ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Owner of the declaration	**Industrieverband Hartschaum e.V., IVH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVH-20220129-CBG1-DE
Issue date	15/08/2022
Valid until	14/08/2027

EPS hard foam – white with low bulk density
preferentially for ETICS and interior insulation

Industrieverband Hartschaum e.V. (IVH)

Member of EUMEPS, the association of European Manufacturers of Expanded Polystyrene

Institut Bauen und Umwelt e.V.

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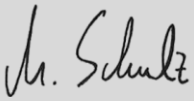
General information

Industrieverband Hartschaum e.V. (IVH)	EPS hard foam (bulk density 15 kg/m³)
Programme holder IBU – Institut Bauen und Umwelt e.V. Hegelplatz 1 D-10117 Berlin Germany	**Owner of the declaration** Industrieverband Hartschaum e.V., IVH Friedrichstrasse 95, Pb 152 D-10117 Berlin
Declaration number EPD-IVH-20220129-CBG1-DE	**Declared product/Declared unit** The declared unit is 1m³ of expanded polystyrene hard foam for heat and sound insulation. The average bulk density is 15 kg/m³.
This declaration is based on the following product category rules: Foam plastic insulation materials, 01.2019 (PCR tested and approved by the independent advisory board (SVR))	**Scope of application:** This EPD describes the EPS hard foam products for thermal and sound insulation with an average bulk density of 15 kg/m³. The participating member firms represent 90 volume percent of the total number of all IVH member firms in the year 2020.
Issue date 15/08/2022	The owner of the declaration is liable for the basic information and supporting evidence; any liability of the IBU in relation to manufacturer's information, LCA data and supporting evidence is excluded.
Valid until 14/08/2027	This EPD was compiled in accordance with the requirements of *EN 15804+A2*. This standard is referred to in simplified form as *EN 15804* in the following.
	Verification European standard *EN 15804* serves as the core PCR Independent verification of the declaration and statements in accordance with *ISO 14025:2011* ☐ internal ☒ external
 Dipl. Ing. Hans Peters (President of Institut Bauen und Umwelt e.V.)	
 Dr. Alexander Röder (Executive Director Institut Bauen und Umwelt e.V.)	 Matthias Schulz, Independent Verifier

Product

Product description/Product definition

This environmental product declaration (EPD) describes hard foam insulation products made from expanded polystyrene (EPS) provided by the IVH members. IVH is member of EUMEPS, the association for European Manufacturers of Expanded Polystyrene.

EPS products provided by the IVH members for the heat and sound insulation of buildings.

The insulation materials are factory-made in the form of boards or loose, thermal insulation filler material. This EPD describes the low-bulk density, EPS hard foam products for different fields of application such as façades, preferentially in thermal insulation composite systems (WDVS, ETICS, External Thermal Insulation Composite Systems).

EPS hard foam is a solid insulation material with a cellular structure which is fabricated from welded, expanded polystyrene or one of its co-polymers. It has a closed-cell, air-filled structure (98% air). EPS boards are rectangular, hard insulation products (cut, moulded or continuously foamed). The board edges can have a rebate edge or tongue and groove. As loose filler material, EPS is factory made in the form of air-filled beads (Ø approx. 6 mm). This environmental product declaration covers the homogeneous EPS insulant without material combination with composite boards or laminated insulation boards.

Essential, characteristic properties are thermal conductivity, bending resistance, and transverse tensile strength.

EU regulation no. 305/2011/ (CPR) applies for placing the product on the market in the EU/EFTA (with the

exception of Switzerland). The product requires a declaration of performance based on *DIN EN 13163:2012+A1:2015*, *Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification*, and the CE marking.
The respective national regulations apply to its use.

Application

The primary field of application for the products declared in this document is the **façade insulation with external thermal insulation composite systems (ETICS).**

The joint *Qualitätsrichtlinien für EPS in WDVS, 2020* define the properties of the EPS boards for thermal insulation composite systems declared herein.

Other applications for products under this environmental product declaration include, according to the application types pursuant to *DIN 4108-10*, table 1: WI, DI, WZ, DZ, WAP, WAB, and DES.

- **WI**: Interior wall insulation
- **DI**: Interior insulation of ceiling (bottom side) or roof, insulation under rafters/supporting structure, suspended ceiling, etc.
- **WZ**: Insulation of double walls, core insulation
- **DZ**: Insulation between rafters, double roof, non-walkable but accessible top floor ceilings
- **WAP**: Exterior, buried insulation of the wall; also for application case 'from below against outside air; WAP is not for embedding into the soil and for insulant boards in the external thermal insulation composite system (ETICS).
- **WAB**: Exterior wall insulation behind lining; also for application case 'from below against outside air'
- **DES**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements

Technical data

The following structural/technical data in as-delivered condition are relevant for the declared ETICS product.

Constructional data

Name	Value	Unit
Average bulk density	15	kg/m³
Design value thermal conductivity acc. to DIN 4108-4	0.04	W/(mK)
Thermal conductivity nominal value acc. to EN 12664	0.039	W/(mK)
Bending resistance acc. to EN 12089	>= 0.10	N/mm²
Shearing resistance acc. to EN 12090	>= 0.05	N/mm²
Shear module acc. to EN 12090	>= 1.0	N/mm²
Transverse tensile strength acc. to EN 1607	>= 0.10	N/mm²

The products' performance data meet the declaration of performance in relation to its main features in accordance with *DIN EN 13163:2012+A1:2015 Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification.*

Additional, voluntary information for the product are provided outside of the CE marking.

Base materials/Ancillary materials

The base polymer product for EPS hard foam is polystyrene (PS). It is fabricated by polymerisation of monomeric styrene using a variety of procedures.

The most used raw material production method is polymerisation in a styrene/water suspension, in which the foaming agent pentane is added near the end of the polymerisation process. The PS granulate thus produced is processed into foam in downstream physical processing steps.

The products covered by this declaration are furnished with the flame-retardant polymer-FR. The base material used for insulant production is supplied to the insulant manufacturer in the form of bead-shaped granulate and then physically formed/foamed and reworked.

Composition of expanded polystyrene EPS hard foam

Proportion in mass percent
Polystyrene granulate: 90-93 %
Polymer-FR: 1-5 %
Pentane (in relation to mass percent in the raw material): 5-6 %
Recycled material: 0-12 %

The pentane used for foaming is a C5 hydrocarbon. It is broken down during the manufacturing and storage process.

In the production of flame-protected polystyrene granulate, low amounts of a flame retardant are introduced during polymerisation. Polymer-FR is used as flame retardant for the products declared in this EPD. Manufacturers are required to provide evidence for the products. Polymer-FR is a brominated styrene-butadiene copolymer.

1) The product/at least one part product contains substances of the candidate list of the substances of Very High Concern (SVHC) (as of 17 January 2022) eligible for approval above 0.1 mass percent: **no**

2) The product or at least one part product contains further CMR Category 1A or 1B substances which are not on the candidate list in doses above 0.1 mass percent in at least one part product: **no**

3) Biocidal products were added to this building product or it was treated with biocidal products (is it therefore a processed product as provided for in the EU Biocide Product Directive no. 528/2012): **no**

Manufacture

The manufacture of EPS hard foam follows the process steps pre-foaming, interim storage, foam filling:

In the pre-foaming step, the bead-shaped granulate which holds the foaming agent is softened with overheated water vapour and then expanded by evaporation of the foaming agent. In the next step, the expanded granulate is placed on interim storage in air-penetrable silos. The diffusing air gives the EPS foam particles the stability it needs for the downstream processing steps.

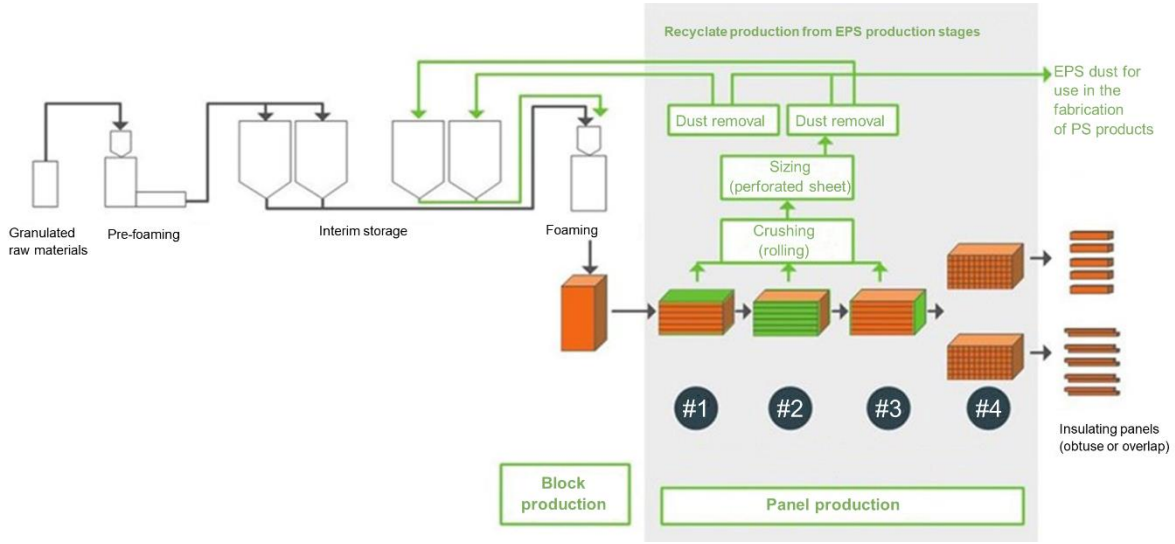
The most used technique for the production of EPS insulant boards is block foaming followed by hot wire cutting.
To this end, the pre-foamed and temporarily stored EPS foam particles are filled into cuboidal block moulds and foamed by adding steam at 110°C to 120°C. In addition, recycled material from production divisions and construction site sections are introduced to the process, and the LCA is accounted for in the module A3.

After a brief cooling-down period, the moulds are removed and the blocks are allowed to settle. Next, the blocks are cut into boards in mechanical or thermal cutters. Additional edge profiles (tongue and groove or rebated edge) can be created by milling.

Boards as shaped parts (second most common technique) can be produced with fully automated machines (shaped part machines). In this case, the finished boards have the desired final shape, e.g. rebated without the need of further processing.

In the belt-foaming process (third most common technique), the boards are foamed in a continuous process in a double-belt plant between revolving steel strips. Here, the boards are produced in the desired thickness and length and then cut.

To make the EPS insulant production more sustainable, recycled material from production offcuts or installation residues taken from construction sites are introduced to the raw material proper. Waste is avoided by reusing such offcuts and remains. Therefore, the use of offcuts and remains is not covered in the modules C1-C4 (disposal stage) and D (credits and charges beyond the system boundaries) of this environmental product declaration.



Environment and health during manufacture

The Technical Rule *TRGS 900* must always be observed for the maximum occupational limit values. Furthermore, no steps beyond the general occupational safety measures are necessary.

EPS hard foam manufacturers are not facilities requiring approval according to *TA Luft*. Additional steps beyond the statutory requirements are not necessary.

In an effort to ensure clean production, the EPS manufacturers within the IVH support the initiative *Operation Clean Sweep*, OCS, a global voluntary initiative of the plastic industry to curtail marine plastic pollution.
The IVH has initiated the *IVH-Initiative Null-Granulatverlust* initiative under the OCS framework which is specifically geared toward logistics and manufacturing processes in the domain of insulant production and to which all IVH members have subscribed.

Product processing/installation

The EPS products possess excellent processing and machining properties due to their relatively low weight among other factors.

The boards are dimensionally stable and absorb only very little humidity, which is relevant both for the entire life stage of the building and for the construction phase.

All applications must be based on the relevant standards and guidelines (e.g., *Qualitätsrichtlinien für EPS in WDVS, 2020* and technical regulations of the craft associations) and manufacturer instructions. Additional building physical analyses (e.g., moisture proofing) contribute to increased energy efficiency.

The boards for ETICS are installed along the façade, and plastered. Where insulation boards must be trimmed on site, hot-wire cutting is recommended. This

allows for precise cutting and avoiding unnecessary waste.
Installation is done by gluing, if necessary also by additional mechanical fixing. Application is system-specific, requiring a general type approval which defines the system components and finish.

Packaging

EPS insulation boards are generally packaged in polyethylene film, protected with cardboard against impact damage, and delivered on wooden pallets. Delivery on EPS bases as an alternative to wooden pallets is common, too. Disposal of the packaging material is done by qualified disposal companies, while the EPS transport bases are recycled.

Condition of use

The air-filled hard foam possesses very good thermal insulation properties. All materials in the polystyrene used in the manufacture of insulation boards are age and moisture resistant when fitted. The insulation performance and the mechanical properties of EPS hard foam do not change throughout its service life.

Environment and health during use

EPS insulants have seen use for more than 60 years. They have no known adverse effects on people, animals and the environment.

According to the German Committee for Health-Related Evaluation of Building Products *(AgBB-Schema)*, EPS insulants are suitable for interior applications.

Reference period of use

EPS hard foam-based insulants have an unlimited service life when handled and used properly, without any performance losses.

Limits on service life are only imposed by the service life of the building components and systems which contain EPS. These service lives can be found in the *BBSR table* “Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach Bewertungssystem Nachhaltiges Bauen (BNB)” of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the portfolio of the Federal Office for Building and Regional Planning (BBSR). Hence, EPS hard foam-based thermal insulation composite systems have a service life of 40 years. In all other building thermal insulation applications, the service life of EPS hard foam is ≥ 50 years.

Extraordinary influences

Fire protection

The EPS hard foam boards declared in this EPD are flame-retardant, do not form burning droplets; building material class B1 acc. to *DIN 4102-1*.

Name	Value
Building material class according to DIN 4102-1	B 1 - flame retardant
Burning drops	no burning droplets
EURO class according to DIN EN 13501-1	E

Water

EPS hard foam is chemically neutral, insoluble in water, and does not release water-soluble substances which may contaminate the ground water, rivers, and seas.

Thanks to their closed cellular structure, insulation materials made from EPS hard foam may generally be left in the existing structure even in high moisture conditions. The insulation performance stays largely the same.

Mechanical destruction

Data on the behaviour of the product, including possible environmental implications in the event of unpredicted mechanical destruction, are irrelevant.

End-of-life phase

EPS hard foam can be reused or recycled at the end of its service life. EPS is fully recyclable.

Seeing that, owing to EPS’s high durability, only very little EPS insulant waste will accrue now and in the future when buildings are dismantled, EPS recycling will mainly rely on leftovers from insulant production. This was taken into account when calculating the ecological metrics of manufacture. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.

Under certain boundary conditions, it is also possible to fabricate insulation boards from recycling material. Besides, ground recycling material can be used as lightweight aggregate for mortar, concrete and screed. It also serves as additive for Styrofoam lightweight concrete, insulation plasters, lightweight plasters, and the clay industry.

In principle, EPS waste can also be utilised for manufacturing new EPS raw materials. By dissolving the hard foam insulant and separation of the polystyrene from extraneous material via flocculation, the polystyrene can be recovered as raw material. The processes are controlled via the “Creasolve procedure” and performed with the PolyStyrene-Loop-Initiative of the European EPS industry at industrial scales (*PolyStyreneLoop-Leitfaden 2020*). This type of utilisation has not yet been included in the LCA data calculation because too little waste is obtained for recycling, due to EPS’s long service life. The standard scenario for a subsequent use continues to be thermal recycling.

LCA: Calculation rules

Declared unit
1 m³ EPS hard foam with 15 kg/m³ bulk density.

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Bulk density	15	kg/m^3

EPD manufacturer groups:
Declaration of a specific product, averaged over several plants and several manufacturers.
The average is formed after weighting of the volume-specific total production quantities of the declared products of the member firms.
As to the variation width, deviations were low with 3% maximum for the use of the main formula constituent polystyrene granulate. Energy requirement variability rather large, due to the different operating parameters and production-related differences. The contributions of power and thermal energy consumption to the overall result, however, are below 15% in most effect categories so that the influence of these variations is rather limited.

System boundary
EPD type: from the cradle to the gate with options, modules C1-C4 and module D (A1-A3 + C + D and additional modules).
The EPD covers the following life cycle stages:

Product stage (A1-A3):
• A1 Raw material provision and processing; working processes of secondary materials serving as input (e.g., recycling processes),
• A2 transport of the raw materials to the factories (reference territory Germany),
• A3 factory production of EPS hard foam, (incl. energy supply, water supply, supply of ancillary materials, supply of recycling material from production and construction side offcuts, production waste disposal, packaging material production).

Construction process stage (A5):
• A5 Installation: only disposal of packaging, other installation operations are not accounted for.

End-of-life stage (C1-C4): End-of-life scenario: 100 % thermal recycling
• C1 manual disassembly without operations relevant to LCA,
• C2 road transport (50 km) to waste treatment. Distance may be adjusted at the building level (e.g., if the effective transport distance is 100 km: multiplication of the LCA values with the factor 2),
• C3 100% thermal recycling of the EPS hard foam,
• C4 no other requirements due to landfilling/disposal.

Credits and charges beyond the system boundaries (D):
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam.

Comparability
A comparison or the evaluation of EPD data is principally only possible if all data sets to be compared were compiled in accordance with *EN 15804* and the building context or product-specific performance characteristics are included.

The background data were taken from the GaBi database *(GaBi software)*.

LCA: Scenarios and further technical information

Characteristic product properties
Biogenic carbon
The product itself does not contain any biogenic carbon; only the transport packaging does in the form of wooden pallets and cardboard. When calculating a building LCA, it should be noted that the amount of biogenic CO_2 of this packaging bound in Module A1–A3 is subtracted out in Module A5 (installation in building).

Information to describe the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in product	0	kg C
Biogenic carbon in relevant packaging	0.02	kg C

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if no modules are declared (MND).

Installation into the building (A5)
A5 only covers packaging disposal; other installation requirements (e.g., clippings) are not accounted for.

End-of-life (C1-C4)

Name	Value	Unit
As mixed building waste	15	kg
For energy recovery	15	kg

Reuse, recovery and recycling potential (D), relevant scenario information
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam. A waste incineration plant with an R1 value of > 0.6 was taken as a basis.

