# ENVIRONMENTAL PRODUCT DECLARATION

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

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|---|---|
| Owner of the Declaration | IVPU Industrieverband Polyurethan-Hartschaum e.V. |
| Programme holder | Institut Bauen und Umwelt e.V. (IBU) |
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## PU thermal insulation boards made of block foam

## IVPU Industrieverband Polyurethan-Hartschaum e.V.

Institut Bauen und Umwelt e.V.

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# 1. General Information

## IVPU e.V.

**Programme holder**
IBU – Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

**Declaration number**
EPD-IVP-20160147-IBE1-EN

**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**
02.09.2016

**Valid to**
01.09.2022

Prof. Dr.-Ing. Horst J. Bossenmayer
(chairman of Institut Bauen und Umwelt e.V.)

Dr. Burkhart Lehmann
(Managing Director Institut Bauen und Umwelt e.V.))

## PU thermal insulation boards made of block foam

**Owner of the declaration**
**IVPU e.V.**
Im Kaisemer 5
D-70191 Stuttgart

**Declared product / declared unit**
1 m² of installed PU thermal insulation board made of block foam and a thickness of 12 cm and a thermal conductivity (WLS) of 0.026 W/mK

**Scope:**
This Environmental Product Declaration applies to polyurethane insulation boards made of block foam as manufactured by the IVPU members Paul Brauder GmbH & Co. KG and puren GmbH.These IVPU members represent the majority of companies within the German polyurethane block foam 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**

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|---|
| The standard *EN 15804* serves as the core PCR |
| Independent verification of the declaration and data according to *ISO 14025:2010* |
| ☐ internally ☒ externally |

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 boards in building construction, as well as for insulation of building equipment and industrial installations. The polyurethane insulating material (PU) product family comprises the product variants polyurethane (PUR) and polyisocyanurate (PIR) - see /EN 13165/.PU insulating materials are produced as block foam and insulation boards with flexible facings.
This Product Declaration covers PU insulation boards without facings made of block foam. This EPD is based on weighted averages which have been determined on the basis of the single values originating from the factories of the aforementioned manufacturing companies (see section 3.1).

Please select one of the following options and delete the header of the selected [alternative]:

**[Alternative 1a: Product according to the CPR based on a hEN]:**
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 *EN xyz:date, title* and the CE-marking. For the application and use the respective national provisions apply.

**[Alternative 1b: Products according to the CPR based on an ETA].**
For the placing of the product on the market in the European Union/European Free Trade Association /EU/EFTA) (with the exception of Switzerland) the

Regulation (EU) No. 305/2011 (CPR) applies. The product needs a declaration of performance taking into consideration *ETA no. xyz:date, title* and the CE-marking.
For the application and use the respective national provisions apply.

**[Alternative 2a: Product not harmonised in accordance with the CPR but in accordance with other provisions for harmonisation of the EU]:**
For the placing on the market in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) the following legal provisions apply:

- *Directive no. xyz: date, title*
- *Regulation no. xyz: date, title*
- and the harmonised standards based on these provisions:
- *EN xyz:date, title*

The CE-marking takes into account the proof of conformity with the respective harmonized standards based on the legal provisions above.
For the application and use the respective national provisions apply.

**[Alternative 2b: Product harmonized as well in accordance with the CPR as with other provisions for harmonisation of the EU]:**
For the placing of the product on the market in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) the Regulation (EU) No. 305/2011/ (CPR) and the following other provisions for harmonisation apply:

- *Directive (EU) xyz:date, title*
- *Regulation (EU) no. xyz:date, title.*

The product needs a declaration of performance in accordance with the CPR taking into consideration /EN xyz: date/, title or /ETA no. xyz/:date, title respectively and the CE-marking.
The CE-marking for the product takes into account the Declaration of Performance in accordance with the CPR and the proof of conformity with the following harmonised standards or based on the other provisions for harmonisation:

- *EN xyz:date, title*
- *Source, date, title*

For the application and use the respective national provisions apply.

**[Alternative 3: Product for which no legal provisions for harmonisation of the EU exist]**
For the use and application of the product the respective national provisions at the place of use apply, in Germany for example the building codes of the federal states and the corresponding national specifications.

## 2.2 Application

The scope of application of PU rigid foam insulation materials comprises 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 13165/ and /DIN EN 14308/ are used.

