSESSMENT

5.1. Functional unit

The LCA results are the life cycle environmental impacts related to the mass of insulation board required to achieve the functional unit. The latter is based on the thermal resistance of the insulation board (ASTM C518-21), as specified in the PCR Part B [5].

Table 4. Functional unit and key parameters

Parameter	Value	Unit
Functional unit	1 m² of insulation material with a thickness that gives an average thermal resistance RSI=1 m²K/W.	
Mass	1.102	kg
Thickness to achieve the functional unit	0.0289	m

5.2. System boundaries

The cradle to grave LCA includes the following life cycle stages and modules (EN 15804 et ISO 21930 [8,9]):

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

Although possible, the recycling of the insulation board at the end-of-life stage was not considered since no product recovery system is currently in place. Thus, module D was not included in the LCA.

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

PRODUCTION STAGE (A1-A3)			CONSTRUCTION PROCESS STAGE (A4-A5)		USE STAGE (B1 - B7)							END-OF-LIFE STAGE (C1 - C4)				BEYOND SYSTEM BOUNDARY
Production of raw materials	Transport of raw materials	Insulation board manufacturing	Transport to construction site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Energy use	Water use	Deconstruction	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 in the LCA ME: Module excluded from the LCA

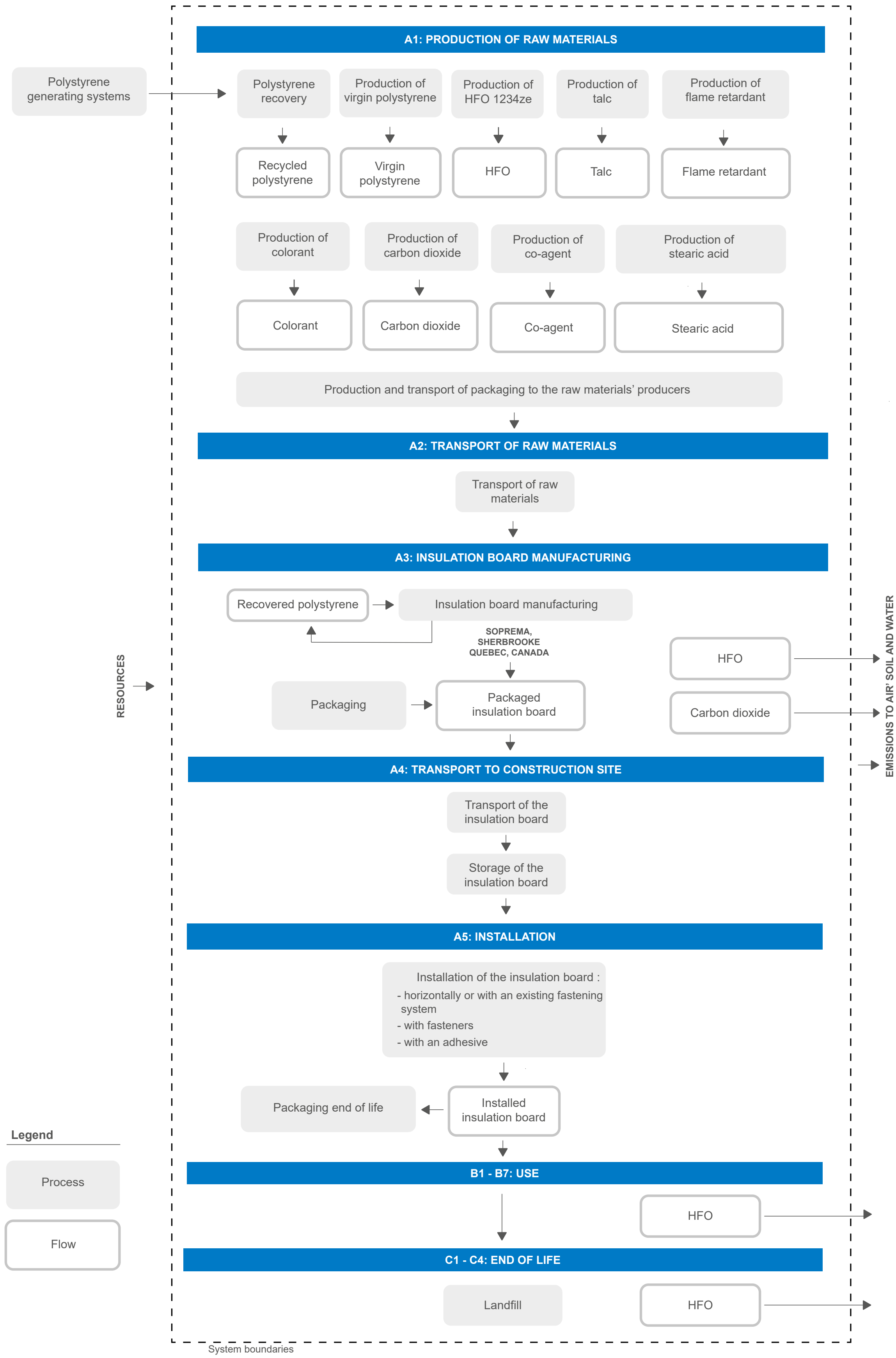


Figure 2. System boundaries - SOPRA-XPSTM insulation board

5.3. Assumptions

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

- Blowing agent: The HFO (blowing agent) diffuses out of the polystyrene foam and is emitted to the air during the life cycle of the insulation board. It is considered that 7% of the HFO's mass is emitted during the manufacturing stage of the insulation board (during storage), 70% during its use and 23% during the end-of-life stage. This scenario is based on the diffusion rate of the HFC-134a blowing agent since the diffusion rate of HFO is currently unknown.

- Blowing agent: The carbon dioxide diffuses completely out of the insulation board in the first months after production. It is estimated that 100% of the carbon dioxide is emitted to the air during the manufacturing stage at SOPREMA's plant since the insulation board is stored on-site for a certain period of time.

- Transport of the recycled polystyrene: The transport distance between the recycled polystyrene generator (e.g. sorting centre) and SOPREMA's suppliers (e.g. broker/wholesaler) was estimated to be 500 km (a conservative estimate).

5.4. Cut-off criteria

As defined in ISO 21930 [8], 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 insulation board were included. Also in line with with the standard, at least 95% of all mass and energy flows were included. No equipment or infrastructure maintenance, administrative activity, or transport of SOPREMA employees or workers were added to the LCA model. No known mass or energy flows were deliberately excluded from this EPD.

5.5. 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 boundaries of the system under study), the environmental impact of the process has to 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 compliance with ISO 21930 [8]. This approach specifies that the impacts associated with secondary materials entering the system are to be attributed to the system that generated them, and that the benefits associated with the recycling of materials leaving the system are not included. In this study, the recycled polystyrene used to manufacture the insulation board has zero impact and no environmental benefits associated with the packaging materials sent for recycling were included.

