ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	EXIBA - European Extruded Polystyrene Insulation Board Association
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-EXI-20260134-IBH1-EN
Issue date	01.04.2026
Valid to	31.03.2031

Extruded Polystyrene (XPS) Foam Insulation with non-halogenated blowing agent

EXIBA

Institut Bauen und Umwelt e.V.

ECO PLATFORM EPD VERIFIED

www.ibu-epd.com | https://epd-online.com

1. General Information

EXIBA

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-EXI-20260134-IBH1-EN

This declaration is based on the product category rules:

Insulating materials made of foam plastics, 01.08.2021
(PCR checked and approved by the SVR)

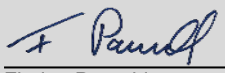
Issue date

01.04.2026

Valid to

31.03.2031

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)



Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

Extruded Polystyrene (XPS) Foam Insulation with non-halogenated blowing agent

Owner of the declaration

EXIBA - European Extruded Polystyrene Insulation Board Association
Rue Belliard 40, box 16
B-1040 Brussels
Belgium

Declared product / declared unit

Extruded polystyrene (XPS) foam insulation boards with non-halogenated blowing agent produced by the members of the European Extruded Polystyrene Insulation Board Association (EXIBA).
The EPD applies to 1 m^3 of XPS board with an average density of 32 kg/m^3.

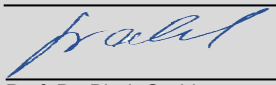
Scope:

The companies contributing to the data collection produce about 85% of the extruded polystyrene foam boards produced with non-halogenated blowing agent sold by the members of the EXIBA association in Europe. The data have been provided by 19 factories out of 7 companies (Austrotherm, BACHL, BASF, Fibran, JACKON Insulation, Ravago Building Solutions and URSA). Data refer to production for the year 2023.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally



Prof. Dr. Birgit Grahl,
(Independent verifier)

2. Product

2.1 Product description/Product definition

Extruded polystyrene foam (XPS) is a thermoplastic insulation foam produced according to *EN 13164 Building insulation, EN 14307 Equipment insulation, EN 14934 Civil engineering* and available in board shape with a density range from 20 to 50 kg/m3.
The boards can be delivered in various compressive Strength values from 150 to 700 kPa. To meet the needs of various applications, the boards are produced with different surfaces: with the extrusion skin, planed, grooved or with thermal embossing. XPS boards are supplied with different edge treatments such as butt edge, ship lap and tongue and groove.
The EPD is related to unfaced XPS products only; Heat lamination of several XPS layers is included. Additional product treatment is not considered.
The declared product reflects the European average of the association members. For the placing on the market of the product in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) Regulation (EU) No. 305/2011 (CPR) applies.
The product needs a declaration of performance taking into consideration one of the three EN
XPS standards (*EN 13164 Building insulation, EN 14307 Equipment insulation, EN 14934 Civil engineering*). For the application and use the respective national provisions apply.

2.2 Application

The variety of the performance properties of XPS thermal insulation foams make them suitable for use in a large number of applications such as: perimeter insulation, perimeter under foundation, insulation with water contact (see 4.2), inverted insulation for terrace roofs, insulation of pitched roofs, floor insulation including insulation of highly loaded industrial floors, insulation of thermal bridges for exterior walls, ETICS, insulation of cavity walls, agricultural building ceiling insulation, prefabricated elements e.g. building sandwich panels, insulation for building equipment and industrial installations (pipe sections, etc…) as well as a structural element for civil engineering.

2.3 Technical Data

Acoustic properties are not relevant for XPS. For fire performance, these products, except in Scandinavia achieve the fire classification Euroclass E according to *EN 13501-1*.