**Constructional data**

| Name | Value | Unit |
|---|---|---|
| Gross density | - | kg/m³ |
| Gross density | 33 | kg/m³ |
| Compressive strength acc. to EN 826 | - | N/mm² |
| Tensile strength acc. to EN 826 | - | N/mm² |
| Compressive strength acc. to /DIN EN 826/ | ≥ 100 | kPa |
| Flexural strength | - | N/mm² |
| Modulus of elasticity acc. to EN 826 | - | N/mm² |
| Tensile strength acc. to /DIN EN 1607/ | ≥ 100 | kPa |
| Calculation value for thermal conductivity | - | W/(mK) |
| Water vapour diffusion resistance factor acc. to EN 12088 | - | - |
| Moisture content at 23 °C, 80% | - | M.-% |
| Modulus of elasticity acc. to /DIN EN 826/ | ≥ 4 | MPa |
| Sound absorption coefficient (if relevant) | - | % |
| Thermal conductivity | - | W/(mK) |
| Design value thermal conductivity (Germany) | 0.026-0.028 | W/(m·K) |
| Dynamic rigidity acc. to DIN EN 29052 | - | MN/mm³ |
| Nominal thermal conductivity acc. to /DIN EN 13165/ | 0.025-0.027 | W/(m·K) |
| Creep behaviour or permanent compressive strength acc. to DIN EN 1606 | - | N/mm² |
| Water vapour diffusion resistance factor acc. to /EN 12088/ | 40 - 200 | - |
| Water absorption after diffusion acc. to EN 12088 | - | Vol.-% |
| Creep behaviour or permanent compression strength acc. to /DIN EN 1606/ | ≥ 20 | kPa |
| Maximum water absorption acc. to DIN EN 12091 | - | Vol.-% |
| Water absorption by capillarity acc. to DIN EN 15801 | - | cm |
| Maximum service temperature acc. to /DIN EN 14706/ | up to + 200 | °C |
| Minimum service temperature acc. to /DIN EN 14308/ - Section 4.3.3 | up to – 200 | °C |

The gross density of PU insulation boards made of block foam for building construction is approx. 33 kg/m³.For special applications it is possible to manufacture boards with a gross density of up to approx. 200 kg/m³.Depending on their thickness, the boards are manufactured with a gross density of approx. 33 kg/m³ with thermal conductivity levels between WLS 026 and WLS 028 (up to a thermal conductivity level WLS 045 at a gross density of approx. 200 kg/m³). These levels correspond to design values of thermal conductivity between 0.026 and 0.028 W/mK or 0.045 W/mK at high gross density.

Nominal compressive stress or nominal compressive strength at 10 % deformation is at 100 kPa (dh) or 150 kPa (ds) acc. to /DIN 4108-10/.Higher compressive strength up to approx. 3000 kPa is possible.

Nominal tensile strength is 100 kPa. Higher tensile strength is possible.

The water vapour diffusion resistance factor μ of polyurethane rigid foam is between 40 and 200 acc. to /DIN 4108-4/.

Maximum moisture absorption of polyurethane rigid foam at diffusion and condensation is at approx. 6 % by volume. Moisture absorption after freezing and thawing was between 2 % and 7 % by volume.

PU rigid foam products for building equipment and industrial installations can be used in a temperature range from – 200 °C up to + 200 °C.

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

Please select one of the following options and delete the header of the selected [alternative]:

**[Alternative 1a: Product according to the CPR, based on a hEN]:**

- Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *EN xyz:date, title.*
- Voluntary data: *source, date, title* (not part of CE-marking).

**[Alternative 1b: Product according to the CPR, based on an ETA]:**

- Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *ETA no. xyz, date, title*.
- Voluntary data: *source, date, title* (not part of CE-marking).

**[Alternative 2a: Product not harmonised in accordance with the CPR but in accordance with other provisions for harmonisation of the EU]:**

- Performance data of the product according to the harmonised standards, based on provisions for harmonization.
- Voluntary data: *source, date, title* (not part of CE-marking).

**[Alternative 2b: Product harmonized as well in accordance with the CPR as with other legal provisions of the EU]:**

- Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *EN xyz: date, title* or *ETA no. xyz, date, title* respectively.
- Performance data of the product, based on the harmonised standards, in accordance with the other provisions for harmonization.
- Voluntary data: *source, date, title* (not part of CE-marking).

**[Alternative 3: Product for which no legal provisions for harmonisation of the EU exist]:**

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

### 2.4 Delivery status

Polyurethane insulation boards made of block foam 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 5,000 mm.

