ENVIRONMENTAL PRODUCT DECLARATION

Papiers White Birch[MC]
S.E.C. PAPIER MASSON WB

WOOD FIBRE INSULATION PRODUCT

NovaFib™

Papier Masson is pleased to present this environmental product declaration (EPD) for its wood fibre insulation product: the NovaFib™. This EPD was developed by CT Consultant in compliance with CAN/CSA-ISO 14025:2006, and has been verified by Marie Bellemare (Marie Bellemare Consulting).

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 Papier Masson,visit https://whitebirchpaper.com/about-us/our-mills/papier-masson/

1| GENERAL INFORMATION

This environmental product declaration (EPD) is in accordance with CAN/CSA-ISO 14025:2006 and the PCRs noted below. ISO 21930:2017 serves as the core PCR along with EN 15804:2012 and the UL Part A PCR. EPDs from different programs may not be comparable.

Program operator	**CSA Group** 178 Rexdale Blvd. Toronto, Ontario Canada M9W 1R3 www.csagroup.org
General program instructions	CSA Group. (2013). CSA Group Environmental Product Declaration (EPD) Program: Program Requirements. CSA Group. https://www.csaregistries.ca/GHG_VR_Listing/EPD_ProcessPage#
Product	NovaFib™ wood fibre thermal insulation
Functional unit	1 m^2 of insulation product with a thickness that gives an average thermal resistance RSI=1 m^2K/W
EPD registration number	
EPD recipient organization	**Papier Masson** 2 Montreal Road West Gatineau, Quebec Canada J8M 2E1 (819) 986-4300 https://whitebirchpaper.com/about-us/our-mills/papier-masson/
Reference product category rules (PCR)	PCR Part A: UL Environment Building Related Products and Services. Life cycle assessment calculation rules and report requirements. v3.1. May 2018. Standard 10010 PCR Part B: UL Environment. Building Related Products and Services. Building Envelope Thermal Insulation EPD requirements. v2.0. April 2018 - February 2023. UL 1001-1
LCA Software	openLCA v1.10.3, GreenDelta (2020)
Date of issue	
Period of validity	April 2023 – April 2028

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, ISO 21930:2017, EN 15804:2012 et UL Part A	☐ INTERNAL ☒ EXTERNAL Marie Bellemare, Marie Bellemare Consulting

2| DESCRIPTION OF PAPIER MASSON

A paper manufacturing industry specialist, Papier Masson produces high-quality newsprint for customers across North America and around the world. Built in 2000, Papier Masson's thermomechanical pulp mill currently supplies 100% of the pulp to produce approximately 240,000 metric tons of newsprint per year. With the objective of diversifying its operations, Papier Masson installed a drying ring in 2017 to produce 15,765 tons per year of its new product, the NovaFibTM wood fibre insulation obtained from the pulp manufacturing. The NovaFibTM manufacturing plant is located at 2 Montreal Road West, Gatineau, Quebec, Canada.

3| DESCRIPTION OF PRODUCT

3.1. Product description and applications

The NovaFibTM is a loose-fill thermal insulation product made up of dried wood fibre produced from softwood residue (wood chips) of certified forests. The product is made of long, rigid, natural wood fibres that give it a high insulating performance. It has a low dust content, displays excellent mechanical strength and a low compaction rate over time. As the wood fibre is entirely of natural origin, with no ink or chemicals apart from a fire retardant, it does not emit VOCs and does not cause irritation. The product appears as loose wood-coloured fibres and is installed by blowing. The NovaFibTM is intended for use in new residential, commercial, and industrial buildings, or for building renovations.

Photo 1. NovaFibTM insulation product

3.2. Product covered by the EPD

This EPD covers the NovaFibTM loose-fill insulation product.

3.3. Technical specifications of the NovaFibTM

Table 1. Thermal performance test results of the NovaFibTM

Product	Standard	Result	Verification laboratory
NovaFibTM	ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus [1]	3.39 $ft^2°Fhr/BTU/in$	R&D Services Inc., Cookeville, Tennessee, United States [2]
		0.235 $m^2K/W/cm$	

Note: The thermal performance test was performed at an average sample temperature of 23.9°C (75.02°F).

The result of the thermal resistance test is available on request from Papier Masson.

Table 2. Other physical properties of the NovaFib™

Property	Value	Unit
Appearance	Wood-coloured fibres	-
Density	21.3	kg/m^3

3.4. Material composition

Table 3. Material composition of the NovaFib™ insulation product

Material	Mass (% of the insulation product)	Production site	Distance travelled to Papier Masson's manufacturing plant
Softwood chips	54.5%	Upper Laurentians, Quebec, Canada	155 km
	25.1%	Abitibi, Quebec, Canada	470 km
	5.4%	Local source, Quebec, Canada	135 km
Boric acid solution	15.0%	Global market	4,823 km

Note: The insulation product does not require a safety data sheet.

3.5. Manufacturing

The manufacturing of the insulation product comprises multiple stages. At the start of the process, the softwood chips are sieved to remove large contaminants (rocks, debris) before being sent to the thermomechanical pulp plant (TMP) via a conveyor belt. At the TMP, the softwood chips are preheated, then washed to remove dense contaminants (sand) before going through a second preheating stage. The heated and softened wood chips then go through the primary refining stage, a mechanical treatment using rotating discs to separate the wood fibres. The resulting pulp is then sieved via a system of perforated baskets and pressed. The pressing stage involves the use of screw presses to increase the dryness of the pulp. A part of this pulp is sent to another refining and sieving stage called "long fibre" which is meant to separate the pulp with long fibres and the pulp with short fibres. The short fibres are sent to the paper manufacturing (another function of Papier Masson's manufacturing plant which is not included in the analysis of the current system), whereas the long fibres are reintroduced at the pressing stage. The pressed pulp is extracted from the TMP and treated mechanically in a cold disintegrator to separate the fibres. The produced wood fibres are then dried and sent to a centrifugal separator which removes the combustion gases (VOCs) produced by the drying of the wood fibres. During this stage of the process, the boric acid solution is incorporated into the wood fibres through nozzles. The treated dry wood fibres are then extracted by a rotary valve and conveyed to the automated packaging system to be packaged for delivery.

