

# ENVIRONMENTAL PRODUCT DECLARATION



## INSULATION PANEL

# NATUR-CHANV/HEMP™

A pioneer in the manufacturing of plant-based insulation products in Canada, Nature fibres presents the environmental product declaration (EPD) of its hemp and polyester fibre insulation panel: Natur-Chanv/Hemp™.

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

The EPD and LCA were prepared by CT Consultant according to EN 15804, ISO 14025 and ISO 21930, and verified by Vertima.

For further information about Nature fibres, visit [www.naturefibres.com](http://www.naturefibres.com)

Period of validity: March 2021 – March 2026



# 1 | GENERAL INFORMATION

|  |  |   |
|--|--|---|
| <b>Program operator</b>                    | <p><b>ASTM International</b><br/>                 100 Barr Harbor Drive<br/>                 West Conshohocken, PA 19428<br/>                 United States of America<br/> <a href="http://www.astm.org">www.astm.org</a></p>   |  |
| <b>Declaration holder</b>                  | <p><b>Nature fibres</b><br/>                 385 Industriel Boulevard<br/>                 Val-des-Sources, Quebec J1T 4T7<br/>                 Canada<br/>                 (819) 716-0141<br/> <a href="http://www.naturefibres.com">www.naturefibres.com</a><br/> <a href="mailto:info@naturefibres.com">info@naturefibres.com</a></p> |  |
| <b>Declared product</b>                    | Natur-Chanv/Hemp™ insulation panel   |   |
| <b>Functional unit</b>                     | 1 m <sup>2</sup> of installed hemp/polyester fibre insulation panel with a thickness that gives an average thermal resistance RSI = 1 m <sup>2</sup> ·K/W.   |   |
| <b>Declaration number</b>                  | EPD-197  |   |
| <b>Date of issue</b>                       | March 2021   |   |
| <b>Period of validity</b>                  | March 2021 – March 2026  |   |
| <b>EPD type</b>                            | Product-specific   |   |
| <b>EPD scope</b>                           | Cradle to grave  |   |
| <b>Reference period</b>                    | 2019   |   |
| <b>Region covered</b>                      | North America  |   |
| <b>LCA Software</b>                        | OpenLCA version 1.10.3 [1]   |   |
| <b>Life cycle inventory database</b>       | ecoinvent version 3.4 [2]  |   |
| <b>Life cycle impact assessment method</b> | TRACI version 2.1 [3]  |   |
| <b>Product Category Rules (PCR)</b>        | UL Environment. Building Related Products and Services. Part B: Building Envelope Thermal Insulation EPD requirements, v2.0, April 2018 [4]  |   |
| <b>PCR review</b>                          | Thomas Gloria, Chairman of the peer review panel.  |   |



## 2 | PREPARATION AND VERIFICATION

- This EPD and the LCA were prepared by:



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- This EPD and the LCA were verified by:

This verification was carried out in accordance with ISO 14025:2006 [5], ISO 14044:2006 [6], and the reference PCR.

INTERNAL  EXTERNAL



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- The PCR "UL Environment, Building Related Products and Services, Part A v3.1, May 2018" [7] based on ISO 21930:2017 [8] and EN 15804:2013 [9] serves as the core PCR, with additional considerations for the USGBC/UL Environment Part A Enhancement (2017).

## 3 | NOTES ON EPD COMPARISON

For products from the same category but from different programs environmental declarations may not be comparable. When EPDs are used to compare the environmental performance of different building envelope thermal insulation products, it is essential to take into account the products' use and their impacts on the building. Therefore, EPDs cannot be used for comparison purposes when the building's energy consumption is not considered [4]. Furthermore, in order to allow comparability, all the life cycle stages of a thermal insulation product must have been considered. The same standards and the same reference PCR must be used, and the product installation scenarios must be equivalent [4]. It should also be noted that the use of different LCA softwares and databases may affect the reliability of the EPD comparison.



## 4 | PRODUCT AND COMPANY DESCRIPTION

### 4.1. Company description

A pioneer in the manufacturing of plant-based insulation products in Canada, Nature fibres produces the Natur-Chanv/Hemp™ insulation panel, an insulation product made of hemp fibres and polyester fibres. In addition to producing insulation panels for buildings, Nature fibres manufactures other hemp products, such as insulation wool for cold-preserving during the transport of food and pharmaceutical products. The manufacturing plant is located at 385 Industriel Boulevard in Val-des-Sources (formerly Asbestos), Quebec, Canada.

### 4.2. Product description and applications

The Natur-Chanv/Hemp™ insulation panel is a semi-rigid panel used for thermal insulation in residential and commercial buildings. It can be used to insulate ceilings, walls and floors. The insulation panel is easily installed by inserting it manually so as to fill the volume between two sections of the frame. The Natur-Chanv/Hemp™ insulation panel is produced using an innovative industrial process that gives it high mechanical resistance and stability that prevents subsidence in the long term. Thanks to its high hemp fibre content, the insulation panel has the ability to regulate hygrometry (absorption and release of excess ambient humidity), limiting the negative effects caused by condensation. Non-allergenic, the panel does not emit volatile organic compounds (VOCs) and is resistant to animals (rodents) and parasites (mites and termites).

### 4.3. Reference product

The insulation panel is available in either standard or custom sizes. For all sizes, the material composition, density and manufacturing steps remain the same. Therefore, this EPD applies to all sizes of Natur-Chanv/Hemp™ insulation panels.



Photo 1. Installed Natur-Chanv/Hemp™ insulation panel

#### 4.4. Material composition

Table 1. Material composition of the Natur-Chanv/Hemp™ insulation panel

| Material        | Mass (% of the panel) | Production site              | Distance travelled to Nature fibres' manufacturing plant |
|-----------------|-----------------------|------------------------------|--|
| Hemp fibre      | 92%                   | Saint-Thomas, Quebec, Canada | 203 km   |
|                 |                       | Bar-sur-Aube, France         | 5954 km  |
| Polyester fibre | 8%                    | Lyon, France                 | 6143 km  |

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

#### 4.5. Thermal performance of the product

Table 2. Thermal performance of the Natur-Chanv/Hemp™ insulation panel

| Standard          | Title   | Result  | Verification laboratory                                |
|-------------------|---|---|--|
| ASTM C518-17 [10] | Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus | 0.257 m <sup>2</sup> ·K/W/cm<br>(3.7 ft <sup>2</sup> ·°F hr/BTu/in) | UL Laboratories Canada Inc.<br>Varenes, Quebec, Canada |

#### 4.6. Density and sizes of the product

Table 3. Density and sizes of the Natur-Chanv/Hemp™ insulation panel upon delivery

| Property  | Value                    | Unit              |
|-----------|--------------------------|-------------------|
| Density   | 35                       | kg/m <sup>3</sup> |
| Thickness | 2.0¼; 3.5¼; 5.5¼; 7.5¼ * | in                |
|           | 5.1; 8.9; 14.0; 19.0 *   | cm                |
| Width     | 15¼; 23¼                 | in                |
|           | 38.7; 59.0               | cm                |
| Length    | 48                       | in                |
|           | 122                      | cm                |

\* The insulation panel can be made to measure with a custom thickness.

### 4.7. Manufacturing

The insulation panel is made of hemp fibres and polyester fibres. The polyester is produced in Lyon, France. The hemp is cultivated in two agricultural regions: 25% of the production comes from the Saint-Thomas area in Quebec (Canada) and 75% of production comes the Bar-sur-Aube area in France. The steps included in the production of hemp fibre are shown in Figure 1. Once the hemp plant has reached maturity, the seeds (hempseeds) are harvested with a combine. The straw is mowed by a mower, baled, and then transported to a nearby defibration plant. The straw enters the defibrator which separates the fibre from the hemp shives. The hemp fibres and the polyester fibres are shipped to the Nature fibres manufacturing plant in Val-des-Sources, Quebec (Canada). During the manufacturing of the insulation panel, the hemp fibres and the polyester fibres are combined (Figure 2). The fibres are then spread out, layered, pressed and heated in a propane furnace, then cooled, cut into panels and packaged for delivery.

