ZAG EPD

Environmental Product Declaration

According to ISO 14025 and EN 15804:2012+A2:2019

FIBRANxps

ECO PLATFORM EPD EN 15804 VERIFIED

EPD number	EPD-21/0001
EPD owner	FIBRAN d.o.o., Kočevarjeva ulica 1, 8000 Novo mesto, Slovenia
EPD Program operator	ZAG EPD
Issue date	07. 07. 2021
Valid until	06. 07. 2026

ZAVOD ZA GRADBENIŠTVO SLOVENIJE LJUBLJANA 17

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General information	FIBRANxps thermal insulation products: MAESTRO, FABRIC, ETICS GF, ETICS BT, INCLINE, SEISMIC, 300, 400, 500, 700
Program holder: Slovenian National Building And Civil Engineering Institute Dimičeva 12 1000 Ljubljana **http://www.zag.si**	**Owner of the Environmental Product Declaration:** Fibran d.o.o. **Kočevarjeva ulica 1** 8000 Novo mesto Slovenia **https://fibran.si/**
Number of the Environmental Product Declaration: EPD-21/0001	**Declared unit:** 1 m^2 of FIBRANxps thermal insulation
This Environmental Product Declaration is based on the Product Category Rules (PCR): Product Category Rules (PCR) Part B: Requirements on the EPD for Insulating materials made of foam plastics. Institut Bauen und Umwelt e.V.	**Scope:** A1-A3, A4, A5, B1-B7, C1, C2, C3, C4, D
Issue date: 07. 07. 2021 **Valid until:** 06. 07. 2026	**Verification:** The CEN standard SIST EN 15804 serves as the core Product Category Rule (PCR) Independent verification of the EPD according to EN ISO 14025 ☒ notranja ☐ zunanja
Production plant: Fibran d.o.o. Cesta Notranjskega odreda 45 **1317 Sodražica** Slovenia	**Title and the handwritten signature of verificator:** *Katja Malovrh Rebec, PhD* Slovenian National Building And Civil Engineering Institute Digitally signed by Katja Malovrh Rebec Date: 2021.10.14 21:50:01 +02'00'
Title and the handwritten signature issuer: *Franc Capuder, MSc* Slovenian National Building And Civil Engineering Institute	**Title and handwritten signature of leading expert:** *Janez Turk, PhD* Slovenian National Building And Civil Engineering Institute ZAVOD ZA GRADBENIŠTVO SLOVENIJE LJUBLJANA

1 Product

1.1 Product description

FIBRANxps is the commercial name of extruded polystyrene as produced and supplied by FIBRAN. Most of the FIBRANxps mass consists of transparent, general purpose and high heat-resistant polystyrene, and for the achievement of foaming, inflating gases are added at 5-8% of the total mass.

The product is used in building applications, such as roofs, floors and walls, as well as in industrial applications and underground applications like: perimeter basement walls, swimming pools, foundation slabs, bridges, roads and railways. Extruded polystyrene thermal insulation, marked with the international abbreviation XPS, is generally implemented in applications where installing other types of insulations would be useless - under extreme loads, in humid environments and even below groundwater level.

FIBRANxps is material made in the form of foam boards (hereinafter panels) of various dimensions, densities, compressive strengths and thermal conductivities. Due to the needs of different applications, the FIBRANxps panels are produced with different surfaces: with production extrusion skin, planed, cut with hot wire or with grooves. The panels can also be inclined. For the same reason, they are also produced with different edges flat, stepped (L edge, "shiplap") and groove ("tongue and groove").

Ten FIBRANxps products (MAESTRO, FABRIC, ETICS GF, ETICS BT, INCLINE, SEISMIC, 300, 400, 500, 700) are covered in this EPD.

1.2 Technical Data

Compressive strength of the FIBRANxps panels is stable over time, even under heavy loads. This makes the panels suitable for use under permanent static as well as dynamic loads under foundations of heavier buildings.

Table 1: Technical characteristics of FIBRANxps

FIBRANxps	Technical data
Thickness	10-200 mm
Width	580-610 mm
Length	1000 – 3000 mm
Compressive stress at 10 % deformation (EN 826:2013)	200-700 kPa
Heat retention (EN 12667:2001 and EN 13164:2012 + A1:2015, Annex C)	0,032-0,036 W/mK
Density (EN 1602:2013)	25-47 kg/m^3
Safety in case of fire (acc. to EN 13501-1:2007 + A1:2009)	class E
Water vapour diffusion resistance factor (EN 12086:2013)	50-150
Deformation under specified compressive load and temperature conditions (EN 1605:2013)	< 5 %vol
Tensile strength perpendicular to faces (EN 1607:2013)	400-600 kPa
Long term water absorption by total immersion (EN 12087:2013)	0,7- 1,5 %vol.
Long term water absorption by diffusion (EN 12088:2013)	< 1%
Thermal insulance	0,25-5,55 m^{2}K/W
Creep under shear load (EN 1606:2013)	130-215 kPa
Dimensional stability under specified conditions (EN 1604:2013)	< 5 %

1.3 Base materials

The basic materials for the production of FIBRANxps are:

- Polystyrene (>86%)
- Blowing agents (<10%)
- Additives (<4%)

The total recycling content is between 20 to 30%. The additives are flame retardant, processing aid, nucleating agent, active nucleating agent and titanium dioxide.