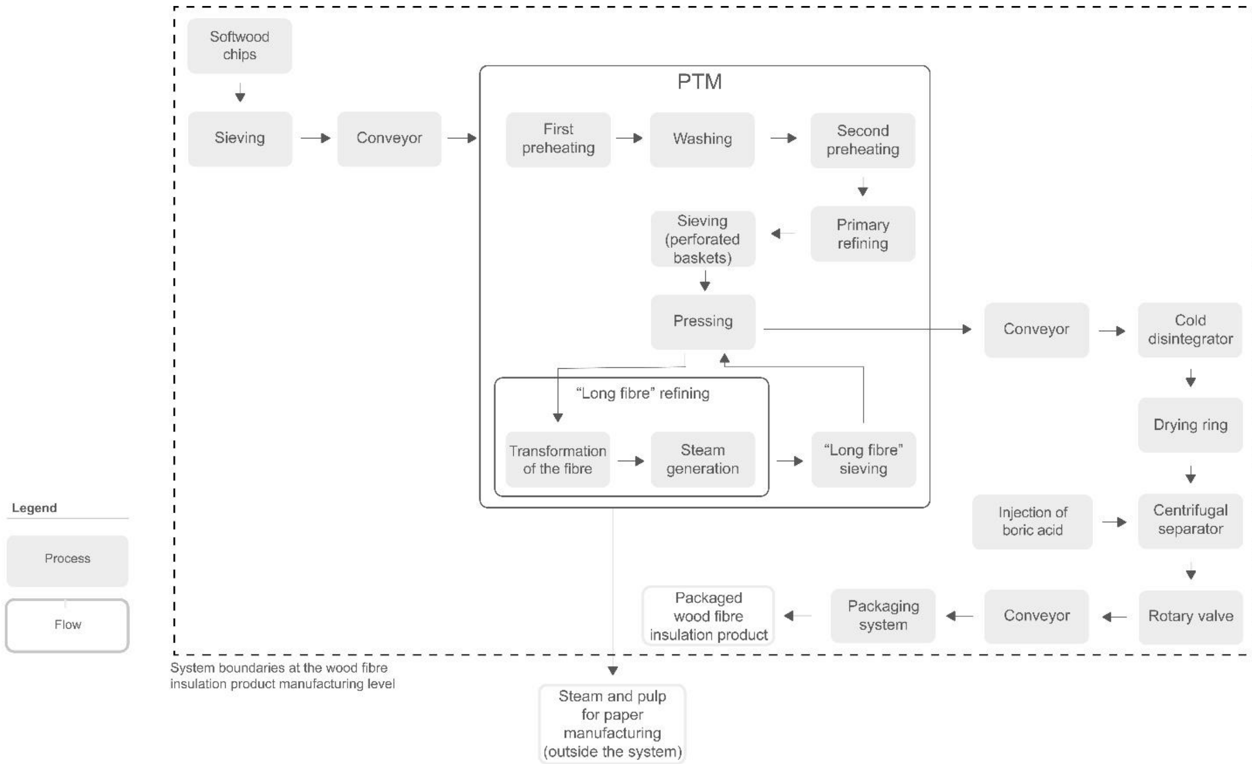


Figure 1. Manufacturing stages of the NovaFib™ insulation product (Gatineau, Quebec, Canada)

3.6. Manufacturing losses

- Contaminated wood chips and dust from the insulation product are recovered by another system (70% energy recovery, 30% agricultural reuse).
- Boric acid solution lost during the injection process is sent to landfill.
- Sludge from the treatment of the water from the manufacturing is recovered by another system (agricultural use). The sludge is comprised of primary sludge (solid fraction from sedimentation) and secondary sludge (bacteria and solids from the degradation of organic matter).

3.7. Packaging

The NovaFib™ 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, and each wood pallet carries 500 kg of insulation product.

3.8. Transport

The insulation product is delivered to the user considering two shipping scenarios:

- Direct shipment to the user located in Quebec, Canada by truck-trailer;
- Direct shipment to the user located in Ontario, Canada by truck-trailer;

Transport to the use stage includes storage of the insulation product in a heated space. No specific transport to the storage space was considered.

3.9. Installation

The installation of the insulation product is carried out using an electric blowing machine. The loose insulation is loaded into the machine and blown into the desired area through a hose. There are no insulation losses during installation as any fallen material is put back into the blowing machine. Following the installation, the wood pallet, plastic bags and packaging film are recycled or sent to a landfill site.

3.10. 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.

3.11. 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 [3].

3.12. End of life

When the building (in which the NovaFib™ 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 [3].

Table 4. 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 (packaging included)	-
Mass	0.9533	kg
Thickness to achieve the functional unit	0.043	m

4.2. System boundaries

The cradle-to-grave LCA includes the following life cycle stages and modules (EN 15804:2012 and ISO 21930:2017 [4,5]):

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

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

PRODUCTION STAGE (A1 - A3)			CONSTRUCTION STAGE (A4 - A5)		USE STAGE (B1 - B7)							END-OF-LIFE STAGE (C1 - C4)				BEYOND SYSTEM BOUNDARIES
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