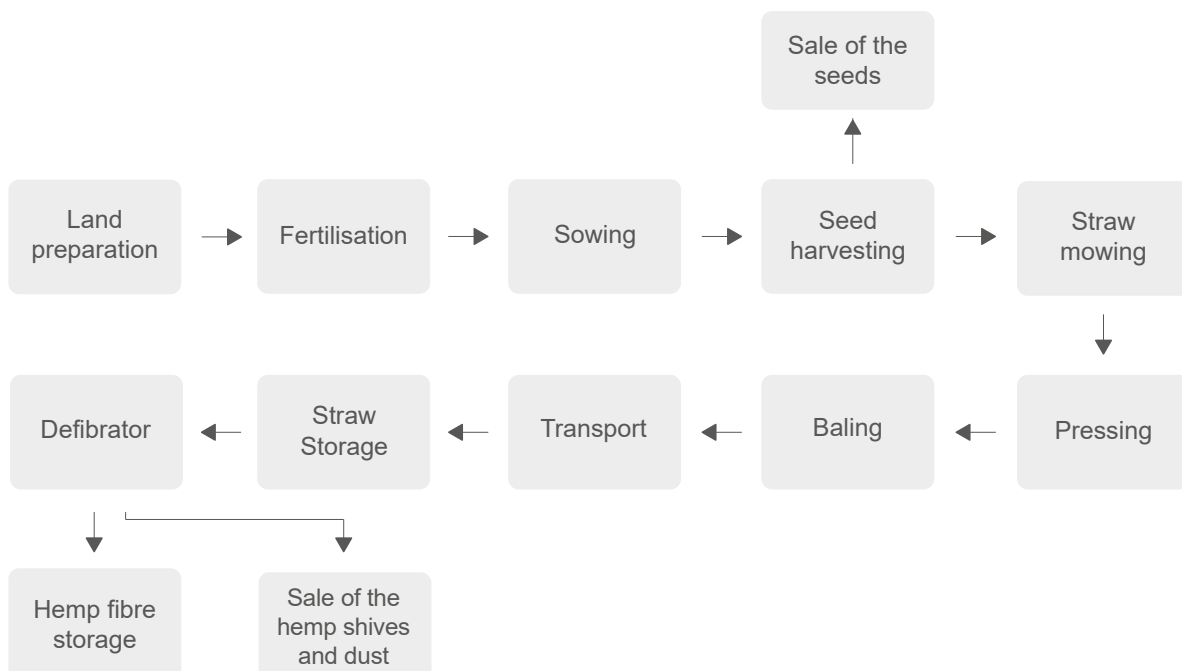


Figure 1. Steps for the production of hemp fibre (Saint-Thomas, Quebec, Canada and Bar-sur-Aube, France)

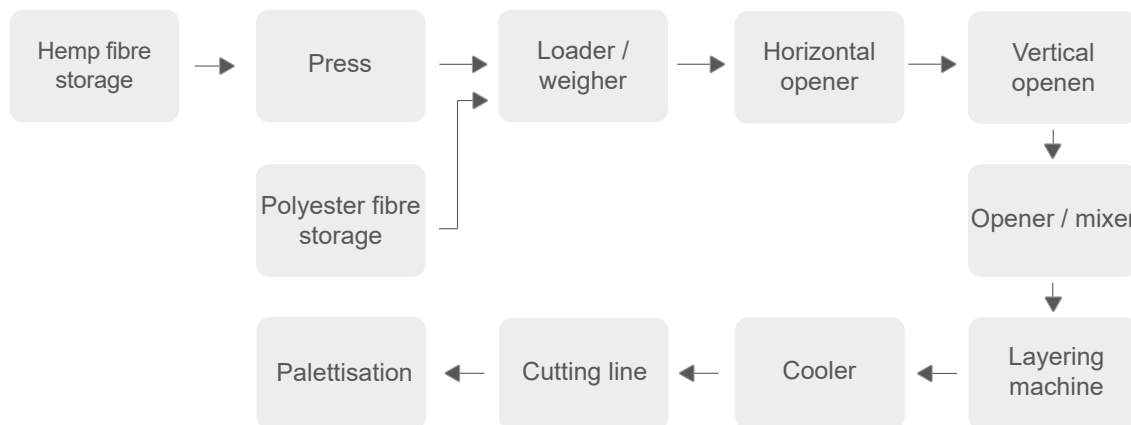


Figure 2. Steps for the production of the insulation panel at Nature fibres' manufacturing plant in Val-des-Sources, Quebec, Canada

## 4.8. Manufacturing losses

There are no material losses during the insulation board manufacturing. Cutting line scraps are collected, crushed, pressed and reincorporated into the manufacturing process.

## 4.9. Packaging

The insulation panel is delivered to the client on a wood pallet wrapped in a plastic film. Each pallet carries on average 104 kg of insulation panels.

## 4.10. Transport

The insulation panel is delivered to the client following a three-step scenario:

- Step 1: Transport to a retail store by truck-trailer over an estimated 250 km distance;
- Step 2: Storage in a retail store;
- Step 3: Transport to the construction site by pick-up truck over an estimated 30 km distance.

## 4.11. Installation

The insulation panel is installed manually between two sections of the frame. The installation does not require any energy or materials. There is no material loss during installation as the scraps are used to insulate the outline of the building openings. Following the installation, the wood pallet and the plastic packaging film are recycled or sent to a landfill site.

## 4.12. Use

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

## 4.13. Reference service life

The reference service life is considered equivalent to that of the building, set to 75 years as a default value by the PCR [4].

## 4.14. End of life

When the building (in which the Natur-Chanv/Hemp™ insulation panel is installed) reaches its end of life, it is assumed that it is demolished without any sorting or recycling of materials. Therefore, the insulation panel will be incorporated into the rest of the demolition waste and sent to a landfill site.

## 5 | METHODOLOGY USED FOR THE LIFE CYCLE ASSESSMENT

### 5.1. Functional unit

The LCA results are the life cycle environmental impacts related to the mass of insulation panel required to achieve the functional unit. The latter is based on the thermal resistance of the insulation panel (ASTM C518-17), as specified in the PCR [4].

Table 4. Functional unit and key parameters

| Parameter                                | Value  | Unit |
|--|--|------|
| Functional unit                          | 1 m <sup>2</sup> of insulation material with a thickness that gives an average thermal resistance RSI=1 m <sup>2</sup> ·K/W. | -    |
| Mass                                     | 1.36   | kg   |
| Thickness to achieve the functional unit | 0.039  | m    |

### 5.2. System boundaries

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

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

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

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

| PRODUCTION STAGE (A1-A3)    |                            |                                | CONSTRUCTION PROCESS STAGE (A4-A5) |              | USE STAGE (B1-B7) |             |        |             |               |            |           | END OF LIFE STAGE (C1-C4) |                                   |                 | BEYOND SYSTEM BOUNDARY |  |
|-----------------------------|----------------------------|--------------------------------|------------------------------------|--------------|-------------------|-------------|--------|-------------|---------------|------------|-----------|---------------------------|-----------------------------------|-----------------|------------------------|--|
| Production of raw materials | Transport of raw materials | Insulation panel 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                      | MND  |