1.4 Manufacturing process

The production process is as follows. All raw materials are dosed via a gravimetric system in accurately measured quantities into the primary extruder. The raw materials are melted under high pressure and temperature in the primary extruder in first step and mixed in second step. During the mixing, gases are added. Then the melt is led to a secondary extruder, where the melt is cooled and mixed, until it exits the extruder. Due to the mixed gases and the pressure difference, the mixture expands in the extruder. Endless foam with extruded skin emerges from the extruder, which then cools and hardens along the line. The hardened panels are then finished along the line, trimmed, planed, grooved, embossed, depending on the type of product being produced.
The entire cutting of the panels is led through the ventilation system to grinding and heat treatment. In this way, the cuttings are processed into granules, which are reused as a basic raw material in the production process. 20 to 30% of the production waste is created, which is completely reused.

1.5 Packaging

FIBRANxps panels are packed with polyethylene foil. The packages are stacked on polystyrene pallet legs and wrapped with polyethylene foil.

1.6 Further information

The owner of the declaration shall be liable for the underlying information and evidence. Further information about the FIBRANxps panels is also available in the manufacturer web page:

https://fibran.si/en/about-us/

2 LCA: Calculation rules

2.1 Declared unit

The declared unit was defined in accordance with Product Category Rules (PCR) Part B: Requirements on the EPD for Insulating materials made of foam plastics, which are issued by the Institut Bauen und Umwelt e.V. The following declared unit was applied:
1m² of FIBRANxps panel with thermal conductivity λ=0.032-0.036 W/mK and with a building service life of at least 50 years. The density of the panel is 32 kg/m^3, the thickness is 30 mm and the mass is 0.961 kg.

2.2 System boundary

System boundaries were defined in accordance with the modular principle described in the European standard for Environmental Product Declarations (EPD): EN 15804:2012+A2:2019. This analysis LCA is based on cradle-to-grave (Figure 1). The LCA of FIBRANxps panels covers all life cycle stages:
A1: raw material extraction and processing;
A2: transport to the manufacturer;
A3: manufacturing;
including provision of all materials, products and energy, as well as waste processing up to the end of-waste state, or disposal of final residues, during the production stage;
A4: transport to the building site;
A5: installation in the building;

including provision of all materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during the construction process stage. These information modules also include all impacts and aspects related to any losses during this construction process stage (i.e. production, transport and waste processing and disposal of the lost materials);
B1: use or application of the installed product;
B2: maintenance;
B3: repair;
B4: replacement;
B5: refurbishment;
B6: operational energy use;
B7: operational water use;
including provision of all materials, products and energy, as well as waste processing up to the end-of waste state or disposal of final residues during the construction process stage. These information modules also include all impacts and aspects related to any loss during this construction process (i.e. production, transport, and waste processing and disposal of the lost products and materials);
C1: de-construction, demolition;
C2: transport to waste processing;
C3: waste processing for reuse, recovery and/or recycling;
C4: disposal;
including provision and all transport, provision of all materials, products and related energy and water use;
D: reuse, recovery and/or recycling potentials, expressed as net impacts and benefits.

The data used for modules A1-A3, A4-A5 and B1-B7 are based on the measured quantities provided by the manufacturer, while data used for modules C1-C4 and D are mostly based on the information provided by the European Platform on Life Cycle Assessment.

