ENVIRONMENTAL
PRODUCT
DECLARATION

SOPREMA

CELLULOSE THERMAL INSULATION PRODUCT

SOPRA-CELLULOSE™

SOPREMA is pleased to present this environmental product declaration (EPD) for its cellulose thermal insulation product composed of recycled paper: the SOPRA-CELLULOSE™. This EPD was developed by CT Consultant in compliance with CAN/CSA-ISO 14025 and has been verified by Jean-François Ménard (CIRAIG).

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

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

Environmental Product Declaration

CSA Group Registered
Based on ISO 14025
and Other Requirements
For more information visit
csaregistries.ca/epd

#6883-2177
June 2022 - 2027

1| GENERAL INFORMATION

This environmental product declaration (EPD) is in accordance with CAN/CSA-ISO 14025 and the PCR noted below. EPDs from different programs may not be comparable.

Program operator	**CSA Group** 178 Rexdale Blvd. Toronto, Ontario Canada M9W 1R3 www.csagroup.org
Product	SOPRA-CELLULOSE™ cellulose thermal insulation
EPD registration number	6883-2177
EPD recipient organization	**SOPREMA** 1451 Nobel Street Sainte-Julie, Quebec Canada J3E 1Z4 (450) 922-2000 www.soprema.ca
Reference PCR	Product category rule (PCR) Guidance for building related products and services. Part B: Building envelope thermal insulation EPD requirements. v2.0. Program operator: UL Environment. Validity period: April 2018 – February 2023 UL 10010-1
Date of issue	June 14, 2022
Period of validity	June 2022 – June 2027

The PCR review was conducted by:	Thomas Gloria, PhD Industrial Ecology 35 Bracebridge Road Newton, Massachusetts United States of America (USA) (617) 533-4929 t.gloria@industrial-ecology.com
This EPD and related data were independently verified by an external verifier, according to CAN/CSA-ISO 14025: 2006	☐ INTERNAL ☒ EXTERNAL Signature Jean-François Ménard Jean-François Ménard, CIRAIG

2| DESCRIPTION OF SOPREMA

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 the cellulose insulation product SOPRA-CELLULOSE™. 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-CELLULOSE™ insulation product is manufactured in an ISO 9001-certified plant [1] located at 1451 Nobel Street in Sainte-Julie, Quebec, Canada.

3| DESCRIPTION OF PRODUCT

3.1 Product description and applications

SOPRA-CELLULOSE™ is a loose-fill insulation product used for thermal and acoustic insulation of interior and exterior walls, attics, floors and ceilings in new constructions or renovation works. This insulation product is composed of recovered paper provided by wholesalers in North America and fire-retardant minerals. The insulation can be installed manually, blown or injected. SOPRA-CELLULOSE™ is GREENGUARD GOLD certified [2], which demonstrates compliance with strict criteria regarding volatile organic compound (VOC) emissions. The insulation product also offers maximum security thanks to its exceptional flame resistance in compliance with the CAN/ULC-S703 standard [3]. SOPRA-CELLULOSE™ contains no asbestos, fiberglass or formaldehyde, and its fire-retardant minerals prevent the intrusion of insects, vermin and small rodents.

Photo 1. SOPRA-CELLULOSE™ insulation product

3.2 Products covered by the EPD

The two products included in the SOPRA-CELLULOSE™ product line are covered by this EPD: SOPRA-CELLULOSE™ and SOPRA-CELLULOSE AB™.

3.3 Technical specifications of the SOPRA-CELLULOSE™ product line

Table 1. Thermal performance test results of the SOPRA-CELLULOSE™ product line

Product	Standard	Thermal resistance	Specific thermal resistance	Verification laboratory
SOPRA-CELLULOSE™	ASTM C518 standard test method for steady-state thermal transmission properties by means of the heat flow meter apparatus [4]	5.437 m^2K/W	25.043 mK/W	R&D Services Inc., Cookeville, Tennessee, United States
		30.874 $ft^2 °Fhr/Btu$	43.345 ft°Fhr/Btu	
SOPRA-CELLULOSE AB™		6.657 m^2K/W	25.882 mK/W	
		37.800 $ft^2 °Fhr/Btu$	44.798 ft°Fhr/Btu	

Table 2. Other physical properties of SOPRA-CELLULOSE™

Property	Unit	CAN/ULC-S703 Requirement	ASTM C739 Requirement
Corrosiveness	–	No perforations	No perforations
Design Density	kg/m^3	As determined	As determined
Fungi Resistance	–	Fungal growth shall not exceed that of the comparative item	Fungal growth shall not exceed that of the comparative item
Moisture Vapour Sorption	%	< 20	< 15
Open Flammability	W/cm^2	≥ 0.12	≥ 0.12
Open Flammability Permanency	W/cm^2	≥ 0.12	N/A
Separation of Chemicals	%	< 1.5	N/A
Smoulder Resistance	%	< 15	< 15

3.4 Reference product

3.4.1 Reference product description

The reference product considered here is representative of the SOPRA-CELLULOSE™ line. It corresponds to a weighted average of the composition, density and thermal resistance based on the total quantity of raw materials and tonnage produced for each product of the SOPRA-CELLULOSE™ line manufactured during the reference year (January-December 2019). The material composition and manufacturing steps are the same regardless of the final density of the product. During installation, the required density of the insulation varies depending on where it is applied. This EPD covers all possible applications of the product.

3.4.2 Reference product properties

Table 3. Thermal performance and density of the SOPRA-CELLULOSE™ reference product

Property	Result	Unit
Specific thermal resistance	25.199	mK/W
	43.616	ft°Fhr/BTU
R-value per inch	3.63	ft^2°Fhr/BTU/in
Density	25.0	kg/m^3

3.5 Material composition

Table 4. Material composition of the SOPRA-CELLULOSE™ insulation product

Material	Mass (share of the insulation product)	Production site	Distance travelled to SOPREMA's manufacturing plant
Recovered paper	81%	Multiple (Canada and USA)	900 km
Boric acid	9%	Turkey	9,593 km
		South America	14,776 km
Ammonium sulfate	7%	North America	650 km
Water	1%	Local water supply system	-
Mineral oil	< 1%	Global market	840 km
Monoammonium phosphate	< 1%	Global market	1,352 km

Note: The SOPRA-CELLULOSE™ has a safety data sheet (CA U DRU SS FS 225) [5].