Legend: x: Module included in the LCA MND: Module not declared



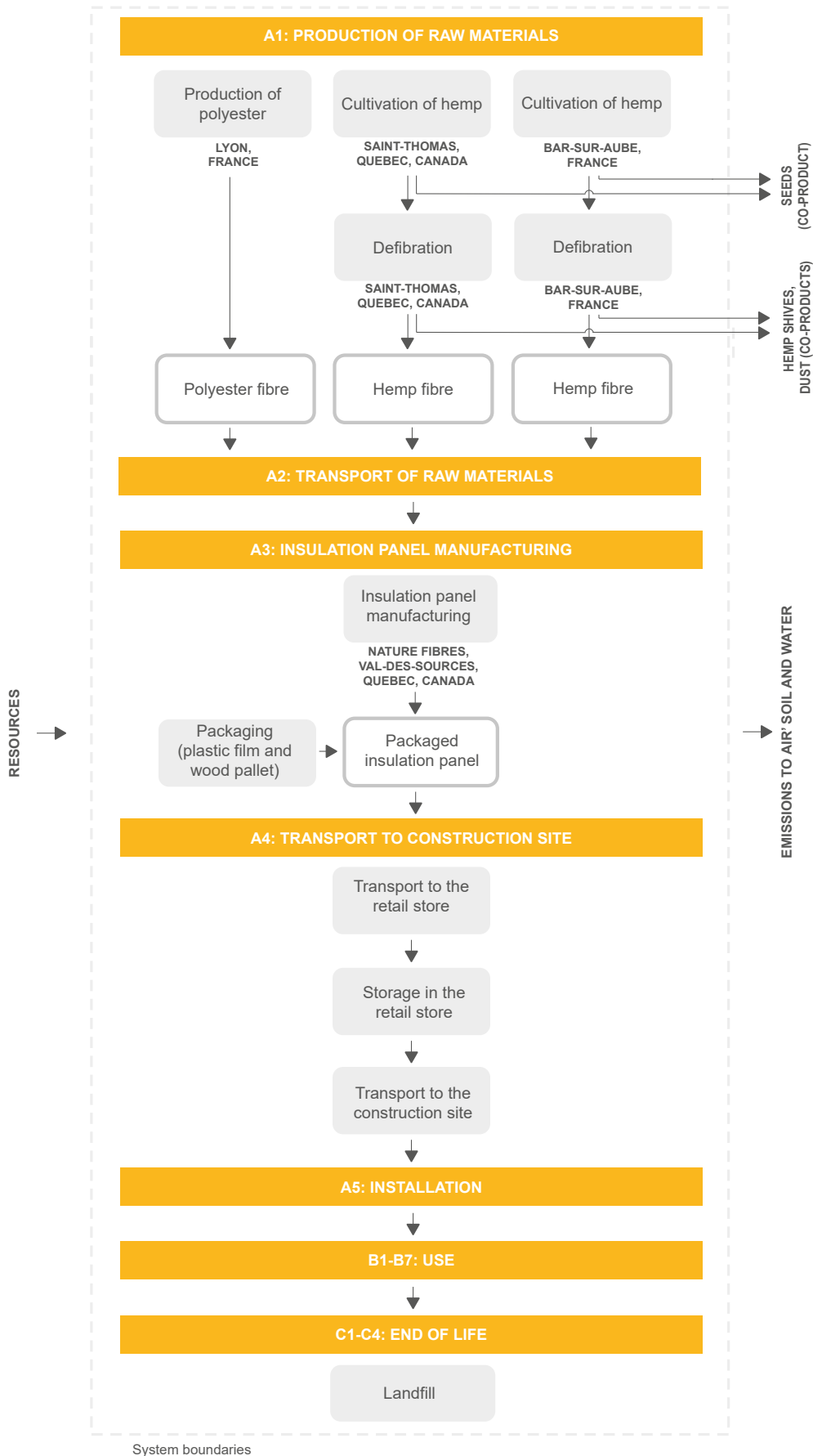


Figure 3. "Cradle to grave" life cycle stages of the Natur-Chanv/Hemp™ insulation panel

### 5.3. Assumptions

Carrying out an LCA entails making assumptions when data is incomplete or missing. Within the framework of this LCA, the following assumptions were developed:

- Hemp fibre production: The farming processes, the hemp cultivar and the agricultural yield of Saint-Thomas and Bar-sur-Aube are equivalent.
- Storage: 78% of warehouses are heated with electricity and 22% are heated with natural gas [11].
- Packaging end of life: There is no reuse of the wood pallet.
- Insulation panel landfill: The methane capture rate at the landfill site is 68.7%, this methane is completely burned in a flare [12].

### 5.4. Cut-off criteria

As defined in ISO 21930 [8], all input and output processes whose mass and/or energy flow account for more than 1% of the total mass and/or cumulative energy of the insulation panel were included. Also in line with with the standard, at least 95% of all mass and energy flows were included. No equipment or infrastructure maintenance, administrative activity, nor transport of Nature fibres employees or workers were added to the LCA model. No known mass or energy flows were deliberately excluded from this EPD.

### 5.5. Allocation

When a farming or manufacturing process yields several outputs (multifunctional processes), its environmental impact must be allocated to the different outputs (product and co-products). During the insulation panel's life cycle, the hemp cultivation and defibration processes produce several outputs. In accordance with the PCR [4], mass allocation was used for these two processes, i.e., the environmental impact of each of these processes was allocated according to the mass of each output.

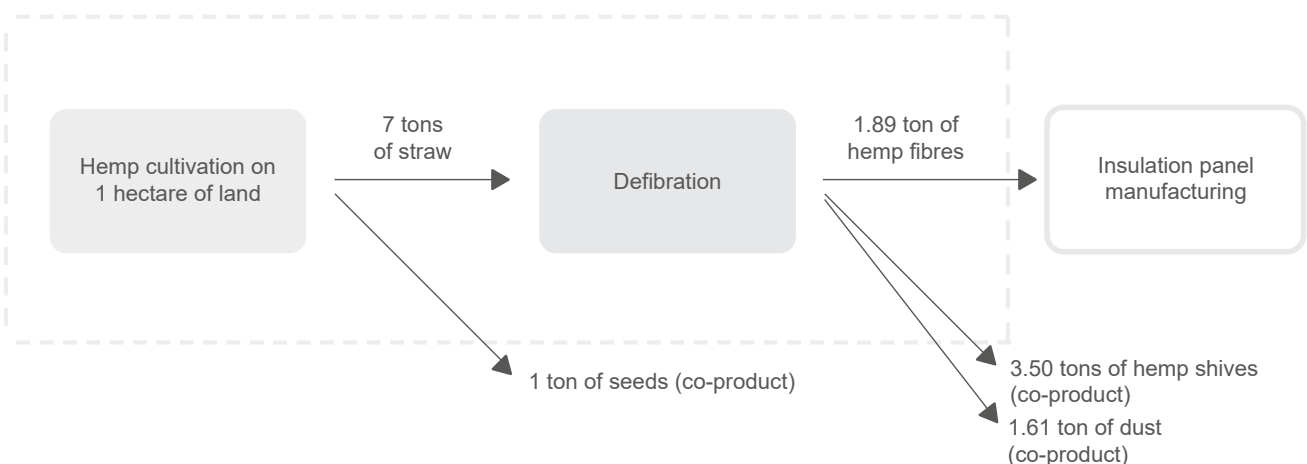


Figure 4. Multifunctional processes subject to mass allocation

## 5.6. Reference period

The inventory data is representative of the 2019 production year.