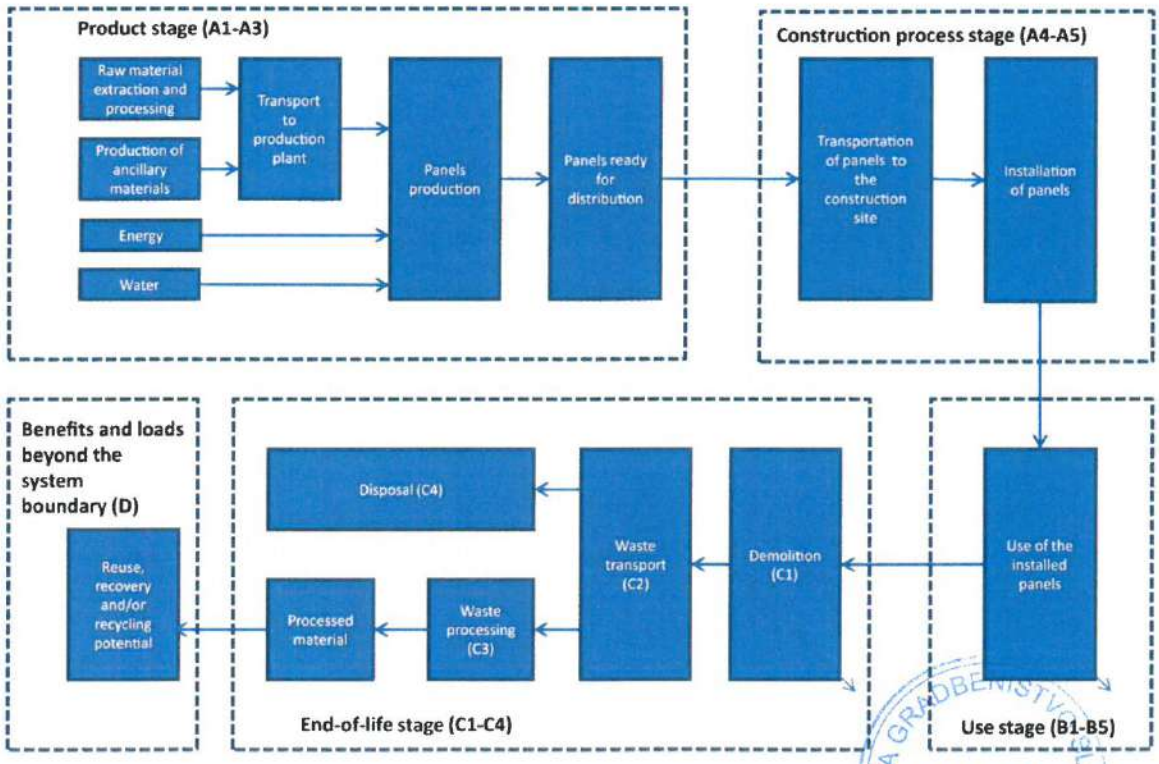

Figure 1: Schematic representation of the system boundaries

The assumptions taken into account are as follows. FIBRANxps is installed in the building manually. No ancillary material, water or energy source such as electricity is required in this stage. 2% of waste material (i.e. clippings) is assumed to be generated from the product installation. Two scenarios are taken into account for waste material treatment, landfilling and incineration with heat recovery.

FIBRANxps does not require any maintenance, repair, replacement or refurbishment during use in standard conditions if properly installed. FIBRANxps do not cause release of any substances to indoor air, soil and water in the use stage. FIBRANxps does not use energy or water during use of the building.

Dismantling of FIBRANxps takes part of the demolition of the entire building. Energy requirements for dismantling are negligible compared to energy required for demolition of the building. Thus the environmental impacts related with dismantling of the product are assumed to be zero.

Two scenarios exist for treatment with waste product, landfilling and incineration with heat recovery.

Benefits beyond the product system boundary refer to recycling of the packaging material. In special scenario, the benefits beyond the product system boundary refer also to energy recovery from incinerating the waste clippings generated from the product installation and incinerating the product after dismantling from the building. In baseline scenario, these kinds of wastes are landfilled, which does not yield any benefits beyond the product system boundary.

2.3 Cut-off rules

The exclusion of inputs and outputs was conducted in accordance with the cut-off rules defined in the standard EN 15804:2012+A2:2019:

- All inputs and outputs to the studied system have been included in the calculation, for which data are available;
- In case of insufficient input data or data gaps for a unit process, the cut-off criteria has been 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process. The total of neglected input flows per module has been a maximum of 5% of energy usage and mass.

2.4 Background data

The LCA analysis was conducted with the GaBi ts (version 10.0.1.92) modelling software, which was developed by Thinkstep (Sphera Solutions GmbH). All processes were modelled based on inventory data given in the GaBi Professional database, except production of processing aid. This process was modelled based on inventory data given in the ecoinvent 3.7 database due to lack of inventory data of required building blocks in GaBi Professional database.

2.5 Data quality

The quality of the data used for calculations within the LCA analysis corresponds to the requirements of EN 15804:2012+A2:2019:

- Generic data have been checked for plausibility;
- Data sets are complete according to the system boundary within the limits set by the criteria for the exclusion of inputs and outputs;
- Data is as current as possible. Data sets used for calculations are valid for the current year and represent a reference year within 10 years for generic data and 5 years for producer specific data;
- The reference year refers to the year which the overall inventory best represents, considering the age/representativeness of the various specific and background data included, i.e. not automatically the year of modelling, calculation or publication year. Validity refers to the date to which the inventory is still judged sufficiently valid with the documented technological and geographical representativeness;
- All datasets are based on 1 year averaged data;

- The time period over which inputs to and outputs from the system has been accounted for is 100 years from the year for which the data set is deemed representative.

2.6 Period under review

The reference year for the data collected for this LCA analysis is 2020.

2.7 Allocation

There are no co-products in the production process of FIBRANxps. Therefore, no allocation procedure has been required in this regard.

2.8 List of substances

FIBRANxps does not contain substances listed in the Candidate List of substances of very high concern (/REACH/ Regulation) exceeding 0.1%.

This product does not contain other Carcinogenic, Mutagenic, Reptrotoxic (CMR) substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass.

3 Additional technical information

3.1 Information on describing the biogenic Carbon Content at factory gate

A mass of biogenic carbon containing materials in the product is more than 5% of the mass of the product. A mass of biogenic carbon containing materials in the packaging is less than 5 % of the total mass of the packaging (Table 2).

Table 2: Information on biogenic carbon content at the factory gate

BIOGENIC CARBON CONTENT	Unit [expressed per declared unit]
Biogenic carbon content in product	0.0051 kg C per 0.961 kg of the product
Biogenic carbon content in accompanying packaging	0.00015 kg C in required 0.018 kg of the packaging

**1 kg biogenic carbon is equivalent to 44/12 kg CO_2.*

4 LCA: Results

Table 3: Selected phases of the LCA

SYSTEM BOUNDARY																
PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARYS
Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
The modules of the product lifecycle, which are included in EPD are marked by "X"																

4.1 Indicators of environmental impacts

According to the standard EN 15804:2012+A2:2019, the environmental impacts are presented with seven indicators (Table 4).