- **Allocation for multi-functional processes.** No processes in the life cycle of the insulation board generate co-products within the boundaries of the system under study. Therefore, there are no multi-functional allocations to be considered in this study.

- **Allocation approach for ecoinvent data.** The ecoinvent data used is "Allocation, cut-off by classification", 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.

5.6. Reference period

The inventory data is representative of a production year (May 2020 - April 2021).

5.7. Data sources and quality

Table 6. Inventory data sources of the insulation board

Data type	Source
Primary data	Primary data was provided by SOPREMA for the period from 1 May 2020 to 31 April 2021 and included: • quality management system data on raw materials, packaging, manufacturing and transport distances to the construction site; • data based on realistic assumptions regarding transport of raw materials, transport to the construction site, installation, use and end of life of the insulation board.
Secondary data	Secondary data was obtained from the following sources: • the ecoinvent version 3.6 cut-off [2] database; • scientific reports; • reference guides.

Table 7. Data quality assessment

Criterion	Evaluation
Geographical representativeness	The primary data represents the life cycle stages of the insulation board sold in Quebec, other Canadian provinces and the USA. The secondary data was selected to be as representative as possible of the geographical context. Regarding the manufacturing processes taking place in Quebec, priority was given to data representative of the Quebec context, otherwise data representative of the global market was used. For the processes related to the life cycle stages of the insulation board in Canada and the USA, the best available Canadian and USA data was used. Geographical representativeness is considered high.
Temporal representativeness	The primary data is representative of the reference period (1 May 2020 to 31 April 2021). Only the HFO consumption was based on a 7-month period extrapolated to a 12-month period. The secondary data comes from recent reports and reference guides, i.e., published less than 10 years ago. Life cycle inventory data is taken from the ecoinvent version 3.6 (2019) database. This version is based on version 3.0 which has been released annually since 2013. It should be noted that some version 3.0 data comes from earlier versions (1991-2012). The data is considered satisfactory in terms of temporal representativeness.
Technological representativeness	The primary data is representative of the technologies used during the insulation board's life cycle. The secondary data was selected in order to represent these technologies as accurately as possible. This included the fasteners for the installation of the insulation board, the machinery, the plant's buildings and the transportation. The secondary data is deemed to have a high technological representativeness.
Completeness	All processes whose mass and energy flow are above the cut-off threshold (1%) were included in the LCA in accordance with the PCR Part B. No known flow was deliberately excluded.

6 | SCENARIOS USED BEYOND THE MANUFACTURING STAGE

6.1. Transport to the construction site (A4)

Table 8. Scenario for insulation board transport from the manufacturing plant to the construction site

Parameter	Value / Specification	Unit
Scenario 1 - Direct shipment to a Canadian user by truck-trailer (58.8% of the tonnage[1])		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	Truck-trailer with a load capacity of 32 tons or more	-
Transport distance	328	km
Capacity utilization[2]	53	%
Density of product	32.8	kg/m^3
Scenario 2 - Shipment to a user via a Canadian distributor by truck-trailer (32.8% of the tonnage)		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	Truck-trailer with a load capacity of 32 tons or more	-
Transport distance	400	km
Capacity utilization	53	%
Density of product	32.8	kg/m^3
Scenario 3 - Shipment to a user via a Canadian distributor by train (6.3% of the tonnage)		
First transport by train		
Fuel type	Diesel	-
Liters of fuel	1 076	L/100km
Vehicle type	Freight train	-
Transport distance	4 389	km
Capacity utilization	100	%
Density of product	32.8	kg/m^3
Second transport by truck-trailer		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	Truck-trailer with a load capacity of 32 tons or more	-
Transport distance	200	km
Capacity utilization	53	%
Density of product	32.8	kg/m^3

[1] The tonnage is equivalent to the total mass of insulation board produced over the reference period.
[2] The capacity of utilization is equal to the mass of product transported divided by the maximum mass that the vehicle can contain.

Parameter	Value / Specification	Unit
Scenario 4 - Direct shipment to a user in the USA by truck-trailer (1.9% of the tonnage)		
Fuel type	Diesel	-
Liters of fuel	25	L/100km
Vehicle type	Truck-trailer with a load capacity between 16 and 32 tons	-
Transport distance	2 477	km
Capacity utilization	37	%
Density of product	32.8	kg/m^3
Scenario 5 - Direct shipment to a Canadian user by train (0.2% of the tonnage)		
First transport by train		
Fuel type	Diesel	-
Liters of fuel	1 076	L/100km
Vehicle type	Freight train	-
Transport distance	2 923	km
Capacity utilization	100	%
Density of product	32.8	kg/m^3
Second transport by truck-trailer		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	Truck-trailer with a load capacity of 32 tons or more	-
Transport distance	200	km
Capacity utilization	53	%
Density of product	32.8	kg/m^3

Table 9. Scenario insulation board storage at the user's or the distributor's site

Parameter	Value / Specification	Unit
Share of storage in Canada	98.1	%
Share of storage in the USA	1.9	%
Storage duration	15	days
Electric heating	0.044	kWh
Natural gas heating	0.057	kWh

6.2. Installation (A5)

Table 10. Building insulation board installation scenario

Parameter	Value / Specification	Unit
Scenario 1 - Manual installation on horizontal surfaces or vertical surfaces that already have a fastening system (81.5% of the tonnage)		
Electricity consumption	-	kWh
Ancillary materials	-	kg
Water consumption	-	m^3
Other resources	-	-
Product loss	-	-
Packaging waste	0.026	kg
Emissions to air, soil and water	-	kg
Volatile organic compound content	-	mg/m^3
Scenario 2 - Manual installation on vertical surfaces using fasteners (16.6% of the tonnage)		
Electricity consumption	-	kWh
Ancillary materials (fasteners)	0.002	kg
Water consumption	-	m^3
Other resources	-	-
Product loss	-	-
Packaging waste	0.026	kg
Emissions to air, soil and water	-	kg
Volatile organic compound content	-	mg/m^3
Scenario 3 - Manual installation on vertical surfaces using an adhesive (1.9% of the tonnage)		
Electricity consumption	-	kWh
Ancillary materials (adhesive)	0.001	kg
Water consumption	-	m^3
Other resources	-	-
Product loss	-	-
Packaging waste	0.026	kg
Emissions to air, soil and water	-	kg
Volatile organic compound content	-	mg/m^3

