Environmental Product Declaration

acc o r d i n g t o  I S O  1 4 0 2 5

EPS rigid foam (grey) with thermal radiation absorber

Industrieverband Hartschaum e.V.

Declaration number
EPD-IVH-2009211-D

Institut Bauen und Umwelt e.V.:
www.bau-umwelt.com
### Summary

**Environmental Product Declaration**

---

#### Programme holder

**Institut Bauen und Umwelt e.V.**

[www.bau-umwelt.com](http://www.bau-umwelt.com)

---

#### Declaration holder

**Industrieverband Hartschaum e.V., IVH**

Kurpfalzring 100a

69123 Heidelberg / Germany

---

#### Declaration number

EPD-IVH-2009211-D

---

#### Declared building products

**Insulating materials made of expanded polystyrene (EPS) with thermal radiation absorber**

This declaration is an environmental product declaration according to ISO 14025 and describes the specific environmental performance of the building products mentioned here in Germany. It is intended to promote the development of environmental and health compatible construction. All relevant environmental data is disclosed in this validated declaration.

The declaration is based on the PCR document "Factory-made insulating materials made of foam plastics", December 2009.

This validated declaration authorises the holder to bear the official stamp of the "Institut Bauen und Umwelt". It only applies to the above-mentioned products for three years from date of issue.

The declaration holder is liable for the information and evidence on which the declaration is based.

The **declaration** is complete and contains in detail:

- Product definition and physical data
- Information about raw materials and origin
- Specifications on manufacturing the product
- Notes on product processing
- Information on product in use, singular effects and end of life
- LCA results
- Evidence and verifications

---

#### Content of the declaration

11 December 2009

**Signatures**

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

This declaration and the rules on which it is based have been verified by the Independent Advisory Board (SVA) according to ISO 14025.

**Verification of the declaration**

---

**Signatures**

Prof. Dr.-Ing. Hans-Wolf Reinhardt (chairman of the SVA) Dr. Birgit Grahl (verifier appointed by the SVA)
This environmental product declaration (EPD) describes rigid foam insulating products made of expanded polystyrene (EPS) of the IVH members.

The main area of application for the products declared here is façade insulation with thermal insulation composite systems.

The Life Cycle Assessment (LCA) was carried out according to DIN ISO 14040/44 as laid down in the requirements of the IBU guidelines “environmental product declarations” on Type III Declarations. Specific data from four member companies of the Industrieverband Hartschaum IVH as well as data from the database “GaBi 4” were used. The Life Cycle Assessment includes raw material and energy generation, raw material transports, the actual manufacturing phase of the EPS rigid foam incl. packaging and its disposal, and a scenario for the end-of-life of the product. 1m³ of an average EPS rigid foam board with an average density of 16.6 kg/m³ for SA-032 is described.

### EPS rigid foam, grey for walls and roofs (production + end of life)

<table>
<thead>
<tr>
<th>Impact category in unit per m³</th>
<th>SA-032</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy, non-renewable [MJ]</td>
<td>875.5</td>
</tr>
<tr>
<td>Primary energy, renewable [MJ]</td>
<td>2.6</td>
</tr>
<tr>
<td>Abiotic resource consumption [kg Sb eqv.]</td>
<td>4.2E-01</td>
</tr>
<tr>
<td>Global warming potential (GWP) [kg CO₂ eqv.]</td>
<td>6.8E+01</td>
</tr>
<tr>
<td>Ozone depletion potential (ODP) [kg R11 eqv.]</td>
<td>2.3E-07</td>
</tr>
<tr>
<td>Acidification potential (AP) [kg SO₂ eqv.]</td>
<td>7.2E-02</td>
</tr>
<tr>
<td>Eutrophication potential (EP) [kg PO₄³⁻ eqv.]</td>
<td>7.6E-03</td>
</tr>
<tr>
<td>Photochemical ozone creation potential (POCP) [kg C₂H₄ eqv.]</td>
<td>2.8E-01</td>
</tr>
</tbody>
</table>

Prepared by: PE INTERNATIONAL, Leinfelden-Echterdingen

In addition, the following evidence and verifications are represented in the environmental declaration:

- VOC emissions
Environmental Product Declaration

**EPS rigid foam (grey) with thermal radiation absorber**

<table>
<thead>
<tr>
<th>Product group</th>
<th>PCR foam plastics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration holder</td>
<td>Industrieverband Hartschaum, IVH</td>
</tr>
<tr>
<td>Declaration number</td>
<td>EPD-IVH-2009211-D</td>
</tr>
</tbody>
</table>

**Scope of validity**

The present EPD describes the EPS rigid foam products with thermal radiation absorber for thermal and sound insulation of walls and roofs. The participating member companies represent 56% of the total volume of all IVH member companies for the year 2008 with their production (based on mass).