3.6 Manufacturing

The insulation product consists of recovered paper and additives. During the production of the insulation product at SOPREMA's manufacturing plant in Sainte-Julie the recovered paper is shredded, and additives are added. The paper pieces and additives are mixed together to form a homogeneous blend. The mixture is mechanically ground and defibrated to form the insulation product, which is then packaged for delivery.

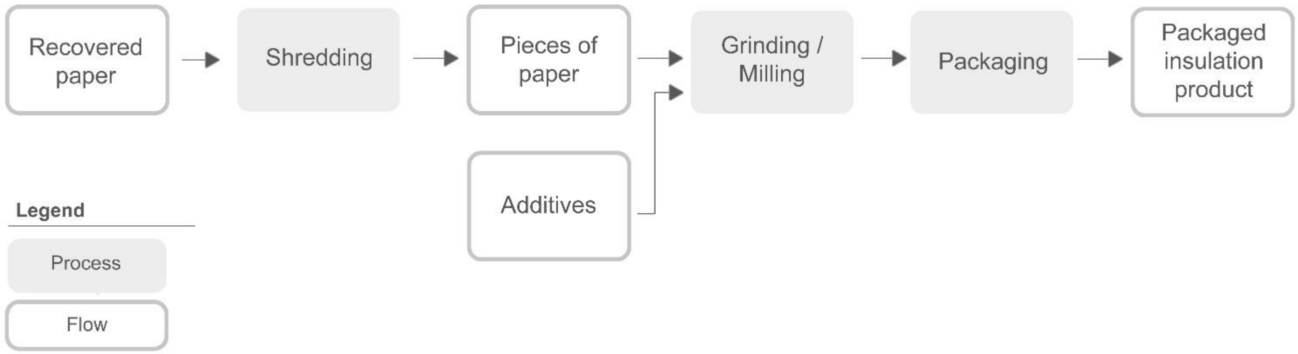


Figure 1. Steps for the production of the SOPRA-CELLULOSE™ insulation product (Saint-Julie, Quebec, Canada)

3.7 Manufacturing losses

- Non-compliant insulation product is recovered by reintroducing it into the insulation manufacturing process.
- Raw materials that are non-compliant or were inadvertently not used in the manufacturing process are recycled or sent to landfill.

3.8 Packaging

The insulation product is delivered to the user in plastic bags on a wood pallet wrapped with a plastic film. Each bag contains 11.3 kg of insulation product, representing 407 kg of insulation product per pallet.

3.9 Transport

The insulation product is delivered to the customer considering five 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 truck-trailer;
- Shipment via distributor by train and truck-trailer;
- Customer pick-up by cube truck or truck-trailer.

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

3.10 Installation

The insulation product is either installed manually by pouring the contents of the loose-fill insulation bags into the desired location or by using a gasoline or electrically powered insulation blowing machine. When a blowing machine is used, the loose-fill insulation is loaded into the machine and is either be blown through a hose or injected through a hole in the wall being insulated using a "needle" type device. There are no insulation losses during installation as the fallen material is put back into the blowing machine. The waste generated during the installation, i.e. the wooden pallet, the plastic bag and the plastic film are sent for recycling.

3.11 Use

Once installed, the insulation product does not require any maintenance, repair or replacement. It does not release any emissions to the air during its service life.

3.12 Reference service life

The reference service life of the insulation product is considered equivalent to that of the building, set to 75 years as the default value in the PCR Part B [6].

3.13 End of life

Although the insulation product can be fully recycled at its end of life, there is no collection program currently in place to recover insulation when buildings are deconstructed. When the building (in which the SOPRA-CELLULOSE™ insulation product is installed) reaches its end of life, it is assumed that it is demolished without any sorting or recycling of materials. Therefore, the insulation product will be incorporated into the rest of the demolition waste and sent to a landfill site.

4| SCOPE OF THE EPD

4.1 Functional unit

The LCA results are the life cycle environmental impacts related to the mass of insulation product required to achieve the functional unit. The latter is based on the thermal resistance of the insulation product, as specified in the PCR Part B [6].

Table 5. Functional unit and key parameters

Parameter	Value	Unit
Functional unit	1 m^2 of insulation product with a thickness that gives an average thermal resistance RSI=1 m^2K/W.	-
Mass	0.9922	kg
Thickness to achieve the functional unit	0.03968	m

4.2 System boundary

The cradle to grave LCA includes the following life cycle stages and modules (EN 15804 and ISO 21930 [7] [8]):

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

Although possible, the recycling of the insulation product 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 6. Life cycle stages and modules included in and excluded from the LCA

PRODUCTION STAGE (A1 - A3)			CONSTRUCTION PROCESS STAGE	USE STAGE (B1 - B7)								END-OF-LIFE STAGE (C1 - C4)				BEYOND SYSTEM BOUNDARY
Production of raw materials	Transport of raw materials	Insulation product 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