Table 11. Transport and end-of-life scenario for packaging waste

Parameter	Value / Specification	Unit
Transport to landfill / recycling / incineration site		
Transport distance	50	km
Vehicle type	Truck with a load capacity between 7.5 and 16 tons	-
Polystyrene wedges and plastic films		
Scenario 1 - Insulation board installed in Canada (98.1% of the tonnage)		
Recycling rate [4]	78	%
Landfill rate [4]	22	%
Incineration rate [4]	0	%
Scenario 2 - Insulation board installed in the USA (1.9% of the tonnage)		
Recycling rate [4]	68	%
Landfill rate [4]	15	%
Incineration rate [4]	17	%

6.3. Reference service life

Table 12. Reference service life of the insulation board

Parameter	Value / Specification	Unit
Reference service life	75	years
Declared product properties	Building envelope thermal insulation	-
Design application parameters	Install per SOPREMA's instructions	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	The insulation board meets the specified R-value	-
Outdoor environment	When used in a protected membrane roof assembly, the insulation board is exposed to rainwater runoff. Under a foundation slab, it is in direct contact with the ground.	-
Indoor environment	The insulation board is encapsulated in the building envelope to prevent exposure to ultraviolet radiation.	-
Use conditions	Not applicable (the insulation board does not require any resources)	-
Maintenance	No maintenance required	-

6.4. Use (B1 - B7)

During use, the insulation board emits HFO to the air. No other emissions or use of resources occur during its lifetime. In addition, no maintenance, repair or replacement processes were included.

Table 13. Insulation board use scenario

Parameter	Value / Specification	Unit
Direct emissions of HFO to the air	0.031	kg
Other emissions to ambient air, soil and water	-	kg
Volatile organic compounds (VOCs)	-	kg

6.5. End of life (C1 - C4)

Table 14. Insulation board end-of-life scenario

<table>
<tr><th colspan="2">Parameter</th><th>Value / Specification</th><th>Unit</th></tr>
<tr><td colspan="2">Description of the end-of-life scenario</td><td>Considering that the building is demolished without any sorting or recycling of materials when it reaches its end of life, the insulation board is assumed to be incorporated into the rest of the demolition waste and sent to a landfill site. HFO remaining in the insulation board is emitted to the air during the end-of-life stage.</td><td>-</td></tr>
<tr><td colspan="2">Transport distance</td><td>50</td><td>km</td></tr>
<tr><td colspan="2">Vehicle type</td><td>Truck with a load capacity between 7.5 and 16 tons</td><td>-</td></tr>
<tr><td rowspan="2">Collection process</td><td>Collected separately</td><td>-</td><td>kg</td></tr>
<tr><td>Collected with mixed construction waste</td><td>1.037</td><td>kg</td></tr>
<tr><td rowspan="4">Recovery</td><td>Re-use</td><td>-</td><td>kg</td></tr>
<tr><td>Recycling</td><td>-</td><td>kg</td></tr>
<tr><td>Incineration</td><td>-</td><td>kg</td></tr>
<tr><td>Incineration with energy recovery</td><td>-</td><td>kg</td></tr>
<tr><td>Landfill</td><td>Product destined for landfill</td><td>1.037</td><td>kg</td></tr>
<tr><td colspan="2">HFO emissions</td><td>0.010</td><td>kg</td></tr>
</table>

7 | LIFE CYCLE IMPACT ASSESSMENT RESULTS

The results of the life cycle impact assessment are reported for 1 m² of insulation board giving an average thermal resistance of RSI = 1 m²K/W. The results were calculated for six impact categories using the TRACI 2.1 impact assessment method [3], and are reported for each declared life cycle module [8,15].

Table 15. Life cycle impact assessment results calculated with TRACI 2.1

INDICATOR		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	B2-B7	C1	C2	C3	C4
Global warming potential	Fossil carbon	kg CO_2 eq	2.06E+0	1.35E+0	2.33E-1	2.12E-1	9.07E-2	8.88E-3	3.13E-2	0.00E+0	0.00E+0	1.16E-2	0.00E+0	1.23E-1
	Biogenic carbon[1]	kg CO_2 eq	-2.32E-5	-4.9318E-2	0.00E+0	4.9295E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
	Total[2]	kg CO_2 eq	2.06E+0	1.30E+0	2.33E-1	2.62E-1	9.07E-2	8.88E-3	3.13E-2	0.00E+0	0.00E+0	1.16E-2	0.00E+0	1.23E-1
Acidification potential		kg SO_2 eq	8.60E-3	5.43E-3	1.93E-3	5.90E-4	4.70E-4	3.97E-5	0.00E+0	0.00E+0	0.00E+0	5.12E-5	0.00E+0	8.47E-5
Eutrophication potential		kg N eq	3.00E-3	2.02E-3	2.90E-4	3.10E-4	2.60E-4	3.39E-5	0.00E+0	0.00E+0	0.00E+0	1.44E-5	0.00E+0	7.27E-5
Smog formation potential		kg O_3 eq	1.29E-1	6.04E-2	4.13E-2	8.24E-3	1.10E-2	5.30E-4	3.06E-3	0.00E+0	0.00E+0	1.18E-3	0.00E+0	3.01E-3
Ozone depletion potential		kg CFC-11 eq	1.96E-7	9.16E-8	5.54E-8	2.39E-8	1.71E-8	1.41E-9	0.00E+0	0.00E+0	0.00E+0	2.62E-9	0.00E+0	3.64E-9
Abiotic depletion potential (fossil resources)		MJ (LHV)	5.58E+0	4.41E+0	4.97E-1	4.17E-1	1.71E-1	2.17E-2	0.00E+0	0.00E+0	0.00E+0	2.38E-2	0.00E+0	3.59E-2

[1] *Since TRACI 2.1 considers biogenic CO_2 as equal to 0, the removal of biogenic carbon and emissions of biogenic CO_2 and methane were modeled separately according to assumptions specific to this study. In order to avoid double counting, the impact factor for biogenic methane in TRACI 2.1 was set to 0.*

[2] *The global warming potential impact category results are presented in three categories: 1) fossil carbon; 2) biogenic carbon (emissions and removals); 3) total (fossil and biogenic carbon).*

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 the EPD users should not use additional measures for comparative purposes.

8 | LIFE CYCLE INVENTORY RESULTS

The life cycle inventory results relate to: 1) resource use; 2) waste and output flows; 3) removals and emissions of biogenic carbon. The inventory categories are presented in Table 21.

