ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A1*

Owner of the Declaration	**IVPU Industrieverband Polyurethan-Hartschaum e.V.**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IVP-20210003-IBE1-EN
Issue date	01.04.2021
Valid to	31.03.2026

PU thermal insulation boards with multi-layer aluminium facing

IVPU
Industrieverband
Polyurethan-Hartschaum e.V.

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

1. General Information

IVPU e.V.	PU thermal insulation boards with multi-layer aluminium facing
Programme holder IBU – Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the declaration** **IVPU e.V.** Heilbronner Str. 154 D-70191 Stuttgart
Declaration number EPD-IVP-20210003-IBE1-EN	**Declared product / declared unit** 1 m² of installed PU thermal insulation board with multi-layer aluminium facing (on both sides), a thickness of 12 cm, and a thermal conductivity design value of 0.023 W/(m·K).
This declaration is based on the product category rules: Insulating materials made of foam plastics, 06.2017 (PCR checked and approved by the SVR) **Issue date** 01.04.2021 **Valid to** 31.03.2026	**Scope:** This EPD applies to all declared products of the IVPU's member companies Karl Bachl GmbH & Co KG, IKO Insulation BV, Kingspan Insulation GmbH & Co KG, puren gmbh, Recticel Dämmsysteme GmbH, Soprema GmbH, Steinbacher Dämmstoff-GmbH, Unilin Insulation bv. The IVPU represents more than 90% of the companies within the German polyurethane insulating materials market. This EPD is based on weighted averages which have been determined on the basis of the single values originating from the factories of the mentioned manufacturing companies (see section 3.1). The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences. The EPD was created according to the specifications of *EN 15804+A1*. In the following, the standard will be simplified as *EN 15804*.
	Verification
	The standard *EN 15804* serves as the core PCR
	Independent verification of the declaration and data according to *ISO 14025:2010*
	☐ internally ☒ externally
Dipl. Ing. Hans Peters (chairman of Institut Bauen und Umwelt e.V.)	
Dr. Alexander Röder (Managing Director Institut Bauen und Umwelt e.V.))	Prof. Dr. Birgit Grahl (Independent verifier)

2. Product

2.1 Product description/Product definition

Polyurethane rigid foam (PU) is a closed-cell foam and factory-made thermal insulating material, which is used in the form of insulation boardsfor insulating buildings as well as for the insulation of building equipment and industrial installations. The polyurethane insulating material (PU) product family consists mostly of the product variant polyurethane (PUR) - see *EN 13165*. PU insulating materials are produced, inter alia, as insulation boards with flexible facings.

This Product Declaration covers PU insulation boards with multi-layer aluminium foil facings on both sides.

For the placing on the market of the product in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) Regulation (EU) No. 305/2011 (*CPR*) applies. The product needs a declaration of performance taking into consideration *DIN EN 13165:2016-09* Thermal insulation products for buildings - Factory made rigid polyurethane foam (PU) products - Specification and the CE-marking.

For the application and use the respective national provisions apply. In Germany, the design values for application in building construction are specified in *DIN 4108-10*. Hygrothermal design values are regulated in *DIN 4108-4*.

2.2 Application

The scope of application of PU rigid foam insulation materials includes thermal insulation in building construction (e.g. pitched roofs, flat roofs, floors, ceilings and exterior walls (inside and outside)). Furthermore, PU rigid foam is used for insulating building equipment and industrial installations.

2.3 Technical Data

For determining technical data, testing methods as stated in *DIN EN 13165* are used. The gross density of PU insulation boards with multi-layer aluminium facings for building construction is approx. 31 - 32 kg/m³.

The boards are manufactured with thermal conductivity level (WLS) 023. This level is equivalent to a thermal conductivity design value of 0.023 W/(m·K). In addition, the nominal value of the thermal resistance of RD = 5.45 (m²·K)/W and the thickness of 22 mm of the insulation board at RD = 1 (m²·K)/W can be specified.

Nominal compressive stress or nominal compressive strength at 10% deformation is 100 kPa (dh) or 150 kPa (ds) acc. to *DIN 4108-10*. Higher compressive strength is possible. Nominal tensile strength perpendicular to the insulation board plane is 40 kPa. Higher tensile strength is possible.

PU insulation boards with multi-layer aluminium facings are impermeable to water vapour and do not absorb moisture.