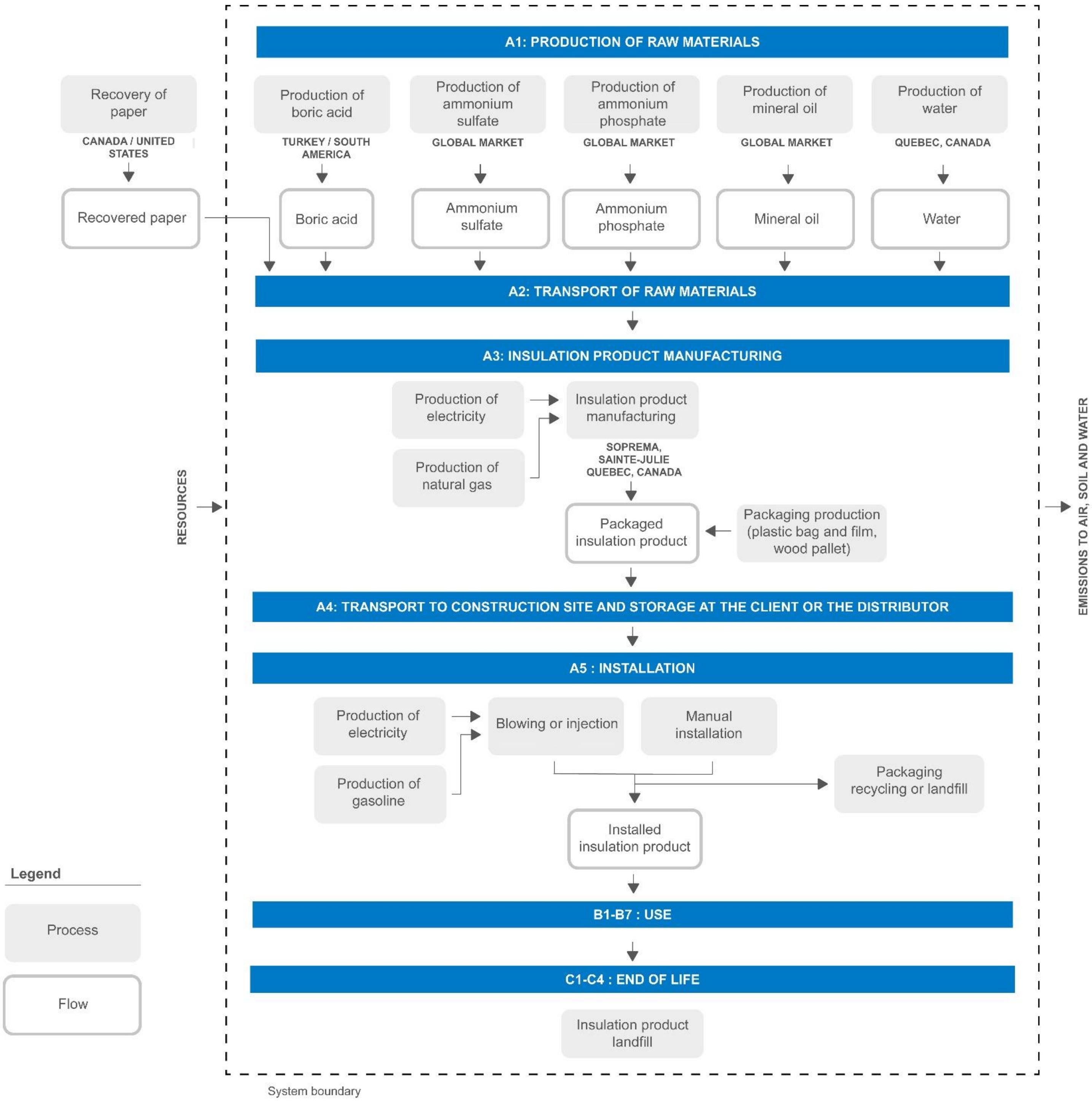


Figure 2. System boundary - SOPRA-CELLULOSE™ insulation product

4.3 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:

- **Transport of the recovered paper (A2).** The transport distance between the recovered paper generator (e.g. sorting centres) and SOPREMA's suppliers (e.g. broker/wholesaler) was estimated to be 500 km (a conservative estimate).

- **Insulation product landfill (A4).** The methane capture rate at the landfill site is 68.7%. This methane is deemed to be completely burned in a flare [9].

4.4 Cut-off criteria

As defined in ISO 21930 [8], all input and output flows whose mass and/or energy account for more than 1% of the total mass input and/or energy of the insulation product were included. Also in line with the standard, at least 95% of all mass and energy flows were included. Infrastructure maintenance, administrative activities and transport of SOPREMA employees or workers were not included in the LCA model. No known mass or energy flows were deliberately excluded from this EPD.

4.5 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 recovered paper used to manufacture the insulation product has zero impact and no environmental benefits associated with the packaging materials sent for recycling were included.

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

- **Allocation approach for life cycle inventory dataset.** The ecoinvent dataset 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.

4.6 Reference period

The inventory data is representative of the January - December 2019 production year.

4.7 Data sources and quality

Table 7. Inventory data sources of the insulation product

Data type	Source
Primary data	Primary data was provided by SOPREMA for the period from 1 January 2019 to 31 December 2019 and included: • quality management system data on raw materials, packaging, manufacturing and transport distances to the distributors; • data based on realistic assumptions regarding transport of raw materials, transport to the construction site, installation, use and end of life of the insulation product.
Secondary data	Secondary data was obtained from the following sources: • the ecoinvent version 3.6 “cut-off” database [10]; • scientific reports; • reference guides.

Table 8. Data quality assessment

Criterion	Evaluation
Geographical representativeness	The primary data represents the life cycle stages of the insulation product taking place 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 Quebec (use of natural gas, electricity and water), otherwise data representative of the global market was used. For the processes and scenarios related to the installation and end of life of the insulation product 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 January to December 2019). The secondary data comes from a recent database, 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 quality is considered high in terms of temporal representativeness.

Technological representativeness	The primary data is representative of the technologies used during the insulation product's life cycle. The secondary data was selected in order to represent these technologies as accurately as possible. This included the blowing machine for the installation of the insulation product, the transportation and the manufacturing plant's buildings and machinery. The 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.