Table 4: Abbreviations and units of indicators of environmental impacts

Indicators of environmental impacts	Abbreviation	Unit
global warming potential-total	GWP-total	kg CO_2 equiv
global warming potential-fossil fuels	GWP-fossil	kg CO_2 equiv
global warming potential-biogenic	GWP-biogenic	kg CO_2 equiv
global warming potential-land use and land use change	GWP-luluc	kg CO_2 equiv
ozone depletion	ODP	kg CFC 11 equiv
acidification of soil and water	AP	kg mol H^+ equiv
eutrophication aquatic freshwater	EP-freshwater	kg PO_4 equiv
eutrophication aquatic marine	EP-marine	kg N equiv
eutrophication terrestrial	EP-terrestrial	mol N equiv
photochemical ozone formation	POCP	kg NMVOC equiv
depletion of abiotic resources - minerals and metals	APD-minerals&metals	kg Sb equiv
depletion of abiotic resources - fossil fuels	APD-fossil	MJ, net calorific value
water use	WDP	m^3 world equiv deprived

The environmental impact indicators for the product are shown in Table 5 and Table 6:

Table 5: Environmental impacts per 1m^2 of FIBRANxps, taking into account scenario with landfilling of waste clippings and the product after dismantling from the building

	Module	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
GWP-total	kg CO2 eq.	2,58E+00	1,80E-01	7,25E-03	0,00E+00	0,00E+00	2,08E-02	0,00E+00	6,64E-02	-3,81E-04	2,85E+00
GWP-fossil	kg CO2 eq.	2,59E+00	1,79E-01	6,87E-03	0,00E+00	0,00E+00	2,06E-02	0,00E+00	6,70E-02	-3,80E-04	2,86E+00
GWP-biogenic	kg CO2 eq.	-1,83E-02	-2,13E-04	3,58E-04	0,00E+00	0,00E+00	-2,50E-05	0,00E+00	-7,00E-04	-6,46E-08	-1,89E-02
GWP-luluc	kg CO2 eq.	1,31E-03	1,45E-03	1,19E-05	0,00E+00	0,00E+00	1,68E-04	0,00E+00	5,61E-05	-8,84E-09	2,99E-03
ODP	kg CFC 11 eq.	7,49E-09	3,50E-17	2,36E-12	0,00E+00	0,00E+00	4,04E-18	0,00E+00	1,62E-16	-1,70E-16	7,49E-09
AP	mol H+ eq.	6,52E-03	7,08E-04	1,05E-05	0,00E+00	0,00E+00	7,88E-05	0,00E+00	2,01E-04	-1,84E-06	7,51E-03
EP-freshwater	kg PO4 eq.	4,91E-06	5,27E-07	2,60E-07	0,00E+00	0,00E+00	6,09E-08	0,00E+00	1,24E-05	-1,26E-09	1,82E-05
EP-marine	kg N eq.	1,39E-03	3,33E-04	3,60E-06	0,00E+00	0,00E+00	3,70E-05	0,00E+00	4,55E-05	-2,72E-07	1,81E-03
EP-terrestrial	mol N eq.	1,51E-02	3,71E-03	4,02E-05	0,00E+00	0,00E+00	4,12E-04	0,00E+00	5,00E-04	-2,95E-06	1,97E-02
POCP	kg NMVOC eq.	5,05E-03	6,41E-04	8,68E-06	0,00E+00	0,00E+00	7,14E-05	0,00E+00	1,45E-04	-9,47E-07	5,92E-03
ADP-mirerals&metals	kg Sb eq.	4,97E-07	1,57E-08	4,20E-10	0,00E+00	0,00E+00	1,81E-09	0,00E+00	4,62E-09	-3,16E-11	5,19E-07
ADP-fossil	MJ, net calorific value	7,87E+01	2,36E+00	7,21E-02	0,00E+00	0,00E+00	2,73E-01	0,00E+00	9,81E-01	-1,20E-02	8,24E+01
WDP	m3 world eq. deprived	4,55E-01	1,65E-03	3,11E-04	0,00E+00	0,00E+00	1,90E-04	0,00E+00	-8,25E-04	-2,51E-04	4,56E-01

Table 6: Environmental impacts per 1m² of FIBRANxps, taking into account scenario with incineration of waste clippings and the product after dismantling from the building. Heat recovery from waste incineration is evaluated in module D

	Module	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
GWP-total	kg CO2 eq.	2,58E+00	1,80E-01	7,08E-02	0,00E+00	0,00E+00	4,15E-02	3,16E+00	0,00E+00	-8,73E-01	5,15E+00
GWP-fossil	kg CO2 eq.	2,59E+00	1,79E-01	7,04E-02	0,00E+00	0,00E+00	4,13E-02	3,16E+00	0,00E+00	-8,71E-01	5,17E+00
GWP-biogenic	kg CO2 eq.	-1,83E-02	-2,13E-04	3,75E-04	0,00E+00	0,00E+00	-5,55E-05	9,72E-05	0,00E+00	-1,54E-03	-1,96E-02
GWP-luluc	kg CO2 eq.	1,31E-03	1,45E-03	1,11E-05	0,00E+00	0,00E+00	3,35E-04	1,56E-05	0,00E+00	-3,97E-05	3,08E-03
ODP	kg CFC 11 eq.	7,49E-09	3,50E-17	2,36E-12	0,00E+00	0,00E+00	8,09E-18	2,19E-16	0,00E+00	-3,14E-14	7,49E-09
AP	mol H+ eq.	6,52E-03	7,08E-04	1,21E-05	0,00E+00	0,00E+00	1,58E-04	2,78E-04	0,00E+00	-3,39E-04	7,33E-03
EP-freshwater	kg PO4 eq.	4,91E-06	5,27E-07	6,08E-09	0,00E+00	0,00E+00	1,22E-07	2,93E-08	0,00E+00	-6,83E-08	5,53E-06
EP-marine	kg N eq.	1,39E-03	3,33E-04	3,91E-06	0,00E+00	0,00E+00	7,39E-05	6,09E-05	0,00E+00	-1,23E-04	1,74E-03
EP-terrestrial	mol N eq.	1,51E-02	3,71E-03	5,67E-05	0,00E+00	0,00E+00	8,23E-04	1,30E-03	0,00E+00	-1,34E-03	1,96E-02
POCP	kg NMVOC eq.	5,05E-03	6,41E-04	9,37E-06	0,00E+00	0,00E+00	1,42E-04	1,80E-04	0,00E+00	-4,51E-04	5,57E-03
ADP-mirerals&metals	kg Sb eq.	4,97E-07	1,57E-08	3,93E-10	0,00E+00	0,00E+00	3,63E-09	3,31E-09	0,00E+00	-2,36E-07	2,84E-07
ADP-fossil	MJ, net calorific value	7,87E+01	2,36E+00	5,94E-02	0,00E+00	0,00E+00	5,46E-01	3,58E-01	0,00E+00	-1,45E+01	6,75E+01
WDP	m3 world eq. deprived	4,55E-01	1,65E-03	5,58E-03	0,00E+00	0,00E+00	3,80E-04	2,55E-01	0,00E+00	9,83E-03	7,28E-01