8.1. Resource use inventory indicators

Table 16. Life cycle inventory results for resource use

INDICATOR	UNIT	TOTAL	PRODUCTION STAGE (A1-A3)			CONSTRUCTION STAGE (A4-A5)		USE STAGE (B1 - B7)		END-OF-LIFE STAGE (C1 - C4)			
			A1	A2	A3	A4	A5	B1	B2-B7	C1	C2	C3	C4
Renewable primary energy used as energy carrier (fuel)[1]	MJ (LHV)	6.77E+0	2.34E+0	3.85E-2	4.27E+0	1.04E-1	8.95E-3	0.00E+0	0.00E+0	0.00E+0	2.22E-3	0.00E+0	4.55E-3
Renewable primary resources with energy content used as material[1]	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
Total use of renewable primary resources with energy content[1]	MJ (LHV)	6.77E+0	2.34E+0	3.85E-2	4.27E+0	1.04E-1	8.95E-3	0.00E+0	0.00E+0	0.00E+0	2.22E-3	0.00E+0	4.55E-3
Non-renewable primary resources used as an energy carrier (fuel)[1]	MJ (LHV)	2.15E+1	1.38E+1	3.51E+0	2.14E+0	1.48E+0	1.16E-1	0.00E+0	0.00E+0	0.00E+0	1.71E-1	0.00E+0	2.61E-1
Non-renewable primary resources with energy content used as material[1]	MJ (LHV)	1.36E+1	1.25E+1	0.00E+0	1.03E+0	0.00E+0	7.10E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary resources with energy content[1]	MJ (LHV)	3.50E+1	2.63E+1	3.51E+0	3.17E+0	1.48E+0	1.87E-1	0.00E+0	0.00E+0	0.00E+0	1.71E-1	0.00E+0	2.61E-1
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
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
Secondary materials[2]	kg	9.80E-1	9.80E-1	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
Recovered energy[3]	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
Use of net freshwater resources[2]	m^3	1.15E-2	9.28E-3	6.97E-4	5.67E-4	5.43E-4	5.29E-5	0.00E+0	0.00E+0	0.00E+0	3.01E-5	0.00E+0	2.89E-4

[1] The results of these indicators were calculated with the CED LHV method [16] according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [17].

[2] The results of these indicators were calculated according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [17] by using inventory data.

[3] The insulation board is not used for energy recovery. This inventory indicator is therefore zero.

8.2. Waste categories and output flows inventory indicators

Table 17. Life cycle inventory results for waste categories and output flows

INDICATOR	UNIT	TOTAL	PRODUCTION STAGE (A1-A3)			CONSTRUCTION STAGE (A4-A5)		USE STAGE (B1 - B7)		END-OF-LIFE STAGE (C1 - C4)			
			A1	A2	A3	A4	A5	B1	B2-B7	C1	C2	C3	C4
Hazardous waste disposed[1]	kg	1.55E-6	0.00E+0	0.00E+0	1.55E-6	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-hazardous waste disposed[1]	kg	1.06E+0	0.00E+0	0.00E+0	1.62E-2	0.00E+0	5.86E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.04E+0
High-level radioactive waste[2]	m³	1.09E-9	8.29E-11	3.63E-11	2.05E-10	7.49E-10	6.66E-12	0.00E+0	0.00E+0	0.00E+0	1.90E-12	0.00E+0	4.37E-12
Intermediate- and low-level radioactive waste[2]	m³	1.64E-8	1.53E-9	9.28E-9	1.13E-9	3.17E-9	2.32E-10	0.00E+0	0.00E+0	0.00E+0	4.37E-10	0.00E+0	6.14E-10
Components for re-use[3]	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
Materials for recycling[1]	kg	4.98E-2	0.00E+0	0.00E+0	2.93E-1	0.00E+0	2.06E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for energy recovery[3]	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
Exported energy[3]	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

[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" [17] by using the foreground data provided by the manufacturer.

[2] The results of these indicators were calculated according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [17] by using the inventory data. It is important to note that the foreground data of this LCA does not include radioactive waste, i.e. the insulation board manufacturing process does not directly generate radioactive waste. According to ISO 21930 [8], 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).

[3] The insulation board is not recovered or reused. These inventory indicators are therefore zero.

8.3. Biogenic carbon emissions and removals inventory indicators

The ISO 21930 standard and the PCR Part A require that the removals and emissions of biogenic carbon dioxide (CO_2) be presented separately when included in the calculation of the global warming potential impact category [4,8].

Table 18. Life cycle inventory results for biogenic carbon emissions and removals

INDICATOR	UNIT	TOTAL	PRODUCTION STAGE (A1-A3)			CONSTRUCTION STAGE (A4-A5)		USE STAGE (B1 - B7)		END-OF-LIFE STAGE (C1 - C4)			
			A1	A2	A3	A4	A5	B1	B2-B7	C1	C2	C3	C4
Biogenic carbon removal from product[1]	kg CO_2	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
Biogenic carbon emission from product[1 2]	kg CO_2	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
Biogenic carbon removal from packaging[1]	kg CO_2	-5.08E-5	-4.9318E-2	0.00E+0	4.9295E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Biogenic carbon emission from packaging[1 2]	kg CO_2	1.03E-5	0.00E+0	0.00E+0	1.03E-5	0.00E+0	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Calcination carbon emissions	kg CO_2	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
Carbonation carbon removals	kg CO_2	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
Carbon emissions from combustion of waste from non-renewable sources used in production processes	kg CO_2	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
Carbon emissions from combustion of waste from renewable sources used in production processes	kg CO_2	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