4.8 Scenarios used beyond the manufacturing stage

4.8.1 Transport to the construction site (A4)

Table 9. Scenario for insulation product transport from the manufacturing plant to the construction site

Parameter	Value / Specification	Unit
Scenario 1 - Direct shipment to a Canadian user by truck-trailer (68.22% of the tonnage[1])		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	53’ truck-trailer	-
Transport distance	177	km
Capacity utilization[2]	Unknown	%
Mass transported	1.052	kg/FU
Scenario 2 - Shipment to a user via a distributor in the USA by truck (18.66% of the tonnage)		
First transport by truck-trailer		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	53’ truck-trailer	-
Transport distance	443	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU

[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. In the ecoinvent 3.6 database, it is not clear whether the percentage of capacity utilization is based on the total mass of the truck or on its maximum load, thus the capacity of utilization is unknown.*

Parameter	Value / Specification	Unit
Scenario 2 - continued		
Second transport by cube truck		
Fuel type	Diesel	-
Liters of fuel	13	L/100km
Vehicle type	Camion cube	-
Transport distance	150	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU
Scenario 3 - Pick-up by the user by truck (7.58% of the tonnage)		
Transport by pick-up truck (4.77% of the tonnage)		
Fuel type	Diesel	-
Liters of fuel	9	L/100km
Vehicle type	Pick-up truck	-
Transport distance	169	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU
Transport by truck-trailer (2.81% of the tonnage)		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	53' truck-trailer	-
Transport distance	169	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU
Scenario 4 - Shipment to a user via a Canadian distributor by truck (3.18% of the tonnage)		
First transport by truck-trailer		
Fuel type	Diesel	-
Liters of fuel	35	L/100km
Vehicle type	53' truck-trailer	-
Transport distance	174	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU

Parameter	Value / Specification	Unit
Scenario 4 - continued		
Second transport by cube truck		
Fuel type	Diesel	-
Liters of fuel	13	L/100km
Vehicle type	Cube truck	-
Transport distance	150	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU
Scenario 5 - Shipment to a user via a Canadian distributor by train (2.05% of the tonnage)		
First transport by train		
Fuel type	Diesel	-
Liters of fuel	1076	L/100km
Vehicle type	Freight train	-
Transport distance	3012	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU
Second transport by cube truck		
Fuel type	Diesel	-
Liters of fuel	13	L/100km
Vehicle type	Cube truck	-
Transport distance	400	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU
Scenario 6 - Direct shipment to a Canadian user by train (0.31% of the tonnage)		
First transport by train		
Fuel type	Diesel	-
Liters of fuel	1076	L/100km
Vehicle type	Freight train	-
Transport distance	2741	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU

Parameter	Value / Specification	Unit
Scenario 6 - continued		
Second transport by cube truck		
Fuel type	Diesel	-
Liters of fuel	13	L/100km
Vehicle type	Cube truck	-
Transport distance	50	km
Capacity utilization	Unknown	%
Mass transported	1.052	kg/FU

Table 10. Scenario for the insulation product storage at the user's or the distributor's site

Parameter	Value / Specification	Unit
Share of storage in Quebec, Canada	73.6	%
Share of storage in the USA	18.7	%
Share of storage in other Canadian provinces	7.7	%
Storage duration	15	days
Electric heating	0.021	kWh/FU
Natural gas heating	0.008	kWh/FU

4.8.2 Installation (A5)

Table 11. Building insulation product installation scenario

Parameter	Value / Specification	Unit
Scenario 1 – Installation using an electric blowing machine (73.6% of the tonnage)		
Electricity consumption	0.004	kWh/kg installed insulation product
Ancillary materials	-	kg
Water consumption	-	m^3
Other resources	-	-
Product loss	-	-

Parameter	Value / Specification	Unit
Scenario 1 - continued		
Packaging waste	0.061	kg/FU
Emissions to air, soil and water	-	kg
Volatile organic compound content	-	mg/m^3
Scenario 2 - Installation using a gasoline-powered blowing machine (21.4% of the tonnage)		
Electricity consumption	-	kWh
Water consumption	-	m^3
Other resources	0.004	L gasoline/kg installed insulation product
Product loss	-	-
Packaging waste	0.061	kg/FU
Emissions to air, soil and water	-	kg
Volatile organic compound content	-	mg/m^3
Scenario 3 - Manual installation (5% of the tonnage)		
Electricity consumption	-	kWh
Water consumption	-	m^3
Other resources	-	-
Product loss	-	-
Packaging waste	0.061	kg/FU
Emissions to air, soil and water	-	kg
Volatile organic compound content	-	mg/m^3

Table 12. Transport and end-of-life scenario for packaging waste

Parameter	Value / Specification	Unit
Transport to landfill / recycling site		
Transport distance	50	km
Vehicle type	Truck	-

Parameter	Value / Specification	Unit
Wood pallet for the insulation product's packaging		
Recycling rate	100	%
Landfill rate	0	%
Incineration rate	0	%
Biogenic carbon contained in the wood pallet	0.1	kg CO_2/FU
Plastic bag and film for the insulation product's packaging		
Recycling rate	100	%
Landfill rate	0	%
Incineration rate	0	%

Table 13. Blowing machine transport scenario for installation of the insulation product

Parameter	Value / Specification	Unit
Transport distance	100	km
Vehicle type	Truck	-
Mass of the blowing machine	404	kg

4.8.3 Reference service life

Table 14. Reference service life of the insulation product

Parameter	Value / Specification	Unit
Reference service life	75	years
Declared product properties	Building envelope thermal insulation	-
Design application parameters	Installation per SOPREMA's instructions	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	The insulation product meets the specified R-value	-
Outdoor environment	Not applicable (interior use only)	-
Indoor environment	The insulation product is encapsulated in the building envelope to prevent exposure to water	-
Use conditions	Not applicable (the insulation product does not require any resources)	-
Maintenance	No maintenance required	-

4.8.4 Use (B1 - B7)

It is considered that there are no emissions of substances or use of resources during the use stage of the insulation product. In addition, no maintenance, repair or replacement processes are occurring.

4.8.5 End of life (C1 - C4)

Table 15. Insulation product end-of-life scenario

Parameter		Value / Specification	Unit
Description of the end-of-life scenario		Considering that the building is demolished without any sorting or recycling of materials when it reaches its end of life, the insulation product is assumed to be incorporated into the rest of the demolition waste and sent to a landfill site.	-
Transport distance		50	km
Vehicle type		Truck	-
Collection process	Collected separately	-	kg
	Collected with mixed construction waste	0.992	kg/FU
Recovery	Re-use	-	kg
	Recycling	-	kg
	Incineration	-	kg
	Incineration with energy recovery	-	kg
Landfill	Product destined for landfill	0.992	kg
Biogenic carbon emissions (excluding packaging)		0.267	kg CO_2/FU
Biogenic methane emissions (excluding packaging)		0.020	kg CH_4/FU

5| ENVIRONMENTAL IMPACTS

5.1 Life cycle impact assessment results

The results of the life cycle impact assessment are reported for 1 m² of insulation product 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 [11], and are reported for each declared life cycle module [8][12].