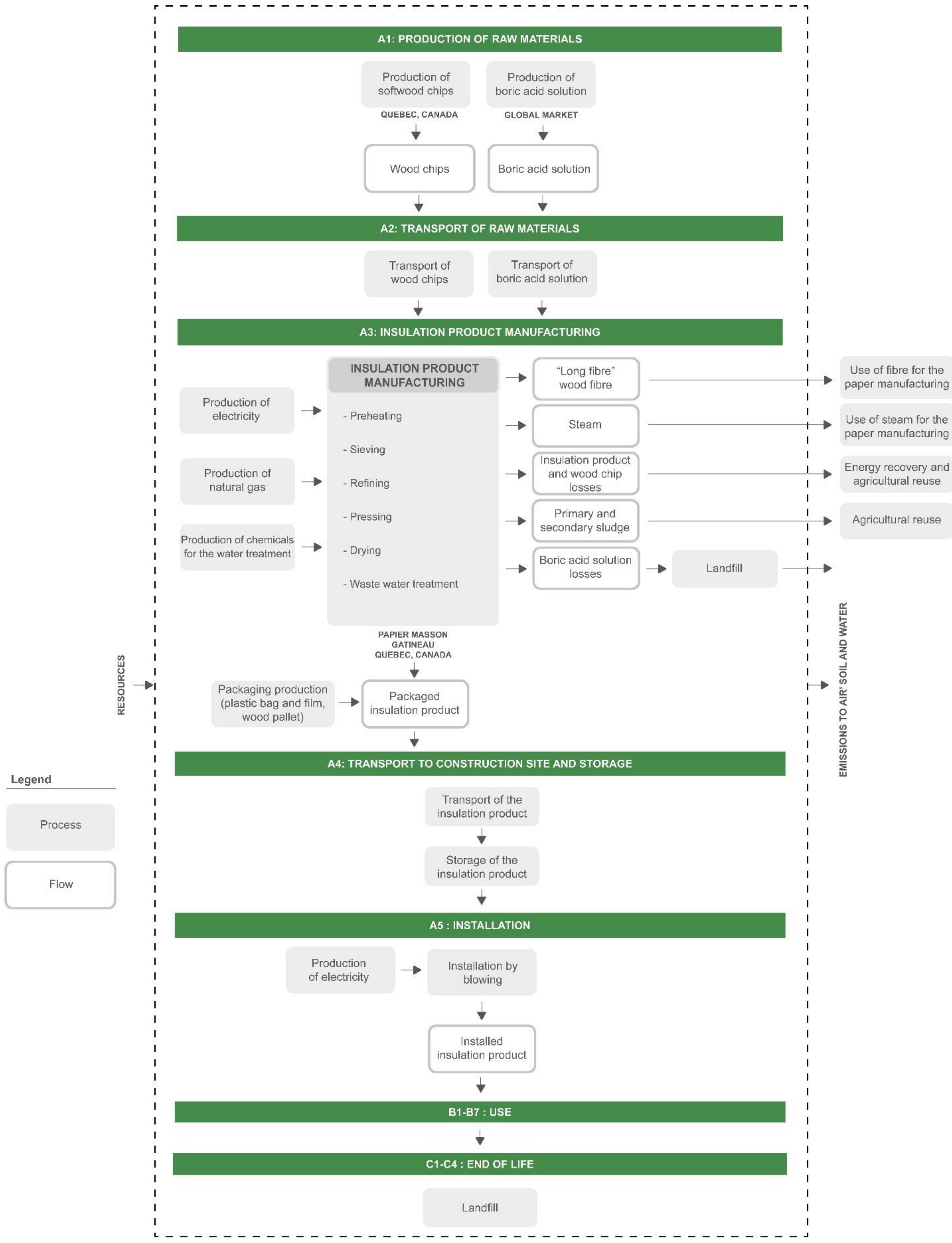


Figure 2. System boundaries - NovaFibTM insulation product

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:

- **Boric acid solution losses (A3).** The losses of boric acid solution during its injection through nozzles into the wood fibres are considered to be of 10% (estimation by Papier Masson).
- **Transport of the insulation product to the construction site (A4).** the NovaFib™ being a new product, the transport distances from Papier Masson's manufacturing plant to the construction site are based on realistic scenarios developed by Papier Masson and not on measured data.
- **Insulation product landfill (C4).** The methane capture rate at the landfill site is 68.7%, the methane is deemed to be completely burned in a flare [6].

4.4. Cut-off criteria

As defined in ISO 21930:2017 [5], 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 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 in the present study are:

- **Allocation for multifunctional processes.** There are four multifunctional processes in the manufacturing stage (Figure 3):

    1. Primary refining: In this process, two outputs are generated: wood pulp and steam. The steam is produced by the transformation of the electrical energy used by the primary refiner. Part of this steam is used for wood chip preheating, and the rest is used for the paper manufacturing (outside the system). Thus, the environmental impacts of the electricity consumed by the primary refiner must be allocated between the wood pulp and the steam for the paper manufacturing (outside the system). Since no physical relationship could be established between the produced wood pulp (mass) and the steam for the paper manufacturing (energy), the distribution of impacts was done using an economic allocation, as specified in the PCR Part A [7]. The distribution of the economic value of the two outputs is 97% for the wood pulp and 3% for the steam.

    2. "Long fibre refining" – Transformation of the fibre: Part of the pulp from the pressing stage is sent to the "long fibre" refining process which separates the pulp with long fibres and the pulp with short fibres (Section 3.5). The short fibres are destined for the paper manufacturing (outside the system) and the long fibres are destined for the insulation product manufacturing. In accordance with the PCR Part A [7], a mass allocation was used, i.e. the environmental impacts of the electricity of the "long fibre" – transformation of the fibre refiner were allocated according to the mass of each output : 93% of the short fibre (paper) and 7% of the long fibre (insulation product).

3. “Long fibre refining” - Steam generation: During the “long fibre” refining process, steam is generated from the transformation of the electrical energy used by the “long fibre” refiner. The impacts of the refiner's electricity consumption were distributed using an economic allocation between the produced wood pulp (98% of the economic value) and the energy contained in the steam for the paper manufacturing (2%) (outside the system).

4. “Long fibre” sieving: The pulp from the long fibre refining process is sieved to separate the long and short fibre pulp. The short fibres are sent to the paper manufacturing (93% of the mass) (outside the system) and the long fibres are incorporated into the pressing process (7% of the mass) to produce wood fibre for the insulation product. The impacts of the electricity consumption were distributed using a mass allocation.