Polyurethane rigid foam is a distinctive thermosetting material and therefore cannot be melted.

Constructional data

Name	Value	Unit
Gross density	31 - 32	kg/m³
Compressive strength acc. to DIN EN 826	100 – 150	kPa
Tensile strength to DIN EN 1607	≥ 40	kPa
Flexural strength	-	N/mm²
Modulus of elasticity acc. to DIN EN 826	≥ 4	N/mm²
Calculation value for thermal conductivity	0.023	W/(mK)
Water vapour diffusion resistance factor acc. to EN 12088	∞	-
Moisture content at 23 °C, 80%	-	M.-%
Dimensional stability under defined temperature and humidity conditions DS(TH)i	DS(70/90) 3 and DS(-20,-)1	Class
Thermal conductivity acc. to DIN EN 13165	0.022	W/(mK)
Limiting dimensions of thickness Ti	T2	Class
Dynamic rigidity acc. to DIN EN 29052	-	MN/mm³
Creep behaviour or permanent compressive strength acc. to DIN EN 1606	≥ 0.02	N/mm²
Water absorption after diffusion acc. to EN 12088	-	Vol.-%
Maximum water absorption acc. to DIN EN 12091	-	Vol.-%
Water absorption by capillarity acc. to DIN EN 15801	-	cm

Declared value of thermal resistance RD	5.45	(m²•K)/W
Thickness at RD = 1 (m²•K)/W	22	mm

Performance data of the production in accordance with the declaration of performance with respect to its essential characteristics according to *DIN 4108-10: 2015-12* (Table 6).

2.4 Delivery status

Polyurethane insulation boards with multi-layer aluminium facings are manufactured with plane-parallel surfaces or as tapered insulation boards in a thickness range of 20 to 300 mm. This Product Declaration refers to a board thickness of 120 mm. The format of the boards depends on the planned application. The width can be up to 1,250 mm and the length up to 12 m.

2.5 Base materials/Ancillary materials

The 12 cm PU board with multi-layer aluminium facings consists of 3.71 kg/m² PU rigid foam and 0.33 kg/m² multi-layer aluminium facings. Polyurethane rigid foam is formed by the chemical reaction of MDI (approx. 58 – 65 %) and polyol (approx. 26 – 31 %), adding low boiling point blowing agents (approx. 3 – 6 %). Insulation boards with flexible facings are foamed exclusively with the hydrocarbon pentane. Due to the closed-cell structure, the blowing agent remains within the foam cells. Water (approx. 0.2 – 1.5 %), foam stabilisers and catalysts (approx. 2 – 6 %), as well as flame retardants (approx. 2 – 5 %) are added as ancillary materials.

The raw materials used for the production of polyurethane rigid foam are mainly obtained from crude oil, undergoing several production stages. Alternatively, polyols can be produced, in part, from renewable, plant-based raw materials or recycled materials. This is not part of the current LCA.

Polyurethane rigid foam does not contain volatile isocyanates.
Under the current Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (*REACH*) polyurethane rigid foam is declared as follows:

- Polyurethane rigid foam contains substances listed in the Candidate List for authorization on 16 January 2020 exceeding 0.1 percentage by mass: **no**.
- Polyurethane rigid foam contains other carcinogenic, mutagenic, reprotoxic (CMR) substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: **no**
- Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) *Ordinance on Biocide Products No. 528/2012*): **no**

Multi-layer aluminium facings consist of approx. equal shares of aluminium, paper, and low density polyethylene (LDPE).

2.6 Manufacture

Polyurethane rigid foam insulation boards with flexible multi-layer aluminium facings are produced in a continuous process on a double belt line. In this process, the polyurethane reaction mixture pours from a mixing head onto the bottom facing where it foams up and glues – still within the line's pressure area – with the top multi-layer aluminium facing. After passing the double belt line, the foam boards are cut to the desired dimensions.

Quality assurance

The declared products are subject to quality controls. Quality assurance is based on surveillance and certification by independent Notified Bodies.

2.7 Environment and health during manufacturing

No health protection measures extending beyond the legally-mandated work protection measures for industrial businesses are required during the entire manufacturing process. No special environmental protection measures apart from the legal provisions are required.