## 5.7. Data sources and quality

Table 6. Inventory data sources of the insulation panel

| Data type      | Source  |
|----------------|---|
| Primary data   | <p>Primary data was provided by Nature fibres for the period from 1 January to 31 December 2019 and included:</p> <ul style="list-style-type: none"> <li>measured data concerning hemp cultivation and the manufacturing of the insulation panel;</li> <li>data based on realistic assumptions regarding transport of raw materials, transport to the construction site, installation and use of the insulation panel.</li> </ul> |
| Secondary data | <p>Secondary data was obtained from the following sources:</p> <ul style="list-style-type: none"> <li>the ecoinvent version 3.4 "cut-off" [2] database;</li> <li>scientific reports;</li> <li>reference guides.</li> </ul>  |

Table 7. Data quality assessment

| Criterion                        | Evaluation  |
|----------------------------------|---|
| Geographical representativeness  | <p>The primary data represents the life cycle stages of the insulation panel in Quebec and France. The secondary data was selected in such a way that their geographical context is as representative as possible. In the case of processes taking place in Quebec (Canada), data representative of the Quebec context was prioritized, otherwise, data representative of the global market was used. Regarding the processes related to hemp cultivation and the manufacturing of polyester in France, the best available data was used following this order of priority: Europe / Switzerland / World. The data is considered to have high geographical representativeness.</p> |
| Temporal representativeness      | <p>The primary data is representative of 2019. 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 3.4 (2017) database. This version is based on version 3.0 which has been released annually since 2013. It should be noted that some version 3.0 data comes from earlier versions (1991-2012). The data is considered satisfactory in terms of temporal representativeness.</p>  |
| Technological representativeness | <p>The primary data is representative of the technologies used during the insulation panel's life cycle. The secondary data was selected in order to represent these technologies as accurately as possible. This included the machinery used for hemp cultivation, the energy mix, transport, and methane drainage resulting from the deterioration of the insulation panel in the landfill. The secondary data is deemed to have a high technological representativeness.</p>   |
| Completeness                     | <p>All processes whose mass and energy flow are above the cut-off threshold (1%) were included in the LCA in accordance with the PCR. No known flow was deliberately excluded.</p>  |

## 6 | SCENARIOS USED BEYOND THE MANUFACTURING STAGE

### 6.1. Transport to the construction site (A4)

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

| Parameter  | Unit              | Value / Specification                                 |
|--|-------------------|---|
| <b>1. Transport from the manufacturing plant to the retail store</b> |                   |   |
| Fuel type  | -                 | Diesel  |
| Liters of fuel   | L/100 km          | 31  |
| Vehicle type   | -                 | Truck-trailer with a load capacity of 32 tons or more |
| Transport distance   | km                | 250   |
| Capacity utilization   | %                 | 50  |
| Density of product   | kg/m <sup>3</sup> | 35  |
| <b>2. Transport from the retail store to the construction site</b>   |                   |   |
| Fuel type  | -                 | Gasoline  |
| Liters of fuel   | L/100 km          | 10  |
| Vehicle type   | -                 | Pick-up truck   |
| Transport distance   | km                | 30  |
| Capacity utilization   | %                 | 100   |
| Density of product   | kg/m <sup>3</sup> | 35  |

Table 9. Scenario for the loading and unloading of the insulation panel during transport from the manufacturing plant to the construction site

| Parameter                        | Unit | Value / Specification |
|----------------------------------|------|-----------------------|
| Machine type                     | -    | Forklift              |
| Fuel type                        | -    | Propane               |
| Number of loading and unloadings | -    | 3                     |

Table 10. Scenario for the storage of the insulation panel in the retail store

| Parameter           | Unit | Value / Specification |
|---------------------|------|-----------------------|
| Storage duration    | days | 20                    |
| Electric heating    | kWh  | 0.157                 |
| Natural gas heating | kWh  | 0.045                 |

## 6.2. Installation (A5)

Table 11. Building insulation panel installation scenario

| Parameter                         | Unit              | Value / Specification |
|-----------------------------------|-------------------|-----------------------|
| Electricity consumption           | kWh               | -                     |
| Ancillary materials               | kg                | -                     |
| Water consumption                 | m <sup>3</sup>    | -                     |
| Other resources                   | -                 | -                     |
| Product loss                      | -                 | -                     |
| Packaging waste                   | kg                | 0.289                 |
| Emissions to air, soil and water  | kg                | -                     |
| Volatile organic compound content | mg/m <sup>3</sup> | -                     |

Table 12. End of life packaging scenario

| Parameter   | Unit               | Value / Specification                                 |
|---|--------------------|---|
| <b>Wood pallets</b>                                     |                    |   |
| Recycling rate [7]                                      | %                  | 20  |
| Landfill rate [7]                                       | %                  | 80  |
| Biogenic carbon contained in the wood pallet (removal)  | kg CO <sub>2</sub> | 0.64  |
| <b>Plastic film</b>                                     |                    |   |
| Recycling rate [7]                                      | %                  | 78  |
| Landfill rate [7]                                       | %                  | 22  |
| <b>Transport to the landfill site / recycling plant</b> |                    |   |
| Transport distance                                      | km                 | 50  |
| Vehicle type  | -                  | Truck-trailer with a load capacity of 32 tons or more |

## 6.3. Use (B1-B7)

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

## 6.4. Reference service life

Table 13. Reference service life of the insulation panel

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

## 6.5. End of life (C1-C4)

Table 14. Scenario for the end of life of the insulation panel

| Parameter                                       | Unit                                    | Value / Specification  |       |
|---|---|--|-------|
| 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 panel is assumed to be incorporated into the rest of the demolition waste and sent to a landfill site. |       |
| Transport distance                              | km                                      | 50   |       |
| Vehicle type                                    | -                                       | Truck-trailer with a load capacity of 32 tons or more  |       |
| Collection process                              | Collected separately                    | kg   | -     |
|   | Collected with mixed construction waste | kg   | 1.36  |
| Recovery  | Reuse                                   | kg   | -     |
|   | Recycling                               | kg   | -     |
|   | Incineration                            | kg   | -     |
|   | Incineration with energy recovery       | kg   | -     |
| Landfill  | Product destined for landfill           | kg   | 1.36  |
| Biogenic carbon emissions (excluding packaging) | kg CO <sub>2</sub>                      |  | 0.238 |

## 7 | LIFE CYCLE IMPACT ASSESSMENT RESULTS

The results of the life cycle impact assessment are reported for 1 m<sup>2</sup> of insulation panel giving an average thermal resistance of RSI = 1 m<sup>2</sup>.K/W. The results were calculated for six impact categories using the TRACI 2.1 impact assessment method [3], and are reported for each declared life cycle module [8].

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

| INDICATOR                                      | UNIT                         | TOTAL                 | PRODUCTION STAGE |          |         | CONSTRUCTION STAGE |         | USE STAGE | END OF LIFE STAGE |         |         |         |         |
|--|------------------------------|-----------------------|------------------|----------|---------|--------------------|---------|-----------|-------------------|---------|---------|---------|---------|
|  |                              |                       | (A1-A3)          |          |         | (A4-A5)            |         | (B1-B7)   | (C1-C4)           |         |         |         |         |
|  |                              |                       | A1               | A2       | A3      | A4                 | A5      | B1 - B7   | C1                | C2      | C3      | C4      |         |
| Global warming potential                       | Fossil carbon                | kg CO <sub>2</sub> eq | 2.28E+0          | 8.85E-1  | 1.51E-1 | 7.00E-1            | 5.05E-1 | 7.12E-3   | 0.00E+0           | 0.00E+0 | 1.14E-2 | 0.00E+0 | 2.41E-2 |
|  | Biogenic carbon <sup>1</sup> | kg CO <sub>2</sub> eq | -1.60E+0         | -1.90E+0 | 0.00E+0 | -6.33E-1           | 0.00E+0 | 3.01E-1   | 0.00E+0           | 0.00E+0 | 0.00E+0 | 0.00E+0 | 6.35E-1 |
|  | Total <sup>2</sup>           | kg CO <sub>2</sub> eq | 6.84E-1          | -1.02E+0 | 1.51E-1 | 6.71E-2            | 5.05E-1 | 3.08E-1   | 0.00E+0           | 0.00E+0 | 1.14E-2 | 0.00E+0 | 6.59E-1 |
| Acidification potential                        | kg SO <sub>2</sub> eq        | 1.30E-2               | 7.66E-3          | 1.75E-3  | 1.77E-3 | 1.64E-3            | 3.96E-5 | 0.00E+0   | 0.00E+0           | 5.18E-5 | 0.00E+0 | 1.20E-4 |         |
| Eutrophication potential                       | kg N eq                      | 1.94E-2               | 5.59E-3          | 2.10E-4  | 6.80E-4 | 7.70E-4            | 1.66E-3 | 0.00E+0   | 0.00E+0           | 1.27E-5 | 0.00E+0 | 1.05E-2 |         |
| Smog formation potential                       | kg O <sub>3</sub> eq         | 1.42E-1               | 5.56E-2          | 2.97E-2  | 2.47E-2 | 2.69E-2            | 8.50E-4 | 0.00E+0   | 0.00E+0           | 1.22E-3 | 0.00E+0 | 2.63E-3 |         |
| Ozone depletion potential                      | kg CFC-11 eq                 | 3.85E-7               | 9.75E-8          | 3.57E-8  | 1.35E-7 | 1.07E-7            | 1.63E-9 | 0.00E+0   | 0.00E+0           | 2.74E-9 | 0.00E+0 | 4.86E-9 |         |
| Abiotic depletion potential (fossil resources) | MJ (LHV)                     | 4.31E+0               | 1.55E+0          | 3.19E-1  | 1.35E+0 | 1.01E+0            | 1.63E-2 | 0.00E+0   | 0.00E+0           | 2.46E-2 | 0.00E+0 | 4.80E-2 |         |