### 2.5 Base materials/Ancillary materials

The PU insulation board made of block foam is 12 cm thick and consists of 3.96 kg/m² PU rigid foam. Polyurethane rigid foam is formed by the chemical reaction of methylene diphenyl diisocyanate (MDI, approx. 55-65 %) and polyol (approx. 20-30 %) adding low boiling point blowing agents (approx. 4-6 %)This Product Declaration refers to insulation boards made of block foam that have been foamed using the hydrocarbon pentane. Due to the closed-cell structure, the blowing agent remains within the foam cells. Water (approx. 0.5 %), foam stabilisers and catalysts (approx. 3 %), as well as flame retardants (chlorinated or non-chlorinated phosphoric acid esters, approx. 5 - 10 %) are added as ancillary materials.
The raw materials used for the production of polyurethane rigid foams are mainly obtained from crude oil, undergoing several production stages. Polyols can also be produced from renewable raw materials (industrial sugar, glycerin, sorbitol or plant oil).
Polyurethane rigid foam materials meet all relevant requirements regarding the use of certain substances (/Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (/REACH/). In accordance with the current REACH candidate list, the foam formulations contain no SVHC substances. Polyurethane rigid foam does not contain volatile isocyanates.

### 2.6 Manufacture

Polyurethane rigid foam insulation boards made of block foam are produced on block units. In this manufacturing process, the polyurethane reaction mixture pours from a mixing head onto a paper base and foams up to a height of approx. 90 cm.
After the cooling phase, the rigid foam blocks are cut to boards with the desired dimensions.

**Quality assurance**

The declared products as per /DIN EN 13165/ bear the quality mark of the “Überwachungsgemeinschaft Polyurethan-Hartschaum”. 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 rigid foam boards can be cut, sawed, milled, and abraded with conventional construction tools and portable machines. They can be fixed either mechanically or by gluing. It is possible to glue the boards by using either hot-setting or cold-setting adhesives following the manufacturer's recommendations. Alternatively, PU rigid foam boards can be laid loosely, e.g. on floors.
Joints between cut PU 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. When working on an industrial scale, workers who carry out these processes are 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 utilised in waste incineration plants or be returned to the manufacturer for recycling.

## 2.9 Packaging

Primarily plastic foils are used for packaging.

## 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 717-1/ and /DIN (EN) ISO 16000-6, 9 and 11/) showed that volatile organic substances (VVOC, VOC) are emitted in small quantities in the form of the hydrocarbon pentane.
Regarding the current REACH candidate list, the foam formulations contain no SVHC substances (see section 2.6).
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 (40 - 50 years, /BNB/).The insulating performance stays the same throughout the entire service life.

## 2.13 Extraordinary effects

### Fire

According to national approvals, polyurethane insulating materials made of block foam are classified either as normally ignitable (B2 acc. to /DIN 4102-1/ or E acc. to /DIN EN 13501-1/) or as non-readily ignitable (B1 acc. to/ DIN 4102-1/ or C acc. to /DIN EN 13501-1/). In case of fire, PU rigid foam carbonises without dripping off burning droplets and does not tend to smoulder.

When burning, sooty products, water vapour, carbon monoxide, carbon dioxide, nitrogen oxides, as well as traces of hydrogen cyanide are formed. The composition of the smoke gas is the same as with 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 and it also depends on the ventilation conditions in the affected area.

### Fire prevention

| Name | Value |
|---|---|
| Building material class | - |
| Building material class | - |
| Burning droplets | - |
| Burning droplets | - |
| Smoke gas development | - |
| Smoke gas development | - |

### 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 if they are mounted mechanically or laid loosely. Clean and undamaged polyurethane insulation boards can be re-used, re-utilised from material recycling, or recycled as raw material (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 re-utilised from 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 which are used to insulate window frames and thermal bridges et al.

### 2.15 Disposal

According to the /Kreislaufwirtschaftsgesetz/ (Circular Economy Act) 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. With thermal treatment, the energy content of the insulating material is recovered.

### 2.16 Further information

Please visit www.ivpu.de and www.daemmtbesser.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 made of block foam and has the following specifications:

**Declared Unit**

| Name | Value | Unit |
|---|---|---|
| Declared unit | 1 | $m^2$ |
| Gross density | 33 | $kg/m^3$ |
| Thermal conductivity | 0.026 | W/(m·K) |
| conversion factor [Mass/Declared Unit] ($kg/m^2$) | 3.96 | - |
| Thermal resistance (R value) | 4.6 | $m^2$•W/K |
| Grammage | 3.96 | $kg/m^2$ |
| Layer thickness | 0.12 | m |

The LCA results can be converted linearly for other gross density or board thickness values.

This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the two above-mentioned IVPU members Paul Bauder GmbH & Co. KG and puren GmbH (EPD Class 2a).
Energy consumption and the quantity of production waste have been weighted according to the quantities of produced PU rigid foam in m3. Raw material consumption has been weighted according to produced quantities in kg.