**1. Product definition**

**Product definition**

This environmental product declaration (EPD) describes rigid foam insulating products made of expanded polystyrene (EPS) of the IVH members. The association mark for EPS products of the IVH members is Styropor®. These products are used for the thermal and sound insulation of buildings. They are produced in factories in the form of boards or as loose, thermally insulating filler material.

The present EPD describes the silver-grey EPS rigid foam products for thermal and sound insulation. The silver-grey insulating materials are equipped with infrared radiation absorbers which effect a considerably improvement of the insulation performance.

The white EPS insulating products for the ranges of application ‘walls’ and ‘roofs’ are described in the environmental product declaration EPD-IVH-2009311-D.

The data for the also white EPS insulating products for ceilings and floors as well as external basement walls and floor slaps are included in the environmental product declaration EPD-IVH-2009111-D.

EPS rigid foam is a rigid insulating material with a cell structure made of fused, expanded polystyrene or one of its copolymers. It has a closed cell structure filled with air (98% air).

EPS boards are rigid insulating products (cut, formed or continuously expanded) in a rectangular shape. The board’s edges can be equipped with stepped rebate or tongue and groove. EPS as loose filler material is produced in factories in the form of air-filled beads (Ø approx. 6mm).

This environmental product declaration describes the homogenous EPS insulating material without material combination with composite boards or clad insulating boards. Important characterising properties are the thermal conductivity, the compressive strength and the sound insulation.

**Application**

The main area of application for the products declared here is façade insulation with thermal insulation composite systems.
Marketing and application rules

The product standard is DIN EN 13163 – Thermal insulation products for buildings – Factory made products of expanded polystyrene (EPS) - Specification

The insulating products declared herein in addition possess the required national technical approvals (abZ) of the Deutsche Institut für Bautechnik (German Institute for Building Technology; DIBt, approval area 33: façade construction). The approvals in particular contain information on the rated value of thermal conductivity and on fire behaviour. Approval holders are the relevant IVH member companies.

DIN 4108-10 – Thermal protection and energy economy in buildings – Application-related requirements for thermal insulation materials – Factory made – sets the minimum requirements for the individual ranges of application.

Quality assurance

EPS rigid foam products are subject to initial, self- and external monitoring according to the building rules list, Part B (CE mark).

The self-monitoring of the products by the IVH members is carried out on the basis of the quality management system (QMS) of the Bundesfachabteilung Qualitätssicherung EPS (BFA QS EPS) following DIN EN ISO 9001. The external monitoring through factory sampling is made by testing laboratories approved by the building supervisory board.

The certification as building product complying with the regional building regulations (-> Ü mark) is carried out by company-neutral and independent notified bodies in BFA QS EPS.

In addition, the thermal insulation products declared herein are subject to regular verifications by anonymous and penalty-regulated market samplings by the BFA QS EPS as part of the external monitoring. In this respect, the important properties of the products are analysed by the Forschungsinstitut für Wärmeschutz (FIW) and submitted to the BFA QS EPS.

The application types of DIN 4108-10 are assigned to special quality types of the BFA QS EPS.

Table 0-1: Quality types according to BFA guidelines

<table>
<thead>
<tr>
<th>Quality types according to BFA guidelines</th>
<th>Application type according to DIN 4108-10</th>
<th>Quality type</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS rigid foam products (radiation absorber)</td>
<td>Façade insulating board WDV</td>
<td>WAP</td>
</tr>
<tr>
<td>Façade insulating board WDV</td>
<td>EPS 032 WDV&lt;sup&gt;2)&lt;/sup&gt;</td>
<td>EPSSe 035 WDV&lt;sup&gt;3)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Plastered external insulation of wall</td>
<td>EPSSe 032 WDV&lt;sup&gt;3)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>1) 035: Rated value of thermal conductivity, λ = 0.035W/(m*K)</td>
<td>2) 032: Rated value of thermal conductivity, λ = 0.032W/(m*K)</td>
<td>3) e = plasticised to improve the sound insulation</td>
</tr>
</tbody>
</table>
Geometrical data

The dimensions depend on the manufacturer-related products. They comply with the approval notifications.

Standard dimensions:
Length 1,000mm, width 500mm, thickness 20 mm to 300mm
Other dimensions are possible.

Physical data

Raw density range\(^1\): \(\rho = \text{approx. } 17\text{kg/m}^3\)
Properties\(^2\) according to application standard DIN 4108-10 (extract):

- Tolerances on dimensions for thickness according to EN 823
  \(\pm 1\text{mm}\)
- Tolerances on dimensions for length and width according to EN 822
  \(\pm 2\text{mm/m}\)
- Bending strength according to EN 12089
  \(\geq 50\text{kPa}\)
- Tensile strength perpendicular to the board plane according to EN 1607
  \(\geq 80\text{kPa (EPSe)}\)
  \(\geq 100\text{kPa}\)
- Dimensional stability under constant laboratory conditions according to EN 1603
  \(\pm 0.2\%\)
- Shear strength
  \(\geq 50\text{kPa}\)
  \(\geq 25\text{kPa (EPSe)}\)

Special properties assigned to BFA quality types partially exceed the requirements of DIN 4108-10. These may be seen from the relevant BFA quality guidelines.