Table 16. Life cycle impact assessment results calculated with TRACI 2.1

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 - B7	C1	C2	C3	C4
Global warming potential	Fossil carbon	kg CO_2 eq	4.66E-1	1.30E-1	9.38E-02	6.82E-2	1.18E-1	2.22E-2	0.00E+0	0.00 E+0	1.10E-2	0.00 E+0	2.33E-2
	Biogenic carbon[1]	kg CO_2 eq	-5.95E-1	-1.41E+0	0.00E+00	-3.98E-2	0.00E+0	9.18E-2	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	7.66E-1
	Total[2]	kg CO_2 eq	-1.28E-1	-1.28E+0	9.38E-02	2.84E-2	1.18E-1	1.14E-1	0.00E+0	0.00 E+0	1.10E-2	0.00 E+0	7.89E-1
Acidification potential		kg SO_2 eq	3.44E-3	1.56E-3	6.40E-04	3.60E-4	5.30E-4	9.84E-5	0.00E+0	0.00 E+0	4.85E-5	0.00 E+0	2.00E-4
Eutrophication potential		kg N eq	3.19E-3	4.90E-4	1.10E-04	2.60E-4	1.90E-4	2.92E-5	0.00E+0	0.00 E+0	1.36E-5	0.00 E+0	2.10E-3
Smog formation potential		kg O_3 eq	5.22E-2	1.51E-2	1.39E-02	5.24E-3	1.12E-2	2.23E-3	0.00E+0	0.00 E+0	1.12E-3	0.00 E+0	3.41E-3
Ozone depletion potential		kg CFC-11 eq	8.71E-8	1.83E-8	2.27E-08	6.65E-9	2.81E-8	4.84E-9	0.00E+0	0.00 E+0	2.48E-9	0.00 E+0	4.10E-9
Abiotic depletion potential (fossil resources)		MJ (LHV)	9.80E-1	2.62E-1	2.04E-01	1.49E-1	2.57E-1	4.41E-2	0.00E+0	0.00 E+0	2.25E-2	0.00 E+0	4.21E-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.

5.2 Life cycle inventory results

5.2.1 Resource use inventory indicators

Table 17. 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 - B7	C1	C2	C3	C4
Renewable primary energy used as energy carrier (fuel)[1]	MJ (LHV)	8.33E-1	1.25E-1	1.50E-2	5.56E-1	9.89E-2	1.44E-2	0.00E+0	0.00 E+0	2.11E-3	0.00 E+0	2.15E-2
Renewable primary resources with energy content used as material[1]	MJ (LHV)	9.17E-1	5.22E-2	0.00E+0	8.65E-1	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Total use of renewable primary resources with energy content[1]	MJ (LHV)	1.75E+0	1.77E-1	1.50E-2	1.42E+0	9.89E-2	1.44E-2	0.00E+0	0.00 E+0	2.11E-3	0.00 E+0	2.15E-2
Non-renewable primary resources used as an energy carrier (fuel)[1]	MJ (LHV)	7.10E+0	1.93E+0	1.44E+0	9.63E-1	1.89E+0	3.25E-1	0.00E+0	0.00 E+0	1.62E-1	0.00 E+0	3.92E-1
Non-renewable primary resources with energy content used as material[1]	MJ (LHV)	5.90E-1	3.12E-1	0.00E+0	2.77E-1	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Total use of non-renewable primary resources with energy content[1]	MJ (LHV)	7.69E+0	2.24E+0	1.44E+0	1.24E+0	1.89E+0	3.25E-1	0.00E+0	0.00 E+0	1.62E-1	0.00 E+0	3.92E-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	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Secondary materials[2]	kg	8.53E-1	8.53E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Use of net freshwater resources[4]	m^3	7.24E-3	2.97E-3	1.70E-4	3.05E-3	6.00E-4	8.94E-5	0.00E+0	0.00 E+0	1.94E-5	0.00 E+0	3.40E-4

[1] *The results of these indicators were calculated with the CED LHV method* [13] *according to the "ACLCA Guidance to calculating non-LCIA inventory metrics in accordance with ISO 21930: 2017"* [14].

[2] *The result of this indicator was calculated according to the "ACLCA Guidance to calculating non-LCIA inventory metrics in accordance with ISO 21930: 2017"* [14] *by using inventory data.*

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

[4] *The results of this indicator were determined by using the "Water consumption" indicator of the ReCiPe 2016 Midpoint (H) impact method* [15].

5.2.2 Waste categories and output flows inventory indicators

Table 18. 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 - B7	C1	C2	C3	C4
Hazardous waste disposed[1]	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Non-hazardous waste disposed[1]	kg	1.03E+0	0.00E+0	0.00E+0	3.64E-2	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	9.92E-1
High-level radioactive waste[2]	m³	2.67E-10	8.55E-11	1.47E-11	5.91E-11	6.77E-11	1.53E-11	0.00E+0	0.00 E+0	1.81E-12	0.00 E+0	2.25E-11
Intermediate- and low-level radioactive waste[2]	m³	1.41E-8	2.64E-9	3.80E-9	1.05E-9	4.65E-9	8.18E-10	0.00E+0	0.00 E+0	4.15E-10	0.00 E+0	7.17E-10
Components for reuse[3]	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Materials for recycling[1]	kg	7.18E-2	0.00E+0	0.00E+0	1.10E-2	0.00E+0	6.07E-2	0.00E+0	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+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" [14] *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" [14] *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 product 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 product is not recovered or reused. These inventory indicators are therefore zero.

5.2.3 Biogenic carbon emissions and removals inventory indicators

Table 19. 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 - B7	C1	C2	C3	C4
Biogenic carbon removal from product[1]	kg CO_2	-1.39E+0	-1.41E+0	0.00E+0	1.46E-2	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Biogenic carbon emission from product[1 2]	kg CO_2	2.77E-1	0.00E+0	0.00E+0	1.19E-2	0.00E+0	0.00E+0	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	2.65E-1
Biogenic carbon removal from packaging[1]	kg CO_2	-2.78E-17	-5.48E-3	0.00E+0	-8.63E-2	0.00E+0	9.18E-2	0.00E+0	0.00 E+0	0.00E+0	0.00 E+0	0.00E+0
Biogenic carbon emission from packaging[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	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+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	0.00 E+0	0.00E+0	0.00 E+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"* [14].