LCA: Results

The following tables show the results of the indicators of the impact assessment, resource utilisation, waste, and other output flows in relation to **1 m³ EPS hard foam with 15 kg/m³ bulk density.**

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

Production stage			Construction process stage		Use stage							End of life stage				Credits and charges beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from the gate to the site	Assembly	Use/Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste treatment	Disposal	Reuse, recovery or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	X	ND	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 15 kg/m³ bulk density

Core indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
Total GWP	[kg CO_2 eq.]	4.70E+1	5.91E-1	0.00E+0	4.53E-2	5.04E+1	0.00E+0	-2.10E+1
GWP fossil	[kg CO_2 eq.]	4.68E+1	5.23E-1	0.00E+0	4.49E-2	5.04E+1	0.00E+0	-2.09E+1
GWP biogenic	[kg CO_2 eq.]	1.75E-1	6.75E-2	0.00E+0	1.67E-4	2.77E-3	0.00E+0	-9.61E-2
GWP luluc	[kg CO_2 eq.]	1.38E-2	3.33E-5	0.00E+0	2.89E-4	5.52E-4	0.00E+0	-1.27E-2
ODP	[kg CFC11 eq.]	2.57E-13	2.94E-16	0.00E+0	1.15E-17	6.55E-15	0.00E+0	-2.09E-13
AP	[mol H^+ eq.]	6.58E-2	1.05E-4	0.00E+0	3.88E-5	6.75E-3	0.00E+0	-2.54E-2
EP fresh water	[kg P eq.]	5.25E-5	4.29E-8	0.00E+0	9.25E-8	9.03E-7	0.00E+0	-2.40E-5
EP marine	[kg N eq.]	1.81E-2	2.50E-5	0.00E+0	1.21E-5	1.15E-3	0.00E+0	-7.47E-3
EP terrestrial	[mol N eq.]	1.97E-1	4.89E-4	0.00E+0	1.46E-4	3.16E-2	0.00E+0	-8.02E-2
POCP	[kg NMVOC eq.]	7.10E-1	6.88E-5	0.00E+0	3.32E-5	3.10E-3	0.00E+0	-2.11E-2
ADPE	[kg Sb eq.]	4.88E-6	4.03E-9	0.00E+0	3.91E-9	9.40E-8	0.00E+0	-3.17E-6
ADPF	[MJ]	1.37E+3	2.61E-1	0.00E+0	5.96E-1	7.38E+0	0.00E+0	-3.61E+2
WDP	[m³ world eq. deprived]	3.30E+0	6.09E-2	0.00E+0	1.75E-4	4.08E+0	0.00E+0	-1.40E+0

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

RESULTS OF THE LCA – INDICATORS TO DESCRIBE THE USE OF RESOURCES in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 15 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PERE	[MJ]	2.66E+1	5.78E-1	0.00E+0	3.46E-2	1.60E+0	0.00E+0	-7.18E+1
PERM	[MJ]	5.05E-1	-5.05E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	2.71E+1	7.26E-2	0.00E+0	3.46E-2	1.60E+0	0.00E+0	-7.18E+1
PENRE	[MJ]	7.84E+2	8.89E+0	0.00E+0	5.96E-1	5.77E+2	0.00E+0	-3.61E+2
PENRM	[MJ]	5.79E+2	-8.63E+0	0.00E+0	0.00E+0	-5.70E+2	0.00E+0	0.00E+0
PENRT	[MJ]	1.37E+3	2.61E-1	0.00E+0	5.96E-1	7.38E+0	0.00E+0	-3.61E+2
SM	[kg]	2.04E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	1.98E-1	1.45E-3	0.00E+0	3.08E-5	9.58E-2	0.00E+0	-7.02E-2

Key	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; 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 in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 15 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
HWD	[kg]	1.34E-7	5.62E-11	0.00E+0	2.49E-11	1.55E-9	0.00E+0	-7.96E-8
NHWD	[kg]	3.49E-1	5.50E-2	0.00E+0	9.62E-5	3.06E-1	0.00E+0	-1.59E-1
RWD	[kg]	8.07E-3	8.79E-6	0.00E+0	5.72E-7	1.96E-4	0.00E+0	-2.31E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	1.05E+0	0.00E+0	0.00E+0	7.76E+1	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	2.42E+0	0.00E+0	0.00E+0	1.79E+2	0.00E+0	0.00E+0

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

RESULTS OF THE LCA – Additional impact categories in accordance with *EN 15804+A2*-optional: 1 m³ EPS hard foam with 15 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PM	[Cases of illness]	4.69E-7	1.24E-9	0.00E+0	2.43E-10	4.22E-8	0.00E+0	-2.20E-7
IRP	[kBq U235 eq.]	8.93E-1	8.13E-4	0.00E+0	5.44E-5	1.81E-2	0.00E+0	-3.78E+0
ETP-fw	[CTUe]	7.39E+2	9.56E-2	0.00E+0	4.95E-1	2.88E+0	0.00E+0	-6.67E+1
HTP-c	[CTUh]	1.57E-8	8.44E-12	0.00E+0	9.79E-12	2.92E-10	0.00E+0	-3.34E-9
HTP-nc	[CTUh]	7.11E-7	8.20E-10	0.00E+0	4.83E-10	1.01E-8	0.00E+0	-1.33E-7
SQP	[-]	3.00E+1	7.59E-2	0.00E+0	1.87E-1	2.02E+0	0.00E+0	-4.91E+1

Key	PM = Potential Occurrence of Diseases due to Particle Emissions; IR = Potential Effects of Human Exposure to U235; ETP- fw = Potential Toxicity Comparison Unit for Ecosystems; HTP-c = Potential Toxicity Comparison Unit for Humans (carcinogenic effect); HTP-nc = Potential Toxicity Comparison Unit for Humans (non-carcinogenic effect); SQP = Potential Soil Quality Index

Restriction notice 1 – applies to the “Potential effects of human exposure to U235” indicator. This effect category mainly deals with the possible effect of low-dose ionising radiation on human health in the nuclear cycle. It does not take into account effects which are attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emanating from the soil, from radon and from some building materials is also not measured by this indicator.

Restriction notice 2 – applies to the indicators: “Abiotic depletion potential for non-fossil resources”, “Abiotic depletion potential for fossil resources”, “Water withdrawal potential (user)”, “Potential toxicity comparison unit for ecosystems”, “Potential toxicity comparison unit for humans – carcinogenic effect”, “Potential toxicity comparison unit for humans – non-carcinogenic effect”, “Potential soil quality index". The results of this environmental impact category must be applied with care, as uncertainties with these results are high or because there is a lack of experience with the indicator.

EPS is generally radon-free.

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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Owner of the declaration	**Industrieverband Hartschaum e.V., IVH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVH-20220130-CBG1-DE
Issue date	15/08/2022
Valid until	14/08/2027

EPS hard foam – white with intermediate bulk density
preferentially for flat roof or floor insulation
with intermediate compressive strength

Industrieverband Hartschaum e.V. (IVH)

Member of EUMEPS, the association of European Manufacturers of Expanded Polystyrene

Institut Bauen und Umwelt e.V.

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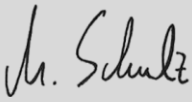
General information

Industrieverband Hartschaum e.V. (IVH)	EPS hard foam (bulk density 20 kg/m³)
Programme holder IBU – Institut Bauen und Umwelt e.V. Hegelplatz 1 D-10117 Berlin Germany	**Owner of the declaration** Industrieverband Hartschaum e.V., IVH Friedrichstrasse 95, Pb 152 D-10117 Berlin
Declaration number EPD-IVH-20220130-CBG1-DE	**Declared product/Declared unit** The declared unit is 1m³ of expanded polystyrene hard foam for heat and sound insulation. The average bulk density is 20 kg/m³.
This declaration is based on the following product category rules: Foam plastic insulation materials, 01.2019 (PCR tested and approved by the independent advisory board (SVR))	**Scope of application:** This EPD describes the EPS hard foam products for thermal and sound insulation with an average bulk density of 20 kg/m³. The participating member firms represent 90 volume percent of the total number of all IVH member firms in the year 2020.
Issue date 15/08/2022	The owner of the declaration is liable for the basic information and supporting evidence; any liability of the IBU in relation to manufacturer's information, LCA data and supporting evidence is excluded. This EPD was compiled in accordance with the requirements of *EN 15804+A2*. This standard is referred to in simplified form as *EN 15804* in the following.
Valid until 14/08/2027	**Verification** European standard *EN 15804* serves as the core PCR Independent verification of the declaration and statements in accordance with *ISO 14025:2011* ☐ internal ☒ external
 Dipl. Ing. Hans Peters (President of Institut Bauen und Umwelt e.V.)	
 Dr. Alexander Röder (Executive Director Institut Bauen und Umwelt e.V.)	 Matthias Schulz, Independent Verifier

Product

Product description/Product definition

This environmental product declaration (EPD) describes hard foam insulation products made from expanded polystyrene (EPS) provided by the IVH members. IVH is member of EUMEPS, the association for European Manufacturers of Expanded Polystyrene.

EPS products provided by the IVH members for the heat and sound insulation of buildings.

The insulation materials are factory-made in the form of boards or loose, thermal insulation filler material. This EPD describes the EPS hard foam products with intermediate bulk density and intermediate compressive strength for different applications such as flat roof or floor insulation with intermediate compressive strength.

EPS hard foam is a solid insulation material with a cellular structure which is fabricated from welded, expanded polystyrene or one of its co-polymers. It has a closed-cell, air-filled structure (98% air). EPS boards are rectangular, hard insulation products (cut, moulded or continuously foamed). The board edges can have a rebate edge or tongue and groove. As loose filler material, EPS is factory made in the form of air-filled beads (Ø approx. 6 mm). This environmental product declaration covers the homogeneous EPS insulant without material combination with composite boards or laminated insulation boards.

Essential, characteristic properties are thermal conductivity, bending resistance, and transverse tensile strength.

EU regulation no. 305/2011/ (CPR) applies for placing the product on the market in the EU/EFTA (with the

exception of Switzerland). The product requires a declaration of performance based on *DIN EN 13163:2012+A1:2015, Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification*, and the CE marking.
The respective national regulations apply to its use.

Application

Primary fields of application for the products declared in this document are **flat roof and floor insulation.** Minimum requirements for these applications are described in *DIN 4108-10* according to the types DAA dm and DEO dm.

Other applications for products under this environmental product declaration include, according to the application types pursuant to *DIN 4108-10*, table 1: DAD, WAA.

- **DAA dm**: Exterior insulation of flat roof and ceiling, exposure-protected, insulation under sealing; intermediate compressive strength
- **DAD**: Exterior insulation of roof and ceiling, exposure-protected, insulation under cover
- **DEO dm**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements; intermediate compressive strength
- **WAA**: Exterior wall insulation behind sealing

Technical data

The following structural/technical data in as-delivered condition are relevant for the product.

Constructional data

Name	Value	Unit
Average bulk density	20	kg/m³
Compressive strength to EN 826	>= 0.10	N/mm²
Design value thermal conductivity acc. to DIN 4108-4	0.035	W/(mK)
Thermal conductivity nominal value acc. to EN 12664	0.034	W/(mK)
Bending resistance acc. to EN 12089	>= 0.15	N/mm²

The products' performance data meet the declaration of performance in relation to its main features in accordance with *DIN EN 13163:2012+A1:2015 Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification.*

Additional, voluntary information for the product are provided outside of the CE marking.

Base materials/Ancillary materials

The base polymer product for EPS hard foam is polystyrene (PS). It is fabricated by polymerisation of monomeric styrene using a variety of procedures.

The most commonly used raw material production method is polymerisation in a styrene/water suspension, in which the foaming agent pentane is added near the end of the polymerisation process. The PS granulate thus produced is processed into foam in downstream physical processing steps.

The products covered by this declaration are furnished with the flame-retardant polymer-FR. The base material used for insulant production is supplied to the insulant manufacturer in the form of bead-shaped granulate and then physically formed/foamed and reworked.

Composition of expanded polystyrene EPS hard foam

Proportion in mass percent
Polystyrene granulate: 90-93 %
Polymer-FR: 1-5 %
Pentane (in relation to mass percent in the raw material): 5-6 %
Recycled material: 0-12 %

The pentane used for foaming is a C5 hydrocarbon. It is broken down during the manufacturing and storage process.

In the production of flame-protected polystyrene granulate, low amounts of a flame retardant are introduced during polymerisation. Polymer-FR is used as flame retardant for the products declared in this EPD. Manufacturers are required to provide evidence for the products. Polymer-FR is a brominated styrene-butadiene copolymer.

1) The product/at least one part product contains substances of the candidate list of the substances of Very High Concern (SVHC) (as of 17 January 2022) eligible for approval above 0.1 mass percent: **no**

2) The product or at least one part product contains further CMR Category 1A or 1B substances which are not on the candidate list in doses above 0.1 mass percent in at least one part product: **no**

3) Biocidal products were added to this building product or it was treated with biocidal products (is it therefore a processed product as provided for in the EU Biocide Product Directive no. 528/2012): **no**

Manufacture

The manufacture of EPS hard foam follows the process steps pre-foaming, interim storage, foam filling:

In the pre-foaming step, the bead-shaped granulate which holds the foaming agent is softened with overheated water vapour and then expanded by evaporation of the foaming agent. In the next step, the expanded granulate is placed on interim storage in air-penetrable silos. The diffusing air gives the EPS foam particles the stability it needs for the downstream processing steps.

The most commonly used technique for the production of EPS insulant boards is block foaming followed by hot wire cutting.

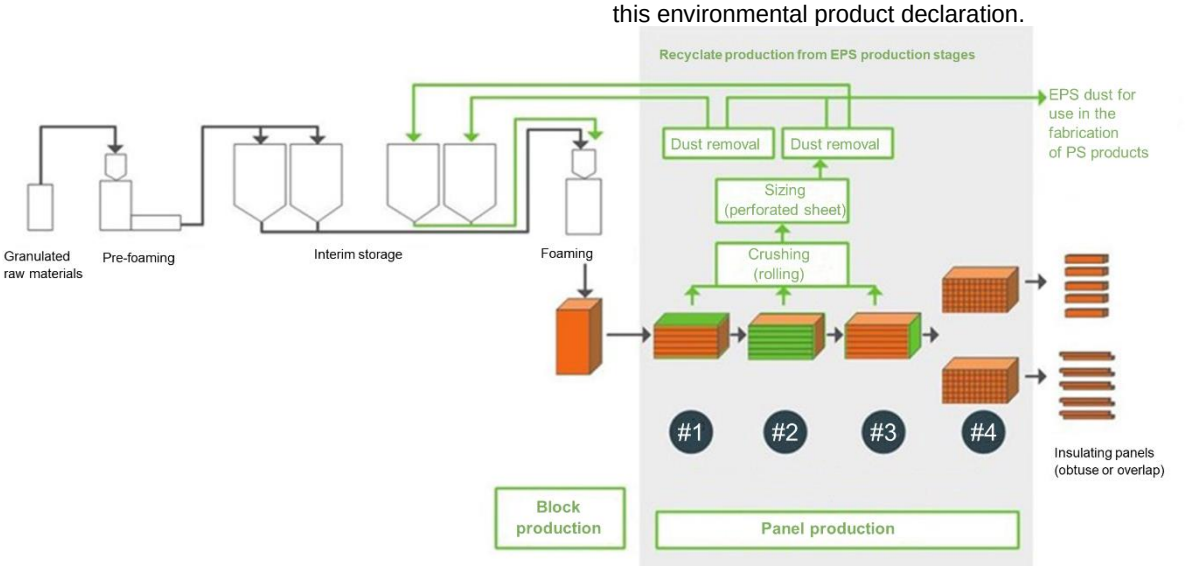
To this end, the pre-foamed and temporarily stored EPS foam particles are filled into cuboidal block moulds and foamed by adding steam at 110°C to 120°C. In addition, recycled material from production divisions and construction site sections are introduced to the process, and the LCA is accounted for in the module A3.

After a brief cooling-down period, the moulds are removed and the blocks are allowed to settle. Next, the blocks are cut into boards in mechanical or thermal cutters. Additional edge profiles (tongue and groove or rebated edge) can be created by milling.

Boards as shaped parts (second most common technique) can be produced with fully automated machines (shaped part machines). In this case, the finished boards have the desired final shape, e.g. rebated without the need of further processing.

In the belt-foaming process (third most common technique), the boards are foamed in a continuous process in a double-belt plant between revolving steel strips. Here, the boards are produced in the desired thickness and length and then cut.

To make the EPS insulant production more sustainable, recycled material from production offcuts or installation residues taken from construction sites are introduced to the raw material proper. Waste is avoided by reusing such offcuts and remains. Therefore, the use of offcuts and remains is not covered in the modules C1-C4 (disposal stage) and D (credits and charges beyond the system boundaries) of this environmental product declaration.



Environment and health during manufacture

The Technical Rule *TRGS 900* must always be observed for the maximum occupational limit values. Furthermore, no steps beyond the general occupational safety measures are necessary.

EPS hard foam manufacturers are not facilities requiring approval according to *TA Luft*. Additional steps beyond the statutory requirements are not necessary.

In an effort to ensure clean production, the EPS manufacturers within the IVH support the initiative *Operation Clean Sweep*, OCS, a global voluntary initiative of the plastic industry to curtail marine plastic pollution.
The IVH has initiated the *IVH-Initiative Null-Granulatverlust* initiative under the OCS framework which is specifically geared toward logistics and manufacturing processes in the domain of insulant production and to which all IVH members have subscribed.

Product processing/installation

The EPS products possess excellent processing and machining properties due to their relatively low weight among other factors.

The boards are dimensionally stable and absorb only very little humidity, which is relevant both for the entire life stage of the building and for the construction phase.

All applications must be based on the relevant standards and guidelines (e.g., technical regulations of the craft associations) and manufacturer instructions. Additional building physical analyses (e.g., moisture proofing) contribute to increased energy efficiency.

Where insulation boards must be trimmed on site, hot-wire cutting is recommended. This allows for precise cutting and avoiding unnecessary waste.

Installation is done by gluing, if necessary also by additional mechanical fixing. Applications may be system-specific, i.e. system components and processing are predefined

Packaging

EPS insulation boards are generally packaged in polyethylene film, protected with cardboard against impact damage, and delivered on wooden pallets. Delivery on EPS bases as an alternative to wooden pallets is common, too. Disposal of the packaging material is done by qualified disposal companies, while the EPS transport bases are recycled.

Condition of use

The air-filled hard foam possesses very good thermal insulation properties. All materials in the polystyrene used in the manufacture of insulation boards are age and moisture resistant when fitted. The insulation

performance and the mechanical properties of EPS hard foam do not change throughout its service life.

Environment and health during use

EPS insulants have seen use for more than 60 years. They have no known adverse effects on people, animals and the environment.

According to the German Committee for Health-Related Evaluation of Building Products *(AgBB-Schema)*, EPS insulants are suitable for interior applications.

Reference period of use

EPS hard foam-based insulants have an unlimited service life when handled and used properly, without any performance losses.