4.2 Indicators of raw material use

The results of the raw materials use are in accordance with the standard EN 15804:2012+A2:2019, shown with ten indicators (Table 7). Indicators include the use of renewable and non-renewable energy, the use of renewable and non-renewable material resources and the use of water.

Table 7: Abbreviations and units of indicators of raw material use

Indicators of raw material use	Abbreviation	Unit
use of renewable primary energy, excluding raw material	PERE	MJ, net calorific value
use of renewable primary energy, including raw material	PERM	MJ, net calorific value
sharing of renewable primary energy	PERT	MJ, net calorific value
use of non-renewable primary energy, excluding raw materials	PENRE	MJ, net calorific value
use of non-renewable primary energy sources, including raw materials	PENRM	MJ, net calorific value
sharing of primary non-renewable energy	PENRT	MJ, net calorific value
use of secondary materials	SM	kg
use of renewable secondary fuels	RSF	MJ, net calorific value
use of non-renewable secondary fuels	NRSF	MJ, net calorific value
use fresh drinking water	FW	m^3

The indicators of the use of raw materials for the product are shown in Table 8 and Table 9.

Table 8: Raw material use per 1m² of FIBRANxps, taking into account scenario with landfilling of waste clippings and the product after dismantling from the building

	Module	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
PERE	MJ	2,61E+00	1,36E-01	1,00E-02	0,00E+00	0,00E+00	1,57E-02	0,00E+00	7,10E-02	-5,03E-04	2,85E+00
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	2,61E+00	1,36E-01	1,00E-02	0,00E+00	0,00E+00	1,57E-02	0,00E+00	7,10E-02	-5,03E-04	2,85E+00
PENRE	MJ	7,86E+01	2,37E+00	7,22E-02	0,00E+00	0,00E+00	2,74E-01	0,00E+00	9,81E-01	-1,20E-02	8,23E+01
PENRM	MJ	9,25E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,25E-04
PENRT	MJ	7,86E+01	2,37E+00	7,22E-02	0,00E+00	0,00E+00	2,74E-01	0,00E+00	9,81E-01	-1,20E-02	8,23E+01
SM	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,27E-02	2,27E-02
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m3	1,28E-02	1,55E-04	1,63E-05	0,00E+00	0,00E+00	1,80E-05	0,00E+00	9,01E-06	-5,91E-06	1,30E-02

Table 9: Raw material use per 1m² of FIBRANxps, taking into account scenario with incineration of waste clippings and the product after dismantling from the building

	Module	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
PERE	MJ	2,61E+00	1,36E-01	1,00E-02	0,00E+00	0,00E+00	3,14E-02	7,07E-02	0,00E+00	-9,37E-02	2,77E+00
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	2,61E+00	1,36E-01	1,00E-02	0,00E+00	0,00E+00	3,14E-02	7,07E-02	0,00E+00	-9,37E-02	2,77E+00
PENRE	MJ	7,86E+01	2,37E+00	5,95E-02	0,00E+00	0,00E+00	5,48E-01	3,58E-01	0,00E+00	-1,45E+01	6,74E+01
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	7,86E+01	2,37E+00	5,95E-02	0,00E+00	0,00E+00	5,48E-01	3,58E-01	0,00E+00	-1,45E+01	6,74E+01
SM	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,27E-02	2,27E-02
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m3	1,28E-02	1,55E-04	1,39E-04	0,00E+00	0,00E+00	3,60E-05	5,99E-03	0,00E+00	1,46E-04	1,93E-02

4.3 Other indicators of environmental impacts and output flow indicators

According to the standard EN 15804:2012+A2:2019, the results for other environmental information (waste disposal data) are presented with three indicators, and the results of the output flows from the system are based on four indicators (Table 10).

Table 10: *Abbreviations and units of other indicators of environmental impacts and of indicators describing output flows*

Indicators for other environmental information	Abbreviation	Units
disposal of hazardous waste	HWD	kg
disposal of non-hazardous waste	NHWD	kg
disposal of radioactive waste	RWD	kg
Output flow indicators	Abbreviation	Units
constituents suitable for re-use	CRU	kg
constituents suitable for re-use	MFR	kg
materials for renewable energy	MER	kg
energy emitted	EE	MJ on the energy carrier

Indicators for other environmental information and output flow indicators for the product are shown in Table 11 and Table 12.