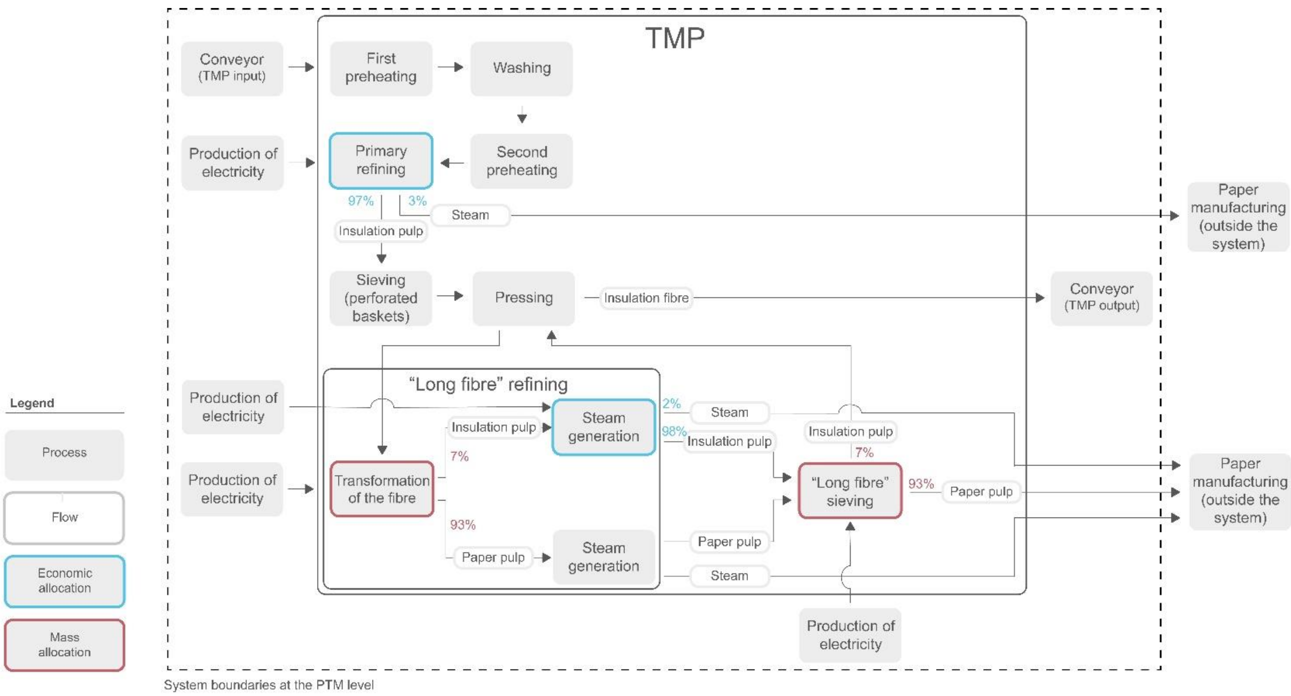


Figure 3. Allocation procedure for the NovaFib™ insulation product manufacturing

- **Allocation for end-of-life processes.** The cut-off approach was chosen in compliance with ISO 21930:2017 [5]. This approach specifies that the benefits associated with the recycling or recovery of materials leaving the system are not included, and that the impacts associated with secondary materials entering the system are to be attributed to the system that generated them. In this study, there are no environmental benefits associated with the energy recovery of wood chips and dust, the reuse of sludge for agricultural purposes or the recycling of packaging materials. There are no secondary materials entering the system.

- **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 21930:2017.

4.6. Reference period

The NovaFib™ being a new product, the inventory data for the LCA is representative of the period of production from 1 January 2021 to 30 September 2021. This nine-month period is considered representative of a year as it includes seasonal variations.

4.7. Data sources and quality

Table 6. Inventory data sources of the insulation product

Data type	Source
Primary data	Primary data was provided by Papier Masson for the period from 1 January to 30 September 2021. The primary data included: • measured data on raw materials' quantities and transport, packaging, manufacturing and energy for installation; • data based on realistic assumptions regarding boric acid solution losses, transport to the construction site, end of life of the insulation product and of the insulation packaging.
Secondary data	Secondary data was obtained from the following sources: • the ecoinvent version 3.6 “cut-off” [8] 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 product in Quebec. The secondary data was selected to be as representative as possible of the geographical context of the NovaFib™. Regarding the manufacturing, priority was given to data representative of Quebec (softwood chips production, use of electricity and natural gas), or data representative of the global market was used. For the processes and scenarios related to the transport, installation and end-of-life stages of the insulation product in Ontario or Quebec (Canada), the best available data for these regions were selected. Geographical representativeness is considered high.
Temporal representativeness	The primary data is representative of the reference period (1 January 2021 to 30 September 2021). The data was extrapolated to one year of production (see Section 4.6). The data of the life cycle stages from A4 to C4 are based on realistic assumptions. 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 quality is considered satisfactory in terms of temporal representativeness.

Criterion	Evaluation
Technological representativeness	The primary data collected is representative of the technologies used during the insulation product's life cycle. The secondary data was selected to represent these technologies as accurately as possible. This included the use of a natural gas boiler (primary refining and preheating) and burner (drying) during the manufacturing stage, the blowing machine used for the installation of the insulation product, the transportation and the methane drainage resulting from the deterioration of the insulation product in the landfill. 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 [3]. No known flow was deliberately excluded from the LCA.

4.8. Scenarios used beyond the manufacturing stage

4.8.1 Transport to the construction site (A4)

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

Parameter	Value / Specification	Unit
Scenario 1 - Direct shipment to a user in Quebec, Canada by truck-trailer (50% of the tonnage[1])		
Fuel type	Diesel	-
Liters of fuel	25	L/100km
Vehicle type	Truck-trailer with a load capacity between 16 and 32 tons	-
Transport distance	300	km
Capacity utilization[2]	Unknown	%
Gross density	21.3	kg/m^3
Scenario 2 - Direct shipment to a user in Ontario, Canada by truck-trailer (50% 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	-

[1] *The tonnage is equivalent to the total mass of insulation produced over the reference period.*

[2] *The capacity of utilization is equal to the mass of insulation 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
Transport distance	250	km
Capacity utilization	Unknown	%
Gross density	21.3	kg/m^3

Table 9. Scenario for the insulation product storage during transport

Parameter	Value / Specification	Unit
Share of storage in Quebec, Canada	50	%
Share of storage in Ontario, Canada	50	%
Storage duration	15	days
Electric heating	0.010	kWh/UF
Natural gas heating	0.011	kWh/UF

4.8.2 Installation (A5)

Table 10. Building insulation product installation scenario

Parameter	Value / Specification	Unit
Electricity consumption	0.0017	kWh/kg installed insulation product
Ancillary materials	-	kg
Water consumption	-	m^3
Other resources	-	-
Product loss	-	-
Packaging waste	0.047	kg/UF
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 site		
Transport distance	50	km
Vehicle type	Truck with a load capacity between 7.5 and 16 tons	-
Wood pallet for the insulation product's packaging		
Recycling rate [7]	20	%
Landfill rate [7]	80	%
Plastic bag and film for the insulation product's packaging		
Recycling rate [7]	78	%
Landfill rate [7]	22	%

Table 12. Blowing machine transport scenario for installation of the insulation product

Parameter	Value / Specification	Unit
Transport distance	100	km
Vehicle type	Truck with a load capacity between 7.5 and 16 tons	-

4.8.3 Reference service life

Table 13. 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	Install as per Papier Masson's instructions (electric blowing machine)	-
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	-

Parameter	Value / Specification	Unit
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 14. Insulation product end-of-life scenario

Parameter		Value / Specification	Unit
Description of the end-of-life scenario		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 with a load capacity between 7.5 and 16 tons	-
Collection process	Collected separately	-	kg
	Collected with mixed construction waste	0.9063	kg/UF
Recovery	Reuse	-	kg
	Recycling	-	kg
	Incineration	-	kg
	Incineration with energy recovery	-	kg
Landfill	Product destined for landfill	0.9063	kg
Biogenic carbon emissions (excluding packaging)		0.247	kg CO_2/UF
Biogenic methane emissions (excluding packaging)		0.027	kg CH_4/UF

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 [9], and are reported for each declared life cycle module [5] [10].