Limits on service life are only imposed by the service life of the building components and systems which contain EPS. These service lives can be found in the *BBSR table* "Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach Bewertungssystem Nachhaltiges Bauen (BNB)" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the portfolio of the Federal Office for Building and Regional Planning (BBSR). Hence, EPS hard foam-based thermal insulation composite systems have a service life of 40 years. In all other building thermal insulation applications, the service life of EPS hard foam is ≥ 50 years.

Extraordinary influences

Fire protection

The EPS hard foam boards declared in this EPD are flame-retardant, do not form burning droplets; building material class B1 acc. to *DIN 4102-1*.

Name	Value
Building material class according to DIN 4102-1	B 1 - flame retardant
Burning drops	no burning droplets
EURO class according to DIN EN 13501-1	E

Water

EPS hard foam is chemically neutral, insoluble in water, and does not release water-soluble substances which may contaminate the ground water, rivers, and seas.

Thanks to their closed cellular structure, insulation materials made from EPS hard foam may generally be left in the existing structure even in high moisture conditions. The insulation performance stays largely the same.

Mechanical destruction

Data on the behaviour of the product, including possible environmental implications in the event of unpredicted mechanical destruction, are irrelevant.

End-of-life phase

EPS hard foam can be reused or recycled at the end of its service life. EPS is fully recyclable.

Seeing that, owing to EPS's high durability, only very little EPS insulant waste will accrue now and in the future when buildings are dismantled, EPS recycling will mainly rely on leftovers from insulant production. This was taken into account when calculating the ecological metrics of manufacture. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.

Under certain boundary conditions, it is also possible to fabricate insulation boards from recycling material. Besides, ground recycling material can be used as lightweight aggregate for mortar, concrete and screed. It also serves as additive for Styrofoam lightweight concrete, insulation plasters, lightweight plasters, and the clay industry.

In principle, EPS waste can also be utilised for manufacturing new EPS raw materials. By dissolving the hard foam insulant and separation of the polystyrene from extraneous material via flocculation, the polystyrene can be recovered as raw material. The processes are controlled via the "Creasolve procedure" and performed with the *PolyStyrene-Loop-Initiative* of the European EPS industry at industrial scales (*PolyStyreneLoop-Leitfaden* 2020). This type of utilisation has not yet been included in the LCA data calculation because too little waste is obtained for recycling, due to EPS's long service life.

The standard scenario for a subsequent use continues to be thermal recycling.

LCA: Calculation rules

Declared unit
1 m³ EPS hard foam with 20 kg/m³ bulk density.

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Bulk density	20	kg/m^3

EPD manufacturer groups:
Declaration of a specific product, averaged over several plants and several manufacturers.

The average is formed after weighting of the volume-specific total production quantities of the declared products of the member firms.
As to the variation width, deviations were low with 3% maximum for the use of the main formula constituent polystyrene granulate. Energy requirement variability rather large, due to the different operating parameters and production-related differences. The contributions of power and thermal energy consumption to the overall result, however, are below 15% in most effect categories so that the influence of these variations is rather limited.

System boundary
EPD type: from the cradle to the gate with options, modules C1-C4 and module D (A1–A3 + C + D and additional modules).

The EPD covers the following life cycle stages:

Product stage (A1-A3):
• A1 Raw material provision and processing; working processes of secondary materials serving as input (e.g., recycling processes),
• A2 transport of the raw materials to the factories (reference territory Germany),
• A3 factory production of EPS hard foam, (incl. energy supply, water supply, supply of ancillary materials, supply of recycling material from production and construction side offcuts, production waste disposal, packaging material production).

Construction process stage (A5):
• A5 Installation: only disposal of packaging, other installation operations are not accounted for.

End-of-life stage (C1-C4): End-of-life scenario: 100% thermal recycling
• C1 manual disassembly without operations relevant to LCA,
• C2 road transport (50 km) to waste treatment. The transport distance may be adjusted at the building level (e.g., if the effective transport distance is 100 km: multiplication of the LCA values with the factor 2).
• C3 100% thermal recycling of the EPS hard foam.
• C4 no other requirements due to landfilling/disposal.

Credits and charges beyond the system boundaries (D):
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam.

Comparability
A comparison or the evaluation of EPD data is principally only possible if all data sets to be compared were compiled in accordance with *EN 15804* and the building context or product-specific performance characteristics are included.

The background data were taken from the GaBi database *(GaBi software)*.

LCA: Scenarios and further technical information

Characteristic product properties
Biogenic carbon
The product itself does not contain any biogenic carbon; only the transport packaging does. When calculating a building LCA, it should be noted that the amount of biogenic CO_2 of this packaging bound in Module A1–A3 is subtracted out in Module A5 (installation in building).

Information to describe the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in product	0	kg C
Biogenic carbon in relevant packaging	0.03	kg C

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if no modules are declared (MND).

Installation into the building (A5)
A5 only covers packaging disposal; other installation requirements (e.g., clippings) are not accounted for.

End-of-life (C1-C4)

Name	Value	Unit
As mixed building waste	20	kg
For energy recovery	20	kg

Reuse, recovery and recycling potential (D), relevant scenario information
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam. A waste incineration plant with an R1 value of > 0.6 was taken as a basis.

LCA: Results

The following tables show the results of the indicators of the impact assessment, resource utilisation, waste, and other output flows in relation to **1 m³ EPS hard foam with 20 kg/m³ bulk density**.

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

Production stage			Construction process stage		Use stage							End of life stage				Credits and charges beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from the gate to the site	Assembly	Use/Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste treatment	Disposal	Reuse, recovery or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	X	ND	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 20 kg/m³ bulk density

Core indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
Total GWP	[kg CO_2 eq.]	5.98E+1	3.90E-1	0.00E+0	6.04E-2	6.72E+1	0.00E+0	-2.78E+1
GWP fossil	[kg CO_2 eq.]	5.97E+1	2.82E-1	0.00E+0	5.98E-2	6.72E+1	0.00E+0	-2.76E+1
GWP biogenic	[kg CO_2 eq.]	2.09E-1	1.08E-1	0.00E+0	2.22E-4	3.70E-3	0.00E+0	-1.27E-1
GWP luluc	[kg CO_2 eq.]	1.83E-2	1.94E-5	0.00E+0	3.85E-4	7.36E-4	0.00E+0	-1.68E-2
ODP	[kg CFC11 eq.]	4.34E-13	1.76E-16	0.00E+0	1.53E-17	8.73E-15	0.00E+0	-2.76E-13
AP	[mol H^+ eq.]	8.66E-2	7.23E-5	0.00E+0	5.17E-5	9.01E-3	0.00E+0	-3.37E-2
EP fresh water	[kg P eq.]	7.07E-5	2.57E-8	0.00E+0	1.23E-7	1.20E-6	0.00E+0	-3.18E-5
EP marine	[kg N eq.]	2.35E-2	1.81E-5	0.00E+0	1.61E-5	1.53E-3	0.00E+0	-9.88E-3
EP terrestrial	[mol N eq.]	2.57E-1	3.36E-4	0.00E+0	1.95E-4	4.21E-2	0.00E+0	-1.06E-1
POCP	[kg NMVOC eq.]	9.25E-1	4.93E-5	0.00E+0	4.42E-5	4.13E-3	0.00E+0	-2.79E-2
ADPE	[kg Sb eq.]	6.94E-6	2.42E-9	0.00E+0	5.22E-9	1.25E-7	0.00E+0	-4.19E-6
ADPF	[MJ]	1.76E+3	1.59E-1	0.00E+0	7.95E-1	9.84E+0	0.00E+0	-4.78E+2
WDP	[m³ world eq. deprived]	4.39E+0	4.04E-2	0.00E+0	2.33E-4	5.44E+0	0.00E+0	-1.85E+0

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

RESULTS OF THE LCA – INDICATORS TO DESCRIBE THE USE OF RESOURCES in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 20 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PERE	[MJ]	4.16E+1	8.40E-1	0.00E+0	4.61E-2	2.13E+0	0.00E+0	-9.50E+1
PERM	[MJ]	7.97E-1	-7.97E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	4.24E+1	4.34E-2	0.00E+0	4.61E-2	2.13E+0	0.00E+0	-9.50E+1
PENRE	[MJ]	9.89E+2	4.78E+0	0.00E+0	7.95E-1	7.70E+2	0.00E+0	-4.78E+2
PENRM	[MJ]	7.65E+2	-4.62E+0	0.00E+0	0.00E+0	-7.60E+2	0.00E+0	0.00E+0
PENRT	[MJ]	1.76E+3	1.59E-1	0.00E+0	7.95E-1	9.84E+0	0.00E+0	-4.78E+2
SM	[kg]	3.34E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	2.51E-1	9.62E-4	0.00E+0	4.10E-5	1.28E-1	0.00E+0	-9.29E-2

Key	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; 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 in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 20 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
HWD	[kg]	1.67E-7	3.45E-11	0.00E+0	3.32E-11	2.06E-9	0.00E+0	-1.05E-7
NHWD	[kg]	4.60E-1	3.02E-2	0.00E+0	1.28E-4	4.08E-1	0.00E+0	-2.11E-1
RWD	[kg]	8.79E-3	5.26E-6	0.00E+0	7.63E-7	2.61E-4	0.00E+0	-3.05E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	6.53E-1	0.00E+0	0.00E+0	1.03E+2	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	1.51E+0	0.00E+0	0.00E+0	2.38E+2	0.00E+0	0.00E+0

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

RESULTS OF THE LCA – Additional impact categories in accordance with *EN 15804+A2*-optional: 1 m³ EPS hard foam with 20 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PM	[Cases of illness]	6.16E-7	7.49E-10	0.00E+0	3.24E-10	5.63E-8	0.00E+0	-2.91E-7
IRP	[kBq U235 eq.]	1.04E+0	4.86E-4	0.00E+0	7.26E-5	2.41E-2	0.00E+0	-5.01E+0
ETP-fw	[CTUe]	9.98E+2	5.89E-2	0.00E+0	6.60E-1	3.85E+0	0.00E+0	-8.84E+1
HTP-c	[CTUh]	2.07E-8	5.04E-12	0.00E+0	1.31E-11	3.90E-10	0.00E+0	-4.42E-9
HTP-nc	[CTUh]	9.21E-7	4.60E-10	0.00E+0	6.44E-10	1.34E-8	0.00E+0	-1.76E-7
SQP	[-]	4.22E+1	4.64E-2	0.00E+0	2.49E-1	2.70E+0	0.00E+0	-6.50E+1

Key	PM = Potential Occurrence of Diseases due to Particle Emissions; IR = Potential Effects of Human Exposure to U235; ETP- fw = Potential Toxicity Comparison Unit for Ecosystems; HTP-c = Potential Toxicity Comparison Unit for Humans (carcinogenic effect); HTP-nc = Potential Toxicity Comparison Unit for Humans (non-carcinogenic effect); SQP = Potential Soil Quality Index

Restriction notice 1 – applies to the “Potential effects of human exposure to U235” indicator. This effect category mainly deals with the possible effect of low-dose ionising radiation on human health in the nuclear cycle. It does not take into account effects which are attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emanating from the soil, from radon and from some building materials is also not measured by this indicator.

Restriction notice 2 – applies to the indicators: “Abiotic depletion potential for non-fossil resources”, “Abiotic depletion potential for fossil resources”, “Water withdrawal potential (user)”, “Potential toxicity comparison unit for ecosystems”, “Potential toxicity comparison unit for humans – carcinogenic effect”, “Potential toxicity comparison unit for humans – non-carcinogenic effect”, “Potential soil quality index". The results of this environmental impact category must be applied with care, as uncertainties with these results are high or because there is a lack of experience with the indicator.

EPS is generally radon-free.

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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Owner of the declaration	**Industrieverband Hartschaum e.V., IVH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVH-20220131-CBG1-DE
Issue date	15/08/2022
Valid until	14/08/2027

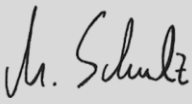
EPS hard foam – white with intermediate bulk density
preferentially for flat roof or floor insulation
high compressive strength

Industrieverband Hartschaum e.V. (IVH)

Member of EUMEPS, the association of European Manufacturers of Expanded Polystyrene

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

General information

Industrieverband Hartschaum e.V. (IVH)	EPS hard foam (bulk density 25 kg/m³)
Programme holder IBU – Institut Bauen und Umwelt e.V. Hegelplatz 1 D-10117 Berlin Germany	**Owner of the declaration** Industrieverband Hartschaum e.V., IVH Friedrichstrasse 95, Pb 152 D-10117 Berlin
Declaration number EPD-IVH-20220131-CBG1-DE	**Declared product/Declared unit** The declared unit is 1m³ of expanded polystyrene hard foam for thermal and sound insulation. The average bulk density is 25 kg/m³.
This declaration is based on the following product category rules: Foam plastic insulation materials, 01.2019 (PCR tested and approved by the independent advisory board (SVR))	**Scope of application:** This EPD describes the EPS hard foam products for thermal and sound insulation with an average bulk density of 25 kg/m³. The participating member firms represent 90 volume percent of the total number of all IVH member firms in the year 2020.
Issue date 15/08/2022	The owner of the declaration is liable for the basic information and supporting evidence; any liability of the IBU in relation to manufacturer's information, LCA data and supporting evidence is excluded. This EPD was compiled in accordance with the requirements of *EN 15804+A2*. This standard is referred to in simplified form as *EN 15804* in the following.
Valid until 14/08/2027	**Verification** European standard *EN 15804* serves as the core PCR Independent verification of the declaration and statements in accordance with *ISO 14025:2011* ☐ internal ☒ external
 Dipl. Ing. Hans Peters (President of Institut Bauen und Umwelt e.V.)	 Matthias Schulz, Independent Verifier
 Dr. Alexander Röder (Executive Director Institut Bauen und Umwelt e.V.)	

Product

Product description/Product definition

This environmental product declaration (EPD) describes hard foam insulation products made from expanded polystyrene (EPS) provided by the IVH members. IVH is member of EUMEPS, the association for European Manufacturers of Expanded Polystyrene.

EPS products provided by the IVH members for the heat and sound insulation of buildings.

The insulation materials are factory-made in the form of boards or loose, thermal insulation filler material. This EPD describes the EPS hard foam products with intermediate bulk density and high compressive strength for different applications such as flat roof or floor insulation.

EPS hard foam is a solid insulation material with a cellular structure which is fabricated from welded, expanded polystyrene or one of its co-polymers. It has a closed-cell, air-filled structure (98% air). EPS boards are rectangular, hard insulation products (cut, moulded or continuously foamed). The board edges can have a rebate edge or tongue and groove. As loose filler material, EPS is factory made in the form of air-filled beads (Ø approx. 6 mm). This environmental product declaration covers the homogeneous EPS insulant without material combination with composite boards or laminated insulation boards.

Essential, characteristic properties are thermal conductivity and compressive strength.

EU regulation no. 305/2011/ (CPR) applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The product requires a

declaration of performance based on *DIN EN 13163:2012+A1:2015, Thermal insulation products for buildings –*
Factory made products of expanded polystyrene (EPS) – Specification, and the CE marking.
The respective national regulations apply to its use.

Application

Primary fields of application for the products declared in this document are **flat roof and floor insulation.** Minimum requirements for these applications are described in *DIN 4108-10* according to the types DAA dh and DEO dh.

Other applications for products under this environmental product declaration include, according to the application types pursuant to *DIN 4108-10*, table 1: WAS, WAA.

- **DAA dh**: Exterior insulation of flat roof and ceiling, exposure-protected, insulation under sealing; high compressive strength
- **DEO dh**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements; high compressive strength
- **WAS**: Exterior insulation of walls exposed to spray water also with partial soil embedding, base
- **WAA**: Exterior wall insulation behind sealing.

Technical data

The following structural/technical data in as-delivered condition are relevant for the product.

Constructional data

Name	Value	Unit
Average bulk density	25	kg/m³
Compressive strength to EN 826	>= 0.150	N/mm²
Design value thermal conductivity acc. to DIN 4108-4	0.035	W/(mK)
Thermal conductivity nominal value acc. to EN 12664	0.034	W/(mK)
Bending resistance acc. to EN 12089	>= 0,10; >= 0,15	N/mm²

The products' performance data meet the declaration of performance in relation to its main features in accordance with *DIN EN 13163:2012+A1:2015 Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification.*

Additional, voluntary information for the product are provided outside of the CE marking.

Base materials/Ancillary materials

The base polymer product for EPS hard foam is polystyrene (PS). It is fabricated by polymerisation of monomeric styrene using a variety of procedures.

The most used raw material production method is polymerisation in a styrene/water suspension, in which the foaming agent pentane is added near the end of the polymerisation process. The PS granulate thus produced is processed into foam in downstream physical processing steps.

The products covered by this declaration are furnished with the flame-retardant polymer-FR. The base material used for insulant production is supplied to the insulant manufacturer in the form of bead-shaped granulate and then physically formed/foamed and reworked.

Composition of expanded polystyrene EPS hard foam

Proportion in mass percent
Polystyrene granulate: 90-93 %
Polymer-FR: 1-5 %
Pentane (in relation to mass percent in the raw material): 5-6 %
Recycled material: 0-12 %

The pentane used for foaming is a C5 hydrocarbon. It is broken down during the manufacturing and storage process.

In the production of flame-protected polystyrene granulate, low amounts of a flame retardant are introduced during polymerisation. Polymer-FR is used as flame retardant for the products declared in this EPD. Manufacturers are required to provide evidence for the products. Polymer-FR is a brominated styrene-butadiene copolymer.

1) The product/at least one part product contains substances of the candidate list of the substances of Very High Concern (SVHC) (as of 17 January 2022) eligible for approval above 0.1 mass percent: **no**

2) The product or at least one part product contains further CMR Category 1A or 1B substances which are not on the candidate list in doses above 0.1 mass percent in at least one part product: **no**

3) Biocidal products were added to this building product or it was treated with biocidal products (is it therefore a processed product as provided for in the EU Biocide Product Directive no. 528/2012): **no**

Manufacture

The manufacture of EPS hard foam follows the process steps pre-foaming, interim storage, foam filling:

In the pre-foaming step, the bead-shaped granulate which holds the foaming agent is softened with overheated water vapour and then expanded by evaporation of the foaming agent. In the next step, the expanded granulate is placed on interim storage in air-penetrable silos. The diffusing air gives the EPS foam particles the stability it needs for the downstream processing steps.