Table 11: Other indicators of environmental impacts and indicators describing output flows per 1m² of FIBRANxps, taking into account scenario with landfilling of waste clippings and the product after dismantling from the building

	Modul	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
HWD	kg	2,34E-06	1,25E-10	8,33E-12	0,00E+00	0,00E+00	1,44E-11	0,00E+00	1,76E-10	-1,40E-09	2,34E-06
NHWD	kg	9,53E-03	3,72E-04	1,92E-02	0,00E+00	0,00E+00	4,29E-05	0,00E+00	9,35E-01	-1,37E-07	9,64E-01
RWD	kg	1,89E-03	4,30E-06	6,89E-06	0,00E+00	0,00E+00	4,97E-07	0,00E+00	1,14E-05	-6,08E-08	1,91E-03
CRU	kg	6,51E-03	0,00E+00	3,63E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,88E-03
MFR	kg	4,79E-03	0,00E+00	1,79E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,27E-02
MER	kg	1,30E-03	0,00E+00	2,71E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,57E-03
EE	MJ	2,90E-02	0,00E+00	2,44E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,14E-02

Table 12: Other indicators of environmental impacts and indicators describing output flows per 1m² of FIBRANxps, taking into account scenario with incineration of waste clippings and the product after dismantling from the building

	Modul	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
HWD	kg	2,34E-06	1,25E-10	6,03E-12	0,00E+00	0,00E+00	2,89E-11	6,38E-11	0,00E+00	-4,35E-09	2,34E-06
NHWD	kg	9,53E-03	3,72E-04	2,57E-04	0,00E+00	0,00E+00	8,60E-05	1,14E-02	0,00E+00	-2,25E-03	1,94E-02
RWD	kg	1,89E-03	4,30E-06	7,07E-06	0,00E+00	0,00E+00	9,90E-07	2,04E-05	0,00E+00	-1,93E-05	1,90E-03
CRU	kg	6,51E-03	0,00E+00	3,63E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,88E-03
MFR	kg	4,79E-03	0,00E+00	1,79E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,27E-02
MER	kg	1,30E-03	0,00E+00	1,95E-02	0,00E+00	0,00E+00	0,00E+00	9,36E-01	0,00E+00	0,00E+00	9,57E-01
EE	MJ	2,90E-02	0,00E+00	4,59E-01	0,00E+00	0,00E+00	0,00E+00	2,22E+01	0,00E+00	0,00E+00	2,27E+01

4.4 The indicators to describe the additional environmental impacts

According to the standard EN 15804:2012+A2:2019, the results for additional environmental impacts are presented with six indicators (Table 13). Results for the product are shown in Table 14 and Table 15.

Table 13: *Abbreviations and units of additional environmental impact indicators*

Additional environmental impact indicators	Abbreviation	Units
particulate matter emissions	PM	disease incidence
ionizing radiation, human health	IRP	kBq U 235 eq.
eco-toxicity (freshwater)	ETP-fw	CTUe
human toxicity, cancer effects	HTP-c	CTUh
human toxicity, non-cancer effects	HTP-nc	CTUh
land use related impacts/soil quality	SWP	dimensionless

Table 14: Additional environmental impact indicators per 1m² of FIBRANxps, taking into account scenario with landfilling of waste clippings and the product after dismantling from the building

	Modul	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
PM	disease incidents	4,54E-08	3,92E-09	7,53E-11	0,00E+00	0,00E+00	4,29E-10	0,00E+00	1,97E-09	-1,68E-11	5,18E-08
IRP	kBq U235 eq.	1,40E-01	6,29E-04	4,66E-04	0,00E+00	0,00E+00	7,26E-05	0,00E+00	1,63E-03	-5,92E-06	1,42E-01
ETP-fw	CTUe	4,38E+01	1,75E+00	4,42E-02	0,00E+00	0,00E+00	2,03E-01	0,00E+00	9,25E-01	-7,19E-04	4,67E+01
HTP-c	CTUh	4,15E-10	3,55E-11	1,41E-12	0,00E+00	0,00E+00	4,09E-12	0,00E+00	4,16E-11	-2,61E-14	4,98E-10
HTP-nc	CTUh	1,64E-08	2,15E-09	9,94E-11	0,00E+00	0,00E+00	2,44E-10	0,00E+00	3,49E-09	-9,38E-13	2,24E-08
SQP	Pt	1,57E+00	8,12E-01	1,09E-02	0,00E+00	0,00E+00	9,35E-02	0,00E+00	6,64E-02	-4,75E-05	2,55E+00

Table 15: Additional environmental impact indicators per 1m² of FIBRANxps, taking into account scenario with incineration of waste clippings and the product after dismantling from the building

	Modul	A1-A3	A4	A5	B	C1	C2	C3	C4	D	Total
Abbrevation	**Unit**										
PM	disease incidents	4,54E-08	3,92E-09	6,83E-11	0,00E+00	0,00E+00	8,57E-10	1,63E-09	0,00E+00	-3,48E-09	4,84E-08
IRP	kBq U235 eq.	1,40E-01	6,29E-04	4,99E-04	0,00E+00	0,00E+00	1,45E-04	3,23E-03	0,00E+00	-3,02E-03	1,41E-01
ETP-fw	CTUe	4,38E+01	1,75E+00	2,85E-02	0,00E+00	0,00E+00	4,05E-01	1,61E-01	0,00E+00	-1,81E-01	4,59E+01
HTP-c	CTUh	4,15E-10	3,55E-11	9,09E-13	0,00E+00	0,00E+00	8,19E-12	1,73E-11	0,00E+00	-3,96E-10	8,09E-11
HTP-nc	CTUh	1,64E-08	2,15E-09	3,92E-11	0,00E+00	0,00E+00	4,88E-10	5,59E-10	0,00E+00	-4,76E-09	1,49E-08
SQP	Pt	1,57E+00	8,12E-01	1,16E-02	0,00E+00	0,00E+00	1,88E-01	9,99E-02	0,00E+00	-6,92E-02	2,61E+00

