ENVIRONMENTAL PRODUCT DECLARATION
as per ISO 14025 and EN 15804

Provider of the Declaration
Knauf Bulgaria EOOD

Programme holder
Institut Bauen und Umwelt e.V. (IBU)

Publisher
Institut Bauen und Umwelt e.V. (IBU)

Declaration number
EPD-KNB-20130006-IAC1-EN

Issue date
30/04/2013

Valid to
29/04/2018

Gypsum fibreboards
Knauf Bulgaria
1. General Information

Knauf Bulgaria

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Rheinufer 108
D-53639 Königswinter

Declaration number
EPD-KNB-20130006-IAC1-EN

This Declaration is based on the Product Category Rules:
Plasterboard, 07-2012
(PCR tested and approved by the independent expert committee)

Issue date
30/04/2013

Valid to
29/04/2018

Owner of the Declaration
Knauf Bulgaria EOOD
Angelov vrah 27
1618 Sofia

Declared product / Declared unit
Gypsum fibreboards / 1 square meter of gypsum fibre board with a declared thickness of 12.5 mm and density of 1180 kg/m³.

Scope:
The declaration is valid for four specific fibre board products manufactured by Knauf Bulgaria. Calculations are based on average data applicable for all four products, as production is located at one site in Bulgaria. The declaration covers details of:
- the product definition and relevant technical information
- the raw materials and origin of the raw materials
- the descriptions of the production process and transport
- the results of the life cycle assessment

The owner of the declaration shall be liable for the underlying information and evidence.

Verification
The CEN Norm EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025

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

Prof. Dr.-Ing. Hans-Wolf Reinhardt
(Chairman of SVA)

Mr Carl-Otto Neven
(Independent tester appointed by SVA)

2. Product

2.1 Product description
Knauf gypsum fibre boards are manufactured from high-quality calcined gypsum reinforced with dispersed cellulose fibers originated from selected types of recycled paper. Knauf produces four types of gypsum fibre boards: Vidiwall (gypsum fibre boards for lining walls, ceilings, metal and wooden structures), Vidiwall HI (impregnated fibre boards suitable for wet areas and facade walls), VidiFire A1 (fibre boards with class of reaction to fire A1) and Vidifloor (floor boards).
The declared unit refers to an average product reflecting the specifications of the four product types which are manufactured with identical substances though with different quantities. Data used in calculations represent site-specific production volumes for 2011 and cover all four product types forming the average product. There are no by-products resulting from the production line subject to this study. Thus, the EPD is applicable to all four products.

2.2 Application
The gypsum fibre boards are used for cladding of structural and non-structural building elements, fire protecting linings, dry floor screeds.

2.3 Technical Data
The gypsum fibre boards are manufactured in accordance to the following specifications:

<table>
<thead>
<tr>
<th>Constructional data</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross density according to EN 15283-2</td>
<td>1050 - 1250</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Bending strength (longitudinal) according to EN 15283-2</td>
<td>≥5.5</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Modulus of elasticity according to EN 15283-2</td>
<td>3900</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Brinell hardness</td>
<td>30</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Calculation value for thermal conductivity</td>
<td>0.28</td>
<td>W/(mK)</td>
</tr>
<tr>
<td>Moisture content at 20 °C, 65% humidity</td>
<td>&lt;1.3</td>
<td>M.-%</td>
</tr>
</tbody>
</table>
2.4 Placing on the market / Application rules

The manufacturing process of the gypsum fibre boards conforms to the following standard and rules:
- Ordinance on main requirements and conformity assessment of construction products (Bulgarian legislation)
- European Technical Approvals ETA 07/0086, issued by DIBT, Berlin, on 3/17/2008 valid until 16/03/2013
- Tests for reaction to fire (Stuttgart, LAPI)

2.5 Delivery status

The gypsum fibre boards are delivered in different dimensions with thickness varying between 10, 12.5, 15 and 18 mm, width between 1000, 1200 and 1250 mm and length varying between 2000, 2500, 2600, 2750, 2800 and 3000 mm. Other sizes are negotiable.