Thermal insulation

Rated value of thermal conductivity according to national technical approvals (abZ):
\(\lambda = 0.032\text{W/(m*K)}; \quad \lambda = 0.035\text{W/(m*K)}\)
EPS rigid foam with \(\lambda = 0.040\text{W/(m*K)}\) or \(0.045\text{W/(m*K)}\) is not subject matter of this declaration.

Sound insulation

In order to improve the sound insulation, plasticized EPS rigid foam boards of the BFA quality type EPSe 035 WDV or EPSe 032 WDV are used e.g. in thermal insulation composite systems. For the purpose of evidence for sound insulation, the BFA quality guideline “Façade insulating boards made of EPS rigid foam in thermal insulation composite systems (WDVS)” contains corresponding correction values \(\Delta R'_{\text{w},R}\) to calculate the assessed sound insulation value \(R'_{\text{w},R}\) of a wall structure (solid wall with thermal insulation composite system).

---

1. The raw density range results from the averaged values. These are based on the minimum raw densities to be complied with for the various areas of application and the pertinent market shares.
2. For the exact requirements of the relevant application type see DIN 4108-10.
Environmental Product Declaration

EPS rigid foam (grey) with thermal radiation absorber

<table>
<thead>
<tr>
<th>Product group</th>
<th>PCR foam plastics</th>
<th>Prepared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration holder</td>
<td>Industrieverband Hartschaum, IVH</td>
<td>December-2009</td>
</tr>
<tr>
<td>Declaration number</td>
<td>EPD-IVH-2009211-D</td>
<td></td>
</tr>
</tbody>
</table>

Fire protection

EPS insulating products are classified building product class E according to DIN EN 13501-1. In Germany, they are assessed as flame retardant (building product class B1) according to DIN 4102-1. The B1 classification is regulated in the relevant national technical approvals.

Change of state:
Melting point / range: > 100°C
Ignition temperature: approx. 370°C
Spontaneous ignition temperature: approx. 450°C
EPS rigid foam has been assessed “non-burning dripping” (DIN EN 13501).

2. Raw materials

Raw materials / additives

The polymeric raw material for ‘Styropor’ or EPS is polystyrene (PS). It is produced of monomeric styrene by polymerisation based on various processes. The process most often used is polymerisation in a styrene/water suspension using the foaming agent pentane at the end of the polymerisation. The PS granulate thus produced is further processed into foam in downstream physical processing steps. The products considered in this declaration are equipped with the flame retardant hexabromocyclododecane (HBCD).

The basic material EPS is supplied to the foam producer in the form of bead-like granulate and transformed / expanded and finished there physically.

<table>
<thead>
<tr>
<th>Percentage in mass %</th>
<th>Composition of EPS boards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polystyrene granulate</td>
<td>84 – 98 %</td>
</tr>
<tr>
<td>Recyclate</td>
<td>0 – 12 %</td>
</tr>
<tr>
<td>Hexabromocyclododecane</td>
<td>1 – 2 %</td>
</tr>
<tr>
<td>Graphite</td>
<td>3.5 – 5 %</td>
</tr>
<tr>
<td>Foaming agent referred to the finished product</td>
<td></td>
</tr>
<tr>
<td>Pentane</td>
<td>4 – 6 %</td>
</tr>
</tbody>
</table>

Auxiliary substances/additives/material explanation

The pentane used for expansion is a C5 hydrocarbon.

For the manufacture of flame-protected polystyrene granulate, a flame retardant is in addition added in low amounts during the polymerisation. The cycloaliphatic HBCD has been proven and tested as flame retardant for approx. 40 years. It is firmly incorporated in the polymer cell matrix.
Environmental Product Declaration

EPS rigid foam (grey) with thermal radiation absorber

<table>
<thead>
<tr>
<th>Product group</th>
<th>PCR foam plastics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration holder</td>
<td>Industrieverband Hartschaum, IVH</td>
</tr>
<tr>
<td>Declaration number</td>
<td>EPD-IVH-2009211-D</td>
</tr>
</tbody>
</table>

### Material explanation

**Polystyrene:** Polystyrene is produced by polymerisation of styrene monomers. Styrene is typically produced by dehydration of ethylbenzene, a product of the refinement of the fossil raw materials crude oil and natural gas. The raw material polysterene is supplied to the foam producer in the form of bead-like granulate. In order to facilitate the expansion process, the foaming agent pentane is added during the polymerisation process. For the manufacturing process of polystyrene, this study uses aggregated data of the GaBi 4 database.