2.8 Product processing/Installation

Polyurethane insulation boards can be cut, sawed, milled, and abraded with conventional construction tools and portable machines. In general, the boards are fixed mechanically (pitched and flat roofs, cavity core insulation). Alternatively, PU insulation boards can be laid loosely, e.g. on floors. Observing the manufacturer's recommendations, it is also possible to glue the boards together by using either hot-setting or cold-setting adhesives. Joints between cut insulation boards on roof ridges, hips or valleys are to be sealed with polyurethane in-situ foam without thermal bridges.

While sawing, abrading, and milling insulation boards, dust is generated. If there is no sufficient ventilation, workers who carry out these processes have to protect themselves by wearing an appropriate dust filter mask (see leaflet of the "Berufsgenossenschaft der Chemischen Industrie" on respiratory protection). Dust concentration in the air (general limit of dust concentration as per *TRGS 900*, Technische Regeln für Gefahrstoffe) must not exceed the following values:

- 10 mg/m³ (measured as inhalable fraction)
- 1.25 mg/m³ (measured as alveolar fraction)

These limits are time-weighted averages assuming an 8-hour exposure per day, 5 days a week, during working lifetime.

Cutting leftovers can be thermally recycled in household waste incineration plants or disposed of in a material recycling process.

2.9 Packaging

Mainly, plastic foils and EPS or PU wedges are used as packaging material. The plastic foils can be recycled whereas the PU wedges can be reused in the form of PU press plates.

2.10 Condition of use

Under normal conditions of use, the material does not undergo any changes in terms of substance during its service life. Polyurethane is resistant to most chemicals used in construction and does not rot.

2.11 Environment and health during use

The requirements of the Committee for Health-related Evaluation of Building Products (*AgBB*) have been met. Measurements of emissions using testing chambers in accordance with the relevant testing norms (*DIN EN 16516*) showed that volatile organic substances (VVOC, VOC) are only emitted in small quantities.

Regarding the current *REACH* candidate list, the foam formulations contain no SVHC substances (see section 2.5).

Polyurethane insulating materials are odourless.

2.12 Reference service life

When used properly, the service life of polyurethane rigid foam corresponds to the service life of the insulated construction components. The performance of the insulation boards stays the same throughout the entire service life.

2.13 Extraordinary effects

Fire

According to national approvals, polyurethane insulating materials are classified either as class E acc. to *DIN EN 13501-1* or as class C acc. to *DIN EN 13501-1*. Pitched roof constructions with polyurethane insulation over rafters that comply with the classification report of *IBS 316052507-A* are classified as REI 30 (fire-retardant). Roof structures with top-side polyurethane insulation acc. to *DIN 18234-2* meet the fire-protection requirements stated in the Industrial Building Guideline even for fire containment or fire fighting sections with a roof surface of more than 2,500 m².

In case of fire, PU rigid foam does not tend to smoulder. When exposed to heat, PU rigid foam carbonizes without dripping off burning droplets. When burning, sooty products, water vapour, carbon monoxide, carbon dioxide, nitrogen oxides, as well as hydrogen cyanide are formed. The composition of the smoke gas is the same as other nitrogen-containing organic substances.

The toxicity of the combustion gases mainly depends on the amount of burned material in relation to the size of the room in which the gases are distributed. It also depends on the ventilation conditions in the affected area.

Fire Protection

Designation	Value
Building material class acc. to DIN EN 13501-1	E – C
Flaming droplets/particles acc. to DIN EN 13501-1	d0, none
Smoke development acc. to DIN EN 13501-1	s1 – s3

Water

Due to the predominant closed-cell structure, insulating materials made of polyurethane rigid foam absorb water only in small quantities. They are not hygroscopic, i.e. they do not absorb water vapour from the air. When unexpectedly exposed to water (e.g. flood), only very small amounts of soluble substances are emitted.

Mechanical destruction
If the product is mechanically destroyed, there are no relevant effects on the environment.

2.14 Re-use phase
Dismantling polyurethane insulating materials as well as sorting and waste identifying can be done without difficulties, since they are usually mounted mechanically or laid loosely.

Clean and undamaged polyurethane insulation boards can be reused as well as recycled mechanically or raw materially (glycolysis). Glycolysis means that at approx. 200°C, polyurethane rigid foam waste is transformed into a fluid substance called glycolysis polyol, which can be used again as raw material in the production of polyurethane.