2.6 Base materials / Ancillary materials

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcined gypsum</td>
<td>70-90</td>
<td>%</td>
</tr>
<tr>
<td>Post-consumer waste paper</td>
<td>15-20</td>
<td>%</td>
</tr>
<tr>
<td>Grinding powder</td>
<td>0-5</td>
<td>%</td>
</tr>
<tr>
<td>Impregnating substances and others</td>
<td>&lt;1</td>
<td>%</td>
</tr>
</tbody>
</table>

2.7 Manufacture

Production is separated into two phases - the calcination of gypsum and the manufacture of gypsum fibre boards. The raw material for the gypsum production are natural gypsum (mineral calcium sulphate dihydrate) extracted in mines and gypsum generated as by-product during the desulphurization of coal-fired power stations flue gas desulfurization gypsum (FGD gypsum). Both materials are dried and calcined.

In the second stage the calcined gypsum is mixed with the paper fibres produced from shredded post-consumer waste paper. These constituents are laid onto a moving conveyor belt and water is added. The wet pulp is compressed to form a continuous slab and dried. Next it is polished, impregnated and cut into desired length and formatted to the required board sizes.

2.8 Environment and health during manufacturing

The base materials for the production of gypsum fibre boards (gypsum, waste paper, water) are harmless and safe to humans and the environment. To further improve environmental performance the following measures have been applied:
- Control of effluent and air emissions through periodic sampling and testing by certified laboratories
- Regular change of filter systems
- Planned expansion of the wastewater treatment plant
- Use of FDG generated as by-product in thermal power plants saving natural resources by reducing natural gypsum input
- Reuse of waste from production (reincorporation into the manufacturing process)
- Plans for implementation of ISO 18001 OHSAS for 2013
- The manufacturing plant has been certified under ISO 9001 and ISO 14001

2.9 Product processing/Installation

Storage

Gypsum fibre boards should be stored indoors on a dry and even floor, only in horizontal position. They should be protected against moisture all-round covering of the boards or components by means of foil. The fibre boards may risk being damaged (in particular surface and edges) if not stored as indicated (indoors on a dry and even floor, in horizontal position).

Cutting and Installation

Gypsum fibre boards could be notched with a modeling knife and broken on the stand edge. Neat edges may be also obtained by using an electric saw (air aspiration must be applied). Fixing the fibre boards requires the use of appropriate means depending on the basic bearing structure. Boards are installed by means of screws, nails or clamps.

Dust and noise

Dust is produced during the mining of gypsum and during the stages of crushing and calcining. Unlike some types of dust, gypsum dust presents a very low health risk since being soluble and temporary in the environment. When correctly installed no dust will be released during the period of use. Some of the production waste (e.g. grinded powder from gypsum fibre boards cutting...
captured by filter system) is used as an input material in the production process. Industrial and environmental protections are assured through evacuation plans in case of fire, regular emergency training and coaching staff on fire safety. As noise reduction measures sound-proved screens and boxes were installed. Noise levels have been measured by an accredited firm attesting conformity to permitted noise levels.

2.10 Packaging
The gypsum fibre boards are palletized on wooden pallets, wrapped with polyethylene foil, polyester strapping tape and strengthened with cardboard angles. During transport and storage Knauf gypsum fibre boards need to be protected from moisture (kept in closed and dry storage places). After use pallets are usually reused by industry, foil and cardboard angles can be returned for recycling.

2.11 Condition of use
Damaged gypsum fibre boards or components manufactured by using the present boards must not be used or installed. Where components are produced on site by using fibre gypsum boards the moisture of the wood substructure must not increase inadequately until installation of the fibre gypsum boards (protection against precipitation or very high construction moisture).

When installed in accordance with specifications, gypsum fibre boards retain their mechanical and physical properties during use period of the product’s life cycle. Direct contact with water should be avoided, except for Vidiwall HI which is impregnated and as such suitable for wet areas.

2.12 Environment and health during use
Gypsum and post-consumer paper waste are natural raw materials and because gypsum fibre boards are manufactured without glues, odors or other environmental or health risks are avoided. Gypsum fibre boards are fire- and moisture-resistant, and offer excellent indoor climate conditions due to the products’ active breathing ability. Their pH is 7 which is close to that of human skin. The biological safety of Vidiwall fibre boards were certified by the Institute for Building Biology in Rosenheim, Germany, May 2012.