Physical properties data

Name	Value	Unit
Gross density	20 - 50	kg/m^3
Calculation value for thermal conductivity acc. to EN 12667 and EN 13164 Annex C	0.03 - 0.04	W/(mK)
Water vapour diffusion resistance factor acc. to EN 12086	50 - 250	-
Water absorption after diffusion acc. to EN 12088	3 - 5	Vol.-%
Deformation under compressive load and temperature acc. to EN 1605	≤ 5	%
Compressive stress or strength at 10% deflection acc. to EN 826	0.15 - 0.70	N/mm²
Compressive modulus of elasticity acc. to EN 826	10 - 40	N/mm²
Tensile strength perpendicular to faces acc. to EN 1607	0.1 - 0.4	N/mm²
Compressive creep/long-term comppressive strength acc. to EN 1606	< 0.25	N/mm²
Freeze-thaw resistance acc. to EN 12091	≤ 2	Vol.-%
Dimensional stability acc. to EN 1604	≤ 5	%

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *EN 13164:2012+A1:2015 - Thermal Insulation products for buildings, EN 14307:2015 Thermal Insulation products for building equipment and industrial installations,* and *EN 14934:2007 Thermal insulation and light weight fill products for civil engineering applications*.

2.4 Delivery status

Length: 1000-3000 mm; Width: 600-1200 mm;
Thickness: 20-200 mm (400 mm multilayer product).

2.5 Base materials/Ancillary materials

Name	Value	Unit
Polystyrene (GPPS)	53 - 89	%
recycled PS (rGPPS)	0 - 41	%
Blowing agents	4 - 9	%
Flame retardant	0 - 4	%
Additives (e.g. pigments)	< 1.5	%

The brominated flame retardant is used to enable the foam to meet fire performance standards. Other additives are used, e.g. color pigments and processing aids in minor quantities.
Polystyrene (GPPS) is produced from oil and gas therefore, it is linked to the availability of these raw materials.
Information that the product does not contain substances listed in the Candidate List of substances of very high concern (*REACH* Regulation) exceeding 0.1 %.
This product contains substances listed in the candidate list (date: 21.01.2025) exceeding 0.1 percentage by mass: no
This product contains other Carcinogenic, Mutagenic, Reptrotoxic (CMR) substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: no
Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No.528/2012): no

2.6 Manufacture

XPS is produced by a continuous extrusion process using electricity as the main power source: polystyrene granules are melted in an extruder and a blowing agent is injected into the extruder under high pressure.
The drop in pressure at the exit die causes the polystyrene to foam into a board with a homogeneous and closed-cell structure.
Then the boards' edges are trimmed, and the product is cut to dimensions. The smooth foam skin resulting from the extrusion process remains on the boards or is removed mechanically for particular board types to achieve better adhesive strength in combination with e.g. concrete, mortar, or construction adhesives. Some boards receive special surface patterns or grooves.
Most of XPS foams off-grade material or scrap from production are ground and extruded in a separate recycling line, the resulting polystyrene granules are then used in the production process of XPS.
A large number of the manufacturing plants are certified according to *ISO 9001*.

2.7 Environment and health during manufacturing

No further health protection measures beyond the regulated measures for manufacturing firms are necessary during all production steps. A large number of the manufacturing plants are certified according to *ISO 14001* or/and *OCS*.

2.8 Product processing/Installation

Handling recommendations for XPS foams can be found in product and application literature, brochures and data sheets provided directly by suppliers or available from the internet.
There are no special required instructions regarding personal precautions and environmental protection during the product handling and installation.
The XPS cut off can be mechanical recycled and reinserting into the production of new XPS products.

2.9 Packaging

The boards are stacked in bundles, wrapped in 4 to 6 sided polyethylene film and palletised.
The polyethylene-based packaging film is recyclable and actually recycled in those countries having a return system.

2.10 Condition of use

Water pick-up by capillarity does generally not occur with XPS foams due to their closed-cell structure. The thermal insulation performance of XPS is practically not affected by exposure to water or water vapour.
Usually, maintenance will not be required if the XPS boards are installed according to handling installation requirements (see: Installation description, see chapter 2.8).