<sup>1</sup> Since TRACI 2.1 considers biogenic CO<sub>2</sub> as equal to 0, the removals of biogenic carbon and emissions of biogenic CO<sub>2</sub> 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.

<sup>2</sup> The global warming potential impact category results are presented in three categories: 1) fossil carbon; 2) biogenic carbon (emissions and removals); 3) total (fossil and biogenic carbon).

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

# 8 | LIFE CYCLE INVENTORY RESULTS

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

## 8.1. Resource use inventory indicators

Table 16. Life cycle inventory results for resource use

| INDICATOR   | UNIT           | TOTAL   | PRODUCTION STAGE |         |         | CONSTRUCTION PROCESS STAGE |         | USE STAGE | END OF LIFE STAGE |         |         |         |
|---|----------------|---------|------------------|---------|---------|----------------------------|---------|-----------|-------------------|---------|---------|---------|
|   |                |         | (A1-A3)          |         |         | (A4-A5)                    |         | (B1-B7)   | (C1-C4)           |         |         |         |
|   |                |         | A1               | A2      | A3      | A4                         | A5      | B1 - B7   | C1                | C2      | C3      | C4      |
| Renewable primary energy used as energy carrier (fuel) <sup>1</sup>               | MJ (LHV)       | 1.01E+1 | 7.96E-1          | 3.78E-2 | 8.46E+0 | 7.88E-1                    | 4.31E-3 | 0.00E+0   | 0.00E+0           | 2.06E-3 | 0.00E+0 | 1.09E-2 |
| Renewable primary resources with energy content used as material <sup>1</sup>     | MJ (LHV)       | 2.32E+1 | 1.85E+1          | 0.00E+0 | 4.63E+0 | 0.00E+0                    | 0.00E+0 | 0.00E+0   | 0.00E+0           | 0.00E+0 | 0.00E+0 | 0.00E+0 |
| Total use of renewable primary resources with energy content <sup>1</sup>         | MJ (LHV)       | 3.33E+1 | 1.93E+1          | 3.78E-2 | 1.31E+1 | 7.88E-1                    | 4.31E-3 | 0.00E+0   | 0.00E+0           | 2.06E-3 | 0.00E+0 | 1.09E-2 |
| Non-renewable primary resources used as an energy carrier (fuel) <sup>1</sup>     | MJ (LHV)       | 2.97E+1 | 1.01E+1          | 2.30E+0 | 9.35E+0 | 7.28E+0                    | 1.26E-1 | 0.00E+0   | 0.00E+0           | 1.73E-1 | 0.00E+0 | 3.53E-1 |
| Non-renewable primary resources with energy content used as material <sup>1</sup> | MJ (LHV)       | 3.04E+0 | 2.81E+0          | 0.00E+0 | 2.33E-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 <sup>1</sup>     | MJ (LHV)       | 3.28E+1 | 1.29E+1          | 2.30E+0 | 9.59E+0 | 7.28E+0                    | 1.26E-1 | 0.00E+0   | 0.00E+0           | 1.73E-1 | 0.00E+0 | 3.53E-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   | 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  | 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 <sup>2</sup>                                      | m <sup>3</sup> | 7.43E-3 | 4.12E-3          | 3.77E-4 | 1.21E-3 | 1.25E-3                    | 7.68E-5 | 0.00E+0   | 0.00E+0           | 2.99E-5 | 0.00E+0 | 3.76E-4 |

<sup>1</sup> 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].

<sup>2</sup> The results of this indicator were calculated based on the output flows specified in the "ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017" [14].



## 8.2. Waste categories and output flows inventory indicators

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

| INDICATOR  | UNIT           | TOTAL    | PRODUCTION STAGE |          |          | CONSTRUCTION PROCESS STAGE |          | USE STAGE | END OF LIFE STAGE |          |         |          |
|--|----------------|----------|------------------|----------|----------|----------------------------|----------|-----------|-------------------|----------|---------|----------|
|  |                |          | (A1-A3)          |          |          | (A4-A5)                    |          | (B1-B7)   | (C1-C4)           |          |         |          |
|  |                |          | A1               | A2       | A3       | A4                         | A5       | B1 - B7   | C1                | C2       | C3      | C4       |
| Hazardous waste disposed <sup>1</sup>                      | kg             | 2.07E-2  | 1.67E-2          | 2.04E-3  | 2.05E-4  | 9.66E-4                    | 2.22E-4  | 0.00E+0   | 0.00E+0           | 1.40E-4  | 0.00E+0 | 4.20E-4  |
| Non-hazardous waste disposed <sup>1</sup>                  | kg             | 2.62E+0  | 8.00E-1          | 1.79E-1  | 1.45E-2  | 1.05E-1                    | 2.37E-1  | 0.00E+0   | 0.00E+0           | 1.36E-2  | 0.00E+0 | 1.27E+0  |
| High-level radioactive waste <sup>1</sup>                  | m <sup>3</sup> | 5.15E-10 | 3.58E-10         | 4.25E-11 | 4.23E-11 | 6.08E-11                   | 3.57E-12 | 0.00E+0   | 0.00E+0           | 1.68E-12 | 0.00E+0 | 5.58E-12 |
| Intermediate- and low-level radioactive waste <sup>1</sup> | m <sup>3</sup> | 3.63E-8  | 8.10E-9          | 1.20E-8  | 7.57E-10 | 1.25E-8                    | 5.46E-10 | 0.00E+0   | 0.00E+0           | 9.18E-10 | 0.00E+0 | 1.50E-9  |
| Components for re-use <sup>2</sup>                         | 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 <sup>2</sup>                       | 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 energy recovery <sup>2</sup>                 | 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  |
| Exported energy <sup>2</sup>                               | 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  |

<sup>1</sup> The results of these indicators were calculated using a waste classification based on Annex K of the national supplement to the NF EN 15804+A1 standard [15] and the Resource Conservation and Recovery Act (RCRA), Subtitle 3 [16] classification.

<sup>2</sup> The insulation panel is not reused, recycled or used for energy recovery. The results of these indicators are therefore equal to zero.

### 8.3. Biogenic carbon emissions and removals inventory indicators

The ISO 21930 standard and the PCR UL Part A v3.1 require that the removals and emissions of biogenic carbon dioxide (CO<sub>2</sub>) be presented separately when included in the calculation of the global warming potential impact category [7,8].