4.5 Impacts for different thickness and density of FIBRANxps

This EPD covers ten FIBRANxps products, which differ in densities and thickness. The range of density is between 25 and 47 kg/m^3 and the range of thickness is between 10 mm and 200 mm. The impacts listed in the tables above concern the product with λ in the range of 0.032-0.036 W/mK, thickness 30 mm and density 32 kg/m^3. To determine the impacts for products with different density and thickness, a conversion factor (A) shall be multiplied with each impact category value. The conversion factor (A) is calculated by:

$$A = \frac{\rho * S}{0.9}$$

Where: ρ = density of the product [kg/m^3] and S = product thickness [m]

5 Interpretation of results

Scenario with landfilling of waste clippings and the product after dismantling from the building

The product stage (i.e. modules A1-A3) contributes the most to the impact categories in life cycle of the FIBRANxps, the exceptions are impact on eutrophication - aquatic freshwater (EP-freshwater) and impact on global warming - land use and land use change (GWP-luluc) (Figure 2). The product stage contributes 90.4% of the total environmental impact in terms of global warming potential - total (GWP-total), 99.8% of the total environmental impact in terms of ozone layer depletion (ODP), 86.7% of the total environmental impact in terms of acidification (AP), 76.9% of the total environmental impact in terms of eutrophication of aquatic marine (EP-marine), 76.4% of the total environmental impact in terms of eutrophication terrestrial (EP-terrestrial), 85.4% of the total environmental impact in terms of photochemical ozone formation (POCP), 95.5% of

the total environmental impact in terms of depletion of abiotic resources - minerals and metals (APD-minerals&metals) and depletion of abiotic resources - fossil fuels (ADP-fossil) and 99.8% of the total environmental impact in terms of water use (WD).

In case of impact on eutrophication - aquatic freshwater (EP-freshwater), the dominating process is disposal of the product (the module C4 as a part of end-of-life stage), contributing 68.3% of the total impact. The product stage contributes 27% of the total environmental impact in terms of EP-freshwater. In case of impact on global warming - land use and land use change (GWP-luluc), transport to the building site contributes 48.6% of the total impact and product stage 43.5%.

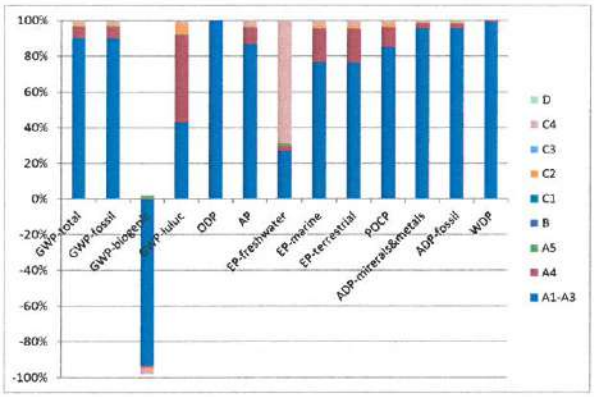

Figure 2: The relative contributions of different life cycle stages to the environmental impact of FIBRANxps. The results take into account scenario with landfilling of waste clippings and the product at the end-of-life stage

Scenario with incineration of waste clippings and the product after dismantling from the building

Taking into account scenario, which considers incineration of waste polystyrene clippings and the product at the end-of-life stage, the results are as follows (Figure 3).

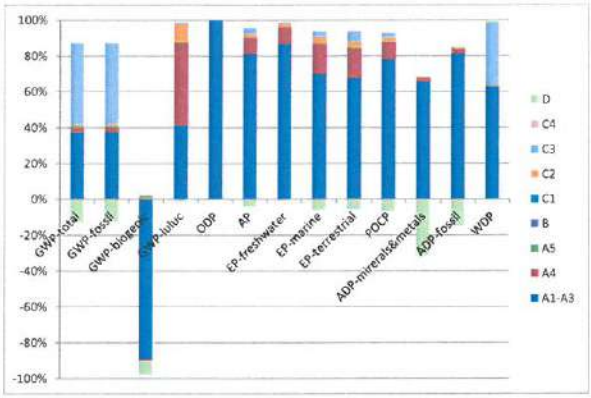

Figure 3: The relative contributions of different life cycle stages to the environmental impact of FIBRANxps. The results take into account scenario with incineration of waste clippings and the product at the end-of-life stage

The product stage (i.e. modules A1-A3) represents 37.3% in terms of GWP-total, 99.97% in terms of ODP, 81.3% in terms of AP, 86.7% in terms of EP-freshwater, 70.1% in terms of EP-marine, 67.6% in terms of EP-terrestrial, 78.0% in terms of POCP, 65.7% in terms of ADP-minerals&metals, 81.5% in terms of ADP-fossil and 64.3% in terms of WDP, taking into account life cycle of FIBRANxps.

Waste processing for energy recovery (i.e. module C3 as apart of end-of-life stage) contributes the most in terms of GWP-total (45.8%). It contributes significantly also in terms of WDP (36.0%).

Transport to the building site (i.e. module A4) yields relatively important contributions in terms of EP-marine (16.8%), EP-terrestrial (16.6%), EP-freshwater (9.3%), POCP (9.9%) and AP (8.8%), taking into account life cycle of FIBRANxps panel.