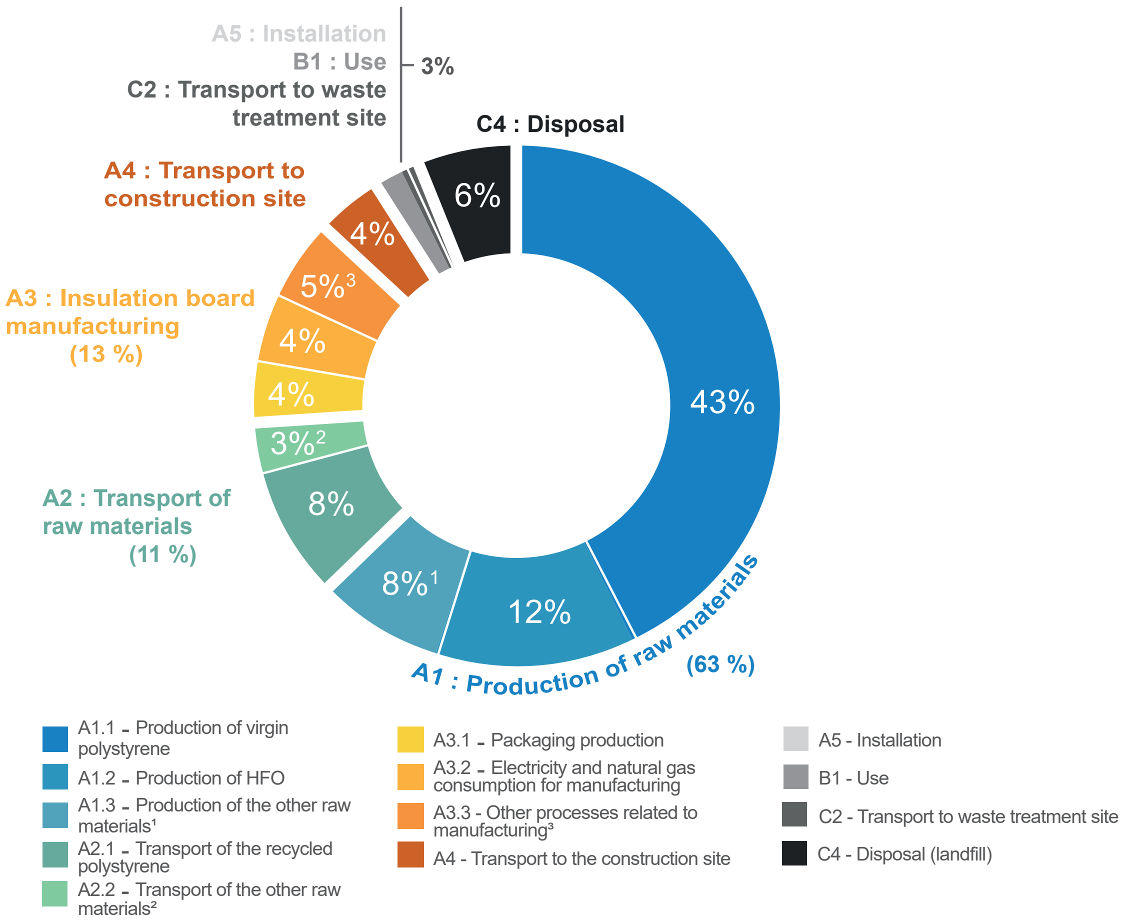
[1] The results of these indicators were calculated according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [17].

[2] For these inventory indicators, only carbon dioxide emissions are included. Methane emissions are excluded in accordance with the PCR Part A [4].

9 | LIFE CYCLE ASSESSMENT INTERPRETATION

9.1. Global warming impact indicator

The life cycle module contributing most to the **global warming** impact indicator is A1 - Production of raw materials (63%), followed by A3 - Insulation board manufacturing (13%) and A2 - Transport of raw materials (11%). These three modules account for 87% of the total impact score. For raw materials production, the main contributor is A1.1 - Production of virgin polystyrene (43%), despite the fact that its mass proportion represents 20% of the insulation board (see Table 1). Regarding the transport of the insulation board's raw materials, the main contributor is A2.1 - Transport of the recycled polystyrene (8%).



[1] *The sub-module "A1.3 - Production of the other raw materials" includes production of the carbone dioxide, flame retardant, stearic acid, talc, colorant and co-agent.*

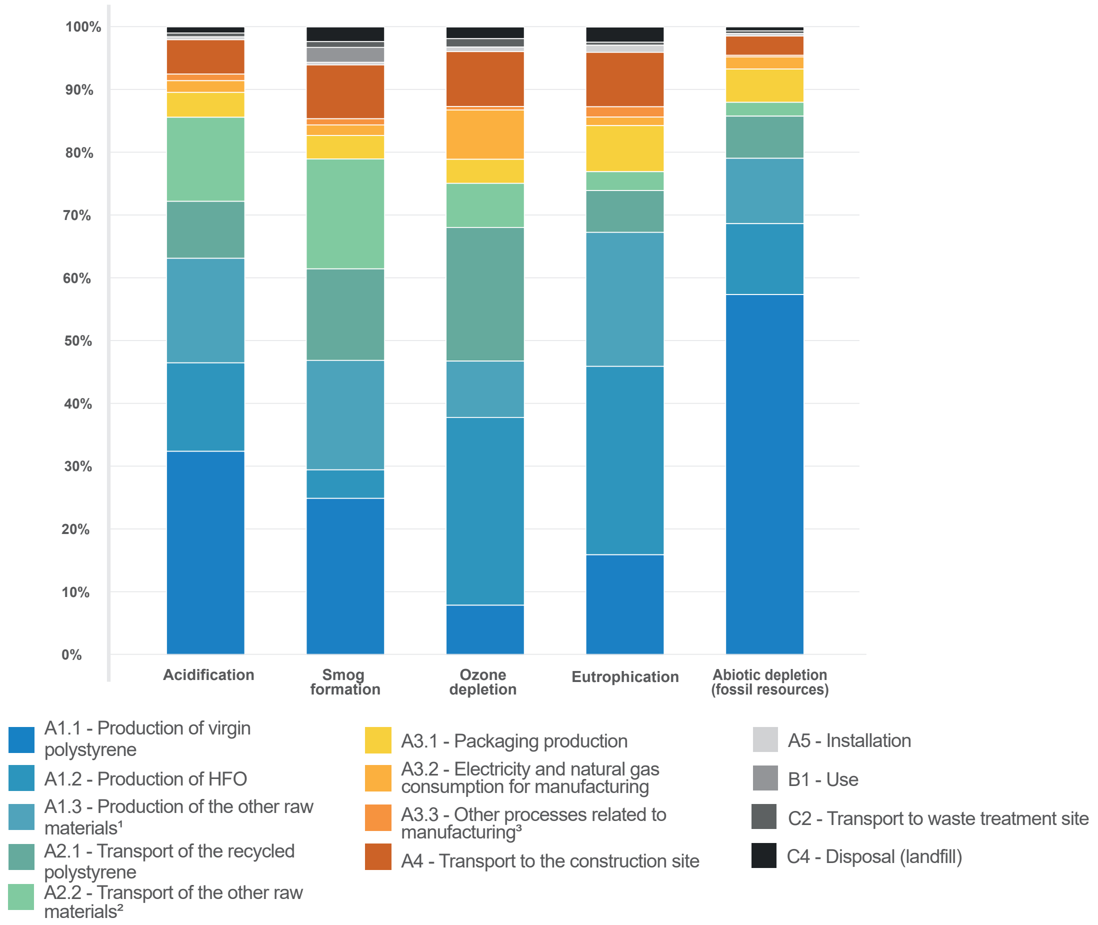
[2] *The sub-module "A2.2 - Transport of the other raw materials" includes transport of the virgin polystyrene, HFO, carbone dioxide, flame retardant, stearic acid, talc, colorant and co-agent.*

[3] *The sub-module "A3.3 - Other processes related to manufacturing" includes emissions of blowing agent, production of the ink cleaning solvent, materials constituting the manufacturing plant and processes and the end of life of manufacturing losses.*

Figure 3. Contribution of the different life cycle modules and sub-modules to the global warming impact category

9.2. Acidification, eutrophication, smog formation, ozone depletion and abiotic depletion impact indicators

The two main modules contributing to the **acidification** impact indicator are A1 - Production of raw materials (63%) and A2 - Transport of raw materials (22%). The sub-module with the highest influence on this indicator is A1.1 - Production of virgin polystyrene (32%). Regarding the **smog formation** indicator, the largest contributors are A1 - Production of raw materials (47%) and A2 - Transport of raw materials (32%). Sub-module A1.1 - Production of virgin polystyrene is the sub-module with the greatest influence on this indicator (25%). The **ozone depletion** indicator is mostly affected by modules A1 - Production of raw materials (47%) and A2 - Transport of raw materials (28%). As for the **eutrophication** impact category, A1 - Production of raw materials (67%) is the main contributing module. A1.2 - Production of HFO is the predominant sub-module for this indicator (30%). In the case of **abiotic resource depletion**, the main contributing module is A1 - Production of raw materials (79%), which includes A1.1 - Production of virgin polystyrene (57%).