2.13 Reference service life
The reference service life of the gypsum fibre boards has been estimated to be at least 50 years, according to the European Technical Approval (07/0086), provided that indicated conditions for packaging, transport, storage, installation, use, maintenance and repair are met. The RSL stated applies only for the specific in-use conditions as mentioned in section 4. The estimated RSL cannot be considered as guarantee, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

2.14 Extraordinary effects
Fire
Based on tests carried out in accordance with BS EN 13823:2010, BS EN ISO 1182:2010, BS EN ISO 1716:2010 and BS EN 13501-1:2007+A1:2009 all gypsum fibre boards feature the following fire protection values:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vidiwall</td>
<td></td>
</tr>
<tr>
<td>Building material class</td>
<td>A2</td>
</tr>
<tr>
<td>Burning droplets</td>
<td>d0</td>
</tr>
<tr>
<td>Smoke gas development</td>
<td>s1</td>
</tr>
<tr>
<td>Vidiwall HI</td>
<td></td>
</tr>
<tr>
<td>Building material class</td>
<td>A2</td>
</tr>
<tr>
<td>Burning droplets</td>
<td>d0</td>
</tr>
<tr>
<td>Smoke gas development</td>
<td>s1</td>
</tr>
<tr>
<td>VidiFloor</td>
<td></td>
</tr>
<tr>
<td>Building material class</td>
<td>A2</td>
</tr>
<tr>
<td>Burning droplets</td>
<td>d0</td>
</tr>
<tr>
<td>Smoke gas development</td>
<td>s1</td>
</tr>
<tr>
<td>VidiFire A1</td>
<td></td>
</tr>
</tbody>
</table>

This means that they can be considered not flammable with negligible smoke gas development and no burning droplets. The VidiFire A1 fibre boards qualify for A1 reaction to fire class.

Water
When exposed to water (e.g. flood) the gypsum fibre boards do not break and will recover previous stability after drying. However, if significant quantities of biodegradable components of the boards are dissolved in water and entered into the sewage system or waterways (in case of floods for exp.), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) levels might increase.

Mechanical destruction
The fibre boards may risk being damaged (in particular surface and edges) if not stored as indicated (indoors on a dry and even floor, in horizontal position).

2.15 Re-use phase
Gypsum fibre boards allow being recycled by the manufacturer, but this is not practiced yet. The boards can be reused if they are properly removed from their initial installation and if their edges and surface are not damaged.

2.16 Disposal
The production site is in full compliance with the waste management legislation. The site’s waste management plan aims at reducing waste following qualitative and quantitative waste reduction principles. The waste code for production residues (wet waste, dry waste, parings and powdery mass) is 17 08 02. These residues are collected in closed containers and fed into the gypsum calcination plant. Negligible amount is disposed as non-hazardous waste. The waste accumulating in the filter system (code 10 13 07) is temporarily stored in containers for technological waste and afterwards reused in production. Gypsum sludge (waste code 10 13 99) as a residue from the process water is disposed as non-hazardous waste.

The waste code of waste paper is 20 01 01 and includes old paper clippings from newspapers, magazines and books. It is fed into the pulping process. Cardboard waste (corrugated boxes and other packaging, code 15 01 01) is also fed into the pulping process. The waste code of plastic packaging
material (polyethylene and polyester) and other materials is 15 01 02. Plastics waste is collected by the producer of plastic packaging materials.

### 3. LCA: Calculation rules

#### 3.1 Declared Unit

The declared unit is 1 m² of gypsum fibre board. The declared thickness of the board is 12.5 mm (best-selling product type) with a declared density of 1180 kg/m³. The conversion to 1 m² is depicted below:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared unit</td>
<td>1</td>
<td>m²</td>
</tr>
<tr>
<td>Conversion factor to 1 kg</td>
<td>0.06779661</td>
<td>-</td>
</tr>
<tr>
<td>Density as declared</td>
<td>1180</td>
<td>kg/m³</td>
</tr>
</tbody>
</table>