When reutilised from mechanical material recycling, polyurethane rigid foam waste is used to produce press boards. In this process, cutting and mounting leftovers, as well as construction waste, are mechanically shredded and subsequently pressed into board-shaped products while adding binding agents. PU pressed adhesive boards are a high-quality material that are used, among others, to insulate window frames or thermal bridges.

2.15 Disposal
According to the Waste Disposal Regulation and the Regulation on the European List of Waste Materials (*AVV*), polyurethane insulating material shall not be disposed of without prior treatment. The waste disposal code for construction waste is 170604. During thermal treatment, the energy content of the insulation material can be recovered.

2.16 Further information
Please visit www.ivpu.de and www.daemmt-besser.de for further information on PU insulating materials.

3. LCA: Calculation rules

3.1 Declared Unit
The declared unit is 1 m² of installed PU thermal insulation board with multi-layer aluminium facing (on both sides) and has the following specifications:

Declared unit

Name	Value	Unit
Declared unit	1	m^2
Gross density of the PU foam	30.92	kg/m^3
Thickness	12	cm
Design value of thermal conductivity	0.023	W/(mK)
Thermal resistance (R-value)	5.45	m²•W/K
Weight of the declared unit	4.04	kg/m²
Conversion factor to 1 kg	4.04	

The declaration is based on a group of manufacturers: EPD type 2c

This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the IVPU members. Average energy consumption for producing PU boards has been weighted according to the quantities of produced PU rigid foam in m^3. Raw material consumption has been weighted according to used quantities in kg. Rigid foam waste is weighted according to the quantities of produced PU rigid foam in m^3 whereas facing waste is weighted according to used quantities of facings in m^2.

3.2 System boundary
Type of EPD: cradle to gate - with options
Life cycle assessment considers the following steps of the life cycle:
· production and supply of raw materials (A1)
· transporting raw materials (A2)
· production including packaging (A3)
· transport to construction site (A4)
· installation in buildings (recycling or therm. treatment of cutting leftovers and packaging waste) (A5)
· transport to End-of-Life (C2)
· waste treatment: energy for shredders (C3)
· thermal treatment (PU foam) (C3)
· recycling or use potentials beyond the system's boundary (D).

3.3 Estimates and assumptions
For all input, specific GaBi data sets were available. Currently, waste from PU foam production and leftovers from cutting on construction sites are handled using mainly material recycling (see 2.15). Using a worst-case approach, only the incineration and the consequent energy benefit beyond the system boundary have been considered in this EPD.

3.4 Cut-off criteria
In this study, all available data from the production are taken into account, i.e. all used raw materials, used thermal energy, as well as electrical power consumption. Therefore, even materials and power consumption levels that have a share of less than 1 % are considered.
It can be assumed that all neglected processes put together account for no more than 5 % of total power and mass consumption. The manufacturers have provided data on transport expenditures for all relevant material flows. Machinery and installations required for production are neglected.

3.5 Background data
Background data originates from the GaBi software database from Sphera (*GaBi ts*). The power mix with different countries has been used. The last revision of the used data was less than 6 years ago.

3.6 Data quality
The data used are primary data originating from the industry and were gathered by the IVPU in 2018. 8 IVPU members participated in this data gathering. The IVPU represents more than 90 % of the companies within the German polyurethane insulating materials market. This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the afore-mentioned manufacturing companies.
The data's quality as well as its technological, geographical, and chronological significance can be classified as very good.

3.7 Period under review
The data basis is based on production data from 2018. The used quantities of raw materials, energy, as well as ancillary materials and fuels are averages compiled over a time span of 12 months.

3.8 Allocation
When thermally treated in waste incineration plants (MVA), recycling as well as use potentials beyond the system boundary for power and thermal energy in module D are taken into account in an input-specific manner considering elemental composition as well as thermal values. Due to manufacturing locations and distribution throughout all of Europe, the substitution processes refer to reference area EU-27.

3.9 Comparability
Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account.

The used background data base is GaBi ts.

4. LCA: Scenarios and additional technical information

The following technical information serves as basis for the declared modules. If modules are not declared (MND), they may also be used for developing specific scenarios in the context of a building assessment.