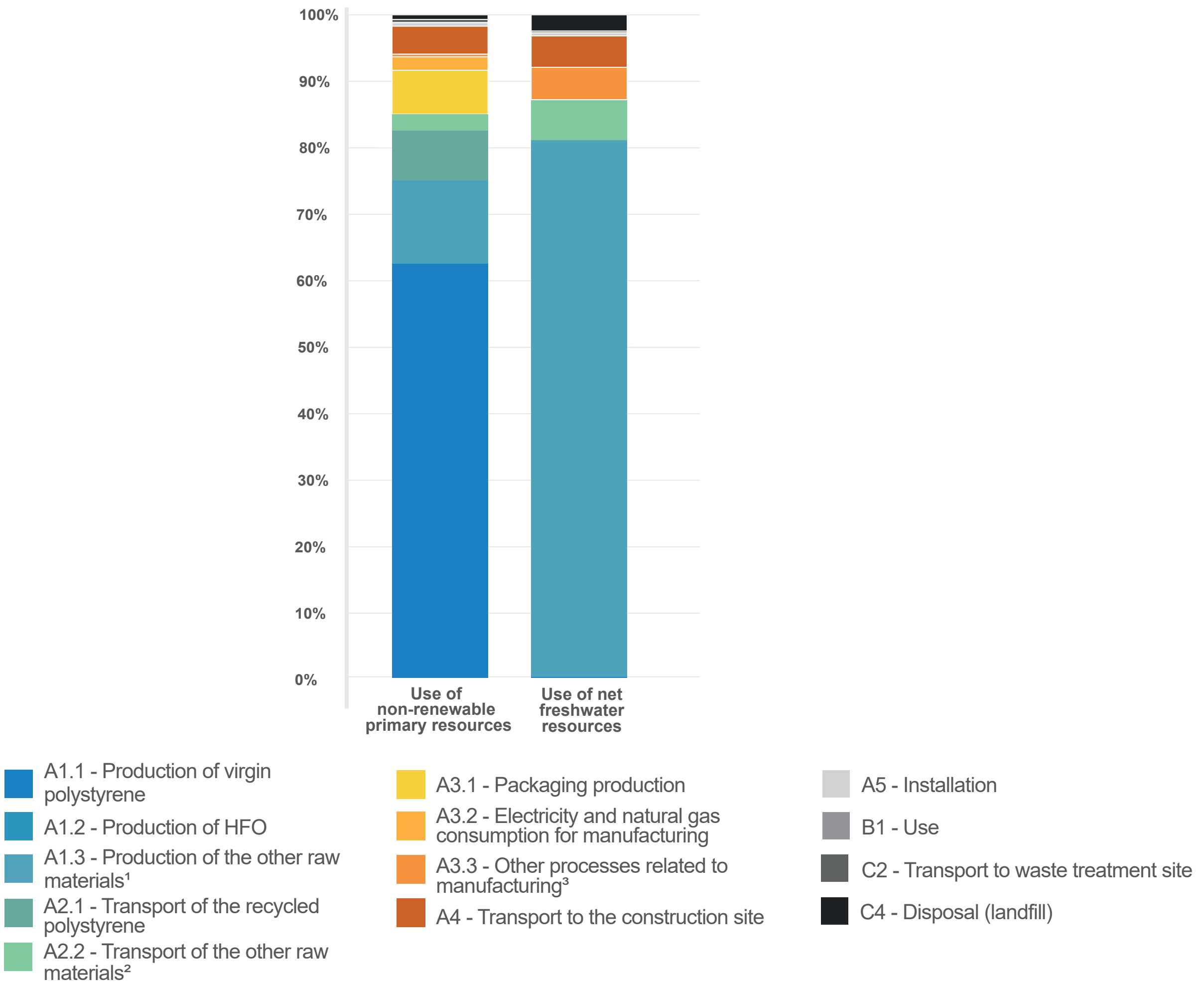


[1,2,3] The sub-modules "A1.3 - Production of the other raw materials", "A2.2 - Transport of the other raw materials" and "A3.3 - Other processes related to manufacturing" are described under Figure 3.

Figure 4. Contribution of the different life cycle modules and sub-modules to the different impact categories

9.3. Use of non-renewable primary resources and use of freshwater resources inventory indicators

The **use of non-renewable primary resources** and **use of freshwater resources** indicators are mainly dominated by modules A1 - Production of raw materials (75%). However, the sub-module contributing the most to the **non-renewable primary resources** indicator is A1.1 - Production of virgin polystyrene (62%), whereas the largest contributor to **freshwater use** is A1.3 - Production of the other raw materials (81%).



[1,2,3] The sub-modules "A1.3 Production of the other raw materials", "A2.2 - Transport of the other raw materials" and "A3.3 - Other processes related to manufacturing" are described under Figure 3.

Figure 5. Contribution of the different life cycle modules and processes to non-renewable primary resources use and freshwater resources use

10 | ADDITIONAL ENVIRONMENTAL INFORMATION

10.1. Environment and health during manufacturing and installation

SOPREMA's SOPRA-XPS™ insulation board is manufactured in a plant commissioned in 2018 covered by a quality management system certified under ISO 9001 [10].

Link to the ISO 9001 certificate: https://www.soprema.ca/wp-content/uploads/2021/10/SOPREMA-ISO-9001-EN-1.pdf

10.2. Environmental certifications and activities

The SOPRA-XPS™ obtained and maintains the GREENGUARD GOLD certification, issued and validated yearly by UL Environment, demonstrating the product line's low emissions for interior environments following the guidelines of the UL 2818 standard [18].

Link to the GREENGUARD GOLD certificate: https://spot.ul.com/main-app/products/detail/5cd9cd5055b0e81d607f4174

The use of the SOPRA-XPS™ can contribute to acquiring green building program certifications such as the U.S. Green Building Council's LEED® rating system.