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

| INDICATOR   | UNIT               | TOTAL    | PRODUCTION STAGE |         |          | CONSTRUCTION PROCESS STAGE |         | USE STAGE | END OF LIFE STAGE |         |         |         |
|---|--------------------|----------|------------------|---------|----------|----------------------------|---------|-----------|-------------------|---------|---------|---------|
|   |                    |          | (A1-A3)          |         |          | (A4-A5)                    |         | (B1-B7)   | (C1-C4)           |         |         |         |
|   |                    |          | A1               | A2      | A3       | A4                         | A5      | B1 - B7   | C1                | C2      | C3      | C4      |
| Biogenic carbon removal from product <sup>1</sup>   | kg CO <sub>2</sub> | -1.90E+0 | -1.90E+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 <sup>1,2</sup>  | kg CO <sub>2</sub> | 2.38E-1  | 0.00E+0          | 0.00E+0 | 0.00E+0  | 0.00E+0                    | 0.00E+0 | 0.00E+0   | 0.00E+0           | 0.00E+0 | 0.00E+0 | 2.38E+0 |
| Biogenic carbon removal from packaging <sup>1</sup>   | kg CO <sub>2</sub> | -5.11E-1 | -5.93E-3         | 0.00E+0 | -6.33E-1 | 0.00E+0                    | 1.28E-1 | 0.00E+0   | 0.00E+0           | 0.00E+0 | 0.00E+0 | 0.00E+0 |
| Biogenic carbon emission from packaging <sup>1,2</sup>  | kg CO <sub>2</sub> | 6.48E-2  | 0.00E+0          | 0.00E+0 | 0.00E+0  | 0.00E+0                    | 6.48E-2 | 0.00E+0   | 0.00E+0           | 0.00E+0 | 0.00E+0 | 0.00E+0 |
| Calcination carbon emissions  | kg CO <sub>2</sub> | 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 removal  | kg CO <sub>2</sub> | 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 <sub>2</sub> | 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 <sub>2</sub> | 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 |

<sup>1</sup> 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].

<sup>2</sup> For these inventory indicators, only carbon dioxide emissions are included. Methane emissions are excluded in accordance with the PCR UL Part A v3.1 [7].

## 9 | LIFE CYCLE ASSESSMENT INTERPRETATION

### 9.1. Global warming impact indicators

#### 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 include carbon absorbed by the hemp fibre and the wood pallet. The output biogenic carbon flows are those related to the end of life emissions from the hemp fibre and pallet wood. 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 panel. This biogenic carbon sequestration helps reduce the global warming potential of the insulation panel.

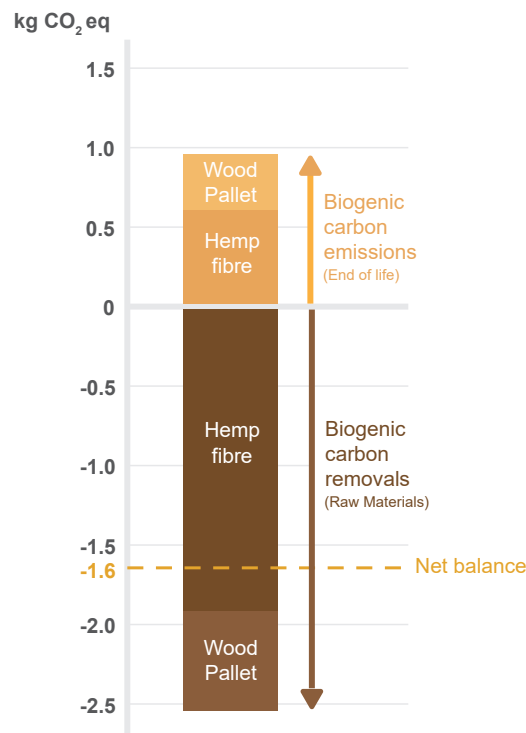
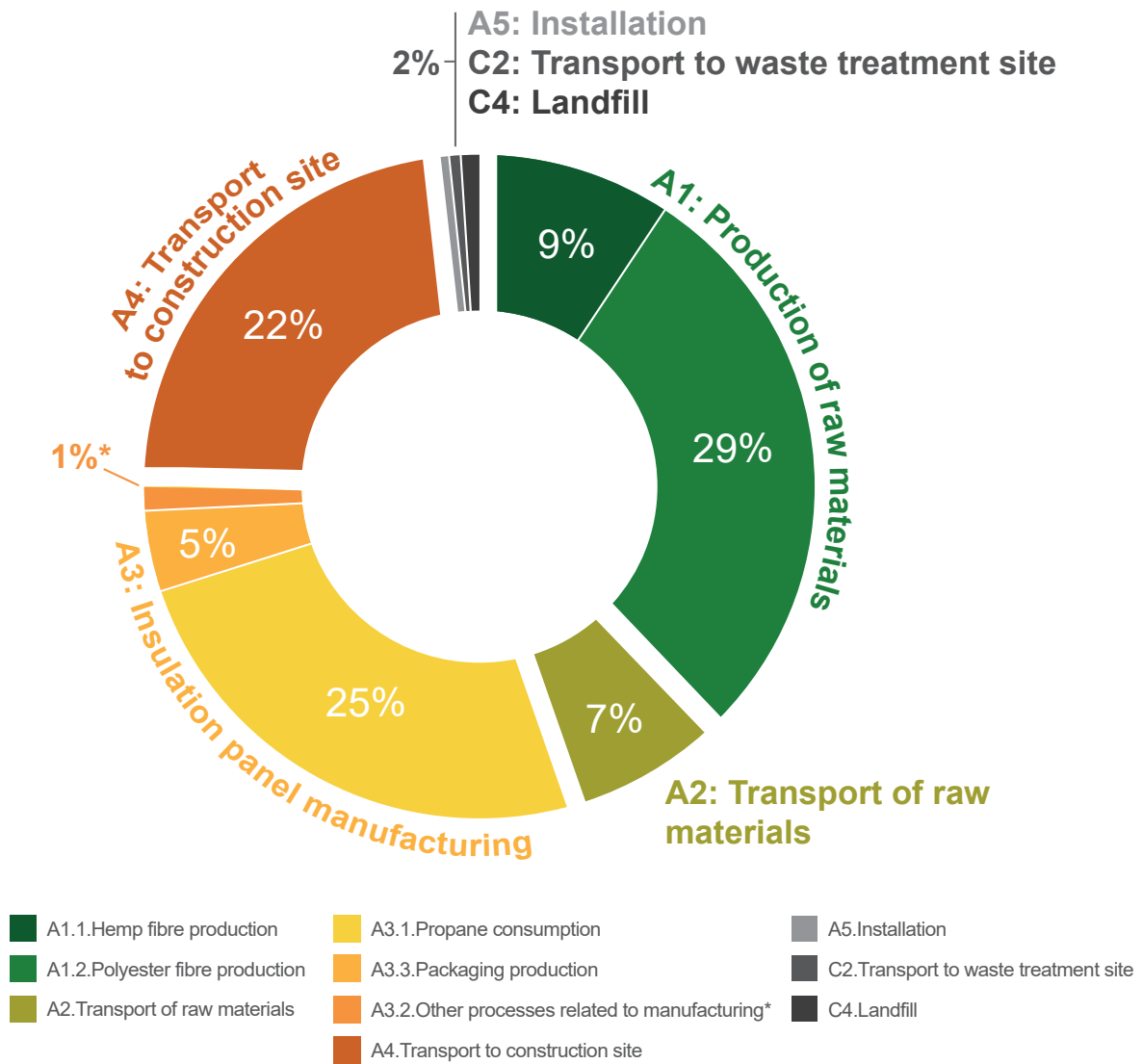


Figure 5. Biogenic carbon flow contribution over the life cycle of the insulation panel

<sup>1</sup> The output flows include biogenic carbon dioxide and methane, expressed in kg CO<sub>2</sub> eq.

### Fossil carbon emissions

Fossil carbon emissions are emissions related to fossil fuels (gasoline, diesel, propane, natural gas). The life cycle module which contributes the most to fossil carbon emissions is A1 Production of raw materials (38%), followed by A3 Insulation panel manufacturing (31%) and lastly A4 Transport to construction site (22%). These three modules represent 92% of the total fossil carbon emissions. Regarding production of raw materials, the main contributor is A1.2 Polyester fibre production (29%). As for the manufacturing of the insulation panel, the biggest contributor is A3.1 Propane consumption (25%).