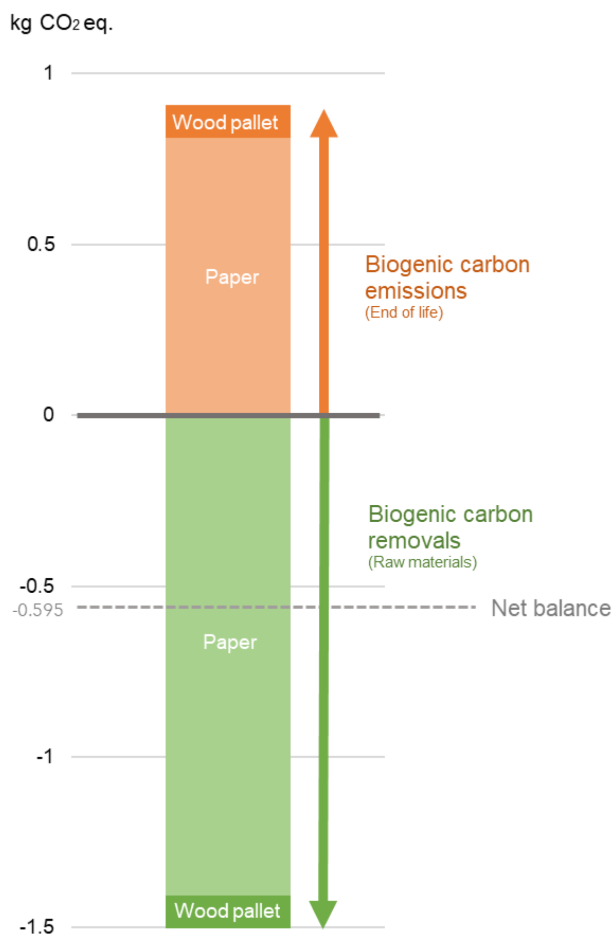
[2] *For this inventory indicator, only carbon dioxide emissions are included. Methane emissions are excluded in accordance with the PCR Part A* [16].

5.3 Life cycle assessment interpretation

5.3.1 Global warming impact indicator

Biogenic carbon flow

Biogenic carbon, i.e., carbon from biomass, is comprised of input flows (removals) and output flows (emissions). The input biogenic carbon flows are the carbon absorbed by the recovered paper and by the wood pallet used for packaging. The output biogenic carbon flows are those related to the end-of-life emissions from paper and the wood pallet. The total input biogenic carbon flows are higher than the output flows (negative net balance), which means that biogenic carbon is sequestered over the life cycle of the insulation product.

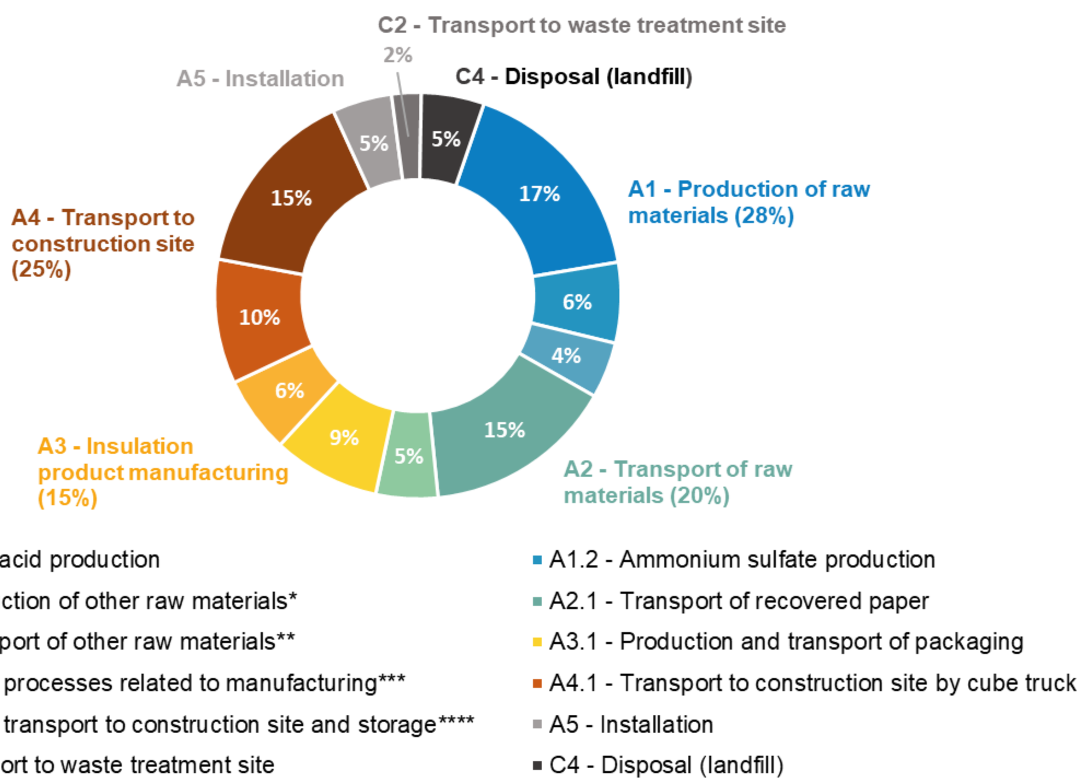


The output flows include biogenic carbon dioxide and methane, expressed in kg CO_2 eq.