As mentioned in section 2.5, gypsum fibre boards are delivered in different dimensions than the declared product in section 3.1 (12.5 mm thickness with a density of 1180 kg/m³). In order to properly interpret the results presented in section 5, a correction coefficient for a specific product should be used. The LCA results in section 5 should be multiplied by a correction coefficient, which is calculated by the following formula:

$$CC = \frac{T_s}{T_a}$$

where:

- $CC$ is the correction coefficient
- $T_s$ is the thickness in mm of the declared product
- $T_a$ is the thickness in mm of the specific product

For example for a product with a thickness of 15 mm and a density of 1180 kg/m³, the correction coefficient will be calculated the following way:

$$CC = \frac{15}{12.5} = 1.2$$

#### 3.2 System boundary

The EPD uses the cradle to gate approach. The assessment includes the upstream lifecycle product stages raw material extraction, transport and manufacturing. These stages are referred to as A1 – A3 according EN 15804.

#### 3.3 Estimates and assumptions

This EPD mainly reflects site specific data related to product manufacturing. LCA results are valid for the specified technological process, geographical area and time period. The following assumptions regarding other materials and transport have been made:

- additives – LCI data for the chemical additives used is not available, therefore approximations have been applied based on the chemical composition. Hexamethyldisilazane, dipropylene glycol monomethyl ether and formic acid are used as substitutes for potassium methylsilanetriolate, mixture of acrylic acid ester and styrene, and citric acid monohydrate in the same order. Approximation is based on CAS numbers provided and chemical expert judgement.

- since the contribution of additives to the production volumes is less than 1%, the potential use of non-renewable primary energy resources used as raw material in the production of additives is not calculated (e.g. oil-based chemicals).

- assumptions applied for transport are summarized above. The total amount of vehicle kilometers is calculated as the total number of trips multiplied by the one-way distance for each trip. For short distances (<1500 km) it is assumed that the vehicles return empty (e.g. the total number of vehicle kilometres is doubled). For long distances and train transport is assumed that group transport is in place and thus only one-way distances are accounted – this is applied only for transport from Germany (transport of impregnations and impregnations-dispersion).

- water use is declared as tap water and well water. In the calculations the total amount of water is classified as tap water, since characterisation factors in Ecoinvent 2.2 for well water withdrawal are not available.

#### 3.4 Cut-off criteria

Since waste paper and FGD gypsum are considered secondary material, the environmental burden from paper production is allocated to the previous system and not included in the system under study. Capital goods, such as buildings, machinery, vehicles, and infrastructure are not included in the scope of the study. Polyester tape and cardboard angles for packaging is excluded based on the minimum quantity used.

#### 3.5 Background data

Primary data were provided by Knauf describing the manufacturing process and transport conditions. Raw material manufacturer delivered data on raw material extraction (natural gypsum). Background data were sourced from Ecoinvent 2.2 database.

#### 3.6 Data quality

This study is mainly based on primary data collected from the participating parties and their respective production sites. Data collected is representative for 2011 for all four products, forming the average product. Default assumptions regarding average vehicle load and respective characterization factors are derived from the Ecoinvent report on transport. Missing data on characterization factors for chemicals used is fulfilled by assumptions as described above.

#### 3.7 Period under review

The data set employed in the EPD is based on data collection covering 2011 production data. The entered quantities for raw materials, energy and operating supplies are based on average values of 12 months operations.

#### 3.8 Allocation

The manufacturing site analyzed in this EPD is only producing gypsum fibre boards. There is thus no need for allocation procedures.

#### 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.

4. LCA: Scenarios and additional technical information

The present EPD analyzes the cradle to gate impacts of gypsum fibre boards, thus only declaring the modules A1-A3 in terms of environmental burden. The gypsum fibre boards are relatively new product and numerical data regarding their use phase and end of life stage is limited for the moment. However, following information could be applied to develop specific scenarios within the context of a building evaluation.

**Transport**
Packed and palletized on wooden pallets, final products are transported to building sites by trucks inland and by ship to other continents.