**Pentane:** Pentane is an element of natural gas and petroleums. It is produced by distillation and acts as a foaming agent during foam production because it extends during heat application.

**HBCD:** Rigid foam insulating materials are subject to the national technical building regulations. With regard to their fire behaviour, they are assessed and classified according to DIN 4102-1. In order to obtain the classification of the building product into the flammability rating for the required application type, styrene has to be equipped with flame retardants. For this purpose, hexabromocyclododecane is used. For the present study, a literature search was carried out, based on which the effects on the environment during the production of the flame retardant can be estimated.

**Graphite:** Graphite is a very common natural mineral. The exploited product has many shapes (e.g. granulate, powder). In the declared EPS products, it provides for an improved reflection of thermal radiation, which in turn improves the insulation performance of the EPS products in the event of a lower layer thickness.

Carbon black or similar material can also be used instead of graphite. These other materials are not considered in this declaration.

### Raw materials production and origin of substances

The monomeric styrene and the pentane are crude oil or natural gas products.

### Local and general availability of raw materials

Styrene is produced either by dehydration of ethylbenzene - a product of the refinement of the fossil raw materials crude oil and natural gas - or as byproduct during the production of propylene oxide in the so-called SM/PO process (styrene monomer & propylene oxide).
3. Manufacturing the product

**Manufacturing the product**

EPS rigid foam is produced in the processing steps pre-expansion, intermediate storage, expansion:

Pre-expansion means that the bead-like granulate, in which the foaming agent is embedded, is softened with overheated water steam and then expanded by evaporation of the foaming agent. Subsequently, the expanded granulate is intermediate stored in air-permeable silos. The air diffusing into the EPS foam particles gives them the stability required for further processing.

The process most often used to produce insulating boards is the block expansion with subsequent cutting. For this purpose, the EPS foam particles are filled into square block moulds and expanded by adding steam at a temperature of 110 to 120°C. After a short cooling time, the blocks are removed from the mould and stored. With regard to EPSe products, the blocks are pressed in a further step before they are cut. They are then cut into boards on mechanical or thermal cutting machines. Additional edge profiles (tongue and groove or stepped rebate) can be produced by milling.

Boards as moulded parts (second most used process) can also be produced on fully automatic machines (moulding machines). The finished boards are then immediately available in the desired finished shape, e.g. rebated.

Belt expansion (third most used process; extrusion) means that the boards are expanded in a continuous process on a double belt press between rotating steel strips. The boards are produced and cut in the desired thickness and length.

**Figure 3-1:** Process flow of the manufacture of EPS rigid foam boards

**Health protection production**

In principle, the Technical Rule TRGS 900 (Febr. 2009) with regard to maximum occupational exposure limit values is to be met. Furthermore, no other measures going beyond the general occupational health and safety measures are required.

**Environmental protection production**

Firms producing EPS rigid foam in Germany do not belong to the plants requiring approval according to TA Luft (Technical Instructions on Air Quality). They are thus not considered in this declaration. In addition, measures going beyond the statutory requirements are also not required.
4. Product processing

Processing recommendations

The thermal insulation of the building envelope with EPS products is one of the most sensible measures to increase the energy efficiency resulting in sustainable energy saving. They are, among other things, excellently processible and machinable because of their relatively low weight.

For all applications, the pertinent standards and guidelines (e.g. BFA quality guidelines/controls and the technical rules of the skilled crafts associations) as well as the manufacturer's instructions are to be observed. Additional building-physical evidence (e.g. moisture proofing) support the optimisation increasing the energy efficiency.

The boards are dimensionally stable and absorb almost no moisture. This is not only of major importance for the entire life cycle of the building but also already during the construction phase.

Façade insulating board for thermal insulation composite systems (quality type WDV):

EPS 035 WDV, EPS 035 WDV, EPS 032 WDV, EPS 032 WDV

The boards are mounted to the façade and plastered. The boards are mounted by bonding or by additional mechanical fixing, if required.

The application is system-bound and requires a general technical approval which defines the system components as well as the processing.

Occupational health and safety/ Environmental protection

EPS rigid foam products are stable and inert, given normal application, storage and handling conditions. When working with naked flames, extinguishing agents should be provided near-by. Hot-wire cutting should not be carried out in unventilated rooms.

No special first aid measures are required.

Packaging

EPS insulating boards are typically packaged and delivered in PE foil. The packaging materials are disposed of via qualified waste management companies.

5. Building product in use

Constituents

Raw material granulate is used to produce EPS rigid foam boards for thermal insulation.

A major part of the foaming agent pentane required for the foam structure is released during the manufacturing process. An emission during the storage and phase of use depends on various parameters, among other things on the foam structure, temperature, open surface and the air exchange when installed. The foam filled with air provides for excellent thermal insulation properties.