Transport to construction site (A4)

Name	Value	Unit
Litres of fuel	0.00159	l/100km
Transport distance	500	km
Gross density of products transported	30.92	kg/m³
Capacity utilisation (including empty runs)	85	%

Installation in buildings (A5)

Name	Value	Unit
Material loss	2	%
Packaging waste	0.53	kg

End of life cycle (C1-C4)

Name	Value	Unit
Waste processing (C3) energy for shredders	0.799	MJ
Reuse	0	kg
Recycling (aluminium content of facing)	0.03	kg
Energy recovery	2.67	kg
Landfilling	0	kg

Upon removal from the building, products are assumed to be transported 100 km (module C2) to a recycling facility. The foam waste in the EoL phase is sent to a waste incineration plant.
The waste is shredded and incinerated. These processes are grouped to module C3. Resulting potential benefits for electricity and thermal energy due to the incineration are grouped to module D.
Aluminum facings are recycled. The recycling including the recycling effort and the potential benefits are addressed in module D.

5. LCA: Results

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

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse- Recovery- Recycling- potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	X	MND	MND	MNR	MNR	MNR	MND	MND	MND	X	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A1: 1 m² of installed PU board with multi-layer aluminium facing

Parameter	Unit	A1-A3	A4	A5	C2	C3	D
Global warming potential	[kg CO_2-Eq.]	1.12E+1	4.25E-1	3.62E-1	8.20E-2	8.78E+0	-4.20E+0
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	1.84E-5	6.99E-17	9.98E-17	1.35E-17	4.09E-15	-5.31E-14
Acidification potential of land and water	[kg SO_2-Eq.]	2.27E-2	3.44E-4	8.41E-5	6.64E-5	3.49E-3	-5.76E-3
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	3.21E-3	6.40E-5	2.07E-5	1.24E-5	8.69E-4	-6.72E-4
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.20E-2	-5.59E-6	5.85E-6	-1.08E-6	2.25E-4	-5.21E-4
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	1.64E-6	3.13E-8	1.17E-9	6.05E-9	4.71E-8	-6.96E-7
Abiotic depletion potential for fossil resources	[MJ]	2.65E+2	5.80E+0	8.17E-2	1.12E+0	3.06E+0	-5.77E+1

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A1: 1 m² of installed PU board with multi-layer aluminium facing

Parameter	Unit	A1-A3	A4	A5	C2	C3	D
Renewable primary energy as energy carrier	[MJ]	2.40E+1	3.27E-1	1.87E+0	6.31E-2	1.04E+0	-1.58E+1
Renewable primary energy resources as material utilization	[MJ]	3.09E+0	0.00E+0	-1.84E+0	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	2.71E+1	3.27E-1	2.53E-2	6.31E-2	1.04E+0	-1.58E+1
Non-renewable primary energy as energy carrier	[MJ]	9.15E+1	5.82E+0	2.04E+1	1.12E+0	1.74E+2	-7.07E+1
Non-renewable primary energy as material utilization	[MJ]	1.90E+2	0.00E+0	-2.03E+1	0.00E+0	-1.70E+2	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	2.82E+2	5.82E+0	1.02E-1	1.12E+0	3.90E+0	-7.07E+1
Use of secondary material	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m^3]	8.85E-2	3.78E-4	8.13E-4	7.30E-5	2.10E-2	-2.03E-2

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A1: 1 m² of installed PU board with multi-layer aluminium facing

Parameter	Unit	A1-A3	A4	A5	C2	C3	D
Hazardous waste disposed	[kg]	9.14E-6	2.71E-7	5.70E-11	5.23E-8	2.07E-9	-1.98E-8
Non-hazardous waste disposed	[kg]	3.78E-1	8.90E-4	1.76E-3	1.72E-4	4.86E-2	-1.42E-1
Radioactive waste disposed	[kg]	6.78E-3	7.20E-6	8.13E-6	1.39E-6	3.33E-4	-5.17E-3
Components for re-use	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.60E-1
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.78E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	3.71E-1	0.00E+0	1.49E+1	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	6.60E-1	0.00E+0	2.69E+1	0.00E+0

6. LCA: Interpretation

Modules A1-A3: Impacts on the environment during the production stage are mainly determined by raw material production and processing in A1: for nearly all categories (and also for renewable energy consumption), these impacts can mostly be attributed to the PU foam, and to a lesser extent to the multi-layer aluminium facings. The production of isocyanate (approx. 50 %) and polyols (approx. 20 %) is the main reason for the PU foam's GWP. In terms of ADPE and ODP, PU foam is of vital importance (96 % and 100 % respectively) due to the production of isocyanate. Approx. 90 % of non-renewable primary energy consumption is determined by the PU core, which in turn is determined by isocyanate (approx. 50 %) and polyols (approx. 30 %). Approx. 55 % of renewable primary energy consumption is determined by the PU core, which in turn is determined by isocyanate (less than 40 %) and polyols (nearly 30 %)

Module D: The utilization potential for the next product system originates from using primary energy generated from MVAs which burn PU cores in order to generate power and steam. Additionally, Module D possesses the recycling potential of the aluminium used.