**Installation in the building**
Installation of Vidiwall and Vidifire
Fixing the Vidiwall boards requires the use of appropriate means depending on the basic bearing structure. Boards are installed by means of screws, nails or clamps. Fixing on metal sub-structures is performed by using special screws for gypsum fibre boards. Fixing on wooden sub-structures is performed by means of nails or clamps, which are galvanized or have some other type of anti-corrosion coating. This procedure is also applicable for Vidiwall HI and Vidifire.

Installation of Vidifloor
Installing Vidifloor requires absolutely flat surface, covered by polyethylene foil and applied 10mm thick insulation tape along the walls. An expanded polystyrene layer could be used under the boards as an insulation layer. Vidifloor gypsum fibre boards are applied in two layers over it, with a layer of adhesive in between. The boards installed are immediately fixed with screws under loading or with clamps. It should not be walked on the dry floor base for four hours in order to allow the adhesive to set.

Installation in building is considered to use limited amount of energy for cutting and screwing. As auxiliary materials zinc-coated and/or stainless nails, screws or staples, insulation material (polystyrene) and adhesive are/could be used.
It could be assumed that 5% of fibre board used on construction sites becomes waste, mainly due to off-cuts (based on a figure for plasterboard published by the European manufacturers of gypsum products).

**Use, maintenance and repair**
Damaged gypsum fibre boards or components manufactured by using the present boards must not be used or installed. Where components are produced on site by using fibre gypsum boards the moisture of the wood substructure must not increase inadequately until installation of the fibre gypsum boards (protection against precipitation or very high construction moisture). When correctly installed, no dust will be released during the period of use of the gypsum fibre boards. It is assumed that during use phase there is no significant resource use, if any occasional.

**End of life**
Gypsum fibre boards allow being recycled by the manufacturer, but this is not practiced yet. The boards can be reused if they are properly removed from their initial installation and if their edges and surface are not damaged. However, since this is not a widely established practice, no possible benefits of recycling or reuse were taken into account in this study.

The reference service life of the gypsum fibre boards has been estimated to be at least 50 years, according to the European Technical Approval (07/0086), provided that indicated conditions for packaging, transport, storage, installation, use, maintenance and repair are met.
The environmental impacts resulting from the production of 1 m² of gypsum fibreboard are expressed in impact categories based on the CML method. The following categories are considered:

### RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: Gypsum fibreboards / 1 square meter of gypsum fibre board with a declared thickness of 12.5 mm and density of 1180 kg/m³

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming potential</td>
<td>[kg CO₂ Äq. ]</td>
<td>2.14E-1</td>
<td>1.97E-1</td>
<td>2.82E+0</td>
</tr>
<tr>
<td>Depletion potential of the stratospheric ozone layer</td>
<td>[kg CFC11 Äq. ]</td>
<td>9.20E-9</td>
<td>2.76E-8</td>
<td>8.25E-7</td>
</tr>
<tr>
<td>Acidification potential of land and water</td>
<td>[kg SO₂ Äq. ]</td>
<td>1.09E-3</td>
<td>9.58E-4</td>
<td>1.76E-2</td>
</tr>
<tr>
<td>Eutrophication potential</td>
<td>[kg PO₄³⁻ Äq. ]</td>
<td>1.11E-3</td>
<td>2.86E-4</td>
<td>1.29E-2</td>
</tr>
<tr>
<td>Formation potential of tropospheric ozone photochemical oxidants</td>
<td>[kg Ethn Äq. ]</td>
<td>4.09E-5</td>
<td>2.51E-5</td>
<td>8.04E-4</td>
</tr>
<tr>
<td>Abiotic depletion potential for non fossil resources</td>
<td>[kg Sb Äq. ]</td>
<td>6.11E-3</td>
<td>1.14E-2</td>
<td>6.99E-7</td>
</tr>
<tr>
<td>Abiotic depletion potential for fossil resources</td>
<td>[MJ ]</td>
<td>3.19E+0</td>
<td>2.62E+0</td>
<td>8.86E+1</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA - RESOURCE USE: Gypsum fibreboards / 1 square meter of gypsum fibre board with a declared thickness of 12.5 mm and density of 1180 kg/m³