### 3.2 System boundary

Type of EPD: cradle to gate - with options
The life-cycle assessment considers the following modules of the life cycle:
· production and provision of raw materials (A1)
· transporting raw materials (A2)
· production including packaging (A3)
· transport to construction site (A4)
· installation in buildings (recycling or thermal treatment of cutting leftovers and packaging waste) (A5)
· transport to End of Life (C2)
· waste treatment: energy for shredders (C3)
· thermal treatment in waste incineration plants (MVA) - (C4)
· use potential beyond the system's boundary due to energy substitution in the MVA (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 can be handled using mainly material recycling (see 2.15). However, using a worst-case approach, in this EPD the incineration and the consequent energy benefit beyond the system boundary shall be considered and be declared in module D.

### 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 and the cut-off limit of 5 % acc. to the PCR Part A is met.
The manufacturers have provided data on transport expenditures for all relevant material flows. Machinery and installations required for the production are neglected.

### 3.5 Background data

Background data originates from the GaBi software database from thinkstep AG (/GaBi ts 2016D/).The German electrical power mix is used for production while the European power mix is used for the use potentials in module D. 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 2015.2 IVPU members (see above) participated in this data gathering. These IVPU members represent the majority of companies within the German polyurethane block foam 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 aforementioned 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 2015, considering 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 calorific values. Due to distribution throughout all of Europe, the substitution processes in module D refer to the reference area of Europe (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 database has to be mentioned

## 4. LCA: Scenarios and additional technical information

The following technical information serves as the basis for the declared modules. If modules are not declared (MND), it 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 |
| Capacity utilisation (including empty runs) | 85 | % |
| Gross density of products transported | 33 | kg/m$^3$ |

**Installation in buildings (A5)**

| Name | Value | Unit |
|---|---|---|
| Materia loss | 5 | % |
| Packaging waste | 0.04 | kg |

**End of life cycle (C1-C4)**

| Name | Value | Unit |
|---|---|---|
| Reuse | 0 | kg |
| Energy recovery | 396 | kg |
| Landfilling | 0 | kg |

**Reuse, recovery, and recycling potentials (D), relevant scenario data**

100 % thermal treatment in an MVA.

# 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 | X | X |

**RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A1: 1 m² of installed PU insulation board made of block foam**

| Parameter | Unit | A1-A3 | A4 | A5 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| GWP | [kg $CO_2$-Eq.] | 1.48E+1 | 2.89E-1 | 5.40E-1 | 5.72E-2 | 1.02E-1 | 8.74E+0 | -4.00E+0 |
| ODP | [kg CFC11-Eq.] | 2.34E-5 | 1.32E-12 | 4.00E-7 | 2.62E-13 | 7.25E-11 | 2.59E-11 | -1.29E-9 |
| AP | [kg $SO_2$-Eq.] | 3.06E-2 | 1.64E-3 | 6.18E-4 | 3.24E-4 | 2.84E-4 | 3.51E-3 | -6.26E-3 |
| EP | [kg $(PO_4)^{3-}$-Eq.] | 4.90E-3 | 4.09E-4 | 1.08E-4 | 8.09E-5 | 2.54E-5 | 8.91E-4 | -6.37E-4 |
| POCP | [kg ethene-Eq.] | 1.96E-2 | -6.73E-4 | 2.12E-4 | -1.33E-4 | 1.96E-5 | 2.36E-4 | -6.72E-4 |
| ADPE | [kg Sb-Eq.] | 2.88E-5 | 1.92E-8 | 4.89E-7 | 3.80E-9 | 3.34E-8 | 6.87E-8 | -6.71E-7 |
| ADPF | [MJ] | 3.06E+2 | 3.97E+0 | 5.24E+0 | 7.85E-1 | 1.11E+0 | 2.07E+0 | -5.52E+1 |

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

**RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A1: 1 m² of installed PU insulation board made of block foam**

| Parameter | Unit | A1-A3 | A4 | A5 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| PERE | [MJ] | 1.63E+1 | 2.26E-1 | 2.38E-1 | 4.46E-2 | 4.98E-1 | 2.27E-1 | -8.87E+0 |
| PERM | [MJ] | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 |
| PERT | [MJ] | 1.63E+1 | 2.26E-1 | 2.38E-1 | 4.46E-2 | 4.98E-1 | 2.27E-1 | -8.87E+0 |
| PENRE | [MJ] | 2.26E+2 | 3.98E+0 | 5.56E+0 | 7.88E-1 | 1.78E+0 | 2.33E+0 | -6.72E+1 |
| PENRM | [MJ] | 9.90E+1 | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 | 0.00E+0 |
| PENRT | [MJ] | 3.25E+2 | 3.98E+0 | 5.56E+0 | 7.88E-1 | 1.78E+0 | 2.33E+0 | -6.72E+1 |
| SM | [kg] | 0.00E+0 | 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 | [$m^3$] | 9.47E-2 | 5.65E-4 | 2.26E-3 | 1.12E-4 | 7.69E-4 | 2.02E-2 | -1.38E-2 |