The most used technique for the production of EPS insulant boards is block foaming followed by hot wire cutting.
To this end, the pre-foamed and temporarily stored EPS foam particles are filled into cuboidal block

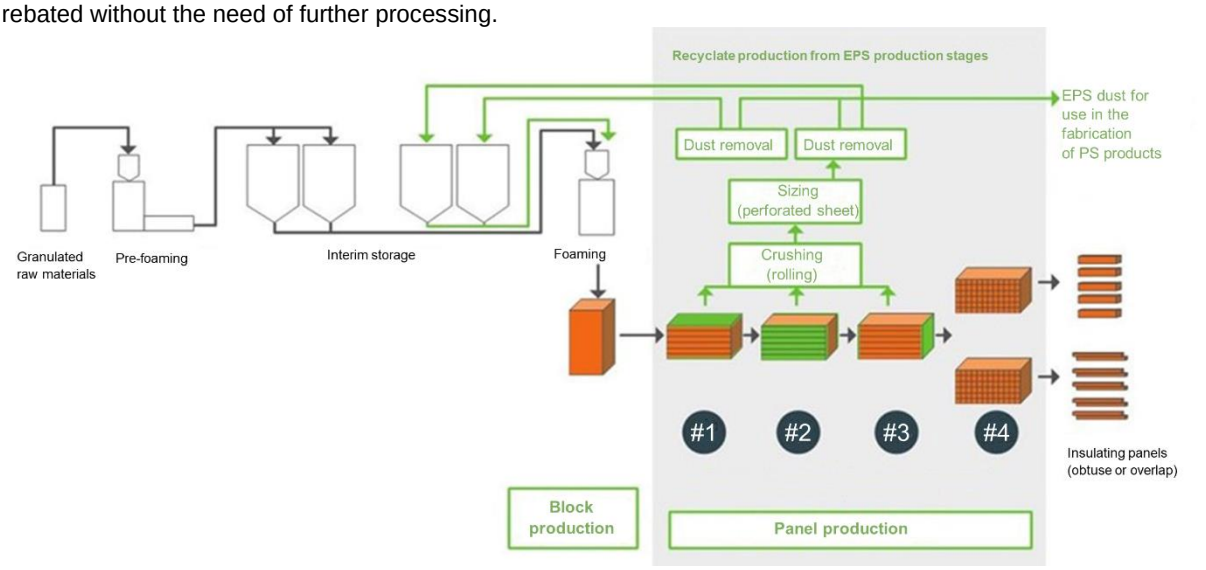
moulds and foamed by adding steam at 110°C to 120°C. In addition, recycled material from production divisions and construction site sections are introduced to the process, and the LCA is accounted for in the module A3.

After a brief cooling-down period, the moulds are removed and the blocks are allowed to settle. Next, the blocks are cut into boards in mechanical or thermal cutters. Additional edge profiles (tongue and groove or rebated edge) can be created by milling.

Boards as shaped parts (second most common technique) can be produced with fully automated machines (shaped part machines). In this case, the finished boards have the desired final shape, e.g. rebated without the need of further processing.

In the belt-foaming process (third most common technique), the boards are foamed in a continuous process in a double-belt plant between revolving steel strips. Here, the boards are produced in the desired thickness and length and then cut.

To make the EPS insulant production more sustainable, recycled material from production offcuts or installation residues taken from construction sites are introduced to the raw material proper. Waste is avoided by reusing such offcuts and remains. Therefore, the use of offcuts and remains is not covered in the modules C1-C4 (disposal stage) and D (credits and charges beyond the system boundaries) of this environmental product declaration.



Environment and health during manufacture

The Technical Rule *TRGS 900* must always be observed for the maximum occupational limit values. Furthermore, no steps beyond the general occupational safety measures are necessary.

EPS hard foam manufacturers are not facilities requiring approval according to *TA Luft*. Additional steps beyond the statutory requirements are not necessary.

In an effort to ensure clean production, the EPS manufacturers within the IVH support the initiative *Operation Clean Sweep*, OCS, a global voluntary initiative of the plastic industry to curtail marine plastic pollution.
The IVH has initiated the *IVH-Initiative Null-Granulatverlust* initiative under the OCS framework which is specifically geared toward logistics and manufacturing processes in the domain of insulant production and to which all IVH members have subscribed.

Product processing/installation

The EPS products possess excellent processing and machining properties due to their relatively low weight among other factors.

The boards are dimensionally stable and absorb only very little humidity, which is relevant both for the entire life stage of the building and for the construction phase.

All applications must be based on the relevant standards and guidelines (e.g., technical regulations of the craft associations) and manufacturer instructions. Additional building physical analyses (e.g., moisture proofing) contribute to increased energy efficiency.

Where insulation boards must be trimmed on site, hot-wire cutting is recommended. This allows for precise cutting and avoiding unnecessary waste.
Installation is generally done by gluing, if necessary also by additional mechanical fixing. Applications are commonly system-specific, i.e. the system components and handling are predefined.

Packaging

EPS insulation boards are generally packaged in polyethylene film, protected with cardboard against impact damage, and delivered on wooden pallets. Delivery on EPS bases as an alternative to wooden pallets is common, too. Disposal of the packaging material is done by qualified disposal companies, while the EPS transport bases are recycled.

Condition of use

The air-filled hard foam possesses very good thermal insulation properties. All materials in the polystyrene used in the manufacture of insulation boards are age and moisture resistant when fitted. The insulation

performance and the mechanical properties of EPS hard foam do not change throughout its service life.

Environment and health during use

EPS insulants have seen use for more than 60 years. They have no known adverse effects on people, animals and the environment.

According to the German Committee for Health-Related Evaluation of Building Products *(AgBB-Schema)*, EPS insulants are suitable for interior applications.

Reference period of use

EPS hard foam-based insulants have an unlimited service life when handled and used properly, without any performance losses.

Limits on service life are only imposed by the service life of the building components and systems which contain EPS. These service lives can be found in the *BBSR table* "Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach Bewertungssystem Nachhaltiges Bauen (BNB)" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the portfolio of the Federal Office for Building and Regional Planning (BBSR). Hence, EPS hard foam-based thermal insulation composite systems have a service life of 40 years. In all other building thermal insulation applications, the service life of EPS hard foam is ≥ 50 years.

Extraordinary influences

Fire protection

The EPS hard foam boards declared in this EPD are flame-retardant, do not form burning droplets; building material class B1 acc. to *DIN 4102-1*.

Name	Value
Building material class according to DIN 4102-1	B 1 - flame retardant
Burning drops	no burning droplets
EURO class according to DIN EN 13501-1	E

Water

EPS hard foam is chemically neutral, insoluble in water, and does not release water-soluble substances which may contaminate the ground water, rivers, and seas.

Thanks to their closed cellular structure, insulation materials made from EPS hard foam may generally be left in the existing structure even in high moisture conditions. The insulation performance stays largely the same.

Mechanical destruction

Data on the behaviour of the product, including possible environmental implications in the event of unpredicted mechanical destruction, are irrelevant.

End-of-life phase

EPS hard foam can be reused or recycled at the end of its service life.

Seeing that, owing to EPS's high durability, only very little EPS insulant waste will accrue now and in the future when buildings are dismantled, EPS recycling will mainly rely on leftovers from insulant production. This was taken into account when calculating the ecological metrics of manufacture. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.

Under certain boundary conditions, it is also possible to fabricate insulation boards from recycling material. Besides, ground recycling material can be used as lightweight aggregate for mortar, concrete and screed. It also serves as additive for Styrofoam lightweight concrete, insulation plasters, lightweight plasters, and the clay industry.

In principle, EPS waste can also be utilised for manufacturing new EPS raw materials. By dissolving the hard foam insulant and separation of the polystyrene from extraneous material via flocculation, the polystyrene can be recovered as raw material. The processes are controlled via the "Creasolve procedure" and performed with the *PolyStyrene-Loop-Initiative* of the European EPS industry at industrial scales (*PolyStyreneLoop-Leitfaden* 2020). This type of utilisation has not yet been included in the LCA data calculation because too little waste is obtained for recycling, due to EPS's long service life.
The standard scenario for a subsequent use continues to be thermal recycling.

LCA: Calculation rules

Declared unit
1 m³ EPS hard foam with 25 kg/m³ bulk density.

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Bulk density	25	kg/m^3

EPD manufacturer groups:
Declaration of a specific product, averaged over several plants and several manufacturers.

The average is formed after weighting of the volume-specific total production quantities of the declared products of the member firms.
As to the variation width, deviations were low with 3% maximum for the use of the main formula constituent polystyrene granulate. Energy requirement variability rather large, due to the different operating parameters and production-related differences. The contributions of power and thermal energy consumption to the overall result, however, are below 15% in most effect categories so that the influence of these variations is rather limited.

System boundary
EPD type: from the cradle to the gate with options, modules C1-C4 and module D (A1-A3 + C + D and additional modules).
The EPD covers the following life cycle stages:

Product stage (A1-A3):
• A1 Raw material provision and processing; working processes of secondary materials serving as input (e.g., recycling processes),
• A2 transport of the raw materials to the factories (reference territory Germany),
• A3 factory production of EPS hard foam, (incl. energy supply, water supply, supply of ancillary materials, supply of recycling material from production and construction side offcuts, production waste disposal, packaging material production).

Construction process stage (A5):
• A5 Installation: only disposal of packaging, other installation operations are not accounted for.

End-of-life stage (C1-C4): End-of-life scenario: 100% thermal recycling
• C1 manual disassembly without operations relevant to LCA,
• C2 road transport (50 km) to waste treatment. Distance may be adjusted at the building level (e.g., if the effective transport distance is 100 km: multiplication of the LCA values with the factor 2).
• C3 100% thermal recycling of the EPS hard foam.
• C4 no other requirements due to landfilling/disposal.

Credits and charges beyond the system boundaries (D):
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam.

Comparability
A comparison or the evaluation of EPD data is principally only possible if all data sets to be compared were compiled in accordance with *EN 15804* and the building context or product-specific performance characteristics are included.

The background data were taken from the GaBi database *(GaBi software)*.

LCA: Scenarios and further technical information

Characteristic product properties
Biogenic carbon
The product itself does not contain any biogenic carbon; only the transport packaging does. When calculating a building LCA, it should be noted that the amount of biogenic CO_2 of this packaging bound in Module A1–A3 is subtracted out in Module A5 (installation in building).

Information to describe the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in product	0	kg C
Biogenic carbon in relevant packaging	0.01	kg C

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if no modules are declared (MND).

Installation into the building (A5)
A5 only covers packaging disposal; other installation requirements (e.g., clippings) are not accounted for.

End-of-life (C1-C4)

Name	Value	Unit
As mixed building waste	25	kg
For energy recovery	25	kg

Reuse, recovery and recycling potential (D), relevant scenario information
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam. A waste incineration plant with an R1 value of > 0.6 was taken as a basis.

LCA: Results

The following tables show the results of the indicators of the impact assessment, resource utilisation, waste, and other output flows in relation to **1 m³ EPS hard foam with 25 kg/m³ bulk density**.

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

Production stage			Construction process stage		Use stage							End of life stage				Credits and charges beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from the gate to the site	Assembly	Use/Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste treatment	Disposal	Reuse, recovery or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	X	ND	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 25 kg/m³ bulk density

Core indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
Total GWP	[kg CO_2 eq.]	7.74E+1	5.01E-1	0.00E+0	7.56E-2	8.40E+1	0.00E+0	-3.48E+1
GWP fossil	[kg CO_2 eq.]	7.71E+1	4.67E-1	0.00E+0	7.48E-2	8.39E+1	0.00E+0	-3.46E+1
GWP biogenic	[kg CO_2 eq.]	3.42E-1	3.41E-2	0.00E+0	2.78E-4	4.62E-3	0.00E+0	-1.59E-1
GWP luluc	[kg CO_2 eq.]	2.37E-2	2.92E-5	0.00E+0	4.81E-4	9.19E-4	0.00E+0	-2.10E-2
ODP	[kg CFC11 eq.]	2.34E-13	2.56E-16	0.00E+0	1.92E-17	1.09E-14	0.00E+0	-3.46E-13
AP	[mol H^+ eq.]	1.14E-1	8.82E-5	0.00E+0	6.46E-5	1.13E-2	0.00E+0	-4.21E-2
EP fresh water	[kg P eq.]	9.15E-5	3.73E-8	0.00E+0	1.54E-7	1.50E-6	0.00E+0	-3.98E-5
EP marine	[kg N eq.]	3.11E-2	2.05E-5	0.00E+0	2.02E-5	1.91E-3	0.00E+0	-1.24E-2
EP terrestrial	[mol N eq.]	3.43E-1	4.08E-4	0.00E+0	2.44E-4	5.26E-2	0.00E+0	-1.33E-1
POCP	[kg NMVOC eq.]	1.08E+0	5.67E-5	0.00E+0	5.53E-5	5.17E-3	0.00E+0	-3.49E-2
ADPE	[kg Sb eq.]	7.78E-6	3.50E-9	0.00E+0	6.52E-9	1.57E-7	0.00E+0	-5.25E-6
ADPF	[MJ]	2.21E+3	2.26E-1	0.00E+0	9.94E-1	1.23E+1	0.00E+0	-5.98E+2
WDP	[m³ world eq. deprived]	5.55E+0	5.14E-2	0.00E+0	2.91E-4	6.80E+0	0.00E+0	-2.32E+0

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

RESULTS OF THE LCA – INDICATORS TO DESCRIBE THE USE OF RESOURCES in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 25 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PERE	[MJ]	4.27E+1	3.18E-1	0.00E+0	5.77E-2	2.66E+0	0.00E+0	-1.19E+2
PERM	[MJ]	2.55E-1	-2.55E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	4.30E+1	6.32E-2	0.00E+0	5.77E-2	2.66E+0	0.00E+0	-1.19E+2
PENRE	[MJ]	1.27E+3	7.93E+0	0.00E+0	9.94E-1	9.62E+2	0.00E+0	-5.99E+2
PENRM	[MJ]	9.58E+2	-7.70E+0	0.00E+0	0.00E+0	-9.50E+2	0.00E+0	0.00E+0
PENRT	[MJ]	2.22E+3	2.26E-1	0.00E+0	9.94E-1	1.23E+1	0.00E+0	-5.99E+2
SM	[kg]	2.76E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	3.17E-1	1.23E-3	0.00E+0	5.13E-5	1.60E-1	0.00E+0	-1.16E-1

Key	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; 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 in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 25 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
HWD	[kg]	2.09E-7	4.85E-11	0.00E+0	4.15E-11	2.58E-9	0.00E+0	-1.32E-7
NHWD	[kg]	6.25E-1	4.88E-2	0.00E+0	1.60E-4	5.10E-1	0.00E+0	-2.64E-1
RWD	[kg]	1.15E-2	7.64E-6	0.00E+0	9.54E-7	3.26E-4	0.00E+0	-3.82E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	9.06E-1	0.00E+0	0.00E+0	1.29E+2	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	2.08E+0	0.00E+0	0.00E+0	2.98E+2	0.00E+0	0.00E+0

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

RESULTS OF THE LCA – Additional impact categories in accordance with *EN 15804+A2*-optional: 1 m³ EPS hard foam with 25 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PM	[Cases of illness]	8.13E-7	1.07E-9	0.00E+0	4.05E-10	7.04E-8	0.00E+0	-3.64E-7
IRP	[kBq U235 eq.]	1.36E+0	7.06E-4	0.00E+0	9.07E-5	3.02E-2	0.00E+0	-6.26E+0
ETP-fw	[CTUe]	1.29E+3	8.24E-2	0.00E+0	8.25E-1	4.81E+0	0.00E+0	-1.11E+2
HTP-c	[CTUh]	2.62E-8	7.34E-12	0.00E+0	1.63E-11	4.87E-10	0.00E+0	-5.53E-9
HTP-nc	[CTUh]	1.18E-6	7.24E-10	0.00E+0	8.06E-10	1.68E-8	0.00E+0	-2.20E-7
SQP	[-]	4.05E+1	6.56E-2	0.00E+0	3.11E-1	3.37E+0	0.00E+0	-8.14E+1

Key	PM = Potential Occurrence of Diseases due to Particle Emissions; IR = Potential Effects of Human Exposure to U235; ETP- fw = Potential Toxicity Comparison Unit for Ecosystems; HTP-c = Potential Toxicity Comparison Unit for Humans (carcinogenic effect); HTP-nc = Potential Toxicity Comparison Unit for Humans (non-carcinogenic effect); SQP = Potential Soil Quality Index

Restriction notice 1 – applies to the “Potential effects of human exposure to U235” indicator. This effect category mainly deals with the possible effect of low-dose ionising radiation on human health in the nuclear cycle. It does not take into account effects which are attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emanating from the soil, from radon and from some building materials is also not measured by this indicator.

Restriction notice 2 – applies to the indicators: “Abiotic depletion potential for non-fossil resources”, “Abiotic depletion potential for fossil resources”, “Water withdrawal potential (user)”, “Potential toxicity comparison unit for ecosystems”, “Potential toxicity comparison unit for humans – carcinogenic effect”, “Potential toxicity comparison unit for humans – non-carcinogenic effect”, “Potential soil quality index". The results of this environmental impact category must be applied with care, as uncertainties with these results are high or because there is a lack of experience with the indicator.

EPS is generally radon-free.

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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Owner of the declaration	**Industrieverband Hartschaum e.V., IVH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVH-20220132-CBG1-DE
Issue date	15/08/2022
Valid until	14/08/2027

EPS hard foam – white with high bulk density
preferentially for perimeter and base insulation,
high compressive strength

Industrieverband Hartschaum e.V. (IVH)

Member of EUMEPS, the association of European
Manufacturers of Expanded Polystyrene

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

General information

Industrieverband Hartschaum e.V. (IVH)	EPS hard foam (bulk density 30 kg/m³)
Programme holder IBU – Institut Bauen und Umwelt e.V. Hegelplatz 1 D-10117 Berlin Germany	**Owner of the declaration** Industrieverband Hartschaum e.V., IVH Friedrichstrasse 95, Pb 152 D-10117 Berlin
Declaration number EPD-IVH-20220132-CBG1-DE	**Declared product/Declared unit** The declared unit is 1m³ of expanded polystyrene hard foam for thermal and sound insulation. The average bulk density is 30 kg/m³.
This declaration is based on the following product category rules: Foam plastic insulation materials, 01.2019 (PCR tested and approved by the independent advisory board (SVR))	**Scope of application:** This EPD describes the EPS hard foam products for thermal and sound insulation with an average bulk density of 30 kg/m³. The participating member firms represent 90 volume percent of the total number of all IVH member firms in the year 2020.
Issue date 15/08/2022	The owner of the declaration is liable for the basic information and supporting evidence; any liability of the IBU in relation to manufacturer's information, LCA data and supporting evidence is excluded.
Valid until 14/08/2027	This EPD was compiled in accordance with the requirements of *EN 15804+A2*. This standard is referred to in simplified form as *EN 15804* in the following.
	Verification
	European standard *EN 15804* serves as the core PCR
	Independent verification of the declaration and statements in accordance with *ISO 14025:2011*
	☐ internal ☒ external
Dipl. Ing. Hans Peters (President of Institut Bauen und Umwelt e.V.)	
Dr. Alexander Röder (Executive Director Institut Bauen und Umwelt e.V.)	Matthias Schulz, Independent Verifier

Product

Product description/Product definition

This environmental product declaration (EPD) describes hard foam insulation products made from expanded polystyrene (EPS) provided by the IVH members. IVH is member of EUMEPS, the association for European Manufacturers of Expanded Polystyrene.