Figure 3. Biogenic carbon flow contribution over the life cycle of the insulation product

Fossil carbon emissions

Fossil carbon emissions are emissions from burned fossil resources such as natural gas, gasoline or diesel. The life cycle module contributing the most to **fossil carbon emissions** is A1 - Production of raw materials (28%) followed by modules A4 - Transport to construction site (25%) and A2 - Transport of raw materials (20%). For raw materials production, A1.1 - Boric acid production is the sub-module that contributes the most to fossil carbon emissions (17%). As for transportation to the construction site, the largest fossil carbon emitter of this module is A4.1 - Transport to construction site by cube truck (10%). As for modules A5 - Installation, C2 - Transport to waste treatment site and C4 - Disposal, their contribution to the overall fossil carbon emissions accounts for 12%. Finally, the fossil carbon emissions of the product's lifecycle (4.66E-1 kg CO_2 eq) are lower than the amount of sequestered biogenic carbon (-5.95E-1 kg CO_2 eq), meaning that the insulation product is carbon negative (-1.28E-1 kg CO_2 eq).



** The sub-module "A1.3 - Production of other raw materials" includes production of mineral oil, water and monoammonium phosphate.*

*** The sub-module "A2.2 - Transport of the other raw materials" includes transport of the boric acid, ammonium sulfate, monoammonium phosphate and mineral oil.*

**** The sub-module "A3.2 - Other processes related to manufacturing" includes electricity and natural gas consumption, use of propane and diesel for forklifts, materials constituting the manufacturing plant and processes and the end of life of manufacturing losses and raw materials packaging.*

***** The sub-module "A4.2 - Other transport to construction site and storage" includes transport to the construction site via truck-trailer, pick-up and train, as well as the storage at the user's or distributor's.*

Figure 4. Contribution of the different life cycle modules and sub-modules to fossil carbon emissions

5.3.2 Acidification, eutrophication, smog formation, ozone depletion and abiotic depletion impact indicators

The module with the greatest impact on the **acidification**, **smog formation** and **abiotic resource depletion** impact indicators is A1 - Production of raw materials (45%, 29% and 27%, respectively). The sub-module included in this module with the greatest contribution to these indicators is A1.1 - Boric acid production. Regarding the **ozone depletion** indicator, the largest contributor is A4 - Transport to construction site, whose main contributor is sub-module A4.1 - Transport to construction site by cube truck. The life cycle module with the greatest impact on the **eutrophication** impact category is the product landfill, C4 – Disposal (66%).

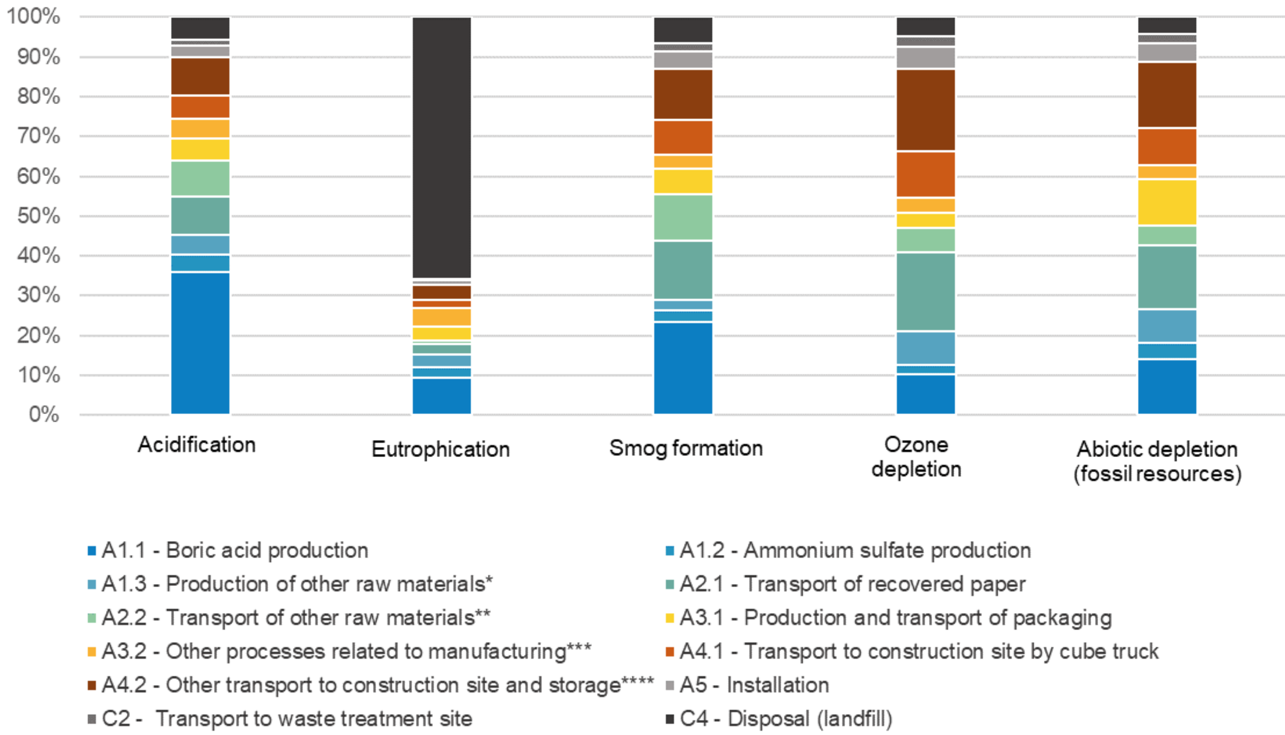


Figure 5. Contribution of the different life cycle modules and sub-modules to the different impact categories

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

The main contributor to the **use of non-renewable resources** indicator is A1 - Production of raw materials (29%), followed by A4 - Transport to construction site (25%). The sub-module A1.1 - Boric acid production has the greatest contribution to A1 - Production of raw materials. As for the **use of freshwater resources** indicator, the main contributing module is A3 - Insulation product manufacturing (42%), followed by A1 - Production of raw materials (41%). As for modules A5 - Installation, C2 - Transport to waste treatment site and C4 – Disposal, they contribute less than 11% of the use of non-renewable resource and freshwater resources indicators.