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

**RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A1: 1 m² of installed PU insulation board made of block foam**

| Parameter | Unit | A1-A3 | A4 | A5 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|
| HWD | [kg] | 1.46E-5 | 3.01E-7 | 2.55E-7 | 5.96E-8 | 1.13E-9 | 1.30E-9 | -2.56E-8 |
| NHWD | [kg] | 3.60E-1 | 3.35E-4 | 4.54E-3 | 6.62E-5 | 1.07E-3 | 8.92E-3 | -2.33E-2 |
| RWD | [kg] | 7.65E-3 | 5.69E-6 | 1.30E-4 | 1.13E-6 | 2.69E-4 | 1.06E-4 | -4.78E-3 |
| 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 | 4.04E+0 |
| EEE | [MJ] | 0.00E+0 | 0.00E+0 | 5.09E-1 | 0.00E+0 | 0.00E+0 | 1.31E+1 | 0.00E+0 |
| EET | [MJ] | 0.00E+0 | 0.00E+0 | 1.16E+0 | 0.00E+0 | 0.00E+0 | 3.02E+1 | 0.00E+0 |

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

# 6. LCA: Interpretation

Modules A1-A3: Impacts on the environment of the production stage are mainly determined by raw material production and processing in A1.

In all impact categories, upstream processes prior to the production of isocyanate have significant effects, especially in the depletion potential of the stratospheric

ozone layer (**ODP,** Ozon Depletion Potential). However, some effects can also be attributed to the upstream processes in the production of polyol and to a small extent to the use of flame retardants.
For example within the impact category Global Warming Potential (**GWP**), isocyanate has a significant effect (approx. 50 %) while polyols and flame retardants only have a moderate share in the overall result (approx. 10 %, respectively).

Non-renewable primary energy consumption (PENRE) can mainly be attributed to the upstream processes within the production of isocyanate and polyol (approx. 70 % in total).

Module C4: The environmental load in C4 is caused by the combustion of the PU insulation board.

Module D: The utilisation potential for the next product system originates from substituting primary energy for the generation of power and steam in MVAs that thermally treat the PU insulation boards.

# 7. Requisite evidence

### 7.1 VOC emissions

Emission tests on PU boards made of block foam 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 /WKI/Germany, among others.

**VOC emissions**

| Name | Value | Unit |
|---|---|---|
| Overview of Results (28 Tage) | - | µg/m³ |
| TVOC (C6 - C16) | 0 - 100 | µg/m³ |
| Sum SVOC (C16 - C22) | 0 - 10 | µg/m³ |
| R (dimensionless) | 0 - 5 | - |
| VOC without NIK | 0 - 100 | µg/m³ |
| Carcinogenic Substances | 0 | µg/m³ |

### 7.2 Isocyanate emission

In the analysis conducted by the Fraunhofer Institut für Holzforschung, Wilhelm-Klauditz-Institut /WKI (1998)/, no isocyanate emission could be detected in the 1-m³ 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 boards made of block foam only detected very small quantities of formaldehydes < 3 µg/m3 (/PU Europe Technical Dossier/ and /Eurofins Test Report/). This is significantly below the threshold value of 120 µg/m3 (Class E1).

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**Publisher**
Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Tel +49 (0)30 3087748- 0
Fax +49 (0)30 3087748- 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

**Programme holder**
Institut Bauen und Umwelt e.V.
Panoramastr 1
10178 Berlin
Germany

Tel +49 (0)30 - 3087748- 0
Fax +49 (0)30 – 3087748 - 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

**Author of the Life Cycle Assessment**
thinkstep AG
Hauptstraße 111
70771 Leinfelden-Echterdingen
Germany

Tel +49 711 341817 0
Fax +49 711 341817 25
Mail info@thinkstep.com
Web **www.thinkstep.com**

**Owner of the Declaration**
IVPU - Industrieverband
Polyurethan-Hartschaum e.V.
Im Kaisemer 5
70191 Stuttgart
Germany

Tel +49 711 2268716
Fax +49 711 29 49 02
Mail ivpu@ivpu.de
Web **http://www.ivpu.de/**