EPS products provided by the IVH members for the heat and sound insulation of buildings.

The insulation materials are factory-made in the form of boards or loose, thermal insulation filler material. This EPD describes white, high bulk density EPS hard foam products for different fields of application, preferentially perimeter or base insulation.

EPS hard foam is a solid insulation material with a cellular structure which is fabricated from welded, expanded polystyrene or one of its co-polymers. It has a closed-cell, air-filled structure (98% air). EPS boards are rectangular, hard insulation products (cut, moulded or continuously foamed). The board edges can have a rebate edge or tongue and groove. As loose filler material, EPS is factory made in the form of air-filled beads (Ø approx. 6 mm). This environmental product declaration covers the homogeneous EPS insulant without material combination with composite boards or laminated insulation boards.

Essential, characteristic properties are thermal conductivity and compressive strength.

EU regulation no. 305/2011/ (CPR) applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The product requires a declaration of performance based on *DIN EN 13163:2012+A1:2015, Thermal insulation products for*

buildings –
Factory made expanded polystyrene. (EPS) products - Specification or a European Technical Assessment (ETA) on the basis of the European Assessment Document EAD 040773-00-1201 and CE marking. The respective national regulations apply to its use.

Application

Main applications of the products declared herein are perimeter and base insulation, and flat roof / floor insulation with very high compressive strength.

Minimum requirements on flat roof, floor and base insulation are given in *DIN 4108-10*, according to types DAA ds, DEO ds, and WAS.

- **DAA ds**: Exterior insulation of flat roof and ceiling, exposure-protected, insulation under sealing; high compressive strength
- **DEO ds**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements; high compressive strength
- **WAS**: Exterior insulation of walls exposed to spray water also with partial soil embedding, base

Minimum requirements for perimeter products under this environmental product declaration are given in the European Assessment Document EAD 040773-00-1201.

Technical data

The following structural/technical data in as-delivered condition are relevant for the product.

Constructional data

Name	Value	Unit
Average bulk density	30	kg/m³
Compressive strength to EN 826	>= 0.200	N/mm²
Design value thermal conductivity acc. to DIN 4108-4	0.035	W/(mK)
Thermal conductivity nominal value acc. to EN 12664	0.034	W/(mK)
Bending resistance acc. to EN 12089	>= 0.25	N/mm²

Please note: The design value for the thermal conductivity of perimeter boards in contact with the ground is determined by general type approvals.

The products' performance data meet the declaration of performance according to CPR in relation to its main features in accordance with *DIN EN 13163:2012+A1:2015 Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification,* or the manufacturer's ETA.

Voluntary information for the product: Source, date, title (not part of CE marking)

Base materials/Ancillary materials

The base polymer product for EPS hard foam is polystyrene (PS). It is fabricated by polymerisation of monomeric styrene using a variety of procedures.

The most commonly used raw material production method is polymerisation in a styrene/water suspension, in which the foaming agent pentane is added near the end of the polymerisation process. The PS granulate thus produced is processed into foam in downstream physical processing steps.

The products covered by this declaration are furnished with the flame retardant polymer-FR. The base material used for insulant production is supplied to the insulant manufacturer in the form of bead-shaped granulate and then physically formed/foamed and reworked.

Composition of expanded polystyrene EPS hard foam

Proportion in mass percent
Polystyrene granulate: 90-93 %
Polymer-FR: 1-5 %
Pentane (in relation to mass percent in the raw material): 5-6 %
Recycled material: 0-12 %

The pentane used for foaming is a C5 hydrocarbon. It is broken down during the manufacturing and storage process.

In the production of flame-protected polystyrene granulate, low amounts of a flame retardant are introduced during polymerisation. Polymer-FR is used as flame retardant for the products declared in this EPD. Manufacturers are required to provide evidence for the products. Polymer-FR is a brominated styrene-butadiene copolymer.

1) The product/at least one part product contains substances of the candidate list of the substances of Very High Concern (SVHC) (as of 17 January 2022) eligible for approval above 0.1 mass percent: **no**

2) The product or at least one part product contains further CMR Category 1A or 1B substances which are not on the candidate list in doses above 0.1 mass percent in at least one part product: **no**

3) Biocidal products were added to this building product or it was treated with biocidal products (is it therefore a processed product as provided for in the EU Biocide Product Directive no. 528/2012): **no**

Manufacture

The manufacture of EPS hard foam follows the process steps pre-foaming, interim storage, foam filling:

In the pre-foaming step, the bead-shaped granulate which holds the foaming agent is softened with overheated water vapour and then expanded by evaporation of the foaming agent. In the next step, the expanded granulate is placed on interim storage in air-penetrable silos. The diffusing air gives the EPS foam particles the stability it needs for the downstream processing steps.

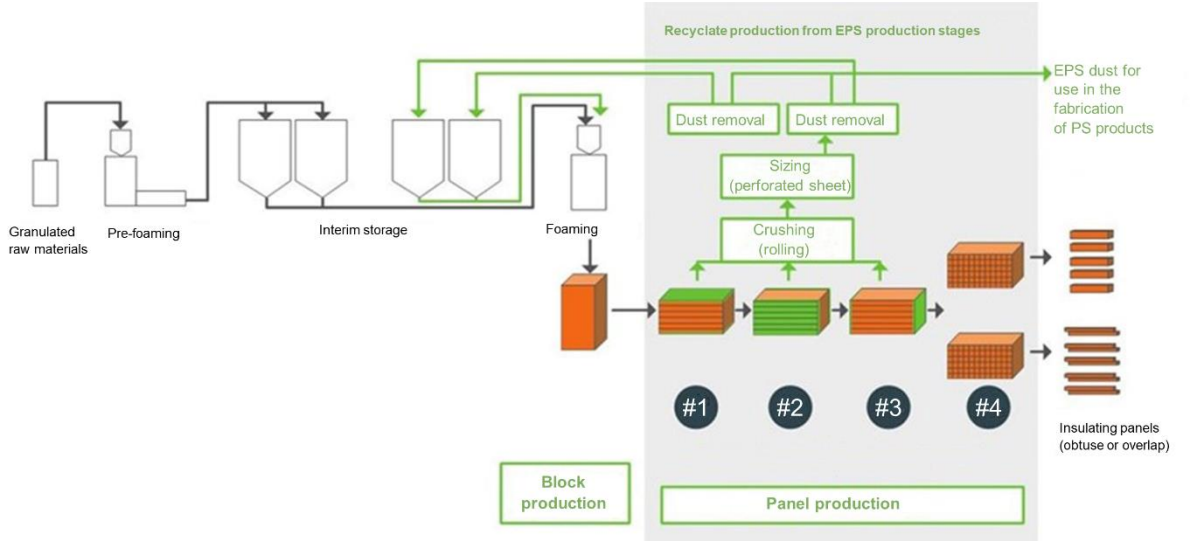
The most commonly used technique for the production of EPS insulant boards is block foaming followed by hot wire cutting.
To this end, the pre-foamed and temporarily stored EPS foam particles are filled into cuboidal block moulds and foamed by adding steam at 110°C to 120°C. In addition, recycled material from production divisions and construction site sections are introduced to the process, and the LCA is accounted for in the module A3.

After a brief cooling-down period, the moulds are removed and the blocks are allowed to settle. Next, the blocks are cut into boards in mechanical or thermal cutters. Additional edge profiles (tongue and groove or rebated edge) can be created by milling.

Boards as shaped parts (second most common technique) can be produced with fully automated machines (shaped part machines). In this case, the finished boards have the desired final shape, e.g. rebated without the need of further processing.

In the belt-foaming process (third most common technique), the boards are foamed in a continuous process in a double-belt plant between revolving steel strips. Here, the boards are produced in the desired thickness and length and then cut.

To make the EPS insulant production more sustainable, recycled material from production offcuts or installation residues taken from construction sites are introduced to the raw material proper. Waste is avoided by reusing such offcuts and remains. Therefore, the use of offcuts and remains is not covered in the modules C1-C4 (disposal stage) and D (credits and charges beyond the system boundaries) of this environmental product declaration. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.



Environment and health during manufacture

The Technical Rule *TRGS 900* must always be observed for the maximum occupational limit values. Furthermore, no steps beyond the general occupational safety measures are necessary.

EPS hard foam manufacturers are not facilities requiring approval according to *TA Luft*. Additional steps beyond the statutory requirements are not necessary.

In an effort to ensure clean production, the EPS manufacturers within the IVH support the initiative *Operation Clean Sweep*, OCS, a global voluntary initiative of the plastic industry to curtail marine plastic pollution.
The IVH has initiated the *IVH-Initiative Null-Granulatverlust* initiative under the OCS framework which is specifically geared toward logistics and manufacturing processes in the domain of insulant production and to which all IVH members have subscribed.

Product processing/installation

The EPS products possess excellent processing and machining properties due to their relatively low weight among other factors.

The boards are dimensionally stable and absorb only very little humidity, which is relevant both for the entire life stage of the building and for the construction phase.

All applications must be based on the relevant standards and guidelines (e.g., IVH guidance *EPS zur Verwendung als Sockelplatten in Spritzwasserbereichen* and technical regulations of the craft associations) and manufacturer instructions. Additional building physical analyses (e.g., moisture proofing) contribute to increased energy efficiency.

Where insulation boards must be trimmed on site, hot-wire cutting is recommended. This allows for precise cutting and avoiding unnecessary waste.
Installation is done by gluing, if necessary also by additional mechanical fixing. Application is system-specific, requiring a general type approval which defines the system components and finish.

Packaging

EPS insulation boards are generally packaged in polyethylene film, protected with cardboard against impact damage, and delivered on wooden pallets. Delivery on EPS bases as an alternative to wooden pallets is common, too. Disposal of the packaging material is done by qualified disposal companies, while the EPS transport bases are recycled.

Condition of use

The air-filled hard foam possesses very good thermal insulation properties. All materials in the polystyrene used in the manufacture of insulation boards are age and moisture resistant when fitted. The insulation performance and the mechanical properties of EPS hard foam do not change throughout its service life.

Environment and health during use

EPS insulants have seen use for more than 60 years. They have no known adverse effects on people, animals and the environment.

According to the German Committee for Health-Related Evaluation of Building Products *(AgBB-Schema)*, EPS insulants are suitable for interior applications.

Reference period of use

EPS hard foam-based insulants have an unlimited service life when handled and used properly, without any performance losses.

Limits on service life are only imposed by the service life of the building components and systems which contain EPS. These service lives can be found in the *BBSR table* “Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach Bewertungssystem Nachhaltiges Bauen (BNB)” of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the portfolio of the Federal Office for Building and Regional Planning (BBSR). Hence, EPS hard foam-based thermal insulation composite systems have a service life of 40 years. In all other building thermal insulation applications, the service life of EPS hard foam is ≥ 50 years.

Extraordinary influences

Fire protection

The EPS hard foam boards declared in this EPD are flame-retardant, do not form burning droplets; building material class B1 acc. to *DIN 4102-1*.

Name	Value
Building material class according to DIN 4102-1	B 1 - flame retardant
Burning drops	no burning droplets
EURO class according to DIN EN 13501-1	E

Water

EPS hard foam is chemically neutral, insoluble in water, and does not release water-soluble substances which may contaminate the ground water, rivers, and seas.

Thanks to their closed cellular structure, insulation materials made from EPS hard foam may generally be left in the existing structure even in high moisture conditions. The insulation performance stays largely the same.

Mechanical destruction

Data on the behaviour of the product, including possible environmental implications in the event of unpredicted mechanical destruction, are irrelevant.

End-of-life phase

EPS hard foam can be reused or recycled at the end of its service life. EPS is fully recyclable.

Seeing that, owing to EPS’s high durability, only very little EPS insulant waste will accrue now and in the future when buildings are dismantled, EPS recycling will mainly rely on leftovers from insulant production. This was taken into account when calculating the ecological metrics of manufacture. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.

Under certain boundary conditions, it is also possible to fabricate insulation boards from recycling material. Besides, ground recycling material can be used as lightweight aggregate for mortar, concrete and screed. It also serves as additive for Styrofoam lightweight concrete, insulation plasters, lightweight plasters, and the clay industry.

In principle, EPS waste can also be utilised for manufacturing new EPS raw materials. By dissolving the hard foam insulant and separation of the polystyrene from extraneous material via flocculation, the polystyrene can be recovered as raw material. The processes are controlled via the “Creasolve procedure” and performed with the *PolyStyrene-Loop-Initiative* of the European EPS industry at industrial scales (*PolyStyreneLoop-Leitfaden* 2020). This type of utilisation has not yet been included in the LCA data calculation because too little waste is obtained for recycling, due to EPS’s long service life. The standard scenario for a subsequent use continues to be thermal recycling.

LCA: Calculation rules

Declared unit
1 m³ EPS hard foam with 30 kg/m³ bulk density.

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Bulk density	30	kg/m^3

EPD manufacturer groups:
Declaration of a specific product, averaged over several plants and several manufacturers.
The average is formed after weighting of the volume-specific total production quantities of the declared products of the member firms.
As to the variation width, deviations were low with 3% maximum for the use of the main formula constituent polystyrene granulate. Energy requirement variability rather large, due to the different operating parameters and production-related differences. The contributions of power and thermal energy consumption to the overall result, however, are below 15% in most effect categories so that the influence of these variations is rather limited.

System boundary
EPD type: from the cradle to the gate with options, modules C1-C4 and module D (A1-A3 + C + D and additional modules).

The EPD covers the following life cycle stages:

Product stage (A1-A3):
• A1 Raw material provision and processing; working processes of secondary materials serving as input (e.g., recycling processes),
• A2 transport of the raw materials to the factories (reference territory Germany),
• A3 factory production of EPS hard foam, (incl. energy supply, water supply, supply of ancillary materials, supply of recycling material from production and construction side offcuts, production waste disposal, packaging material production).

Construction process stage (A5):
• A5 Installation: only disposal of packaging, other installation operations are not accounted for.

End-of-life stage (C1-C4): End-of-life scenario: 100% thermal recycling
• C1 manual disassembly without operations relevant to LCA,
• C2 road transport (50 km) to waste treatment.
Distance may be adjusted at the building level (e.g., if the effective transport distance is 100 km: multiplication of the LCA values with the factor 2).
• C3 100% thermal recycling of the EPS hard foam.
• C4 no other requirements due to landfilling/disposal.

Credits and charges beyond the system boundaries (D):
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam.

Comparability
A comparison or the evaluation of EPD data is principally only possible if all data sets to be compared were compiled in accordance with *EN 15804* and the building context or product-specific performance characteristics are included.

The background data were taken from the GaBi database *(GaBi software)*.

LCA: Scenarios and further technical information

Characteristic product properties
Biogenic carbon
The product itself does not contain any biogenic carbon; only the transport packaging does. When calculating a building LCA, it should be noted that the amount of biogenic CO_2 of this packaging bound in Module A1–A3 is subtracted out in Module A5 (installation in building).

Information to describe the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in product	0	kg C
Biogenic carbon in relevant packaging	0.05	kg C

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if no modules are declared (MND).

Installation into the building (A5)
A5 only covers packaging disposal; other installation requirements (e.g., clippings) are not accounted for.

End-of-life (C1-C4)

Name	Value	Unit
As mixed building waste	30	kg
For energy recovery	30	kg

Reuse, recovery and recycling potential (D), relevant scenario information
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam. A waste incineration plant with an R1 value of > 0.6 was taken as a basis.

LCA: Results

The following tables show the results of the indicators of the impact assessment, resource utilisation, waste, and other output flows in relation to **1 m³ EPS hard foam with 30 kg/m³ bulk density**.