In the installed product, all materials used are non-ageing and moisture-resistant. The insulating performance as well as the mechanical properties during the entire useful life are thus retained unchanged.

Impact relationships

EPS insulating materials have been used for more than 50 years. Negative effects on humans, animals and the environment are not known. Since their
Environment - health

Long-term durability / product in use

Properly installed EPS rigid foams are long-term durable with regard to dimension and physical properties. They are water-resistant and are not decomposed by microorganisms. They are resistant to numerous substances, should, however, not be brought into contact with organic solvents.

Given proper processing, the useful life of EPS rigid foam boards corresponds to that of the building insulated with these boards.

6. Singular effects

Fire

EPS insulating products are classified as flame retardant (building product class B1) according to DIN 4102-1. They are classified as “non-burning dripping”. The fire behaviour is specified within the scope of the national technical approvals.

For fire protection law reasons, the flame retardant HBCD is added to the product to guarantee the flame resistance required by law.

Water

EPS rigid foam is chemically neutral, insoluble in water and does not release any water-soluble substances which could result in a contamination of the ground water, the rivers and the seas.

Because of their closed cell structure, insulating materials made of EPS rigid foam normally also may remain in the existing construction design even in case of considerable moisture content. The insulating effect is largely maintained.

7. End of life phase

Reuse / continued use

Recycling of EPS rigid foam from production waste has been working for years and has been proven and tested. Production waste because of block trimming, cutting or edge profiles is reused in the production plants. This was taken into consideration when calculating the ecological ratios.

The possibility to reuse also clean construction site waste and fragments is not taken into consideration for this EPD. Under certain ancillary conditions it is also possible to produce insulating boards from recycling material. Ground recycling material can also be used as lightweight aggregate for mortar and concrete. It is also used as aggregate for lightweight polystyrene concrete, insulating plasters and lightweight plasters as well as in the clay industry.
Disposal / Dumping

At the end of life, used EPS rigid foam is thermally recycled. The energy contained in the foam is thus recycled. This saves additionally required auxiliary firing of waste incinerators. The energy of 1kg of EPS rigid foam equals that of approx. 1.1 litres of fuel oil.

In addition, the waste heat generated during waste incineration can be used both for power and district heat generation.

The manufacturers recommend as disposal path material or at least thermal recycling of the product, if possible.

8. Life cycle assessment

8.1 Production of EPS rigid foam boards

Declared unit

The declaration refers to the production of one cubic metre (1m³) of expanded grey polystyrene each for the application on walls and roofs in thermal insulation composite systems with thermal conductivities of 0.032W/(mK) and 0.035W/(mK).

The manufacturer data refer to the production processes of different raw densities of the polystyrene; all considered products are among the application types described in this declaration. Average raw densities result according to the market shares of the products considered in this declaration. These are listed in Table 8-1.

The present study classifies the different products according to the application recommendations of the manufacturers. Different raw densities may in this respect fulfil identical properties. Different raw densities are thus grouped.

Thus, products with higher and lower densities are grouped in the product subgroups. This must be considered when assessing the results of the impact categories.

Table 8-1: Raw densities of EPS rigid foam boards

<table>
<thead>
<tr>
<th>Average raw density of the considered product</th>
<th>Radiation absorber (SA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw density in kg/m³</td>
<td>16.6</td>
</tr>
</tbody>
</table>

System limits

The analysis of the product life cycle includes the manufacture, the transport of the main raw materials, the transport of the product and the thermal recycling as end-of-life scenario (“cradle to grave”).

It includes the production of refinery products and the polymers produced from them. Auxiliary substances for the expansion process are also taken into consideration.

The energy flows are included in the GaBi 4 model as background information.

The packaging materials and their disposal are included in the calculation of the manufacturing process.
Cut-off criterion

All data from the company data acquisition, i.e. all raw materials used according to formulation, the thermal energy used, the internal fuel consumption as well as the power consumption, all direct production waste as well as all available emission analyses were considered in the assessment. The manufacturers provided data on the transport expenses for all considered inputs and outputs. In this respect, also substance and energy flows with a proportion less than 1 percent were taken into account.

It can be assumed that the neglected processes would have contributed less than 5% each to the considered impact categories.

Machines, plants and infrastructure required during production are not considered. Transport expenses for packagings were not considered.

Estimates and assumptions

A literature search was conducted for the raw materials HBCD and graphite. Based on this, an estimate for the production of these materials was prepared.

For the packaging, Euro pallets are used which were assumed with an average value of 20kg; a statistical turnover ratio could not be determined, a 10-fold turnover is assumed.

Transports

Transports both for the precursors polystyrene granulate and pentane (supplied as mixed product by the supplier) and the finished product EPS are included. The transport distances are considered according to the information provided by the participating companies. As transport means, trucks of the class 34-40t / Euro 3 are assumed. Table 7-2 shows the range of transport distances for the raw materials and the final product (manufacturer information).