2.11 Environment and health during use

XPS product is in most applications not in direct contact with the environment nor with the indoor air. There is no significant release of substances from the product as installed during its service life, as confirmed by the best possible ratings obtained in existing Volatile Organic Compound (VOC) emission schemes; e. g. Committee for Health-related Evaluation of Building Product *AgBB* French labelling (see 7.1 VOC).

2.12 Reference service life

The durability of XPS foam is normally at least as long as the lifetime of the building in which it is used. This is explained by the superior mechanical and water resistance properties of these products.
Description of the influences on the ageing of the product when applied in accordance with the rules of technology.

2.13 Extraordinary effects

Fire

XPS products, except in Scandinavia, achieve the fire classification Euroclass E according to *EN 13501-1*. In Scandinavia XPS products achieve the fire classification Euroclass F according to *EN 13501-1*.

Fire performance

Name	Value
Building material class	E

If the contact with the external flame stops, neither further burning nor smouldering can be observed. Ignition of the foam can only be observed after longer flame exposures.

Water

Water pick-up by capillarity does generally not occur with XPS foams due to their closed-cell structure. The thermal insulation performance of XPS is practically not affected by exposure to water or water vapour.

Mechanical destruction

Not relevant for XPS products that have superior mechanical properties.

2.14 Re-use phase

In order to maximize the potential to re-use XPS boards, one must avoid that they are damaged or glued. Instead, separation layers between the insulation and the concrete should be used, or mechanical fixation should be applied.
In the inverted roof application, XPS boards are installed loose-laid and therefore can be easily removed and reused on another roof.
For existing conventional flat roofs, the XPS boards can stay in place when, for example, the existing roof construction is thermally upgraded as a plus-roof.
Recovered XPS boards from mechanically fixed applications can be reused for the insulation of basement walls and foundations.
XPS can be mechanically and chemically recycled.
Due to the high calorific value of polystyrene, the energy embedded in XPS boards can be recovered in municipal waste incinerators equipped with energy recovery units for steam and electricity generation and district heating.

2.15 Disposal

XPS boards that cannot be easily retrieved from the building are usually landfilled. The material is assigned to the waste category: 17 06 04 insulation materials other than those mentioned in 17 06 01 (insulation materials containing asbestos) and 17 06 03 (other insulation materials consisting of or containing dangerous substances) *European List of Waste*.

2.16 Further information

Additional information can be found at the following Webpages:
www.austrotherm.com
www.bachl.de
https://germany.ediltec.com/de
www.exiba.org
www.fibran.com
www.xps-spezialdaemmstoff.de
www.jackon-insulation.com
www.ravatherm.com
www.soprema.com
www.ursa.com

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is 1 m^3 of XPS board. The declared product reflects the European average of the association members weighted by market share.

Declared unit

Name	Value	Unit
Gross density	32	kg/m^3
Declared unit	1	m^3

The weighted average for the declared product is calculated in relation to the production volume shares of 19 factories out of 7 participating companies, manufactured at the respective production locations across Europe.

The production process is almost identical for all products. With regard to the variability of the LCA results, fluctuations can occur due to differences e.g. in product compositions, densities, recycled content, and energy mix. A single score evaluation based on EN15804+A2 (EF 3.1) normalization is conducted to assess the range in variation of their corresponding environmental impacts relative to the weighted average. The range varies between +40 % and –46 % relative to the declared weighted average results. The LCA values are estimated to be robust.