The LCA results show high robustness since the primary data, they are based on, don't show any outliers in terms of energy consumption and product's composition while comparing the contributing companies and sites. All background data are sourced from GaBi databases. With the used data sets a good overall representativity with regards to completeness, geographical coverage and technological coverage is ensured.

7. Requisite evidence

7.1 VOC emissions
Emission tests on PU boards with multi-layer aluminium facings found that the VOC values are significantly below the limits determined by the AgBB scheme (*PU Europe Technical Dossier*). The tests were conducted by the research organisations Eurofins (Denmark), VTT (Finland) and Fraunhofer WKI (Germany), *Test report No. MAIC-2016-3308,* among others.

VOC emissions

Name	Value	Unit
TVOC (C6 - C16)	0 - 100	µg/m³
Sum SVOC (C16 - C22)	0 - 10	µg/m³
R (dimensionless)	0 - 0.5	-
VOC without NIK	0 - 100	µg/m³
Carcinogenic Substances	0	µg/m³

AgBB overview of results (3 days [µg/m³])

Name	Value	Unit
TVOC (C6 - C16)	-	µg/m³
Sum SVOC (C16 - C22)	-	µg/m³
R (dimensionless)	-	-
VOC without NIK	-	µg/m³
Carcinogenic Substances	-	µg/m³

7.2 Isocyanate emission
In the analysis conducted by the Fraunhofer Institut für Holzforschung, Wilhelm-Klauditz-Institut WKI *(Test report No. 861-98)*, no isocyanate emission could be detected in the 1m³ test chamber. SUPELCO cartridges have been used for detecting MDI. The detection limit is at 10 ng/m³.

7.3 Formaldehyde
Emission tests on PU insulation boards only detected very small quantities of formaldehydes (< 3 µg/m³ (*PU Europe Technical Dossier*)). This is significantly below the threshold value of 120 µg/m³ (Class E1).

8. References

EN 15804
EN 15804:2012-04+A1 2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

IBU 2019
Institut Bauen und Umwelt e.V.: General Programme Instructions for the Preparation of EPDs at the Institut Bauen und Umwelt e.V., version 1.8, Berlin: Institut Bauen und Umwelt e.V., 2019, http://www.ibu-epd.com

ISO 14025
DIN EN ISO 14025:2011-10, Environmentaldesignations and declarations – Type III Environmental Declarations – Basic principles and procedures.

Product category rules for construction products part A: Calculation rules for LCAs and requirements on the background report 2019/1.8.

Product category rules for construction products part B: Requirements of the EPD for foam plastics insulation materials. 2017/1.2, www.bau-umwelt.de

Further references:
AgBB
Evaluation scheme for VOCs from construction products; approach for assessing health risks caused by volatile organic compounds (VOCs and SVOCs) from construction products, version July 2012.

AVV
Regulation on the European List of Waste Materials 2011, last amended by Art. 5, Section 22 of the Law, dated 24 February 2012 (BGBI. I S.212).

CPR
Regulation (EU) No. 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down hamonised condition for the marketing of construction products and repealing Council Directive 89/106/EC.

DIN 4108-4
DIN 4108-4:2020-11, Thermal insulation and energy economy in buildings - Part 4: Hygrothermal design values.

DIN 4108-10
DIN 4108-10:2015-12, Thermal insulation and energy economy in buildings - Part 10: Application-related requirements for thermal insulation materials - Factory-made products.

DIN 18234-2
DIN 18234-2:2018-05, Fire safety of large roofs for buildings - Fire exposure from below - Part 2: List of roofs which fulfil the requirements of DIN 18234-1; roof areas without openings.

DIN EN 826
DIN EN 826:2013-05, Thermal insulating products for building applications - Determination of compression behaviour.

DIN EN 1606
DIN EN 1606:2013-05, Thermal insulating products for building applications - Determination of compressive creep.