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

Production stage			Construction process stage		Use stage							End of life stage				Credits and charges beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from the gate to the site	Assembly	Use/Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste treatment	Disposal	Reuse, recovery or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	X	ND	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 30 kg/m³ bulk density

Core indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
Total GWP	[kg CO_2 eq.]	8.77E+1	5.71E-1	0.00E+0	9.07E-2	1.01E+2	0.00E+0	-4.17E+1
GWP fossil	[kg CO_2 eq.]	8.74E+1	3.79E-1	0.00E+0	8.98E-2	1.01E+2	0.00E+0	-4.15E+1
GWP biogenic	[kg CO_2 eq.]	2.92E-1	1.91E-1	0.00E+0	3.33E-4	5.55E-3	0.00E+0	-1.91E-1
GWP luluc	[kg CO_2 eq.]	2.75E-2	2.72E-5	0.00E+0	5.78E-4	1.10E-3	0.00E+0	-2.52E-2
ODP	[kg CFC11 eq.]	6.45E-13	2.50E-16	0.00E+0	2.30E-17	1.31E-14	0.00E+0	-4.14E-13
AP	[mol H^+ eq.]	1.27E-1	1.09E-4	0.00E+0	7.75E-5	1.35E-2	0.00E+0	-5.05E-2
EP fresh water	[kg P eq.]	1.05E-4	3.64E-8	0.00E+0	1.85E-7	1.81E-6	0.00E+0	-4.77E-5
EP marine	[kg N eq.]	3.43E-2	2.79E-5	0.00E+0	2.42E-5	2.29E-3	0.00E+0	-1.48E-2
EP terrestrial	[mol N eq.]	3.75E-1	5.05E-4	0.00E+0	2.93E-4	6.31E-2	0.00E+0	-1.59E-1
POCP	[kg NMVOC eq.]	1.39E+0	7.55E-5	0.00E+0	6.63E-5	6.20E-3	0.00E+0	-4.18E-2
ADPE	[kg Sb eq.]	9.29E-6	3.44E-9	0.00E+0	7.82E-9	1.88E-7	0.00E+0	-6.29E-6
ADPF	[MJ]	2.60E+3	2.27E-1	0.00E+0	1.19E+0	1.48E+1	0.00E+0	-7.17E+2
WDP	[m³ world eq. deprived]	6.53E+0	5.96E-2	0.00E+0	3.50E-4	8.17E+0	0.00E+0	-2.78E+0

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

RESULTS OF THE LCA – INDICATORS TO DESCRIBE THE USE OF RESOURCES in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 30 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PERE	[MJ]	5.27E+1	1.50E+0	0.00E+0	6.92E-2	3.19E+0	0.00E+0	-1.43E+2
PERM	[MJ]	1.44E+0	-1.44E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	5.41E+1	6.14E-2	0.00E+0	6.92E-2	3.19E+0	0.00E+0	-1.43E+2
PENRE	[MJ]	1.46E+3	6.43E+0	0.00E+0	1.19E+0	1.15E+3	0.00E+0	-7.18E+2
PENRM	[MJ]	1.15E+3	-6.21E+0	0.00E+0	0.00E+0	-1.14E+3	0.00E+0	0.00E+0
PENRT	[MJ]	2.61E+3	2.27E-1	0.00E+0	1.19E+0	1.48E+1	0.00E+0	-7.18E+2
SM	[kg]	4.78E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	3.52E-1	1.42E-3	0.00E+0	6.15E-5	1.92E-1	0.00E+0	-1.39E-1

Key	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; 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 in accordance with *EN 15804+A2*: 1 m³ EPS hard foam with 30 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
HWD	[kg]	2.45E-7	4.93E-11	0.00E+0	4.98E-11	3.10E-9	0.00E+0	-1.58E-7
NHWD	[kg]	6.64E-1	4.12E-2	0.00E+0	1.92E-4	6.12E-1	0.00E+0	-3.17E-1
RWD	[kg]	1.30E-2	7.45E-6	0.00E+0	1.14E-6	3.92E-4	0.00E+0	-4.58E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	9.36E-1	0.00E+0	0.00E+0	1.55E+2	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	2.16E+0	0.00E+0	0.00E+0	3.58E+2	0.00E+0	0.00E+0

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

RESULTS OF THE LCA – Additional impact categories in accordance with *EN 15804+A2*-optional: 1 m³ EPS hard foam with 30 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PM	[Cases of illness]	9.06E-7	1.07E-9	0.00E+0	4.86E-10	8.45E-8	0.00E+0	-4.36E-7
IRP	[kBq U235 eq.]	1.55E+0	6.89E-4	0.00E+0	1.09E-4	3.62E-2	0.00E+0	-7.51E+0
ETP-fw	[CTUe]	1.48E+3	8.44E-2	0.00E+0	9.90E-1	5.77E+0	0.00E+0	-1.32E+2
HTP-c	[CTUh]	3.07E-8	7.12E-12	0.00E+0	1.96E-11	5.85E-10	0.00E+0	-6.63E-9
HTP-nc	[CTUh]	1.36E-6	6.31E-10	0.00E+0	9.67E-10	2.01E-8	0.00E+0	-2.64E-7
SQP	[-]	6.69E+1	6.63E-2	0.00E+0	3.73E-1	4.05E+0	0.00E+0	-9.75E+1

Key	PM = Potential Occurrence of Diseases due to Particle Emissions; IR = Potential Effects of Human Exposure to U235; ETP- fw = Potential Toxicity Comparison Unit for Ecosystems; HTP-c = Potential Toxicity Comparison Unit for Humans (carcinogenic effect); HTP-nc = Potential Toxicity Comparison Unit for Humans (non-carcinogenic effect); SQP = Potential Soil Quality Index

Restriction notice 1 – applies to the “Potential effects of human exposure to U235” indicator. This effect category mainly deals with the possible effect of low-dose ionising radiation on human health in the nuclear cycle. It does not take into account effects which are attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emanating from the soil, from radon and from some building materials is also not measured by this indicator.

Restriction notice 2 – applies to the indicators: “Abiotic depletion potential for non-fossil resources”, “Abiotic depletion potential for fossil resources”, “Water withdrawal potential (user)”, “Potential toxicity comparison unit for ecosystems”, “Potential toxicity comparison unit for humans – carcinogenic effect”, “Potential toxicity comparison unit for humans – non-carcinogenic effect”, “Potential soil quality index". The results of this environmental impact category must be applied with care, as uncertainties with these results are high or because there is a lack of experience with the indicator.

EPS is generally radon-free.

References

Standards

DIN 4102-1
DIN 4102-1:1998-05, Fire behaviour of building materials and building components – Part 1: Building materials; concepts, requirements and tests

DIN 4108-4
DIN 4108-4:2017-03, Thermal insulation and energy economy in buildings – Part 4: Hygrothermal design values.

DIN 4108-10
DIN 4108-10:2021-11, Thermal insulation and energy economy in buildings – Part 10: Application-specific requirements for thermal insulants – factory-made thermal insulants.

EN 13163
DIN EN 13163:2015-04, Thermal insulation products for buildings – Factory made expanded polystyrene (EPS) products – Specification.

EN 13501-1
DIN EN 13501-1:2019-05, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests.

EN 15804
EN 15804+A2:2019+AC:2021, Sustainability of construction works. Environmental product declarations – Core rules for the product category of construction.

ISO 14025
DIN EN ISO 14025:2011-10, Environmental labels and declarations - Type III environmental declarations – Principles and procedures.

Laws and regulations

EWC
European Waste Catalogue (EWC) of 10th December 2001 (Federal Legal Gazette I p. 3379), last amended by article 1 of the ordinance of 30 June 2020 (Federal Legal Gazette I p. 1533).

BBSR table
Service life of building components for life cycle analyses according to Assessment System for Sustainable Building (BNB) of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR).

TA Luft
Technical guideline for air pollution control (TA Luft: 2021-08-18); the first general administrative specification under federal pollution control law.

TRGS 900
Technical Rules for Hazardous Substances (TRGS 900), edition: January 2006, last amended and expanded in TRGS 900 Änd 2021-06:2021-06-11.

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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Owner of the declaration	**Industrieverband Hartschaum e.V., IVH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVH-20220127-CBG1-DE
Issue date	15/08/2022
Valid until	14/08/2027

EPS hard foam – grey with low bulk density
preferentially for ETICS and interior insulation

Industrieverband Hartschaum e.V. (IVH)

Member of EUMEPS, the association of European Manufacturers of Expanded Polystyrene

Institut Bauen und Umwelt e.V.

ECO PLATFORM EPD VERIFIED

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

General information

Industrieverband Hartschaum e.V. (IVH)

Programme holder
IBU – Institut Bauen und Umwelt e.V.
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D-10117 Berlin
Germany

Declaration number
EPD-IVH-20220127-CBG1-DE

This declaration is based on the following product category rules:
Foam plastic insulation materials, 01.2019
(PCR tested and approved by the independent advisory board (SVR))

Issue date
15/08/2022

Valid until
14/08/2027

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

Dr. Alexander Röder
(Executive Director Institut Bauen und Umwelt e.V.)

EPS hard foam (grey, bulk density 15 kg/m³)

Owner of the declaration
Industrieverband Hartschaum e.V., IVH
Friedrichstrasse 95, Pb 152
D-10117 Berlin

Declared product/Declared unit
The declared unit is 1m³ of expanded polystyrene hard foam for heat and sound insulation. The average bulk density is 15 kg/m³.

Scope of application:
This EPD describes the grey EPS hard foam products for heat and sound insulation with an average bulk density of 15 kg/m³.

The participating member firms represent 90 volume percent of the total number of all IVH member firms in the year 2020.

The owner of the declaration is liable for the basic information and supporting evidence; any liability of the IBU in relation to manufacturer's information, LCA data and supporting evidence is excluded.

This EPD was compiled in accordance with the requirements of *EN 15804+A2*. This standard is referred to in simplified form as *EN 15804* in the following.

Verification

European standard *EN 15804* serves as the core PCR
Independent verification of the declaration and statements in accordance with *ISO 14025:2011*
☐ internal ☒ external

Matthias Schulz,
Independent Verifier

Product

Product description/Product definition

This environmental product declaration (EPD) describes grey hard foam insulation products made from expanded polystyrene (EPS) provided by the IVH members. IVH is member of EUMEPS, the association for European Manufacturers of Expanded Polystyrene.

EPS products provided by the IVH members for the heat and sound insulation of buildings.

The insulation materials are factory-made in the form of boards or loose, thermal insulation filler material. This EPD describes the grey, low-bulk density, EPS hard foam products for different fields of application such as façades, preferentially in thermal insulation composite systems (ETICS, External Thermal Insulation Composite Systems). Acting as heat absorber, the graphite improves the insulation performance substantially.

EPS hard foam is a solid insulation material with a cellular structure which is fabricated from welded, expanded polystyrene or one of its co-polymers. It has a closed-cell, air-filled structure (98% air). EPS boards are rectangular, hard insulation products (cut, moulded or continuously foamed). The board edges can have a rebate edge or tongue and groove. As loose filler material, EPS is factory made in the form of air-filled beads (Ø approx. 6 mm). This environmental product declaration covers the homogeneous EPS insulant without material combination with composite boards or laminated insulation boards.

Essential, characteristic properties are thermal conductivity, bending resistance, and transverse tensile strength.

EU regulation no. 305/2011/ (CPR) applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The product requires a declaration of performance based on *DIN EN 13163:2012+A1:2015, Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification*, and the CE label. The respective national regulations apply to its use.

Application

The primary field of application for the products declared in this document is the **façade insulation with external thermal insulation composite systems (ETICS).**

The joint *Qualitätsrichtlinien für EPS in WDVS, 2020* define the properties of the EPS boards for thermal insulation composite systems declared herein.

Other applications for products under this environmental product declaration include, according to the application types pursuant to *DIN 4108-10*, table 1: WI, DI, WZ, DZ, WAP, WAB, and DES.

- **WI**: Interior wall insulation
- **DI**: Interior insulation of ceiling (bottom side) or roof, insulation under rafters/supporting structure, suspended ceiling, etc.
- **WZ**: Insulation of double walls, core insulation
- **DZ**: Insulation between rafters, double roof, non-walkable but accessible top floor ceilings
- **WAP**: Exterior, buried insulation of the wall; also for application case 'from below against outside air; WAP is not for embedding into the soil and for insulant boards in the external thermal insulation composite system (ETICS).
- **WAB**: Exterior wall insulation behind lining; also for application case 'from below against outside air'
- **DES**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements

Technical data

The following structural/technical data in as-delivered condition are relevant for the declared ETICS product.

Constructional data

Name	Value	Unit
Average bulk density	15	kg/m³
Design value thermal conductivity acc. to DIN 4108-4	0.031 - 0.034	W/(mK)
Thermal conductivity nominal value acc. to EN 12664	0.03 - 0.033	W/(mK)
Bending resistance acc. to EN 12089	>= 0,10; >= 0,15	N/mm²
Shearing resistance acc. to EN 12090	>= 0.05	N/mm²
Shear module acc. to EN 12090	>= 1.0	N/mm²
Transverse tensile strength acc. to EN 1607	>= 0.08; >= 0,10	N/mm²

The products' performance data meet the declaration of performance in relation to its main features in accordance with *DIN EN 13163:2012+A1:2015 Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification.*

Additional, voluntary information for the product is provided outside of the CE marking.

Base materials/Ancillary materials

The base polymer product for EPS hard foam is polystyrene (PS). It is fabricated by polymerisation of monomeric styrene using a variety of procedures.

The most used raw material production method is polymerisation in a styrene/water suspension, in which the foaming agent pentane and the graphite are added near the end of the polymerisation process. The PS granulate thus produced is processed into foam in downstream physical processing steps.

The products covered by this declaration are furnished with the flame-retardant polymer-FR. The base material used for insulant production is supplied to the insulant manufacturer in the form of bead-shaped granulate and then physically formed/foamed and reworked.

Composition of grey expanded polystyrene EPS hard foam

Proportion in mass percent
Polystyrene granulate: 80-90 %
Polymer-FR: 1-5 %
Graphite: 3.5-10 %
Pentane (in relation to mass percent in the raw material): 5-6 %
Recycled material: 0-12 %

The pentane used for foaming is a C5 hydrocarbon. It is broken down during the manufacturing and storage process.

In the production of flame-protected polystyrene granulate, low amounts of a flame retardant are introduced during polymerisation. Polymer-FR is used as flame retardant for the products declared in this EPD. Manufacturers are required to provide evidence for the products. Polymer-FR is a brominated styrene-butadiene copolymer.

1) The product/at least one part product contains substances of the candidate list of the substances of Very High Concern (SVHC) (as of 17 January 2022) eligible for approval above 0.1 mass percent: **no**

2) The product or at least one part product contains further CMR Category 1A or 1B substances which are not on the candidate list in doses above 0.1 mass percent in at least one part product: **no**

3) Biocidal products were added to this building product or it was treated with biocidal products (is it

therefore a processed product as provided for in the EU Biocide Product Directive no. 528/2012): **no**

Manufacture

The manufacture of EPS hard foam follows the process steps pre-foaming, interim storage, foam filling:

In the pre-foaming step, the bead-shaped granulate which holds the foaming agent is softened with overheated water vapour and then expanded by evaporation of the foaming agent. In the next step, the expanded granulate is placed on interim storage in air-penetrable silos. The diffusing air gives the EPS foam particles the stability it needs for the downstream processing steps.

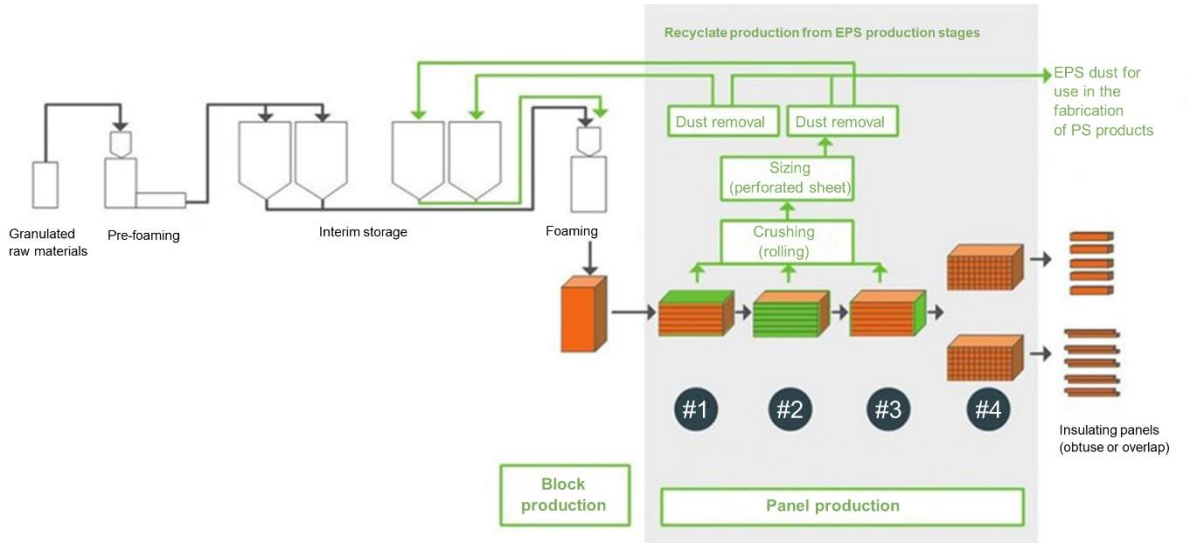
The most used technique for the production of EPS insulant boards is block foaming followed by hot wire cutting.
To this end, the pre-foamed and temporarily stored EPS foam particles are filled into cuboidal block moulds and foamed by adding steam at 110°C to 120°C. In addition, recycled material from production divisions and construction site sections are introduced to the process, and the LCA is accounted for in the module A3.

After a brief cooling-down period, the moulds are removed and the blocks are allowed to settle. Next, the blocks are cut into boards in mechanical or thermal cutters. Additional edge profiles (tongue and groove or rebated edge) can be created by milling.

Boards as shaped parts (second most common technique) can be produced with fully automated machines (shaped part machines). In this case, the finished boards have the desired final shape, e.g. rebated without the need of further processing.

In the belt-foaming process (third most common technique), the boards are foamed in a continuous process in a double-belt plant between revolving steel strips. Here, the boards are produced in the desired thickness and length and then cut.

To make the EPS insulant production more sustainable, recycled material from production offcuts or installation residues taken from construction sites are introduced to the raw material proper. Waste is avoided by reusing such offcuts and remains. Therefore, the use of offcuts and remains is not covered in the modules C1-C4 (disposal stage) and D (credits and charges beyond the system boundaries) of this environmental product declaration.



Environment and health during manufacture

The Technical Rule *TRGS 900* must always be observed for the maximum occupational limit values. Furthermore, no steps beyond the general occupational safety measures are necessary.

EPS hard foam manufacturers are not facilities requiring approval according to *TA Luft*. Additional steps beyond the statutory requirements are not necessary.

In an effort to ensure clean production, the EPS manufacturers within the IVH support the initiative *Operation Clean Sweep*, OCS, a global voluntary initiative of the plastic industry to curtail marine plastic pollution.

The IVH has initiated the *IVH-Initiative Null-Granulatverlust* initiative under the OCS framework which is specifically geared toward logistics and manufacturing processes in the domain of insulant production and to which all IVH members have subscribed.

Product processing/installation

The EPS products possess excellent processing and machining properties due to their relatively low weight among other factors.

The boards are dimensionally stable and absorb only very little humidity, which is relevant both for the entire life stage of the building and for the construction phase.

All applications must be based on the relevant standards and guidelines (e.g., IVH guidance *EPS zur Verwendung als Sockelplatten in*

Spritzwasserbereichen 2020 and technical regulations of the craft associations) and manufacturer instructions. Additional building physical analyses (e.g., moisture proofing) contribute to increased energy efficiency.

The boards for ETICS are installed along the façade and plastered. Where insulation boards must be trimmed on site, hot-wire cutting is recommended. This allows for precise cutting and avoiding unnecessary waste.
Installation is done by gluing, if necessary also by additional mechanical fixing. Application is system-specific, requiring a general type approval which defines the system components and finish.

Packaging

EPS insulation boards are generally packaged in polyethylene film, protected with cardboard against impact damage, and delivered on wooden pallets. Delivery on EPS bases as an alternative to wooden pallets is common, too. Disposal of the packaging material is done by qualified disposal companies, while the EPS transport bases are recycled.

Condition of use

The air-filled hard foam possesses very good thermal insulation properties. All materials in the polystyrene used in the manufacture of insulation boards are age and moisture resistant when fitted. The insulation performance and the mechanical properties of EPS hard foam do not change throughout its service life.

Environment and health during use

EPS insulants have seen use for more than 60 years. They have no known adverse effects on people, animals and the environment.

According to the German Committee for Health-Related Evaluation of Building Products *(AgBB-Schema)*, EPS insulants are suitable for interior applications.
Reference period of use

EPS hard foam-based insulants have an unlimited service life when handled and used properly, without any performance losses.