10.3. Regulated hazardous substances

The insulation board contains only the materials listed in Table 1, which are not on Canada's list of toxic substances [19].

10.4. Energy savings during building operation

The use of an insulation board reduces the energy consumption of a building throughout its life cycle, thereby reducing its environmental impact. In the case of this LCA, the environmental benefits provided by the SOPRA-XPS™ insulation board associated with the reduction of the energy consumed by the building were not included in the results presented in section 7, in line with the PCR Part B. Carrying out energy simulations considering several building scenarios (building geometry, type of heating, fenestration rate, etc.) would provide an assessment of the energy savings associated with the use of the SOPRA-XPS™ insulation board and thus would enable determining the environmental impacts reductions.

10.5. Delayed emissions and unexpected adverse events

There are no unexpected adverse effects resulting from the combustion, water damage or mechanical alteration of the insulation board. There are no delayed environmental emissions resulting from the use of the product other than HFO emissions.

10.6. Blowing agent

January 1, 2021 was marked by an amendment to the Ozone-Depleting Substances and Halocarbon Alternatives Regulations (ODSHAR) from Environment and Climate Change Canada (ECCC) [20].

Part of the legacy of the well-known 1987 Montreal Protocol on the protection of the ozone layer adopted by 197 signatory countries, including Canada [21], these regulations cover and limit the use of halocarbons with a global warming potential (GWP) greater than 150 [20]. Applicable to many products manufactured or imported in Canada, these regulations are intended in particular for manufacturers of foam plastic insulating materials using halocarbon-based blowing agents.

In the USA, several states adopted regulations in 2020 and 2021 limiting the use of HFC-based blowing agents in plastic foams. On September 23, 2021, the U.S. Environmental Protection Agency (EPA) released a regulation under the U.S. Innovation and Manufacturing Act (AIM) of 2020 that establishes the HFC production and consumption benchmarks from which reductions should be made and specifies the timetable established to achieve these reductions. [22]

SOPREMA has chosen to upgrade the SOPRA-XPS™ line by using a blowing agent with a low global warming potential that does not contribute to the depletion of the ozone layer. The HFC-134a blowing agent was therefore replaced by Honeywell's HFO (Solstice®). In October 2020, SOPREMA made the transition to HFO at its Sherbrooke plant. This blowing agent allows the SOPRA-XPS™ to maintain its thermal insulation, water absorption and compressive strength performances equivalent to those obtained using HFC-134a.

10.7. Polystyrene recovery and recycling

Contrary to popular belief, cups, plates, bowls, vegetable or meat trays, and protective packaging for food, electronics and household appliances, are all examples of polystyrene-based objects that are recyclable. As part of the No. 6 plastic family, these items often end up in the trash due to consumers' lack of awareness and because most recycling facilities still don't collect them.

An increasing number of municipalities offer recycling services for food and product packaging polystyrene materials. Residents may bring these used items in dedicated collecting facilities or are invited to place them in their recycling bin. Polystyrene scrap is then diverted from landfill and brought to SOPREMA's Sherbrooke plant. For ease of transportation and storage, it is often densified and delivered in the form of blocks, coils or ingots. It is then mixed with other sources of post-consumer and pre-consumer recycled polystyrene for transformation into plastic beads that can be introduced into the SOPRA-XPS™ manufacturing process.

10.8. Recycled content

To validate the recycled content of the SOPRA-XPS™ insulation board, SOPREMA retained the services of an external consulting firm. The validation of the data related to the purchase and integration of non-virgin material included the verification of the formulations, tonnages registered in the management system and suppliers of the recycled material.

The non-virgin material can be divided into three categories:

- **Pre-consumer recycled material:** materials diverted from the waste stream during a manufacturing process [23].
- **Post-consumer recycled material:** materials generated by households or commercial, industrial or institutional facilities in their role as an end user of the product, and which can no longer be used for the application for which they were designed [23].
- **Recovered material:** materials left over or recovered from the manufacturing process and reintroduced in the latter to avoid their elimination.

The content related to each of these categories for the different products of the SOPRA-XPS™ line is presented in Table 19. The validation was carried out according to ISO 14020 and ISO 14021 [23,24]. The symbol used to illustrate the presence of recycled content complies with ISO 7000-1135 [25].

The recycled content certificate is at https://files.soprema.ca//2021-11-02/Recycled_Content_Certificate_SOPREMA_SOPRA-XPS_2021_EN.pdf6181512c05933482d1f9043b4cc48b595d072ca527029.pdf

Table 19. Recycled and recovered content of SOPRA-XPSTM products (from 01-07-2020 to 30-06-2021)

Product	Pre-consumer Recycled Content	Post-consumer Recycled Content	Total Recycled Content	Recovered Content	Total Recycled and Recovered Content
SOPRA-XPSTM 20	32%	22%	54%	22%	76%
SOPRA-XPSTM 25 CW	38%	25%	63%	14%	77%
SOPRA-XPSTM 30	31%	21%	52%	24%	76%
SOPRA-XPSTM 35	33%	23%	56%	20%	76%
SOPRA-XPSTM 35 DC	33%	23%	56%	20%	76%
SOPRA-XPSTM 40	32%	21%	53%	22%	75%
SOPRA-XPSTM 60	31%	21%	52%	23%	75%
SOPRA-XPSTM 100	26%	17%	43%	27%	70%

10.9. Further information

Additional information on the SOPRA-XPSTM can be found at https://www.soprema.ca/extruded-polystyrene-insulation-boards/

11 | IMPACT AND INVENTORY INDICATORS DEFINITIONS

Table 20. Impact categories used in the study, definition and unit [3]

Indicator Category	Definition	Unit
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.	kg CO_2 eq
Acidification 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).	kg SO_2 eq
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.	kg N eq
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 (NOx) and volatile organic compounds (VOCs) to solar radiation.	kg O_3 eq
Ozone depletion potential	This indicator measures the impact of the depletion of the ozone layer, that protects living organisms from solar radiation. Ozone depletion is mainly caused by chlorofluorocarbon (CFC) and halon emissions.	kg CFC-11 eq
Abiotic depletion potential (fossil resources)	This indicator measures the depletion of abiotic (fossil) energy resources and represents the excess energy required to extract these resources in the future.	MJ (LHV)

Table 21. Inventory categories used in the study, definition and unit [4]

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).	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 fresh water resources	Use of freshwater, excluding non-consumed water (water used to power turbines, or as coolant and recirculated) and water losses caused by natural phenomena (evaporation of rainwater).	m^3
Removals and emissions of biogenic carbon	Product and/or packaging biogenic carbon input (biomass removals) and output (emissions) flows.	kg CO_2