Table 15. 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	6.28E-1	1.02E-1	4.06E-2	4.17E-1	4.67E-2	1.91E-3	0.00E+0	0.00E+0	1.00E-2	0.00E+0	9.23E-3
	Biogenic carbon[1]	kg CO_2 eq	-4.19E-1	-1.43E+0	0.00E+0	2.93E-2	0.00E+0	5.14E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	9.31E-1
	Total[2]	kg CO_2 eq	2.08E-1	-1.33E+0	4.06E-2	4.46E-1	4.67E-2	5.26E-2	0.00E+0	0.00E+0	1.00E-2	0.00E+0	9.41E-1
Acidification of soil and water sources potential		kg SO_2 eq	3.17E-3	1.47E-3	1.90E-4	1.18E-3	2.10E-4	5.39E-6	0.00E+0	0.00E+0	4.43E-5	0.00E+0	7.17E-5
Eutrophication potential		kg N eq	1.02E-3	3.50E-4	4.68E-5	5.00E-4	5.36E-5	3.05E-6	0.00E+0	0.00E+0	1.24E-5	0.00E+0	4.97E-5
Smog formation potential		kg O_3 eq	4.68E-2	1.85E-2	4.48E-3	1.57E-2	4.95E-3	1.60E-4	0.00E+0	0.00E+0	1.02E-3	0.00E+0	2.09E-3
Ozone depletion potential		kg CFC-11 eq	1.78E-7	1.44E-8	9.93E-9	1.37E-7	1.08E-8	2.45E-10	0.00E+0	0.00E+0	2.27E-9	0.00E+0	3.21E-9
Abiotic depletion potential (fossil resources)		MJ (LHV)	1.47E+0	1.82E-1	8.94E-2	1.04E+0	9.90E-2	2.36E-3	0.00E+0	0.00E+0	2.06E-2	0.00E+0	3.15E-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 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 - B7	C1	C2	C3	C4
Renewable primary energy used as energy carrier (fuel)[1]	MJ (LHV)	4.50E+0	1.88E-1	6.80E-3	4.25E+0	4.75E-2	4.73E-3	0.00E+0	0.00E+0	1.92E-3	0.00E+0	3.72E-3
Renewable primary resources with energy content used as material[1]	MJ (LHV)	1.53E+1	1.46E+1	0.00E+0	6.49E-1	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)	1.98E+1	1.48E+1	6.80E-3	4.90E+0	4.75E-2	4.73E-3	0.00E+0	0.00E+0	1.92E-3	0.00E+0	3.72E-3
Non-renewable primary resources used as an energy carrier (fuel)[1]	MJ (LHV)	9.89E+0	1.55E+0	6.32E-1	6.57E+0	7.34E-1	2.51E-2	0.00E+0	0.00E+0	1.48E-1	0.00E+0	2.28E-1
Non-renewable primary resources with energy content used as material[1]	MJ (LHV)	2.78E-1	0.00E+0	0.00E+0	2.78E-1	0.00E+0	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)	1.02E+1	1.55E+0	6.32E-1	6.85E+0	7.34E-1	2.51E-2	0.00E+0	0.00E+0	1.48E-1	0.00E+0	2.28E-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
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
Secondary materials[2]	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
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
Use of net freshwater resources[4]	m^3	2.63E-2	2.89E-3	7.70E-5	2.27E-2	3.60E-4	5.10E-5	0.00E+0	0.00E+0	1.77E-5	0.00E+0	2.40E-4

[1] *The results of these indicators were calculated with the CED LHV method [11] according to the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017"* [12].

[2] *The insulation does not contain any secondary source materials. This inventory indicator is therefore zero.*

[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 [11].*

5.2.2 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 - 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	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Non-hazardous waste disposed[1]	kg	9.55E-1	0.00E+0	0.00E+0	1.52E-2	0.00E+0	3.35E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	9.06E-1
High-level radioactive waste[2]	m^3	1.12E-9	8.47E-11	6.75E-12	8.45E-10	1.43E-10	3.21E-11	0.00E+0	0.00E+0	1.65E-12	0.00E+0	3.54E-12
Intermediate- and low-level radioactive waste[2]	m^3	8.59E-9	2.26E-9	1.67E-9	1.84E-9	1.85E-9	6.21E-11	0.00E+0	0.00E+0	3.79E-10	0.00E+0	5.40E-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	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling[1]	kg	1.26E-1	0.00E+0	0.00E+0	1.12E-1	0.00E+0	1.35E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for energy recovery[3]	kg	3.12E-2	0.00E+0	0.00E+0	3.12E-2	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

[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" [12] *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" [12] *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 does not directly generate radioactive waste. According to ISO 21930:2017* [5]*, 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 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 - B7	C1	C2	C3	C4
Biogenic carbon removal from product[1]	kg CO_2	-1.43E+0	-1.43E+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	3.44E-1	0.00E+0	0.00E+0	9.75E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.47E-1
Biogenic carbon removal from packaging[1]	kg CO_2	-5.46E-2	0.00E+0	0.00E+0	-6.821E-2	0.00E+0	1.36E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Biogenic carbon emission from packaging[1]	kg CO_2	1.00E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.00E-2	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
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
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
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

[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"* [12].