DIN EN 1607
DIN EN 1607:2013-05, Thermal insulating products for building applications - Determination of tensile strength perpendicular to faces.

DIN EN 12091
DIN EN 12091:2013-06, Thermal insulating products for building applications - Determination of freeze-thaw resistance.

DIN EN 13165
DIN EN 13165:2016-09, Thermal insulation products for buildings – Factory-made rigid polyurethane foam (PU) products - Specification; German version EN 13165:2012. (This norm covers polyurethane rigid foam (PUR) and polyisocyanurate rigid foam (PIR)).

DIN 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; German version EN 13501-1:2007+A1:2010.

DIN EN 14308
DIN EN 14308:2016-03, Thermal insulation products for building equipment and industrial installations - Factory made rigid polyurethane foam (PUR) and polyisocyanurate foam (PIR) products.

DIN EN 15801
DIN EN 15801:2010-04, Conservation of cultural property - Test methods - Determination of water absorption by capillarity.

DIN EN 16516
DIN EN 16516:2020-10, Construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air.

DIN EN 29052-1
DIN EN 29052-1:1992-08, Acoustics; determination of dynamic stiffness; part 1: materials used under floating floors in dwellings.

EN 12088
EN 12088:2013, Thermal insulating products for building applications - Determination of long term water absorption by diffusion.

EXCLI Journal
Hoffmann, Hans-Dieter; Schupp, Thomas: “Evaluation of consumer risk resulting from exposure against MDI from polyurethane foam,” scientific article, published in the EXCLI Journal in 2009.

GaBi ts:
GaBi ts Software and Documentation: Database for integrated balancing. LBP, University of Stuttgart and thinkstep AG, Documentation of GaBi ts data sets,http://www.gabi-software.com/deutsch/datenbanken/gabi-datenbanken, 2020.

IBS 316052507-A
IBS Linz: Test report No. 316052507-A, dated 06.04.2017 (IVPU), "Report on the classification of fire resistance of a rafter roof with PU over-rafter insulation".

IVPU
IVPU news: Article "Report on emission of volatile components from PUR rigid foam insulating materials," no. 64 dated June 1999.

Ordinance on Biocide Products No. 528/2012
Regulation (EU) No. 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products.

PU Europe Technical Dossier
Technical Dossier for amendment to mandate M103 VOC/SVOC emissions, doc. 13/241, 2013.

REACH
Regulation (EC) No. 1907/2006 of the European Parliament and of the Council dated 18th December 2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

Test report No. MAIC-2016-3308
Fraunhofer Institut für Holzforschung, Wilhelm-Klauditz-Institut (WKI): Test report No. MAIC-2016-3308, dated 04.08.2016 (PU Europe), "Evaluation of emissions data from PU insulation on a Commission proposal for the classification of emissions from building products in the European Union".

Test report No. 861-98
Fraunhofer Institut für Holzforschung, Wilhelm-Klauditz-Institut (WKI): Test report No. 861-98, dated 07.12.1998 (IVPU), "Test reports on emissions of volatile components from polyurethan insulating materials".

TRGS 900
Federal Institute for Occupational Safety and Health: Technical Rules for Hazardous Substances (TRGS) 900, Threshold values for workplaces, 2006, last modified 24.03.2021.

	Publisher Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	Tel Fax Mail Web	+49 (0)30 3087748- 0 +49 (0)30 3087748- 29 info@ibu-epd.com **www.ibu-epd.com**
	Programme holder Institut Bauen und Umwelt e.V. Panoramastr 1 10178 Berlin Germany	Tel Fax Mail Web	+49 (0)30 - 3087748- 0 +49 (0)30 – 3087748 - 29 info@ibu-epd.com **www.ibu-epd.com**
	Author of the Life Cycle Assessment Sphera Solutions GmbH Hauptstraße 111- 113 70771 Leinfelden-Echterdingen Germany	Tel Fax Mail Web	+49 711 341817-0 +49 711 341817-25 info@sphera.com **www.sphera.com**
	Owner of the Declaration IVPU - Industrieverband Polyurethan-Hartschaum e.V. Heilbronner Str. 154 70191 Stuttgart Germany	Tel Fax Mail Web	+49 711 29 17 16 +49 711 29 49 02 ivpu@ivpu.de **http://www.ivpu.de/**