For XPS products with densities or thickness different from the reference density of 32 kg/m^3, the environmental impacts may be calculated using the following equation:

$$I_{adap} = I_{ref} \times \frac{\rho_{adap}}{\rho_{ref}} \times \frac{d_{adap}}{d_{ref}}$$

I_{adap} – adapted LCIA indicator or LCI parameter
I_{ref} – LCIA indicator or LCI parameter for reference density of 32 kg/m^3
ρ_{adap} – adapted density
ρ_{ref} – reference density 32 kg/m^3
d_{adap} – adapted board thickness
d_{ref} – thickness of reference board (100 mm)

Exceptions are categories, which are not mainly driven by raw material consumption respective
mass. That applies to photochemical ozone creation potential (POCP) and ozone depletion potential (ODP). These two categories do not correlate with the mass of the product and cannot be evaluated that way.

3.2 System boundary

Type of EPD according to *EN15804*: Cradle to gate with options, modules C1–C4, and module D. The following modules are declared: A1–A3, C, D, and additional modules: A4 and A5.

Modules A1-A3
The product stage includes:

- Raw material supply (A1) comprises the production of virgin and recycled polystyrene granulate, blowing and co-blowing agents as well as flame retardants.
- The transport to the manufacturer is considered in module A2.
- The manufacturing of the XPS board (A3) comprises the provision of all materials, products and energy, as well as waste processing up to the end-of-waste state, including packaging of the product and the internal recycling process of the foam scrap.

Modules A4-A5
The construction process stage includes:

- Transport to the construction site (A4)
- Treatment of packaging material (A5) with benefit for potential avoided burdens due to energy substitution of electricity and thermal energy generation are declared in module D (D, D/1, and D/2).
- Installation efforts/losses such as cut-offs have not been accounted for in this module, since such losses highly depend on the specific building geometry and other site-specific factors. If relevant, cuttings can be estimated using the declared values for the production stage (e.g. 5 % wastage: multiplication of the life cycle assessment values by a factor of 0.05).

Modules C1-C4 and D
The end-of-life stage includes:

- Manual dismantling (C1)
- Transport to EoL (C2)
- Waste processing & disposal with three scenarios: Base scenario (C3, C4, D): 100 % incineration; Scenario 1 (C3/1, C4/1, D/1): 100 % landfill; Scenario 2 (C3/2, C4/2, D/2): 100 % recycling
- Reuse, recovery or recycling potential beyond system boundary (D)

3.3 Estimates and assumptions

For electricity production, the following approach has been chosen following the requirements of *IBU Part A*: country-specific residual grid mixes (excluding renewable energy where guarantee of origin(s) is not available). Otherwise, the electricity of the relevant renewable sources (including guarantee of origin) was modelled according to the primary data provided by the participating members in Europe.

The GWP for the electricity mix balanced in modules A1-A3 ranges between 0.0019 - 0.24 kg CO_2-e/kWh.
The GWP for the gas mix balanced in modules A1-A3 ranges between 0.070 - 0.093 kg CO_2-e/MJ.

3.4 Cut-off criteria

In the assessment, all reported data, i.e. all raw materials used, utilised thermal energy, and electric power consumption, were incorporated and modelled using the best available LCI data. Production of capital equipment, facilities and infrastructure required for manufacture is outside the scope of this assessment.

3.5 Background data

The LCA model is created using the *Sphera LCA FE* Software system for life cycle engineering and the Managed LCA content (MLC), developed by Sphera Solutions Inc.
Background data is taken from the MLC databases, see https://lcadatabase.sphera.com/.

3.6 Data quality

The foreground data, mainly the raw materials and energy consumption during the
production process is measured or calculated data. Some exceptions related to production emissions (i.e. blowing agent emissions) were estimated based on literature when necessary. The primary data collection has been done thoroughly; all relevant flows are considered. All participating members provided data for the identified product specifications with similar production process steps for European production.

To ensure consistency, all primary data are collected with the same level of detail using tailored questionnaires, while all

background data are sourced from the Sphera LCA FE databases.

Cross-checks concerning the plausibility of mass and energy flows are carried out on the data received. Similar checks are made on the software model developed during the study.