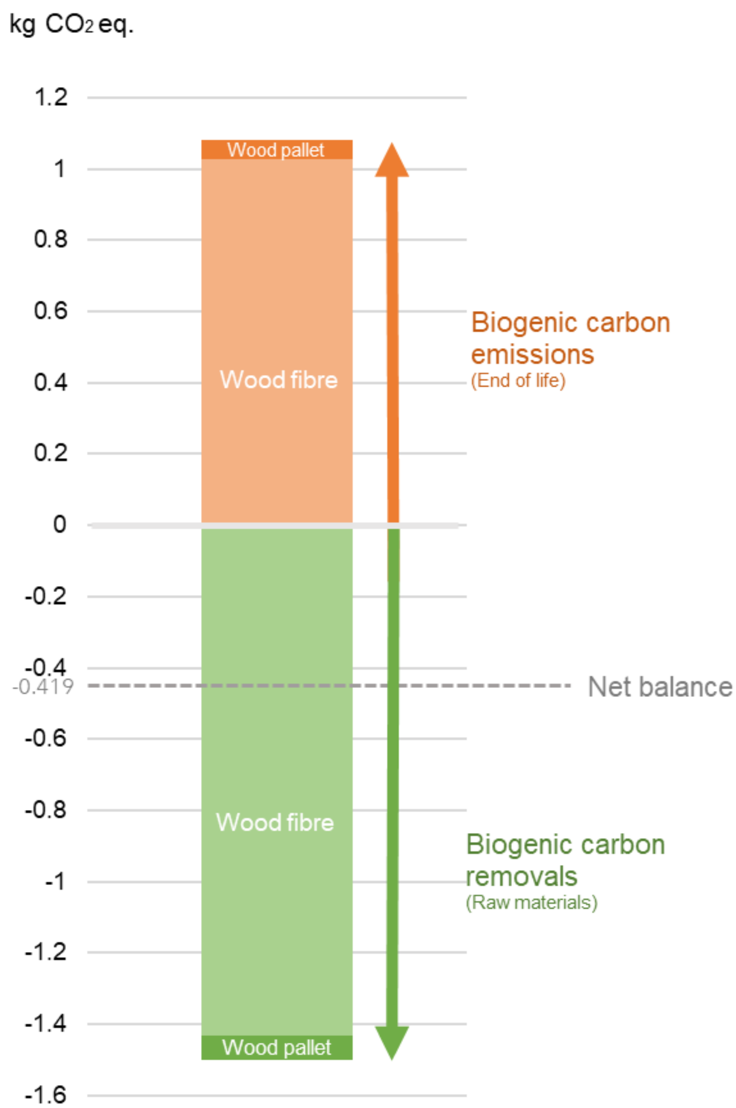
[2] *For this inventory indicator, only carbon dioxide emissions are presented. Methane emissions are excluded in accordance with the PCR Part A* [7].

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 wood fibre used in the insulation product and by the wood pallet used for packaging. The output biogenic carbon flows are those related to the end-of-life emissions from the wood fibre 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 NovaFib™.

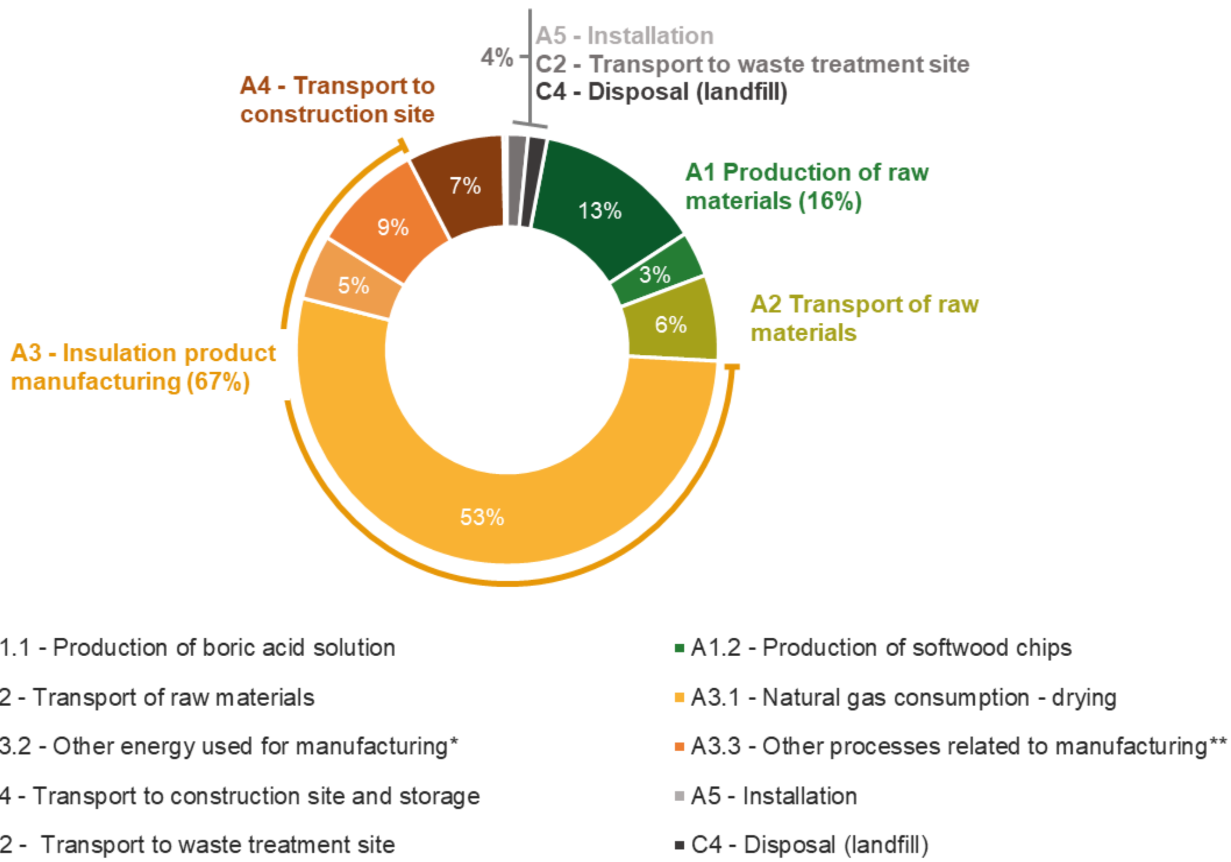


The output flows include biogenic carbon dioxide and methane, expressed in kg CO_2 eq.

Figure 4. Biogenic carbon flow contribution over the life cycle of the insulation product

Fossil carbon emissions

Fossil carbon emissions are gaseous emissions from burned fossil resources such as natural gas, gasoline or diesel. The highest contributing life cycle modules to **fossil carbon emissions** are A3 - Insulation product manufacturing (67%), followed by A1 - Production of raw materials (16%). Modules A4 - Transport to construction site (7%) and A2 - Transport of raw materials (6%) have similar fossil carbon emissions. Sub-module A3.1 - Natural gas consumption - drying which represents the drying of the wood fibre using a burner during the manufacturing stage represents more than half the fossil carbon emissions of the entire life cycle (53%). As for raw materials production, sub-module A1.1 - Production of boric acid solution amounts for 13% of the fossil carbon emissions and A1.2 - Production of softwood chips for 3%, despite the mass of wood fibre representing 7 times the mass of boric acid in the finished product. Regarding modules A5 - Installation, C2 - Transport to waste treatment site and C4 - Disposal (landfill), their contribution to the overall fossil carbon emissions is low (4%).