<table>
<thead>
<tr>
<th>Transport distances</th>
<th>Transport km polystyrene with pentane</th>
<th>Transport km expanded polystyrene</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 - 336</td>
<td>100 - 225</td>
</tr>
</tbody>
</table>

Period under consideration

The acquisition of the manufacturer data as of 2008 serves as data basis.

Background data

The life cycle assessment was calculated on the basis of data from the LCA database GaBi 2009 which was updated with up-to-date energy data within the scope of the data update 2006.

The production data of the analysed building materials originate from the year 2008. The major part of the data for the upstream chain, among other things for the raw materials, originates from industrial sources which were collected under consistent time and methodical ancillary conditions.

Data quality

All data used is less than 6 years old.

Allocation

Accumulating production and packaging waste is energetically recycled. The resulting credits for power and thermal energy are integrated in the manufacturing assessment. The energies saved by a possible energetic recycling are offset with an equivalency process and are reported separately. For power,
the present average “power Germany”, for heat the “thermal energy from natural gas” is used.

8.2 Presentation of assessments and analyses

Life cycle inventory
The following chapter presents the life cycle inventory analysis with regard to the material and energetic resources as well as the created waste.

Primary energy consumption
Over the life cycle of 1m³ of EPS rigid foam, the primary energy consumption is 875.5 MJ/m³ for SA-032.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SA-032</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy, non-renewable [MJ/m³]</td>
<td>875.5</td>
</tr>
<tr>
<td>Primary energy, renewable [MJ/m³]</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Figure 8-1: Primary energy broken down in individual product phases for the product subgroup SA

The production of the precursor polystyrene granulate is the main influencing factor for the result. The denser the material, the higher is the mass of each functional unit of 1m³ and the higher is the primary energy input. As compared to the white rigid foam, the density of the grey EPS rigid foam is lower such that the primary energy consumption is also less.

Within the product subgroups, the raw densities of a bandwidth are grouped and weighted through their per cent by weight. The above presented results are averaged values. In order to make clear the margin of deviation, the figure below shows the primary energy of the individual results of 1m³ of material each.
Figure 8-2: Bandwidth of the primary energy consumption for the product group with radiation absorber

Figure 8-3: Type and distribution of non-renewable energy carriers in the life cycle of 1m³ of EPS rigid foam of the product subgroups SA-032

The shown primary energy includes all raw materials and fossil energy carriers. Because of credits from the incineration process of the end-of-life scenario, negative amounts result for some energy carriers. The resource crude oil is dominating because it is both energy carrier and raw material for polystyrene.
Wastes

The assessment of the waste produced is shown separately for the three fractions overburden/stockpile dump (including ore processing residues), municipal waste (containing household rubbish and commercial waste) and hazardous wastes including radioactive waste.

The **stockpile dump** accounts for the major part in production. This is the result of the generation of power. The negative amount in the end-of-life phase results mathematically from the credit of power and steam during the combustion of polystyrene.

**Hazardous wastes** are essentially waste material which arises from upstream phases; radioactive wastes are exclusively produced from power generation in nuclear power plants.

The following table shows the waste material produced during the production of 1m³ of expanded polystyrene.

**Table 8-3: Waste material produced during the life cycle of 1m³ of EPS for the product subgroup radiation absorber**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Production</th>
<th>Transport</th>
<th>End of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overburden / stockpile dump</td>
<td>51.00</td>
<td>0.01</td>
<td>-43.88</td>
</tr>
<tr>
<td>Household-type commercial waste</td>
<td>0.09</td>
<td>0</td>
<td>0.56</td>
</tr>
<tr>
<td>Hazardous wastes</td>
<td>0.31</td>
<td>3.46E-06</td>
<td>-0.02</td>
</tr>
<tr>
<td>(of these radioactive wastes)</td>
<td>0.02</td>
<td>3.46E-06</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

Water consumption

For the production of 1m³ of EPS, approximately 100 l of water are required. Water is mainly required for the steam of the expansion process, the production of the polystyrene granulate in the upstream chain, the generation of electrical energy and in the waste incineration plant of the EoL scenario. The percentages vary depending on the different manufacturers.

In the end of life, the credit for electrical energy also includes a credit for saved water.

**Table 8-4: Water consumption during the life cycle of 1m³ of EPS for the product subgroup radiation absorber**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Production</th>
<th>Transport</th>
<th>End of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water consumption</td>
<td>82.8</td>
<td>0.01</td>
<td>35.4</td>
</tr>
</tbody>
</table>
### Secondary fuels

No secondary fuels are used for the production of polystyrene.