Limits on service life are only imposed by the service life of the building components and systems which contain EPS. These service lives can be found in the *BBSR table* “Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach Bewertungssystem Nachhaltiges Bauen (BNB)” of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the portfolio of the Federal Office for Building and Regional Planning (BBSR). Hence, EPS hard foam-based thermal insulation composite systems have a service life of 40 years. In all other building thermal insulation applications, the service life of EPS hard foam is ≥ 50 years.

Extraordinary influences

Fire protection

The EPS hard foam boards declared in this EPD are flame-retardant, do not form burning droplets; building material class B1 acc. to *DIN 4102-1*.

Name	Value
Building material class according to DIN 4102-1	B 1 - flame retardant
Burning drops	no burning droplets
EURO class according to DIN EN 13501-1	E

Water

EPS hard foam is chemically neutral, insoluble in water, and does not release water-soluble substances which may contaminate the ground water, rivers, and seas.

Thanks to their closed cellular structure, insulation materials made from EPS hard foam may generally be left in the existing structure even in high moisture conditions. The insulation performance remains largely the same.

Mechanical destruction

Data on the behaviour of the product, including possible environmental implications in the event of unpredicted mechanical destruction, are irrelevant.

End-of-life phase

EPS hard foam can be reused or recycled at the end of its service life.

Seeing that, owing to EPS’s high durability, only very little EPS insulant waste will accrue now and in the future when buildings are dismantled, EPS recycling will mainly rely on leftovers from insulant production. This was taken into account when calculating the ecological metrics of manufacture. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.

Under certain boundary conditions, it is also possible to fabricate insulation boards from recycling material. Besides, ground recycling material can be used as lightweight aggregate for mortar, concrete and screed. It also serves as additive for Styrofoam lightweight concrete, insulation plasters, lightweight plasters, and the clay industry.

In principle, EPS waste can also be utilised for manufacturing new EPS raw materials. By dissolving the hard foam insulant and separation of the polystyrene from extraneous material via flocculation, the polystyrene can be recovered as raw material. The processes are controlled via the “Creasolve procedure” and performed with the PolyStyrene-Loop-Initiative of the European EPS industry at industrial scales (*PolyStyreneLoop-Leitfaden 2020*). This type of utilisation has not yet been included in the LCA data calculation because too little waste is obtained for recycling, due to EPS’s long service life. The standard scenario for a subsequent use continues to be thermal recycling.

LCA: Calculation rules

Declared unit
1 m³ EPS hard foam with 15 kg/m³ bulk density.

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Bulk density	15	kg/m^3

EPD manufacturer groups: Declaration of a specific product, averaged over several plants and several manufacturers.
The average is formed after weighting of the volume-specific total production quantities of the declared products of the member firms.
As to the variation width, deviations were low with 3 % maximum for the use of the main formula constituent polystyrene granulate. Depending on the manufacturer, formulations used different portions of radiation absorber of up to 10 %. Energy requirement variability rather large, due to the different operating parameters and production-related differences. The contributions of power and thermal energy consumption to the overall result, however, are below 15% in most effect categories so that the influence of these variations is rather limited.

System boundary
EPD type: from the cradle to the factory gate with options, modules C1-C4 and module D (A1–A3 + C + D and additional modules).
The EPD covers the following life cycle stages:

Product stage (A1-A3):
• A1 Raw material provision and processing; working processes of secondary materials serving as input (e.g., recycling processes),
• A2 transport of the raw materials to the factories (reference territory Germany),
• A3 factory production of EPS hard foam, (incl. energy supply, water supply, supply of ancillary materials, supply of recycling material from production and construction side offcuts, production waste disposal, packaging material production).

Construction process stage (A5):
• A5 Installation: only disposal of packaging, other installation operations are not accounted for.

End-of-life stage (C1-C4): End-of-life scenario: 100% thermal recycling
• C1 manual disassembly without operations relevant to LCA,
• C2 road transport (50 km) to waste treatment. Distance may be adjusted at the building level (e.g., if the effective transport distance is 100 km: multiplication of the LCA values with the factor 2),
• C3 100% thermal recycling of the EPS hard foam,
• C4 no other requirements due to landfilling/disposal.

Credits and charges beyond the system boundaries (D):
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam.

Comparability
A comparison or the evaluation of EPD data is principally only possible if all data sets to be compared were compiled in accordance with *EN 15804* and the building context or product-specific performance characteristics are included.

The background data were taken from the GaBi database *(GaBi software)*.

LCA: Scenarios and further technical information

Characteristic product properties
Biogenic carbon
The product itself does not contain any biogenic carbon; only the transport packaging does in the form of wooden pallets and cardboard. When calculating a building LCA, it should be noted that the amount of biogenic CO_2 of this packaging bound in Module A1–A3 is subtracted out in Module A5 (installation in building).

Information to describe the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in product	0	kg C
Biogenic carbon in relevant packaging	0.03	kg C

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if no modules are declared (MND).

Installation into the building (A5)

A5 only covers packaging disposal; other installation requirements (e.g., clippings) are not accounted for.

End-of-life (C1-C4)

Name	Value	Unit
As mixed building waste	15	kg
For energy recovery	15	kg

Reuse, recovery and recycling potential (D), relevant scenario information
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam. A waste incineration plant with an R1 value of > 0.6 was taken as a basis.

LCA: Results

The following tables show the results of the indicators of the impact assessment, resource utilisation, waste, and other output flows in relation to **1 m³ EPS hard foam (grey) with 15 kg/m³ bulk density**.

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

Production stage			Construction process stage		Use stage							End of life stage				Credits and charges beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from the gate to the site	Assembly	Use/Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste treatment	Disposal	Reuse, recovery or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	X	ND	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT in accordance with *EN 15804+A2*: 1 m³ EPS hard foam (grey) with 15 kg/m³ bulk density

Core indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
Total GWP	[kg CO_2 eq.]	5.86E+1	3.79E-1	0.00E+0	4.53E-2	5.04E+1	0.00E+0	-2.09E+1
GWP fossil	[kg CO_2 eq.]	5.84E+1	2.59E-1	0.00E+0	4.49E-2	5.04E+1	0.00E+0	-2.08E+1
GWP biogenic	[kg CO_2 eq.]	1.39E-1	1.19E-1	0.00E+0	1.67E-4	2.77E-3	0.00E+0	-9.56E-2
GWP luluc	[kg CO_2 eq.]	3.41E-2	1.83E-5	0.00E+0	2.89E-4	5.52E-4	0.00E+0	-1.26E-2
ODP	[kg CFC11 eq.]	5.56E-13	1.67E-16	0.00E+0	1.15E-17	6.55E-15	0.00E+0	-2.08E-13
AP	[mol H^+ eq.]	1.35E-1	7.09E-5	0.00E+0	3.88E-5	6.75E-3	0.00E+0	-2.53E-2
EP fresh water	[kg P eq.]	6.17E-5	2.44E-8	0.00E+0	9.25E-8	9.03E-7	0.00E+0	-2.39E-5
EP marine	[kg N eq.]	3.13E-2	1.80E-5	0.00E+0	1.21E-5	1.15E-3	0.00E+0	-7.43E-3
EP terrestrial	[mol N eq.]	3.42E-1	3.30E-4	0.00E+0	1.46E-4	3.16E-2	0.00E+0	-7.98E-2
POCP	[kg NMVOC eq.]	7.02E-1	4.88E-5	0.00E+0	3.32E-5	3.10E-3	0.00E+0	-2.10E-2
ADPE	[kg Sb eq.]	7.00E-6	2.30E-9	0.00E+0	3.91E-9	9.40E-8	0.00E+0	-3.15E-6
ADPF	[MJ]	1.43E+3	1.52E-1	0.00E+0	5.96E-1	7.38E+0	0.00E+0	-3.59E+2
WDP	[m³ world eq. deprived]	5.99E+0	3.94E-2	0.00E+0	1.75E-4	4.08E+0	0.00E+0	-1.39E+0

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

RESULTS OF THE LCA – INDICATORS TO DESCRIBE THE USE OF RESOURCES in accordance with *EN 15804+A2*: 1 m³ EPS hard foam (grey) with 15 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PERE	[MJ]	6.76E+1	9.24E-1	0.00E+0	3.46E-2	1.60E+0	0.00E+0	-7.14E+1
PERM	[MJ]	8.83E-1	-8.83E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	6.85E+1	4.12E-2	0.00E+0	3.46E-2	1.60E+0	0.00E+0	-7.14E+1
PENRE	[MJ]	8.61E+2	4.40E+0	0.00E+0	5.96E-1	5.77E+2	0.00E+0	-3.59E+2
PENRM	[MJ]	5.74E+2	-4.25E+0	0.00E+0	0.00E+0	-5.70E+2	0.00E+0	0.00E+0
PENRT	[MJ]	1.44E+3	1.52E-1	0.00E+0	5.96E-1	7.38E+0	0.00E+0	-3.59E+2
SM	[kg]	4.38E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	2.82E-1	9.36E-4	0.00E+0	3.08E-5	9.58E-2	0.00E+0	-6.98E-2

Key	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; 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 in accordance with *EN 15804+A2*: 1 m³ EPS hard foam (grey) with 15 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
HWD	[kg]	1.59E-7	3.29E-11	0.00E+0	2.49E-11	1.55E-9	0.00E+0	-7.91E-8
NHWD	[kg]	3.53E+0	2.80E-2	0.00E+0	9.62E-5	3.06E-1	0.00E+0	-1.59E-1
RWD	[kg]	9.53E-3	4.99E-6	0.00E+0	5.72E-7	1.96E-4	0.00E+0	-2.29E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	6.26E-1	0.00E+0	0.00E+0	7.76E+1	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	1.44E+0	0.00E+0	0.00E+0	1.79E+2	0.00E+0	0.00E+0

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

RESULTS OF THE LCA – Additional impact categories in accordance with *EN 15804+A2*-optional: 1 m³ EPS hard foam (grey) with 15 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PM	[Cases of illness]	1.44E-6	7.12E-10	0.00E+0	2.43E-10	4.22E-8	0.00E+0	-2.19E-7
IRP	[kBq U235 eq.]	9.80E-1	4.61E-4	0.00E+0	5.44E-5	1.81E-2	0.00E+0	-3.76E+0
ETP-fw	[CTUe]	7.51E+2	5.63E-2	0.00E+0	4.95E-1	2.88E+0	0.00E+0	-6.64E+1
HTP-c	[CTUh]	1.77E-8	4.78E-12	0.00E+0	9.79E-12	2.92E-10	0.00E+0	-3.32E-9
HTP-nc	[CTUh]	7.65E-7	4.28E-10	0.00E+0	4.83E-10	1.01E-8	0.00E+0	-1.32E-7
SQP	[-]	5.39E+1	4.43E-2	0.00E+0	1.87E-1	2.02E+0	0.00E+0	-4.89E+1

Key	PM = Potential Occurrence of Diseases due to Particle Emissions; IR = Potential Effects of Human Exposure to U235; ETP- fw = Potential Toxicity Comparison Unit for Ecosystems; HTP-c = Potential Toxicity Comparison Unit for Humans (carcinogenic effect); HTP-nc = Potential Toxicity Comparison Unit for Humans (non-carcinogenic effect); SQP = Potential Soil Quality Index

Restriction notice 1 – applies to the “Potential effects of human exposure to U235” indicator. This effect category mainly deals with the possible effect of low-dose ionising radiation on human health in the nuclear cycle. It does not take into account effects which are attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emanating from the soil, from radon and from some building materials is also not measured by this indicator.

Restriction notice 2 – applies to the indicators: “Abiotic depletion potential for non-fossil resources”, “Abiotic depletion potential for fossil resources”, “Water withdrawal potential (user)”, “Potential toxicity comparison unit for ecosystems”, “Potential toxicity comparison unit for humans – carcinogenic effect”, “Potential toxicity comparison unit for humans – non-carcinogenic effect”, “Potential soil quality index". The results of this environmental impact category must be applied with care, as uncertainties with these results are high or because there is a lack of experience with the indicator.

EPS is generally radon-free.

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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Owner of the declaration	**Industrieverband Hartschaum e.V., IVH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVH-20220128-CBG1-DE
Issue date	15/08/2022
Valid until	14/08/2027

EPS hard foam – grey with intermediate bulk density
preferentially for flat roof and floor insulation

Industrieverband Hartschaum e.V. (IVH)

Member of EUMEPS, the association of European Manufacturers of Expanded Polystyrene

Institut Bauen und Umwelt e.V.

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General information

Industrieverband Hartschaum e.V. (IVH)

Programme holder
IBU – Institut Bauen und Umwelt e.V.
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D-10117 Berlin
Germany

Declaration number
EPD-IVH-20220128-CBG1-DE

This declaration is based on the following product category rules:
Foam plastic insulation materials, 01.2019
(PCR tested and approved by the independent advisory board (SVR))

Issue date
15/08/2022

Valid until
14/08/2027

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

Dr. Alexander Röder
(Executive Director Institut Bauen und Umwelt e.V.)

EPS hard foam (grey, bulk density 20 to 25 kg/m³)

Owner of the declaration
Industrieverband Hartschaum e.V., IVH
Friedrichstrasse 95, Pb 152
D-10117 Berlin

Declared product/Declared unit
The declared unit is 1m³ of expanded polystyrene hard foam for thermal and sound insulation. The average bulk density of the EPS products with 20 to 25 kg/m³ is 20.94 kg/m³ (weighted according to m³ produced by the participating IVH members).

Scope of application:
This EPD describes the grey EPS hard foam products for thermal and sound insulation with an average bulk density of 20.94 kg/m³.

The participating member firms represent 90 volume percent of the total number of all IVH member firms in the year 2020.

The owner of the declaration is liable for the basic information and supporting evidence; any liability of the IBU in relation to manufacturer's information, LCA data and supporting evidence is excluded.

This EPD was compiled in accordance with the requirements of *EN 15804+A2*. This standard is referred to in simplified form as *EN 15804* in the following.

Verification

European standard *EN 15804* serves as the core PCR
Independent verification of the declaration and statements in accordance with *ISO 14025:2011*
☐ internal ☒ external

Matthias Schulz,
Independent Verifier

Product

Product description/Product definition

This environmental product declaration (EPD) describes grey hard foam insulation products made from expanded polystyrene (EPS) provided by the IVH members. IVH is member of EUMEPS, the association for European Manufacturers of Expanded Polystyrene.

EPS products provided by the IVH members for the heat and sound insulation of buildings.

The insulation materials are factory-made in the form of boards or loose, thermal insulation filler material. This EPD describes the grey EPS hard foam products with intermediate bulk density and graphite for various applications, preferentially flat roofs. Acting as heat absorber, the graphite improves the insulation performance substantially.

EPS hard foam is a solid insulation material with a cellular structure which is fabricated from welded, expanded polystyrene or one of its co-polymers. It has a closed-cell, air-filled structure (98% air). EPS boards are rectangular, hard insulation products (cut, moulded or continuously foamed). The board edges can have a rebate edge or tongue and groove. As loose filler material, EPS is factory made in the form of air-filled beads (Ø approx. 6 mm). This environmental product declaration covers the homogeneous EPS insulant without material combination with composite boards or laminated insulation boards.

Essential, characteristic properties are thermal conductivity and compressive strength.

EU regulation no. 305/2011/ (CPR) applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The product requires a declaration of performance based on *DIN EN 13163:2012+A1:2015, Thermal insulation products for buildings –*
Factory made products of expanded polystyrene (EPS) – Specification, and the CE marking.
The respective national regulations apply to its use.

Application

Primary fields of application for the products declared in this document are **flat roof and floor insulation.** Minimum requirements for these applications are described in *DIN 4108-10* according to the types DAA dm and DAA dah, and the types DEO dm and DEO dh.

Other applications for products under this environmental product declaration include, according to the application types pursuant to *DIN 4108-10*, table 1: WAS, DAD, WAA.

- **DAA dm**: Exterior insulation of flat roof and ceiling, exposure-protected, insulation under sealing; intermediate compressive strength
- **DAA dh**: Exterior insulation of flat roof and ceiling, exposure-protected, insulation under sealing; high compressive strength
- **DAD**: Exterior insulation of roof and ceiling, exposure-protected, insulation under cover
- **DEO dm**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements; intermediate compressive strength
- **DEO dh**: Interior insulation of ceiling or ground slab (top side) under screed with sound insulation requirements; high compressive strength
- **WAS**: Exterior insulation of walls exposed to spray water also with partial soil embedding, base
- **WAA**: Exterior wall insulation behind sealing

Technical data

The following structural/technical data in as-delivered condition are relevant for the product.

Constructional data

Name	Value	Unit
Average bulk density	20.94	kg/m^3
Compressive strength to EN 826	0.1 - 0.15	N/mm^2
Design value thermal conductivity acc. to DIN 4108-4	0.031 - 0.032	W/(mK)
Thermal conductivity nominal value acc. to EN 12664	0.03 - 0.031	W/(mK)
Bending resistance acc. to EN 12089	>= 0,15; >= 0,20	N/mm²

The products' performance data meet the declaration of performance in relation to its main features in accordance with *DIN EN 13163:2012+A1:2015 Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) – Specification.*

Additional, voluntary information for the product are provided outside of the CE marking.

Base materials/Ancillary materials

The base polymer product for EPS hard foam is polystyrene (PS). It is fabricated by polymerisation of monomeric styrene using a variety of procedures.

The most used raw material production method is polymerisation in a styrene/water suspension, in which the foaming agent pentane and the graphite are added near the end of the polymerisation process. The PS granulate thus produced is processed into foam in downstream physical processing steps.

The products covered by this declaration are furnished with the flame-retardant polymer-FR. The base material used for insulant production is supplied to the insulant manufacturer in the form of bead-shaped granulate and then physically formed/foamed and reworked.

Composition of grey expanded polystyrene EPS hard foam

Proportion in mass percent
Polystyrene granulate: 80-90 %
Polymer-FR: 1-5 %
Graphite: 3.5-10 %
Pentane (in relation to mass percent in the raw material): 5-6 %
Recycled material: 0-12 %
The pentane used for foaming is a C5 hydrocarbon. It is broken down during the manufacturing and storage process.

In the production of flame-protected polystyrene granulate, low amounts of a flame retardant are introduced during polymerisation. Polymer-FR is used as flame retardant for the products declared in this EPD. Manufacturers are required to provide evidence for the products. Polymer-FR is a brominated styrene-butadiene copolymer.