** The sub-module "A3.2 - Other energy used for manufacturing " includes electricity use and consumption of natural gas for the primary refining and preheating (boiler).*

*** The sub-module "A3.3 - Other processes related to manufacturing" includes product packaging, chemicals for the water treatment, emissions to water and air, transport and end of life of the manufacturing losses and materials constituting the manufacturing plant and processes.*

Figure 5. 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 highest contribution to the **eutrophication**, **ozone depletion** and **abiotic resource depletion** and impact indicators is A3 - Insulation product manufacturing (49%, 77% and 71%, respectively). The greatest contribution to ozone and abiotic resource depletion is A3.1 - Natural gas consumption - drying, with 72 % and 61 % of the total impacts. As for the **acidification** and **smog formation** indicators, the largest contributor is A1 - Production of raw materials (46% and 39%), whose main contributing sub-module is A1.1 - Production of boric acid solution (contributing to 41% and 29% of these impact indicators). Modules A5 - Installation, C2 - Transport to waste treatment site and C4 - Disposal (landfill), have little influence on the total scores of all five impact categories (the sum of these three modules ranging from 3% to 7%).

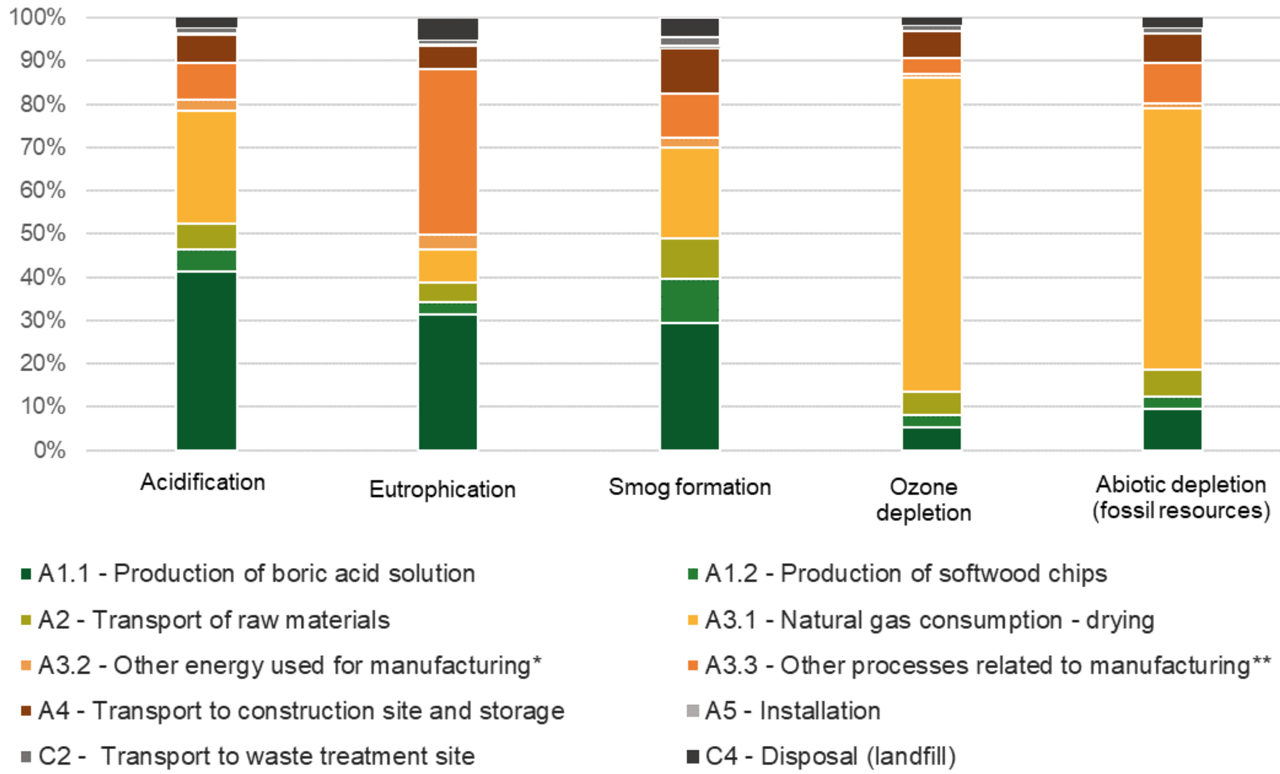


Figure 6. Contribution of the different life cycle modules and sub-modules to the different impact categories

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

Module A3 - Insulation product manufacturing contributes to more than two thirds (67%) of the **use of non-renewable primary resources** indicator, A3.1 - Natural gas consumption - drying being the sub-module dominating this indicator (53% of the total impacts). Regarding the **use of freshwater resources**, the main contributor is also module A3 - Insulation product manufacturing, representing 86% of this indicator, which includes sub-module A3.2 - Other energy used for manufacturing* that dominates this indicator (82%) due to the production of electricity. As for the other life cycle modules (A1 - Production of raw materials, A2 - Transport of raw materials, A4 - Transport to construction site and storage, A5 - Installation, C2 - Transport to waste treatment site and C4 – Disposal), they contribute to less than a third of the use of non-renewable resource and freshwater resources indicators.