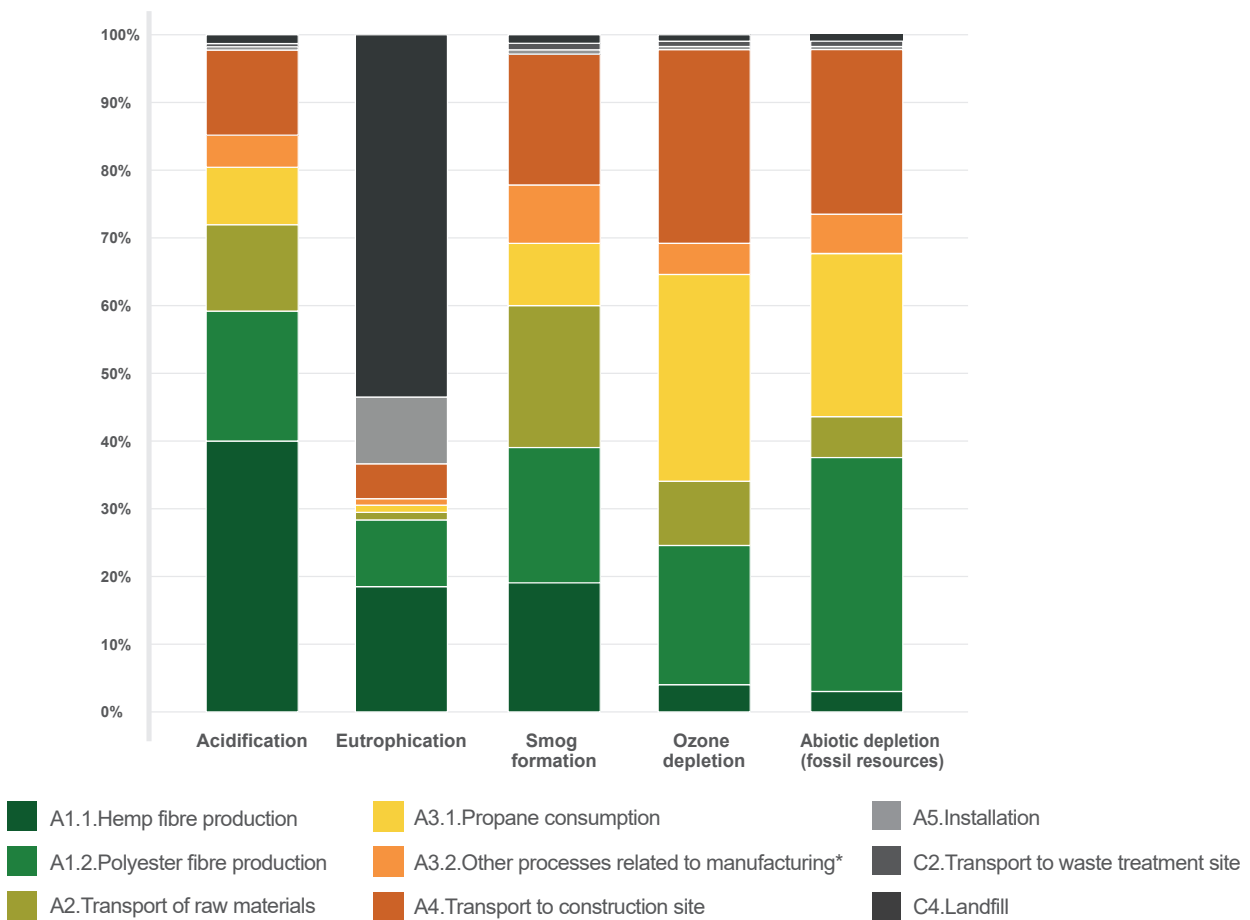


\* "Other processes related to manufacturing" includes: transport of propane, electricity consumption at the manufacturing plant, materials used to build the manufacturing plant and the manufacturing processes and end of life of the polyester fibre's packaging film.

Figure 6. Contribution of the different life cycle modules and processes to fossil carbon emissions

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

The three modules that contribute the most to **acidification** are A1 Production of raw materials (59%), A4 Transport to construction site (13%) and A2 Transport of raw materials (13%). The major contributing processes are A1.1 Hemp fibre production (40%) and A1.2 Polyester fibre production (29%). Regarding the **eutrophication** impact category, the modules C4 Landfill (54%) and A1 Production of raw materials (29%) are the biggest contributors. As for the **smog formation** indicator, A1 Production of raw materials (39%), A2 Transport of raw materials (21%) and A4 Transport to construction site (19%) are the main contributors. The **ozone depletion** indicator is mainly affected by modules A3 Insulation panel manufacturing (35%), A4 Transport to construction site (28%) and A1 Production of raw materials (25%). Regarding the manufacturing of the insulation panel, the process A3.1 Propane consumption contributes significantly to this indicator (31%), because the propane extraction generates hydrocarbon and combustion gas emissions. As for **abiotic depletion**, the main contributors are modules A1 Production of raw materials (36%), A3 Insulation panel manufacturing (31%) and A4 Transport to construction site (23%). The process included in the raw materials production which contributes the most to the depletion of abiotic resources is A1.2 Polyester fibre production (31%).