1) The product/at least one part product contains substances of the candidate list of the substances of Very High Concern (SVHC) (as of 17 January 2022) eligible for approval above 0.1 mass percent: **no**

2) The product or at least one part product contains further CMR Category 1A or 1B substances which are not on the candidate list in doses above 0.1 mass percent in at least one part product: **no**

3) Biocidal products were added to this building product or it was treated with biocidal products (is it therefore a processed product as provided for in the EU Biocide Product Directive no. 528/2012): **no**

Manufacture

The manufacture of EPS hard foam follows the process steps pre-foaming, interim storage, foam filling:

In the pre-foaming step, the bead-shaped granulate which holds the foaming agent is softened with overheated water vapour and then expanded by evaporation of the foaming agent. In the next step, the expanded granulate is placed on interim storage in air-penetrable silos. The diffusing air gives the EPS foam particles the stability it needs for the downstream processing steps.

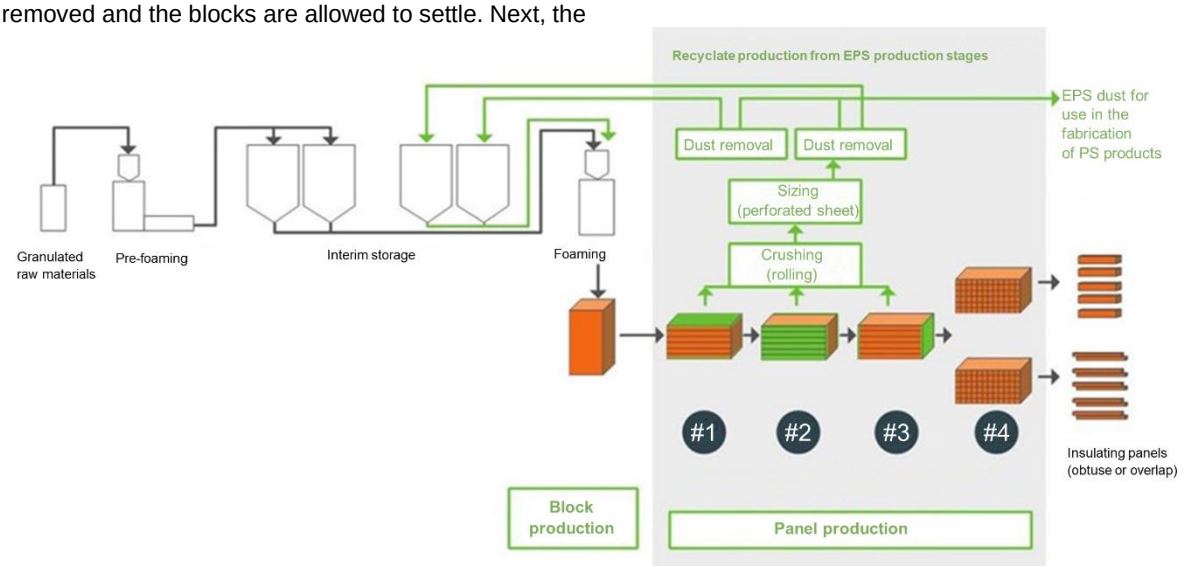
The most used technique for the production of EPS insulant boards is block foaming followed by hot wire cutting.
To this end, the pre-foamed and temporarily stored EPS foam particles are filled into cuboidal block moulds and foamed by adding steam at 110°C to 120°C. In addition, recycled material from production divisions and construction site sections are introduced to the process, and the LCA is accounted for in the module A3.

After a brief cooling-down period, the moulds are removed and the blocks are allowed to settle. Next, the blocks are cut into boards in mechanical or thermal cutters. Additional edge profiles (tongue and groove or rebated edge) can be created by milling.

Boards as shaped parts (second most common technique) can be produced with fully automated machines (shaped part machines). In this case, the finished boards have the desired final shape, e.g. rebated without the need of further processing.

In the belt-foaming process (third most common technique), the boards are foamed in a continuous process in a double-belt plant between revolving steel strips. Here, the boards are produced in the desired thickness and length and then cut.

To make the EPS insulant production more sustainable, recycled material from production offcuts or installation residues taken from construction sites are introduced to the raw material proper. Waste is avoided by reusing such offcuts and remains. Therefore, the use of offcuts and remains is not covered in the modules C1-C4 (disposal stage) and D (credits and charges beyond the system boundaries) of this environmental product declaration.



Environment and health during manufacture

The Technical Rule *TRGS 900* must always be observed for the maximum occupational limit values. Furthermore, no steps beyond the general occupational safety measures are necessary.

EPS hard foam manufacturers are not facilities requiring approval according to *TA Luft*. Additional steps beyond the statutory requirements are not necessary.

In an effort to ensure clean production, the EPS manufacturers within the IVH support the initiative *Operation Clean Sweep*, OCS, a global voluntary initiative of the plastic industry to curtail marine plastic pollution.
The IVH has initiated the *IVH-Initiative Null-Granulatverlust* initiative under the OCS framework which is specifically geared toward logistics and manufacturing processes in the domain of insulant production and to which all IVH members have subscribed.

Product processing/installation

The EPS products possess excellent processing and machining properties due to their relatively low weight among other factors.

The boards are dimensionally stable and absorb only very little humidity, which is relevant both for the entire life stage of the building and for the construction phase.

All applications must be based on the relevant standards and guidelines (e.g., IVH guidance *EPS zur Verwendung als Sockelplatten in Spritzwasserbereichen* and technical regulations of the craft associations) and manufacturer instructions. Additional building physical analyses (e.g., moisture proofing) contribute to increased energy efficiency.

Where insulation boards must be trimmed on site, hot-wire cutting is recommended. This allows for precise cutting and avoiding unnecessary waste.

Installation is done by gluing, if necessary also by additional mechanical fixing. Applications may be system-specific, i.e. system components and processing are predefined.

Packaging

EPS insulation boards are generally packaged in polyethylene film, protected with cardboard against impact damage, and delivered on wooden pallets. Delivery on EPS bases as an alternative to wooden pallets is common, too. Disposal of the packaging material is done by qualified disposal companies, while the EPS transport bases are recycled.

Condition of use

The air-filled hard foam possesses very good thermal insulation properties. All materials in the polystyrene used in the manufacture of insulation boards are age and moisture resistant when fitted. The insulation performance and the mechanical properties of EPS hard foam do not change throughout its service life.

Environment and health during use

EPS insulants have seen use for more than 60 years. They have no known adverse effects on people, animals and the environment.

According to the German Committee for Health-Related Evaluation of Building Products *(AgBB-Schema)*, EPS insulants are suitable for interior applications.

Reference period of use

EPS hard foam-based insulants have an unlimited service life when handled and used properly, without any performance losses.

Limits on service life are only imposed by the service life of the building components and systems which contain EPS. These service lives can be found in the *BBSR table* “Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach Bewertungssystem Nachhaltiges Bauen (BNB)” of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the portfolio of the *Federal Office for Building and Regional Planning (BBSR).* Hence, EPS hard foam-based thermal insulation composite systems have a service life of 40 years. In all other building thermal insulation applications, the service life of EPS hard foam is ≥ 50 years.

Extraordinary influences

Fire protection

The EPS hard foam boards declared in this EPD are flame-retardant, do not form burning droplets; building material class B1 acc. to *DIN 4102-1*.

Name	Value
Building material class according to DIN 4102-1	B 1 - flame retardant
Burning drops	no burning droplets
EURO class according to DIN EN 13501-1	E

Water

EPS hard foam is chemically neutral, insoluble in water, and does not release water-soluble substances which may contaminate the ground water, rivers, and seas.

Thanks to their closed cellular structure, insulation materials made from EPS hard foam may generally be left in the existing structure even in high moisture conditions. The insulation performance remains largely the same.

Mechanical destruction

Data on the behaviour of the product, including possible environmental implications in the event of unpredicted mechanical destruction, are irrelevant.

End-of-life phase

EPS hard foam can be reused or recycled at the end of its service life.

Seeing that, owing to EPS’s high durability, only very little EPS insulant waste will accrue now and in the future when buildings are dismantled, EPS recycling will mainly rely on leftovers from insulant production. This was taken into account when calculating the ecological metrics of manufacture. Clean installation offcuts returned from the construction sites to the EPS manufacturer for recycling are not included in the calculation of the ecological metrics.

Under certain boundary conditions, it is also possible to fabricate insulation boards from recycling material. Besides, ground recycling material can be used as lightweight aggregate for mortar, concrete and screed. It also serves as additive for Styrofoam lightweight concrete, insulation plasters, lightweight plasters, and the clay industry.

In principle, EPS waste can also be utilised for manufacturing new EPS raw materials. By dissolving the hard foam insulant and separation of the polystyrene from extraneous material via flocculation, the polystyrene can be recovered as raw material. The processes are controlled via the “Creasolve procedure” and performed with the *PolyStyrene-Loop-Initiative* of the European EPS industry at industrial scales (PolyStyreneLoop-Leitfaden 2020). This type of utilisation has not yet been included in the LCA data calculation because too little waste is obtained for recycling, due to EPS’s long service life. The standard scenario for a subsequent use continues to be thermal recycling.

LCA: Calculation rules

Declared unit
1 m³ EPS hard foam with 20 to 25 kg/m³ bulk density (weighted average: 20,94 kg/m³).

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Bulk density	20.94	kg/m^3

EPD manufacturer groups
Declaration of an average product, averaged over several plants and several manufacturers.
The average is formed after weighting of the volume-specific total production quantities of the declared products of the member firms.
As to the variation width, deviations were low with 3% maximum for the use of the main formula constituent polystyrene granulate. Depending on the manufacturer, formulations used different portions of radiation absorber of up to 10%. Energy requirement variability rather large, due to the different operating parameters and production-related differences. The contributions of power and thermal energy consumption to the overall result, however, are below 15% in most effect categories so that the influence of these variations is rather limited.

System boundary
EPD type: from the cradle to the gate with options, modules C1-C4 and module D (A1-A3 + C + D and additional modules).
The EPD covers the following life cycle stages:

Product stage (A1-A3):
• A1 Raw material provision and processing; working processes of secondary materials serving as input (e.g., recycling processes),
• A2 transport of the raw materials to the factories (reference territory Germany),
• A3 factory production of EPS hard foam, (incl. energy supply, water supply, supply of ancillary materials, supply of recycling material from production and construction side offcuts, production waste disposal, packaging material production).

Construction process stage (A5):
• A5 Installation: only disposal of packaging, other installation operations are not accounted for.

End-of-life stage (C1-C4): End-of-life scenario: 100% thermal recycling
• C1 manual disassembly without operations relevant to LCA,
• C2 road transport (50 km) to waste treatment. Distance may be adjusted at the building level (e.g., if the effective transport distance is 100 km: multiplication of the LCA values with the factor 2).
• C3 100% thermal recycling of the EPS hard foam.
• C4 no other requirements due to landfilling/disposal.

Credits and charges beyond the system boundaries (D):
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam.

Comparability
A comparison or the evaluation of EPD data is principally only possible if all data sets to be compared were compiled in accordance with *EN 15804* and the building context or product-specific performance characteristics are included.

The background data were taken from the GaBi database *(GaBi software)*.

LCA: Scenarios and further technical information

Characteristic product properties
Biogenic carbon
The product itself does not contain any biogenic carbon; only the transport packaging does in the form of wooden pallets and cardboard. When calculating a building LCA, it should be noted that the amount of biogenic CO_2 of this packaging bound in Module A1–A3 is subtracted out in Module A5 (installation in building).

Information to describe the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in product	0	kg C
Biogenic carbon in relevant packaging	0.02	kg C

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if no modules are declared (MND).

Installation into the building (A5)
A5 only covers packaging disposal; other installation requirements (e.g., clippings) are not accounted for.

End-of-life (C1-C4)

Name	Value	Unit
As mixed building waste	20.94	kg
For energy recovery	20.94	kg

Reuse, recovery and recycling potential (D), relevant scenario information
Module D comprises: energetic recovery potentials resulting from end-of-life cycle thermal recycling of the packaging and EPS hard foam. A waste incineration plant with an R1 value of > 0.6 was taken as a basis.

LCA: Results

The following tables show the results of the indicators of the impact assessment, resource utilisation, waste, and other output flows in relation to **1 m³ EPS hard foam (grey) with 20.94 kg/m³ bulk density**.

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

Production stage			Construction process stage		Use stage							End of life stage				Credits and charges beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from the gate to the site	Assembly	Use/Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste treatment	Disposal	Reuse, recovery or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	X	ND	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT in accordance with *EN 15804+A2*: 1 m³ EPS hard foam (grey) with 20.94 kg/m³ bulk density

Core indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
Total GWP	[kg CO_2 eq.]	7.67E+1	4.24E-1	0.00E+0	6.33E-2	7.03E+1	0.00E+0	-2,91E+1
GWP fossil	[kg CO_2 eq.]	7.64E+1	3.68E-1	0.00E+0	6.27E-2	7.03E+1	0.00E+0	-2.90E+1
GWP biogenic	[kg CO_2 eq.]	2.55E-1	5.64E-2	0.00E+0	2.33E-4	3.87E-3	0.00E+0	-1.33E-1
GWP luluc	[kg CO_2 eq.]	4.27E-2	2.36E-5	0.00E+0	4.03E-4	7.70E-4	0.00E+0	-1.76E-2
ODP	[kg CFC11 eq.]	4.21E-13	2.10E-16	0.00E+0	1.61E-17	9.14E-15	0.00E+0	-2.90E-13
AP	[mol H^+ eq.]	1.70E-1	7.67E-5	0.00E+0	5.41E-5	9.43E-3	0.00E+0	-3.53E-2
EP fresh water	[kg P eq.]	8.07E-5	3.06E-8	0.00E+0	1.29E-7	1.26E-6	0.00E+0	-3.33E-5
EP marine	[kg N eq.]	3.97E-2	1.84E-5	0.00E+0	1.69E-5	1.60E-3	0.00E+0	-1.04E-2
EP terrestrial	[mol N eq.]	4.34E-1	3.55E-4	0.00E+0	2.04E-4	4.41E-2	0.00E+0	-1.11E-1
POCP	[kg NMVOC eq.]	9.77E-1	5.06E-5	0.00E+0	4.63E-5	4.33E-3	0.00E+0	-2.92E-2
ADPE	[kg Sb eq.]	7.95E-6	2.87E-9	0.00E+0	5.46E-9	1.31E-7	0.00E+0	-4.39E-6
ADPF	[MJ]	1.94E+3	1.86E-1	0.00E+0	8.32E-1	1.03E+1	0.00E+0	-5.01E+2
WDP	[m^3 world eq. deprived]	7.74E+0	4.38E-2	0.00E+0	2.44E-4	5.70E+0	0.00E+0	-1.94E+0

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

RESULTS OF THE LCA – INDICATORS TO DESCRIBE THE USE OF RESOURCES in accordance with *EN 15804+A2*: 1 m³ EPS hard foam (grey) with 20.94 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PERE	[MJ]	7.35E+1	4.85E-1	0.00E+0	4.83E-2	2.23E+0	0.00E+0	-9.96E+1
PERM	[MJ]	4.33E-1	-4.33E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	7.40E+1	5.17E-2	0.00E+0	4.83E-2	2.23E+0	0.00E+0	-9.96E+1
PENRE	[MJ]	1.14E+3	6.24E+0	0.00E+0	8.32E-1	8.06E+2	0.00E+0	-5.01E+2
PENRM	[MJ]	8.02E+2	-6.06E+0	0.00E+0	0.00E+0	-7.96E+2	0.00E+0	0.00E+0
PENRT	[MJ]	1.94E+3	1.86E-1	0.00E+0	8.32E-1	1.03E+1	0.00E+0	-5.01E+2
SM	[kg]	1.83E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m^3]	3.57E-1	1.04E-3	0.00E+0	4.29E-5	1.34E-1	0.00E+0	-9.73E-2

Key	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; 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 in accordance with *EN 15804+A2*: 1 m³ EPS hard foam (grey) with 20.94 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
HWD	[kg]	1.96E-7	4.01E-11	0.00E+0	3.48E-11	2.16E-9	0.00E+0	-1.10E-7
NHWD	[kg]	4.21E+0	3.88E-2	0.00E+0	1.34E-4	4.27E-1	0.00E+0	-2.21E-1
RWD	[kg]	1.23E-2	6.26E-6	0.00E+0	7.99E-7	2.73E-4	0.00E+0	-3.20E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	7.50E-1	0.00E+0	0.00E+0	1.08E+2	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	1.72E+0	0.00E+0	0.00E+0	2.50E+2	0.00E+0	0.00E+0

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

RESULTS OF THE LCA – Additional impact categories in accordance with *EN 15804+A2*-optional: 1 m³ EPS hard foam (grey) with 20.94 kg/m³ bulk density

Indicator	Unit	A1-A3	A5	C1	C2	C3	C4	D
PM	[Cases of illness]	1.76E-6	8.84E-10	0.00E+0	3.40E-10	5.90E-8	0.00E+0	-3.05E-7
IRP	[kBq U235 eq.]	1.29E+0	5.78E-4	0.00E+0	7.60E-5	2.53E-2	0.00E+0	-5.25E+0
ETP-fw	[CTUe]	1.04E+3	6.82E-2	0.00E+0	6.91E-1	4.03E+0	0.00E+0	-9.26E+1
HTP-c	[CTUh]	2.38E-8	6.00E-12	0.00E+0	1.37E-11	4.08E-10	0.00E+0	-4.64E-9
HTP-nc	[CTUh]	1.03E-6	5.79E-10	0.00E+0	6.75E-10	1.41E-8	0.00E+0	-1.84E-7
SQP	[-]	5.67E+1	5.42E-2	0.00E+0	2.61E-1	2.83E+0	0.00E+0	-6.82E+1

Key	PM = Potential Occurrence of Diseases due to Particle Emissions; IR = Potential Effects of Human Exposure to U235; ETP- fw = Potential Toxicity Comparison Unit for Ecosystems; HTP-c = Potential Toxicity Comparison Unit for Humans (carcinogenic effect); HTP-nc = Potential Toxicity Comparison Unit for Humans (non-carcinogenic effect); SQP = Potential Soil Quality Index

Restriction notice 1 – applies to the “Potential effects of human exposure to U235” indicator. This effect category mainly deals with the possible effect of low-dose ionising radiation on human health in the nuclear cycle. It does not take into account effects which are attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emanating from the soil, from radon and from some building materials is also not measured by this indicator.

Restriction notice 2 – applies to the indicators: “Abiotic depletion potential for non-fossil resources”, “Abiotic depletion potential for fossil resources”, “Water withdrawal potential (user)”, “Potential toxicity comparison unit for ecosystems”, “Potential toxicity comparison unit for humans – carcinogenic effect”, “Potential toxicity comparison unit for humans – non-carcinogenic effect”, “Potential soil quality index". The results of this environmental impact category must be applied with care, as uncertainties with these results are high or because there is a lack of experience with the indicator.

EPS is generally radon-free.

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