The background data has been taken from the latest available Sphera LCA FE database CUP 2025.1. Most of the necessary life cycle inventories are available in the database.
All primary and secondary data are collected specific to the countries/regions under study. Where country/region specific data are unavailable, proxy data are used (country/region specific data). The overall geographical representativeness is considered to be good.

3.7 Period under review

The foreground data collected by the participating members refers to the year 2023 (annual average).

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Europe

3.9 Allocation

There are no co-products generated during the XPS production. The applied software model does not contain any allocation.

Post-industrial XPS waste, which does not get reused in the process, is sent to a waste incineration plant. All applied incineration processes are displayed via a partial stream consideration for the combustion process, according to the specific composition of the incinerated material. For the waste incineration plant an R1-value of >0.6 is assumed. Resulting electrical and thermal energy benefits are declared in module D.

Environmental burden of the incineration of the product in the EoL scenario is assigned to module C3; resulting benefits for thermal and electrical energy are declared in module D. Benefits are given according to European average data for electrical and thermal energy
generated from natural gas.

Information about allocation procedure of single datasets is documented in https://lcadatabase.sphera.com/.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account. The background database used is *Sphera LCA FE*, CUP 2025.1

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

No biogenic carbon is declared in the product.

Information on describing the biogenic carbon content at factory gate

Name	Value	Unit
Biogenic carbon content in product	-	kg C
Biogenic carbon content in accompanying packaging	0.00141	kg C

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

The following technical information is a basis for the declared modules or can be used for developing specific scenarios in the context of a building assessment if modules are not declared (MND).

The values refer to the declared unit of 1 m^3 XPS insulation foam board.

Transport to the building site (A4)

Name	Value	Unit
Litres of fuel	0.127	l/100km
Transport distance	100	km
Capacity utilisation (including empty runs)	53	%
Gross density of products transported	32	kg/m^3

Installation into the building (A5)

Name	Value	Unit
Polyethylene foil/stretch film (waste packaging sent to incineration)	0.522	kg
XPS bar/EPS beam (waste packaging sent to incineration)	0.0525	kg
Wooden pallets (waste packaging sent to incineration)	0.00332	kg

End of life (C1-C4)

For the End of Life stage, the following scenarios are considered:

- Base scenario (C2, C3, C4, D): 50 km transport via truck with product disposal via 100 % incineration, where any relevant benefits are to be declared in module D.
- Scenario 1 (C2/1, C3/1, C4/1, D/1): 50 km transport via truck with product disposal via 100 % landfill without any benefits in module D/1.
- Scenario 2 (C2/2, C3/2, C4/2, D/2): 1170 km transport via truck and 440 km via ship with disposal via 100 % product recycling. This scenario considers the external mechanical recycling of the product based on primary data collected by participating members from external recycling facilities in Europe. Potential benefits from avoided burdens due to material substitution are declared in module D/2.

Name	Value	Unit
Collected separately waste type (XPS)	32	kg
Energy recovery (Base scenario)	32	kg
Landfilling (Scenario 1)	32	kg
Recycling (Scenario 2)	32	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Module D includes the potential recovery and/or recycling

potentials, expressed as net impacts and potential benefits. Benefits for the product incineration EoL scenario and packaging EoL are calculated by inverting the flows of European datasets (consumption electricity grid mix; thermal energy from natural gas). A waste incineration plant with R1-value > 0.6 is assumed. Benefits for the recycling scenario are calculated by inverting the flow of a dataset representing the production of virgin polystyrene granulate.