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable primary energy as energy carrier</td>
<td>[MJ ]</td>
<td>1.45E-1</td>
<td>2.68E-2</td>
<td>2.49E+0</td>
</tr>
<tr>
<td>Renewable primary energy resources as material utilization</td>
<td>[MJ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>3.50E+0</td>
</tr>
<tr>
<td>Total use of renewable primary energy resources</td>
<td>[MJ ]</td>
<td>1.45E-1</td>
<td>2.68E-2</td>
<td>5.96E+0</td>
</tr>
<tr>
<td>Non renewable primary energy as energy carrier</td>
<td>[MJ ]</td>
<td>3.19E+0</td>
<td>2.62E+0</td>
<td>8.60E+1</td>
</tr>
<tr>
<td>Non renewable primary energy as material utilization</td>
<td>[MJ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>3.58E+1</td>
</tr>
<tr>
<td>Total use of non renewable primary energy resources</td>
<td>[MJ ]</td>
<td>3.19E+0</td>
<td>2.62E+0</td>
<td>8.60E+1</td>
</tr>
<tr>
<td>Use of secondary material</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>6.94E+0</td>
</tr>
<tr>
<td>Use of renewable secondary fuels</td>
<td>[MJ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of non renewable secondary fuels</td>
<td>[MJ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of net fresh water</td>
<td>[m³ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>1.47E+2</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA - OUTPUT FLOWS AND WASTE CATEGORIES: Gypsum fibreboards / 1 square meter of gypsum fibre board with a declared thickness of 12.5 mm and density of 1180 kg/m³

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous waste disposed</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>1.28E-2</td>
</tr>
<tr>
<td>Non hazardous waste disposed</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>8.04E-0</td>
</tr>
<tr>
<td>Radioactive waste disposed</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Components for re-use</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Materials for recycling</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Materials for energy recovery</td>
<td>[kg ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Exported electrical energy</td>
<td>[MJ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Exported thermal energy</td>
<td>[MJ ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
</tbody>
</table>
6. LCA: Interpretation

LCIA results are presented for 1 m² of fibre board with a declared thickness of 12.5mm. The impact assessment results are calculated using characterization factors generated by the Centre of Environmental Science at Leiden University (CML), Netherlands (CML, 2001).

The chart below provides information of the relative contributions of the production stage to the individual environmental impact categories, showing the dominance of the various processes and inputs.

Breaking the emissions down by production processes shows that direct energy consumption is responsible for more than 80% of the total impact for the following categories (Figure 1) - acidification potential, climate change, eutrophication potential, photochemical oxidation, stratospheric ozone depletion, non-renewable energy resources. Direct energy consumption is related to electricity and liquid fossil fuels consumption. Electricity ensures the function of the main system and is used in for the calcination process. Fuel oil is consumed in the drying and calcinations process, diesel and liquefied petroleum gas (LPG) are needed for internal transport activities, while methane provides the heating in the building. As shown in figure 1 impact from electricity dominates with more than 30% in acidification potential, climate change, eutrophication potential, photochemical oxidation, non-renewable energy resources and abiotic depletion of elements. It is noticeable that the prevalent impact in the categories stratospheric ozone depletion and potential abiotic depletion of fossil fuels is caused by the consumption of liquid fossil fuels.

![Relative contribution of production processes/inputs to the environmental impacts](image)

**Figure 2: Relative contribution of the main processes/inputs to the production of 1m² fibre board with a declared thickness of 12.5mm**
Figure 3: Relative contribution of the product stages of 1m² fibre board with a declared thickness of 12.5mm

Raw material acquisition comprises of raw gypsum extraction and water use. Manufacturing process accounts for direct energy use in the production processes (for calcination, drying, cutting, etc.), production of packaging and ancillary materials (e.g. additives) as prescribed in the PCR.

A breakdown of the results by product stages is shown in the figure 2 above. It demonstrates that the manufacturing process is the largest contributor, followed by raw material acquisition and transport of materials and waste for all impact categories except for category stratospheric ozone depletion. For the latter, the transport of materials and waste dominate over raw material extraction. This could be explained by the fact that transportation activities emit N2O which has a strong ozone-depleting potential.

The above displayed results are considered applicable to all four products which composition is quite similar to each other. Calculation rule of the results for products with different dimensions is shown in section 3.1.