12 | ACRONYMS AND EMPIRICAL FORMULAS

- CFC - Chlorofluorocarbons
- CFC-11 - Trichlorofluoromethane
- CH_4 - Methane
- CO_2 - Carbon dioxide
- EPD - Environmental product declaration
- eq - Equivalent
- FU - Functional unit
- HFC-134a - 1,1,1,2-Tetrafluoroethane
- HFO - HFO-1234ze ((1E)-1,3,3,3-Tetrafluoroprop-1-ene)
- LCA - Life cycle assessment
- LHV - Lower heating value
- N - Nitrogen
- NOx - Nitrogen oxides
- O_3 - Ozone
- PCR - Product category rules
- SO_2 - Sulfur dioxide
- VOCs - Volatile organic compounds

13 | GLOSSARY

- **Biogenic carbon:** carbon derived from biomass produced by living organisms through natural processes, excluding carbon which is fossilized or derived from fossil resources [8].
- **Blowing agent:** substance generating a cell-like structure (foam) from materials that can undergo hardening or phase transition (such as polymers or metals) via a foaming process [26].
- **Cut-off criteria:** 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 [8].
- **Environmental impact:** any negative or beneficial modification of the environment, resulting wholly or in part from environmental aspects [28], that is to say elements of the activities, products or services of an organization that can interact with the environment [27].
- **Environmental product declaration (EPD):** environmental declaration providing quantified environmental data using predetermined parameters based on the ISO 14040 and ISO 14044 standards [8].
- **Functional unit (FU):** quantified performance of a product system intended to be used as a reference unit in a life cycle assessment [27].
- **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 [27].
- **Post-consumer recycled material:** materials generated by households or commercial, industrial or institutional facilities in their role as an end user of the product, and which can no longer be used for the application for which they were designed. This includes material returns from the distribution chain. [23].
- **Pre-consumer recycled material:** materials diverted from the waste stream during a manufacturing process. It excludes the reuse of materials in the same process that generated them, such as those resulting from reprocessing and regrinding [23].
- **Product category rules (PCR):** set of specific rules, requirements and guidelines for the development of EPDs [8]. The PCR referenced in this EPD refer to "UL PCR Part B: Building Envelope Thermal Insulation EPD requirements" and "UL PCR Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report."
- **Recovered material:** materials left over or recovered from the manufacturing process and reintroduced in the latter to avoid their elimination.

14 | REFERENCES

[1] GreenDelta (2020). "About openLCA." openLCA version 1.10.3. Available at: https://openlca.org/openlca/

[2] Wernet G, Bauer C, Steubing B, Reinhard J, Moreno-Ruiz E, Weidema B (2016). "The ecoinvent database version 3 (part I): overview and methodology." The International Journal of Life Cycle Assessment, vol 21, pages 1218-30. Available at: https://link.springer.com/article/10.1007/s11367-016-1087-8

[3] United States Environmental Protection Agency, US EPA (2012). "Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI)." TRACI version 2.1. Available at: https://epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci

[4] UL Environment (2018). "Product Category Rules for Building-Related Products and Services. Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report (UL 10010), Version 3.1."

[5] UL Environment (2018). "Product Category Rules for Building-Related Products and Services. Part B : Building Envelope Thermal Insulation EPD Requirements (UL 10010-1), Version 2.0."

[6] International Organization for Standardization, ISO (2006). "ISO 14025:2006. Environmental labels and declarations - Type III environmental declarations - Principles and procedures."

[7] International Organization for Standardization, ISO (2006). "ISO 14044:2006. Environmental management - Life cycle assessment - Requirements and guidelines."

[8] International Organization for Standardization, ISO (2017). "ISO 21930:2017. Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services."

[9] European Committee for Standardization (2013). "EN 15804:2012+A1:2013. Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products."

[10] International Organization for Standardization, ISO (2015). "ISO 9001:2015. Quality management systems - Requirements."

[11] ASTM International (2021). "ASTM C518-21. Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus."

[12] Wallington T et al. (2015). "Atmospheric chemistry of short-chain haloolefins: Photochemical ozone creation potentials (POCPs), global warming potentials (GWPs), and ozone depletion potentials (ODPs)", Chemosphere vol. 129, pages 135-41. Available at: https://doi.org/10.1016/j.chemosphere.2014.06.092

[13] UL Canada, ULC (2017). "CAN/ULC-S701.1:2017. Standard for Thermal Insulation, Polystyrene Boards."

[14] ASTM International (2019). "ASTM C578-19. Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation."

[15] CT Consultant (2021). "Life Cycle Assessment (LCA) report as part of the completion of the environmental product declaration (EPD) of the SOPRA-XPSTM insulation board."

[16] Hischier R et al. (2010). "Implementation of Life Cycle Impact Assessment Methods Data v2.2. ecoinvent Report No 3, Cumulative energy demand", pages 33-40. Available at: https://ecoinvent.org/wp-content/uploads/2020/08/201007_hischier_weidema_implementation_of_lcia_methods.pdf

[17] Flanagan B, 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

[18] UL Environment Standard (2013). "UL GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings - Standard 2."

[19] Environment and Climate Change Canada (2021). "Canadian Environmental Protection Act - Toxic substances list - Schedule 1." Available at: https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/substances-list/toxic/schedule-1.html

[20] Environment and Climate Change Canada (2016). "Canadian Environmental Protection Act - Ozone-depleting Substances and Halocarbon Alternatives Regulations." Available at: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2016-137/page-1.html

[21] Environment and natural resources Canada (2019). "The Montreal Protocol: protecting the ozone layer and tackling climate change." Available at: https://www.canada.ca/en/services/environment/weather/climatechange/canada-international-action/montreal-protocol.html

[22] United States Environmental Protection Agency, US EPA (2021). "Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act." Available at: https://www.epa.gov/climate-hfcs-reduction/final-rule-phasedown-hydrofluorocarbons-establishing-allowance-allocation

[23] International Organization for Standardization, ISO (2016). "ISO 14021:2016 Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)."

[24] International Organization for Standardization, ISO (2000). "ISO 14020:2000 Environmental labels and declarations - General principles."

[25] International Organization for Standardization, ISO (2004). "ISO 7000-1135 Graphical symbols for use on equipment - Registered symbols."

[26] Wypych G (2017). "Handbook of Foaming and Blowing Agents." Available at: https://doi.org/10.1016/B978-1-895198-99-7.50003-9

[27] International Organization for Standardization, ISO (2006). "ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework."

[28] International Organization for Standardization, ISO (2010). "ISO 21931-1:2010. Sustainability in building construction - Framework for methods of assessment of the environmental performance of construction works - Part 1: Buildings."

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