5. LCA: Results

The following tables display the environmental relevant results according to *EN 15804* for 1 m^3 XPS board. The EoL Scenarios are declared as follows:

- Base scenario (C2, C3, C4, D): 100 % incineration
- Scenario 1 (C2/1, C3/1, C4/1, D/1): 100 % landfill
- Scenario 2 (C2/2, C3/2, C4/2, D/2): 100 % recycling

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	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**
X	X	X	X	X	MND	MND	MNR	MNR	MNR	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 m3 XPS board

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
GWP-total	kg CO_2 eq	9.82E+01	4.02E-01	1.82E+00	0	1.98E-01	1.98E-01	3.66E+00	1.08E+02	0	5.46E+00	0	9.73E-01	0	-3.91E+01	-8.18E-01	-7.11E+01
GWP-fossil	kg CO_2 eq	9.79E+01	3.96E-01	1.82E+00	0	1.95E-01	1.95E-01	3.61E+00	1.08E+02	0	5.41E+00	0	9.7E-01	0	-3.88E+01	-8.12E-01	-7.08E+01
GWP-biogenic	kg CO_2 eq	2.23E-01	2.02E-03	5.21E-03	0	9.92E-04	9.92E-04	1.82E-02	2.98E-03	0	3.81E-02	0	1.8E-07	0	-2.01E-01	-4.2E-03	-2.29E-01
GWP-luluc	kg CO_2 eq	5.65E-02	4.18E-03	1.56E-05	0	2.05E-03	2.05E-03	3.77E-02	9.7E-04	0	1.2E-02	0	2.66E-03	0	-5.35E-02	-1.12E-03	-1.54E-02
ODP	kg CFC11 eq	1.99E-10	6.74E-14	1.02E-13	0	3.31E-14	3.31E-14	6.11E-13	5.84E-12	0	8.31E-11	0	3.31E-12	0	-3.66E-10	-7.66E-12	-8.66E-11
AP	mol H^+ eq	1.76E-01	9.04E-04	1.81E-04	0	4.44E-04	4.44E-04	8.96E-03	9.6E-03	0	8.19E-03	0	5.78E-03	0	-4.59E-02	-9.6E-04	-1.17E-01
EP-freshwater	kg P eq	1.97E-04	1.1E-06	1.24E-08	0	5.38E-07	5.38E-07	9.87E-06	7.17E-07	0	8.27E-06	0	5.42E-04	0	-3.55E-05	-7.44E-07	-9.12E-05
EP-marine	kg N eq	5E-02	3.98E-04	3.92E-05	0	1.96E-04	1.96E-04	3.88E-03	2.17E-03	0	1.98E-03	0	1.25E-03	0	-1.33E-02	-2.78E-04	-3.16E-02
EP-terrestrial	mol N eq	5.42E-01	4.24E-03	8.58E-04	0	2.08E-03	2.08E-03	4.14E-02	4.55E-02	0	2.25E-02	0	1.37E-02	0	-1.48E-01	-3.1E-03	-3.44E-01
POCP	kg NMVOC eq	3.12E-01	8.23E-04	1.16E-04	0	4.04E-04	4.04E-04	8.23E-03	6.37E-03	0	4.94E-03	0	3.96E-03	0	-3.6E-02	-7.53E-04	-1.38E-01
ADPE	kg Sb eq	9.19E-06	2.7E-08	1.15E-09	0	1.33E-08	1.33E-08	2.44E-07	6.56E-08	0	7.62E-07	0	6.6E-08	0	-3.84E-06	-8.05E-08	-4.73E-06
ADPF	MJ	2.46E+03	5.21E+00	2.13E-01	0	2.56E+00	2.56E+00	4.73E+01	1.2E+01	0	7.69E+01	0	1.61E+01	0	-6.87E+02	-1.44E+01	-2.1E+03
WDP	m^3 world eq deprived	1.43E+01	1.86E-03	1.66E-01	0	9.12E-04	9.12E-04	1.68E-02	8.79E+00	0	1.09E+00	0	1.2E-01	0	-4.05E+00	-8.47E-02	-1.32E+01

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential)