7. Requisite evidence

7.1 Leaching (heavy metals)

Eluate analysis according to DIN 38414 has tested 13 metals. The results for the tested heavy metals were significantly below statutory limit values. Thus there is no evidence of a potential contamination through the analyzed substances.

Date: 12.06.2010
Measuring agency: Institut für Baubiologie Rosenheim GmbH
Protocol: ICP-MS (Inductively coupled plasma mass spectrometry)

Results:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>&lt;0.005</td>
<td>mg/l</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>&lt;0.001</td>
<td>mg/l</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>&lt;0.005</td>
<td>mg/l</td>
</tr>
<tr>
<td>Chrome (Cr)</td>
<td>&lt;0.005</td>
<td>mg/l</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>&lt;0.005</td>
<td>mg/l</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.9</td>
<td>mg/l</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>&lt;0.001</td>
<td>mg/l</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.035</td>
<td>mg/l</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.005</td>
<td>mg/l</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>&lt;0.001</td>
<td>mg/l</td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>&lt;0.001</td>
<td>mg/l</td>
</tr>
<tr>
<td>Tin (Sn)</td>
<td>&lt;0.005</td>
<td>mg/l</td>
</tr>
<tr>
<td>Zink (Zn)</td>
<td>&lt;0.005</td>
<td>mg/l</td>
</tr>
</tbody>
</table>

7.2 Radioactivity

Radioactivity of the final product has been tested using the activity concentration index. The resulting ACI value is 0.06. There is no evidence of radioactivity induced for instance by radiation doses releases by the Chernobyl accident or aboveground nuclear testing during the 1960 years.

Date: 12.06.2010
Measuring agency: Institut für Baubiologie Rosenheim GmbH
Protocol: Activity concentration index (ACI)

Result: The resulting ACI value is 0.06 which is below the statutory limit value of ACI ≤ 1 as well as the limit value of ACI ≤ 0.75 as defined by the "Institut für Baubiologie" and the more rigorous value of ACI ≤ 0.5 applied by "Umweltinstitut München."
7.3 VOC emissions

Date: 12.06.2010

Measuring agency: Institut für Baubiologie Rosenheim GmbH

Protocol: Acetone liquid extraction

Result: The tested products show results below the established limits of 1mg/kg for saturated and unsaturated aliphatic hydrocarbons, aromatic hydrocarbons, terpenes, aliphatic alcohols, chlorinated hydrocarbons, glycols and glycoethers, esters and phthalates, ketones, aldehydes and below 0.5mg/kg for C6-C12 acids.

8. References

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General principles
for the EPD range of Institut Bauen und Umwelt e.V. (IBU), 2011-09
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DIN 38414-4: German standard methods for the examination of water, waste water and sludge; sludge and sediments (group S); determination of leachability by water (S4)

EN 13823
BS EN 13823:2010:Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item

ISO 1182
ISO 1182:2010: Reaction to fire tests for products -- Non-combustibility test

ISO 1716
ISO 1716:2010 Reaction to fire tests for products -- Determination of the gross heat of combustion (calorific value)

EN 13501-1+A1
BS EN 13501-1:2007+A1:2009 Fire classification of construction products and building elements. Classification using test data from reaction to fire tests

EN 15283-2+A1

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Ordinance on main requirements and conformity assessment of construction products
Ordinance on main requirements and conformity assessment of construction products (Bulgarian legislation: НАРЕДБА за съществените изисквания към строежите и оценяване съответствието на строителните продукти Приета с ПМС № 325 от 06.12.2006 г.; обн., ДВ, бр. 106 от 2006 г.)

Waste codes
17 08 02 gypsum-based construction materials other than those mentioned in 17 08 01
10 13 07 sludges and filter cakes from gas treatment
10 13 99 wastes not otherwise specified
20 01 01 paper and cardboard
15 01 01 paper and cardboard packaging

CML 2001
Method "Centrum voor Milieukunde", Leiden, NL

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European Technical Approval ETA-07/0086
Deutsches Institut für Bautechnik, 2013

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Living with Gypsum: From Raw Material to Finished Products, 2008, Brussels

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Institut für Baubiologie, Rosenheim GmbH, 2012, Germany
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