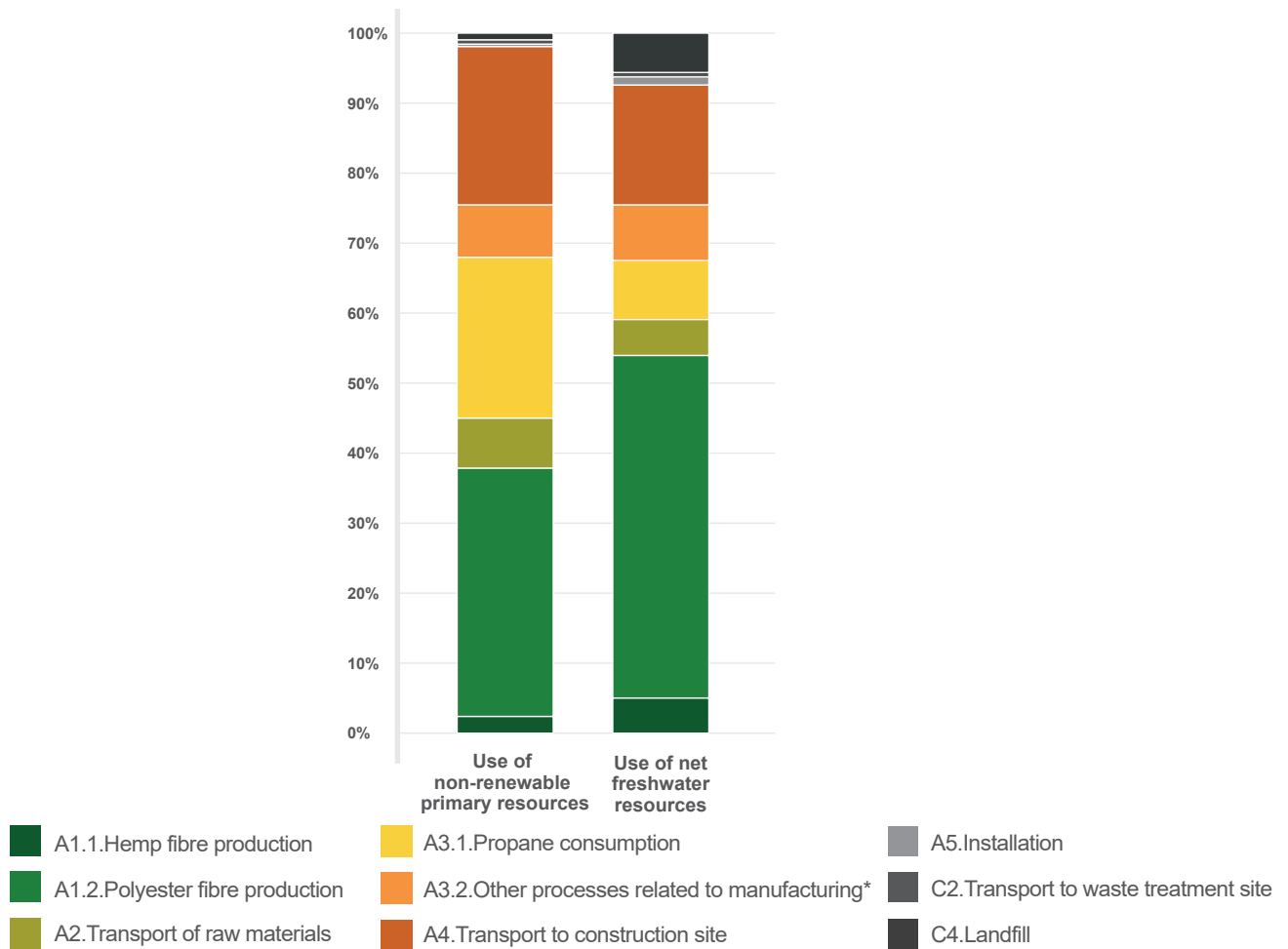


\* "Other processes related to manufacturing" includes: transport of propane, electricity consumption at the manufacturing plant, insulation panel packaging production, materials used to build the manufacturing plant and the manufacturing processes and end of life of the polyester fibre's packaging film.

Figure 7. Contribution of the different life cycle modules and processes to different impact categories

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

The indicator regarding the **use of non-renewable primary resources** is mainly dominated by modules A1 Production of raw materials (38%), A3 Insulation panel manufacturing (29%), and A4 Transport to construction site (22%). The process A1.2 Polyester fibre production is the biggest contributor to this indicator (34%). As for the **use of fresh water resources** indicator, the process which contributes the most is A1.2 Polyester fibre production (47%).



\* "Other processes related to manufacturing" includes: transport of propane, electricity consumption at the manufacturing plant, insulation panel packaging production, materials used to build the manufacturing plant and the manufacturing processes and end of life of the polyester fibre's packaging film.

Figure 8. Contribution of the different life cycle modules and processes to non-renewable primary resources use and freshwater resources use

## 10 | ADDITIONAL ENVIRONMENTAL INFORMATION

### 10.1. Regulated hazardous substances

The insulation panel contains only hemp and polyester fibres, two substances that are not on Canada's list of toxic substances [17]. Thus, no regulated hazardous substances are related to the production of the insulation panel.

### 10.2. Environment and health during manufacturing and installation

The manufacturing of the insulation panel does not have any effect on the health of the factory workers and does not alter the quality of the immediate environment. The insulation panel installation has no effect on the health of the installers. Furthermore, the insulation panel does not emit any substance that could affect the health of the building occupants once installed.

### 10.3. Energy savings during building operation

The use of building envelope thermal insulation reduces energy consumption (heating and air conditioning) during building operation. Because the aim of this EPD is limited to presenting the environmental impacts generated by the insulation panel, energy savings-related environmental impacts reduction were not included. Performing an energy simulation of a specific building insulated with the Natur-Chanv / Hemp™ panel would enable an assessment of the energy savings and would serve as a basis for the calculation of the avoided impacts.

### 10.4. Unexpected adverse events

There are no unexpected adverse effects resulting from the combustion or mechanical alteration of the insulation panel.

### 10.5. Land use change for hemp cultivation

The agricultural land used for the production of hemp in Quebec and France was previously used for the cultivation of another crop (wheat, hay, soybean, etc.). Therefore, no greenhouse gas emissions related to land use change were accounted for in the LCA.

## 11 | IMPACT AND INVENTORY INDICATORS DEFINITIONS

Table 19. Definitions and units of the EPD's impact indicators [3,7]

| 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 <sub>2</sub> , CH <sub>4</sub> , and N <sub>2</sub> O.   | kg CO <sub>2</sub> eq |
| Acidification potential                        | This indicator measures the impact of an increase in the concentration of hydrogen ions (H <sup>+</sup> ) in soil or water environments caused by emissions of acidifying substances (for example, sulfuric acid).   | kg SO <sub>2</sub> eq |
| Eutrophication potential                       | This indicator measures the consequences of an enrichment of water by nutrients (nitrates and phosphates), thus increasing the growth of algae deteriorating the aquatic ecosystem.  | kg N eq               |
| Smog formation potential                       | This indicator measures the formation of smog (ground-level ozone (O <sub>3</sub> )), which is a pollutant that impacts the respiratory system. Smog is produced by the exposure of nitrogen oxides (NO <sub>x</sub> ) and volatile organic compounds (VOCs) to solar radiation. | kg O <sub>3</sub> eq  |
| Ozone depletion potential                      | This indicator measures the impact of the depletion of the ozone layer, which is a gas 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. Definitions and units of the EPD's inventory indicators [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, hemp).   | 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 <sup>3</sup> |
| Use of fresh water resources                                 | Use of freshwater, excluding non-consumed water (water used to power turbines, or as coolant and recirculated) and water losses caused by natural phenomena (evaporation of rainwater).             | m <sup>3</sup>     |
| Removals and emissions of biogenic carbon                    | Product and/or packaging biogenic carbon input (biomass removals) and output (emissions) flows.   | kg CO <sub>2</sub> |



## 12 | ACRONYMS AND EMPIRICAL FORMULAS

- **CFC** - Chlorofluorocarbons
- **CFC-11** - Trichlorofluoromethane
- **CH<sub>4</sub>** - Methane
- **CO<sub>2</sub>** - Carbon dioxide
- **EPD** - Environmental product declaration
- **eq.** - Equivalent
- **FU** - Functional unit
- **LCA** - Life cycle assessment
- **LHV** - Lower heating value
- **N** - Nitrogen
- **NO<sub>x</sub>** - Nitrogen oxides
- **O<sub>3</sub>** - Ozone
- **PCR** - Product category rules
- **SO<sub>2</sub>** - Sulfur dioxide
- **VOCs** - Volatile organic compounds

## 13 | GLOSSARY

- **Biogenic carbon:** carbon derived from biomass produced by living organisms through natural processes, excluding carbon which is fossilized or derived from fossil resources [8].
- **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 [8].
- **Co-product:** any of one or more products from the same process which is not the object of the assessment [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 [23], that is to say elements of the activities, products or services of an organization that can interact with the environment [18].
- **Environmental product declaration (EPD ou Type III declaration):** environmental declaration providing quantified environmental data using predetermined parameters based on the ISO 14040 and ISO 14044 standards [8].
- **Fibre:** long cell or set of cells from the bark of the hemp stalk obtained after treatment and whose structure is comprised largely of cellulose [20].
- **Functional unit (UF):** quantified performance of a product system intended to be used as a reference unit in a life cycle assessment [18].
- **Hemp shives:** all the woody tissues resulting from primary processing, comprising mainly the hemp stalk pith [20].
- **Layering machine:** textile manufacturing equipment used to "layer" the insulating panel, i.e., to spread and structure the fibres without weaving them [21].
- **Life cycle assessment (LCA):** compilation and evaluation of the inputs and outputs (inventory), as well as the assessment of potential environmental impacts of a product during its life cycle [18].
- **Product category rules (PCR):** set of specific rules, requirements and guidelines for the development of EPDs [8]. The PCR referenced in this EPD refers to the PCR "UL PCR Part B: Building Envelope Thermal Insulation EPD requirements".
- **Seed:** part of the fruit containing the germ of a new plant similar to the one that produced it [19].
- **Straw:** natural plant fibres derived from the stalks [22].

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