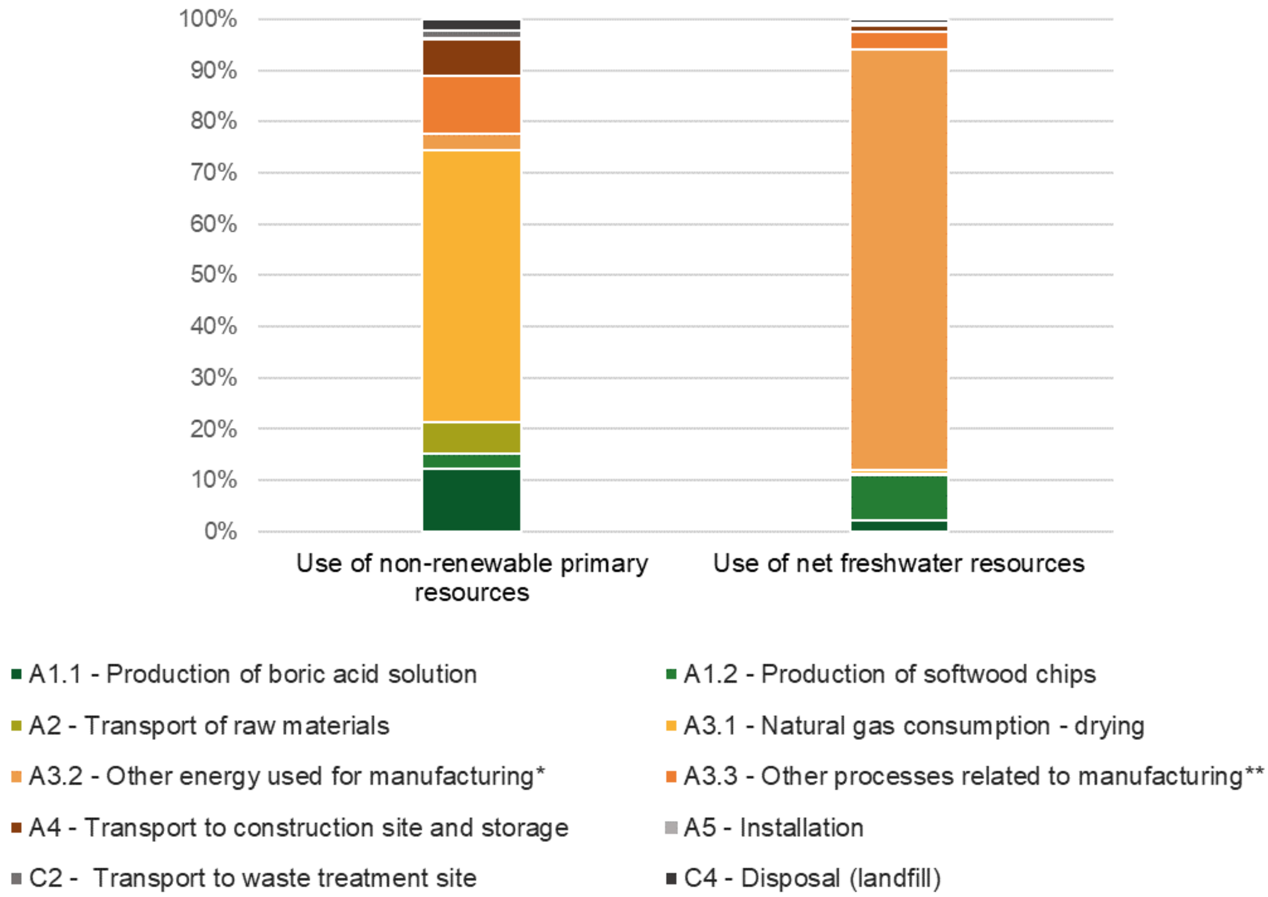


Figure 7. Contribution of the different life cycle modules and processes to non-renewable primary resources use and freshwater resources use

6| ADDITIONAL ENVIRONMENTAL INFORMATION

6.1. Regulated hazardous substances

The insulation product contains only wood fibres and boric acid, both of which are not on Canada's list of toxic substances [13]. Thus, there are no regulated hazardous substances associated with the production of the NovaFib™.

6.2. Health and environmental quality during product manufacturing and installation

Due to the presence of dust during manufacturing and installation, the use of a dust mask (NIOSH 3M 8210 N95 or equivalent), safety glasses and cotton work gloves is recommended. It is recommended to follow the manufacturer's instructions regarding safety measures to be applied when using the blowing machine. Once installed, the insulation product does not emit any substances that could affect the health of the occupants of the building.

6.3. Environmental certifications and activities

The chain of custody and controlled wood system of Papier Masson was evaluated and certified by NEPCon OÜ according to the requirements of FSC-STD-40-003 V2-1, FSC-STD-40-004 V3-0, FSC-STD-40-005 V3-1, FSC-STD-40-007 V2-0 and FSC-STD-50-001 V2-0 of the Forest Stewardship Council® (FSC®).

The FSC® certificate can be viewed via the following link : https://whitebirchpaper.com/wp-content/uploads/Papiers-White-Birch-FSC-COC-w_CW-Certificate-18.11.2019-version-fran%C3%A7aise.pdf

Information about the FSC® program is available at: https://us.fsc.org/en-us

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 NovaFib™ 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 NovaFib™ 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. There are no unexpected adverse effects resulting from the combustion, water damage or mechanical alteration of the insulation product.

6.6. Further information

Additional information can be found at https://whitebirchpaper.com/about-us/our-mills/papier-masson/

7| IMPACT AND INVENTORY INDICATORS DEFINITIONS

Table 19. Impact categories used in the study, definition and unit [9]

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 of soil and water sources potential	This indicator measures the impact of an increase in the concentration of hydrogen ions (H^+) in soil or water environments caused by emissions of acidifying substances (for example, sulfuric acid).	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 (NO_x) 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 20. Inventory categories used in the study, definition and unit [7]

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

- CFC - Chlorofluorocarbon
- CFC-11 - Trichlorofluoromethane
- CH_4 - Methane
- CO_2 - Carbon dioxide
- EPD - Environmental product declaration
- eq - Equivalent
- FU - Functional unit
- LCA - Life cycle assessment
- LHV - Lower heating value
- N - Nitrogen
- NO_x - 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 [5].
- **Biomass:** material of biological origin including organic material (both living and dead) above or below ground (trees, crops, animals) and biological waste (manure). Biomass excludes material embedded in geological formations, fossilized material and peat [5].
- **Co-product:** any of one or more products from the same process which is not the object of the assessment [5].
- **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 [5].
- **Environmental impact:** any negative or beneficial modification of the environment, resulting wholly or in part from environmental aspects [14], that is to say elements of the activities, products or services of an organization that can interact with the environment [15].
- **Environmental product declaration (EPD):** environmental declaration providing quantified environmental data using predetermined parameters based on the ISO 14040:2006 and ISO 14044:2006 standards [5].
- **Functional unit (FU):** quantified performance of a product system intended to be used as a reference unit in a life cycle assessment [15].
- **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 [15].
- **Product category rules (PCR):** set of specific rules, requirements and guidelines for the development of EPDs [5]. 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."

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