### Impact assessment

Table 8-5: Impact categories during the life cycle of 1m³ of EPS rigid foam for the product subgroup radiation absorber

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit per m³</th>
<th>Total</th>
<th>Production</th>
<th>Transport</th>
<th>End of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADP</td>
<td>kg Sb eqv.</td>
<td>4.2E-01</td>
<td>6.3E-01</td>
<td>1.1E-03</td>
<td>-2.2E-01</td>
</tr>
<tr>
<td>GWP</td>
<td>kg CO₂ eqv.</td>
<td>6.8E+01</td>
<td>4.8E+01</td>
<td>1.6E+01</td>
<td>2.0E+01</td>
</tr>
<tr>
<td>ODP</td>
<td>kg R11 eqv.</td>
<td>2.3E-07</td>
<td>1.6E-06</td>
<td>2.6E-10</td>
<td>-1.4E-06</td>
</tr>
<tr>
<td>AP</td>
<td>kg SO₂ eqv.</td>
<td>7.2E-02</td>
<td>1.0E-01</td>
<td>9.2E-04</td>
<td>-3.2E-02</td>
</tr>
<tr>
<td>EP</td>
<td>kg PO₄ eqv.</td>
<td>7.6E-03</td>
<td>1.1E-02</td>
<td>1.6E-04</td>
<td>-3.1E-03</td>
</tr>
<tr>
<td>POCP</td>
<td>kg ethene eqv.</td>
<td>2.8E-01</td>
<td>2.8E-01</td>
<td>7.0E-05</td>
<td>-2.9E-03</td>
</tr>
</tbody>
</table>

Figure 8-4: Life cycle of EPS, product subgroup radiation absorber
Interpretation

All impact categories are dominated by the production. The polystyrene used in the production process already includes a major part of the environmental burden. Because of the incineration process in the end-of-life scenario and the resulting credits for power and steam, negative emissions in all impact categories with the exception of GWP result mathematically. The influence of the product transport can be neglected across all impact categories.

Just as is the case with regard to the description of the primary energy consumption, the results of the impact categories also represent mean values from various raw densities of the product group. Taking the global warming potential as an example, the margin of deviation is shown.

![Graph showing Treibhauspotential in Abhängigkeit der Rohdichte](image)

**Figure 8-5: Bandwidth of the global warming potential for the product group with radiation absorber**
9. Evidence

VOC emissions

Measuring body: Fraunhofer Institute for Building Physics (IBP), institute Holzkirchen, 83626 Valley, Germany

Results:
On the days 3, 7 and 28 of the test chamber experiment, no carcinogenic substances according to AgBB scheme could be determined.
The emissions of volatile organic compounds were below the limits specified by the AgBB scheme on day 3, day 7 and day 28.
The tested insulation meets the requirements of the AgBB scheme on the indoor use of building products.
No hexabromocyclododecane (HBCD) could be determined.

Measurement conditions:
Temperature: 23 °C
area-specific air flow rate: 1.35m³/(m²h)

<table>
<thead>
<tr>
<th>Sample designation: EPS rigid foam insulating board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results summary 28 days</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>TVOC (C₆ – C₁₆)</td>
</tr>
<tr>
<td>Σ VOC without LCI (C₆ – C₁₆)</td>
</tr>
<tr>
<td>Σ SVOC (C₁₆ – C₂₂)</td>
</tr>
<tr>
<td>Σ carcinogens</td>
</tr>
<tr>
<td>Σ Rᵢ [-]</td>
</tr>
</tbody>
</table>

10. PCR document and verification

This declaration is based on the PCR document “Factory-made insulating materials made of foam plastics”, December 2009.

Review of the PCR document by the Independent Advisory Board (SVA).
Chair of the SVA: Prof. Dr.-Ing. Hans-Wolf Reinhardt (University of Stuttgart, IWB)

Independent verification of the declaration according to ISO 14025

- [ ] internal
- [x] external

Validation of the declaration: Dr. Birgit Grahl
Environmental Product Declaration

**EPS rigid foam (grey) with thermal radiation absorber**

**Product group:** PCR foam plastics

**Declaration holder:** Industrieverband Hartschaum, IVH

**Declaration number:** EPD-IVH-2009211-D

**Prepared by:** December 2009

---

### 11. References

/Amtliche Materialprüfanstalt für das Bauwesen, TU Braunschweig/ Amtliche Materialprüfanstalt für das Bauwesen, TU Braunschweig; Prüfung der Luftschalldämmung nach DIN 52210 (Baumusterprüfung nach Teil 3) einer 390 mm dicken zweischaligen Haustrennwand aus Kalksand-Vollsteinen mit Styropor-Trennfugenplatte; Braunschweig, 1987

/APME 1998/ Association of Plastics Manufacturers in Europe APME; Co-Combustion of End of Life Plastics in MSW Combustors; Brussels; 1992-98

/Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AiF)/ Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AiF), Forschungsvorhaben Nr. 12088; Kurztitel: Flachdachsanierung über durchfeuchteter Dämmsschicht; 2001

/Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AiF)/ Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AiF), Forschungsvereinigung Styropor; Forschungsvorhaben Nr. 9289; Niedrigenergiehäuser unter Verwendung des Dämmstoffes Styropor, Teil 1: Konstruktionsempfehlungen und optimierte Anschlusssituationen, Teil 2: Quantitative Darstellung der Wirkung von Wärmebrücken; 1995

/BAM/ Bundesanstalt für Materialforschung und -prüfung (BAM); Emissionen von Flammschutzmitteln aus Bauprodukten und Konsumgütern; Berlin; 2003

/Bayreuth Institute of Environmental Research/ Bayreuth Institute of Environmental Research; Combusting according to DIN 53436 at 500 °C and analysis of the particle and gaseous combustion products an polybrominated dioxins and furans; Bayreuth, 1994

/Bundesfachabteilung Qualitätssicherung EPS (BFA QS EPS)/ Bundesfachabteilung Qualitätssicherung EPS (BFA QS EPS); Qualitätshandbuch; BFA QS EPS; Heidelberg; 2001


/Ecoprofile EPS 2005/ PlasticsEurope: Eco-profiles of the European Plastics Industry, Polystyrene (Expandable) (EPS), 2005
Environmental Product Declaration

PCR foam plastics
Industrieverband Hartschaum, IVH
EPD-IVH-2009211-D


EPS-Sicherheitsdatenblatt gemäß 2001/58/EG des Industrieverband Hartschaum e.V, IVH; Heidelberg; 2003


Fachbereich Architektur, Universität Hannover; Gutachterliche Stellungnahme über das Langzeitverhalten von Styropor (expandierte Polystyrol-Hartschaumplatten) in einer Sichtmauerwerkkonstruktion mit Kerndämmung ohne Luftschicht; Hannover, 1989


Fraunhofer Institut für Bauphysik; IBP-Bericht FtB-15/1996: Praxisbewährung von Wärmedämmverbundsystemen; Holzkirchen, 1997

Fraunhofer Institut; Untersuchung der Hartschaum-Dämmplatte „Styropor F15“ auf die Emission von flüchtigen organischen Verbindungen; 2009 (28 und 90 Tage)


Gert Wolf, ö.b.u.v. Sachverständiger; Langzeitbewährung von Styropor, Gutachten über 31 Jahre Styropor im Flachdach; Remscheid; 1986

Hochschullehrer-Service; Arbeitsblätter für die Architektenausbildung; Industrieverband Hartschaum e.V, IVH; Heidelberg; 1994

Baustoffliche Eigenschaften von Wärmeschutzverbindungen aus expandiertem Polystyrol (EPS) bei unterschiedlichen Umwelteinwirkungen, Diss. Hofbauer, TU Cottbus, 2002

Hygiene-Institut der Universität Heidelberg, Prof. Dr. Med. Sonntag; Fachhygienisches Gutachten zur Frage der Emission von Styrol aus Polystyrol-Hartschaum Marke Styropor; Heidelberg; 1984

Hygiene-Institut der Universität Heidelberg, Prof. Dr. Med. Sonntag; Kein Fluorchlorkohlenwasserstoff in Styropor – Gutachterliche Stellungnahme zur Emission von Treibmittel aus EPS-Hartschaum-Produkten; Heidelberg; 1988

Institut Bio-Bauforschung IBBF; Beurteilung von EPS-Hartschaum unter Berücksichtigung biologischer Aspekte; Karlsfeld; 1982

Ingenieurgemeinschaft Umwelt Technik Bau GbR; Gutachten zum Recycling von Wärmédämm-Verbundsystemen (WDV-Systemen) mit Styropor; Darmstadt; 1995

Institut Bauens und Umwelt e.V., Königswinter (Hrsg.): Leitfaden für die Formulierung der Anforderungen an die Produktkategorien der Produktdeklarationen (Typ III), Stand 01-2006

Institut für Bautenschutz, Baustoffe und Bauphysik; Gutachten über die Langzeitbewährung von Hart-
<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bautenschutz/</td>
<td>Schaumplatten aus expandiertem Polystyrol (EPS) in Wärmedämm-Verbundsystemen; Fellbach; 1984</td>
</tr>
<tr>
<td>ISO 14020/</td>
<td>DIN EN ISO 14020:2002-02: Environmental labels and declarations – General principles</td>
</tr>
<tr>
<td>ISO 14025/</td>
<td>DIN EN ISO 14025:2009-11: Environmental labels and declarations — Type III environmental declarations — Principles and procedures</td>
</tr>
<tr>
<td>PCR 2009/</td>
<td>PCR Schaumkunststoffe: Regeln für die Umwelt-Produktdeklaration – Werkmäßig hergestellte Dämmstoffe aus Schaumkunststoffen, Januar, 2009</td>
</tr>
</tbody>
</table>