Potential environmental benefits beyond the product system boundary stage (i.e. module D) are quite significant in the scenario, which considers incineration of waste polystyrene clippings and the product at the end-of-life stage. For example, the benefits beyond the product system boundary stage contribute 31.3% to the ADP-minerals&metals, 15% to the ADP-fossil and 12.7% to the GWP-total.

Contributors analysis

Polystyrene is the raw material, which contributes the most to the environmental impacts in life cycle of FIBRANxps (Figure 4).

Polystyrene represents 74.7% in terms of total parameter value of global warming (i.e. GWP-total). Energy requirements, related with electricity production, represent further 13.6% in terms of total parameter value. The other raw, ancillary and packaging materials and other processes represent minor contributions, less than 2.5% each.

In case of impact on ODP, polystyrene represents 96.2% of total ODP value. Contribution of other materials and of energy resources is minor.

Also EP-terrestrial and EP-marine are mainly caused by polystyrene (77%), followed by electricity requirements in the process of manufacturing of FIBRANxps and by the transport (delivery of raw material and internal transport in the factory), each contributing around 6-8% to EP-terrestrial and EP-marine. In case of EP-freshwater, polystyrene contributes 66.6% of the impact, followed by electricity (9.5%).

Acidification (AP) is mainly caused by polystyrene (82.9%), followed by electricity requirements in the process of manufacturing of FIBRANxps (5.1%) and delivery of raw materials including internal transport in the factory (2.9%).

POCP is dominated by polystyrene (79.9%). Contribution of electricity required in the process of manufacturing of FIBRANxps is 5.5% to total impact on POCP and contribution of transport is 3.4%.

ADP-m&m is dominated by polystyrene, which contributes 73.8% of total impact on this parameter value. Electricity requirements in the process of manufacturing of FIBRANxps contribute 11.3%. ADP-fossil is also dominated by polystyrene (80.6% in terms of total parameter value).

In terms of water scarcity (i.e. WDP), polystyrene is again the biggest contributor (86.5% of the total parameter value), followed by colour and water requirements in the process of manufacturing of FIBRANxps (each around 1% of the total parameter value).

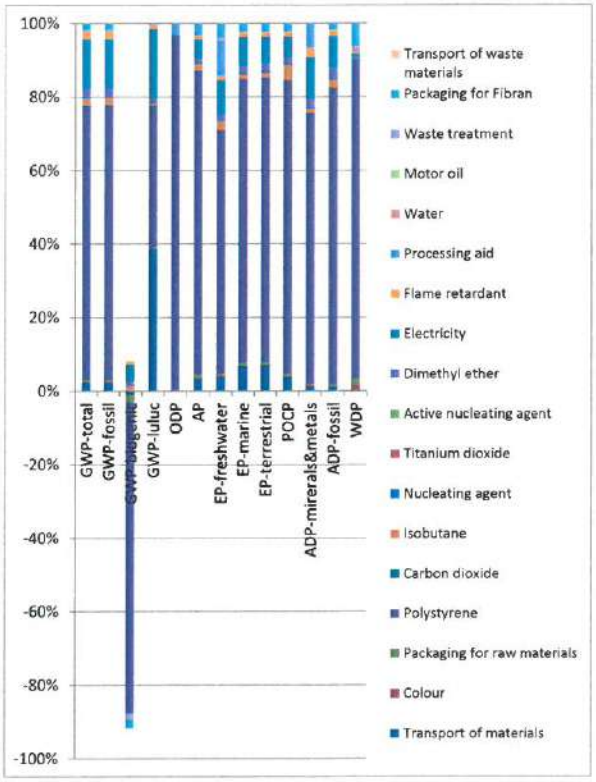

Figure 4: Contributors analysis for product stage of FIBRANxps

6 Additional information

Additional scenarios are possible regarding end-of-life stage. These scenarios were not evaluated in this EPD by means of LCA.

FIBRANxps, which has previously been used on flat roofs or when applied underneath a foundation slabs, can be reused as insulation elsewhere.

After the demolition of the entire building, FIBRANxps can be recycled to polystyrene granulate. The solvent-based purification process is

used to separate polymers from legislated additives. The bromine in the flame retardant is recovered by the bromine recovery unit and re-used to produce new polymeric flame retardants to be applied in insulation products made from the recyclate loop-polystyrene. Granulate, which is obtained from the recycling process, retains all the properties for remanufacturing of new FIBRANxps material. The recycling plant is located in Terneuzen (the Netherlands). The plant has a capacity to recycle 3,300 tons per year of polystyrene-foam demolition waste. The plant will produce approximately 3,000 tons of loop-PS recyclate to be used for the production of new insulation material. The recycling technology is described on https://polystyreneloop.eu/.

Insulation is a material that requires no extra utilities to operate over its life span. Insulation of a building causes reduction in the energy burden associated with heating and cooling of a building.

7 References

1. GaBi (version 10.0) was applied to conduct LCA
2. EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
3. EN ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework (EN ISO 14040:2006)
4. EN ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines (EN ISO 14044:2006)
5. EN ISO 14025:2010 Environmental labels and declarations - Type III environmental
6. Product Category Rules for Building-Related Products and Services - Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2019, version 1.0. Institut Bauen und Umwelt e.V.
7. Product Category Rules (PCR) Part B: Requirements on the EPD for Insulating materials made of foam plastics. Institut Bauen und Umwelt e.V.

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The data specified in the EPD are calculated on the basis of the data provided by the manufacturer. In the event that the manufacturer's information is incorrect, calculations do not apply.