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 m3 XPS board

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
PERE	MJ	1.12E+02	3.92E-01	1.09E-01	0	1.93E-01	1.93E-01	3.54E+00	3.35E+00	0	5.09E+01	0	2.68E+00	0	-2.24E+02	-4.69E+00	-5.2E+01
PERM	MJ	5.06E-02	0	-5.06E-02	0	0	0	0	0	0	0	0	0	0	0	0	0
PERT	MJ	1.12E+02	3.92E-01	5.87E-02	0	1.93E-01	1.93E-01	3.54E+00	3.35E+00	0	5.09E+01	0	2.68E+00	0	-2.24E+02	-4.69E+00	-5.2E+01
PENRE	MJ	1.37E+03	5.21E+00	2.49E+01	0	2.56E+00	2.56E+00	4.73E+01	1.08E+03	1.06E+03	1.14E+03	0	1.61E+01	0	-6.87E+02	-1.44E+01	-2.1E+03
PENRM	MJ	1.09E+03	0	-2.47E+01	0	0	0	0	-1.06E+03	-1.06E+03	-1.06E+03	0	0	0	0	0	0
PENRT	MJ	2.46E+03	5.21E+00	2.13E-01	0	2.56E+00	2.56E+00	4.73E+01	1.2E+01	0	7.69E+01	0	1.61E+01	0	-6.87E+02	-1.44E+01	-2.1E+03
SM	kg	3.71E+00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.73E+01

RSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FW	m^3	4.01E-01	1.94E-04	3.89E-03	0	9.52E-05	9.52E-05	1.75E-03	2.06E-01	0	4.36E-02	0	3.51E-03	0	-1.74E-01	-3.65E-03	-3.28E-01

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2:
1 m3 XPS board

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
HWD	kg	7.78E-07	2.09E-10	1.17E-10	0	1.03E-10	1.03E-10	1.9E-09	6.66E-09	0	9.73E-08	0	3.6E-09	0	-4.34E-07	-9.09E-09	-1.48E-07
NHWD	kg	9.08E-01	7.27E-04	7.62E-03	0	3.57E-04	3.57E-04	6.58E-03	6.19E-01	0	6.45E-02	0	3.2E+01	0	-3.42E-01	-7.16E-03	-4.94E-01
RWD	kg	3.14E-02	9.82E-06	1.22E-05	0	4.83E-06	4.83E-06	8.9E-05	6.89E-04	0	1.17E-02	0	2.32E-04	0	-5.17E-02	-1.08E-03	-1.16E-02
CRU	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MFR	kg	6.48E-03	0	0	0	0	0	0	0	0	3.2E+01	0	0	0	0	0	0
MER	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EEE	MJ	0	0	3.82E+00	0	0	0	0	1.79E+02	0	0	0	0	0	0	0	0
EET	MJ	0	0	6.8E+00	0	0	0	0	3.19E+02	0	0	0	0	0	0	0	0

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional:
1 m3 XPS board

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
PM	Disease incidence	1.76E-06	7.24E-09	1.06E-09	0	3.56E-09	3.56E-09	8.44E-08	5.6E-08	0	6.74E-08	0	5.95E-08	0	-3.74E-07	-7.83E-09	-1.06E-06
IR	kBq U235 eq	4.75E+00	1.41E-03	1.96E-03	0	6.93E-04	6.93E-04	1.28E-02	1.1E-01	0	1.94E+00	0	3.11E-02	0	-8.53E+00	-1.79E-01	-1.84E+00
ETP-fw	CTUe	1.41E+03	6.77E+00	7.94E-02	0	3.32E+00	3.32E+00	6.13E+01	4.8E+00	0	1.27E+01	0	3.68E+01	0	-6.06E+01	-1.27E+00	-1.3E+03
HTP-c	CTUh	2.72E-08	9.13E-11	1.14E-11	0	4.49E-11	4.49E-11	8.28E-10	5.88E-10	0	1.21E-09	0	5.06E-10	0	-7.03E-09	-1.47E-10	-2.36E-08
HTP-nc	CTUh	5.13E-07	5.1E-09	5.59E-11	0	2.51E-09	2.51E-09	4.61E-08	3.11E-09	0	2.52E-08	0	8.99E-09	0	-1.16E-07	-2.43E-09	-3.59E-07
SQP	SQP	8.85E+01	2.3E+00	6.66E-02	0	1.13E+00	1.13E+00	2.07E+01	3.78E+00	0	2.98E+01	0	2.48E+00	0	-1.31E+02	-2.75E+00	-3.09E+01