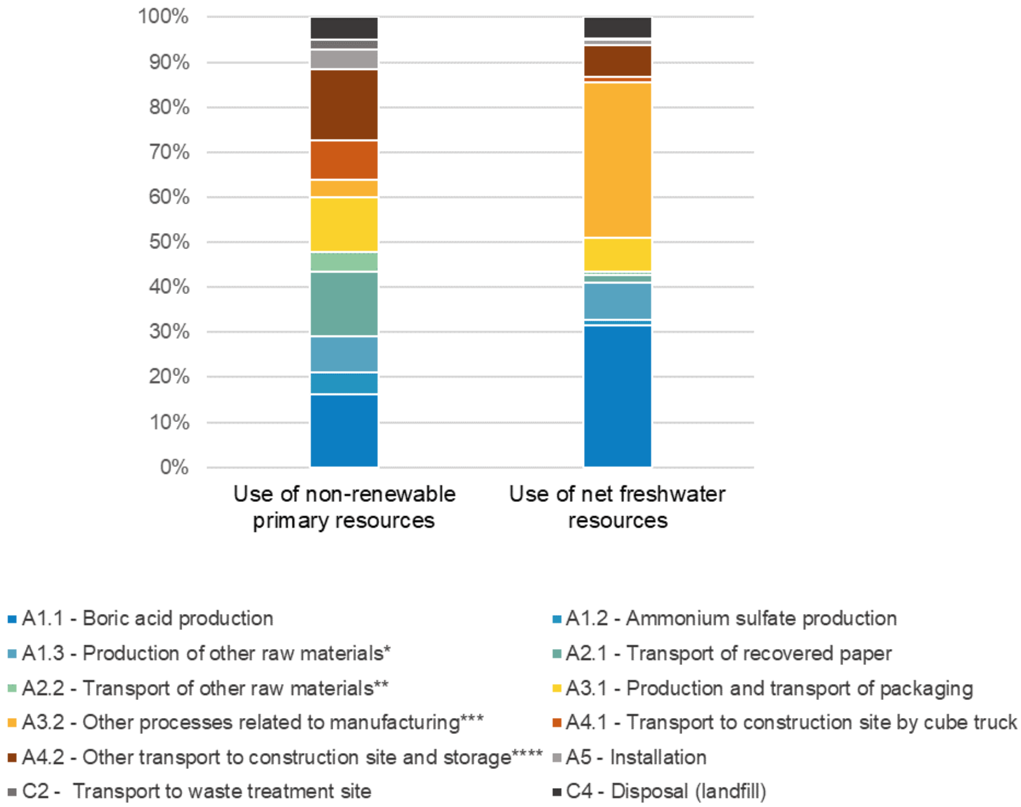


Figure 6. Contribution of the different life cycle modules and processes to non-renewable primary resources use and freshwater resources use

6| ADDITIONAL ENVIRONMENTAL INFORMATION

6.1 Environment and health during manufacturing and installation

This declaration covers SOPRA-CELLULOSETM and SOPRA-CELLULOSE ABTM insulation products from SOPREMA, manufactured in a plant covered by a quality management system certified under ISO 9001 [1].

6.2 Recycled content

Recycling of paper is well-established. Through agreements with its suppliers, SOPREMA acquires various types of recycled paper that are used in the manufacturing of SOPRA-CELLULOSETM insulation products. The recycled content of the SOPRA-CELLULOSETM product range is validated by an independent third-party.

Link to the recycled content certificate:
https://files.soprema.ca//2021-11-02/Recycled_Content_Certificate_SOPREMA_SOPRA-CELLULOSE_2021_EN.pdf6181532a612c5212a4eb9d4cc17d89189cddf84f556e8.pdf

A validated recycled content means that the manufacturer's declaration has been verified by an independent third party in compliance with the requirements of ISO 14020/21 [17,18] and ISO 7000-1135 [19]. Data and information related to the purchase and integration of pre-consumer recycled materials into SOPRA-CELLULOSETM underwent an impartial validation that includes disclosure of formulations as well as confirmation from our suppliers of the origin of materials.

Consequently, SOPRA-CELLULOSETM and SOPRA-CELLULOSE ABTM insulation are both composed of 83% pre-consumer recycled content for the period of January 1 to December 31, 2020.

Residual materials generated on construction sites from the installation of SOPRA-CELLULOSE as well as cellulose fibre insulation reaching the end of their useful life are recyclable. To date, SOPREMA has not established a program for the recovery of these materials. This EPD therefore considered that all SOPRA-CELLULOSETM products were landfilled at the end of their life.

6.3 Regulated hazardous substances

The insulation product contains only the materials listed in Table 1, which are not on Canada's list of toxic substances [20].

6.4 Energy savings during building operation

The use of an insulation material 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-CELLULOSETM insulation product associated with the reduction of the energy consumed by the building were not included in the results presented in Section 5, 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-CELLULOSETM insulation product and thus would enable determining the environmental impacts reductions.

6.5 Delayed emissions and unexpected adverse events

No delayed emissions are expected from this product. No extraordinary effects or environmental impacts are expected due to destruction of the product by fire, water or mechanical means.

6.6 Environmental activities and certifications

SOPRA-CELLULOSETM 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 [2].

Link to certificate: https://spot.ul.com/main-app/products/detail/5ad1ead455b0e82d946a52df

6.7 Further information

Additional information can be found at https://www.soprema.ca/cellulose-insulation/

7| IMPACT AND INVENTORY INDICATORS DEFINITIONS

Table 20. Impact categories used in the study, definition and unit [11]

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 [16]

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 freshwater resources	Freshwater that is consumed, i.e by evaporation (cooling towers), by 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| ACRONYMS AND EMPIRICAL FORMULAS

- CH_4 - Methane
- CO_2 - Carbon dioxide
- EPD - Environmental product declaration
- eq - Equivalent
- FU - Functional unit
- LCA - Life cycle assessment
- LHV - Lower heating value
- MJ - Megajoules
- N - Nitrogen
- NOx - Nitrogen oxides
- O_3 - Ozone
- PCR - Product category rules
- SO_2 - Sulfur dioxide
- VOCs - Volatile organic compounds

9| 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].
- **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 [21], that is to say elements of the activities, products or services of an organization that can interact with the environment [22].
- **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 [22].
- **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 [22].
- **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 [17].
- **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."

10| REFERENCES

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