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Disclaimer 1 – for the indicator “Potential Human exposure efficiency relative to U235”. This impact category deals mainly with the eventual impact of low-dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure or radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators “abiotic depletion potential for non-fossil resources”, “abiotic depletion potential for fossil resources”, “water (user) deprivation potential, deprivation-weighted water consumption”, “potential comparative toxic unit for ecosystems”, “potential comparative toxic unit for humans – cancerogenic”, “Potential comparative toxic unit for humans - not cancerogenic”, “potential soil quality index”. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

6. LCA: Interpretation

Overall, the environmental impact of the life cycle is mainly determined by the pre-chain of the raw materials in module A1 for all indicators. For some indicators e.g., Photochemical ozone formation, human health and Eutrophication, module A3 and module C4/1 show some influence.

The main driver of the LCA in most impact categories is Polystyrene (PS) production. Another important driver is the electricity consumption during XPS production.

In general, the transport, the production of blowing agents, flame retardants, and additives have lower relevance to the considered impact categories with a few exceptions.

In the Climate Change, biogenic indicator, some of the additives have shown relevant negative influence due to the biogenic carbon content in their upstream chains. Transport A2 have also shown some influence on the Climate Change, land use and land use change indicator. Similarly, in the resource use indicator (minerals and metals), pigments are dominating the contributions due to makeup of some of the colourants used. As for the Photochemical ozone formation, human health indicator, the production emissions has shown some relevant influence related to the release to some of the co-blowing

agents during production.

The EoL Base scenario (C3) – thermal treatment leads to significantly higher GWP contributions and benefits when compared to the remaining two EoL scenarios (recycling (C3/2) and landfill (C4/1)). Potential benefits in module D are based on the energy substitution from the incineration of the XPS foam product (C3) and packaging treatment (A5) where the latter is duplicated/contributing to modules D/1 and D/2.
To assess the range in variation of the environmental impacts across the 19 sites under study with respect to the declared average product, a single score evaluation based on EN15804+A2 (EF 3.1) normalization is conducted. The single score of each site is calculated based on the mapped MLC datasets to the corresponding material compositions and production processes.

The range in the environmental impact indicators varies between +40 % and –46 % relative to the declared weighted average results. For the GWP-total indicator, the range is between -/+ 28 % relative to the declared weighted average GWP-total result.

7. Requisite evidence

7.1 VOC Emissions

XPS products can be used indoor however, they are generally not exposed to the indoor air but covered by a finishing element or system.

XPS manufacturers regularly check the VOC emissions of their products and always meet the requirements of the Committee for Health-related Evaluation of Building Products/German Institute for Structural Engineering (AgBB) method.

The tested products all complied with the requirements of *AgBB* for use in the indoor environment.

The tested products also all achieved the A+ rating of the French VOC labelling scheme.

7.2 Leaching performance

EXIBA commissioned a study focusing on the release of substances from different XPS insulation boards due to contact with water.

To examine the possible leaching of substances, the horizontal dynamic surface leaching (HDSL) test according to *DIN CEN/TS 16637-2* was performed and the resulting eluates were analysed.

Only three substances were detected at concentrations above the limit of quantification in one or more XPS insulation boards: styrene, iso-butane and barium. There are German threshold values (GFS-values) for styrene (sum alkylbenzene 20 µg/L) and barium (340 µg/L). The measured concentrations were below these threshold values.

No brominated flame retardants were detected in all eluates in contact with XPS insulation boards.

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Sphera LCA FE
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