



GRAZIMAC

EPD®

THE INTERNATIONAL EPD® SYSTEM

# Environmental Product Declaration

Multiple products EPDs based on representative product

## Thermal Insulation Panels

**Grisol® P2, S, $CO_2$System, PureNOx, F P2, F S**

In accordance with ISO14025:2006 and EN 15804:2012+A2:2019/AC:2021


| Programme: | Programme operator: | EPD registration number: | Publication date | Valid until | Revision date |
|---|---|---|---|---|---|
| The International EPD® System, www.environdec.com | EPD International AB | EPD-IES-0020913 | 2025-03-17 | 2030-03-16 | 2025-06-12 |


An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication atwww.environdec.com.

# General information

## Programme information

| | | |
|---|---|---|
| **EPD owner:** | GRAZIMAC | GRAZIMAC \| Materiais de Construção, Lda<br>Largo da Feira, 2425-617 Monte Redondo - Leiria<br>www.grazimac.pt \| correio@grazimac.pt |
| **LCA accountability:** | piep<br>inovação em engenharia de polímeros | Centre for Innovation in Polymer Engineering (PIEP)<br>Universidade do Minho, Campus de Azurém, Edifício 15<br>4800-058 Guimarães – PORTUGAL<br>www.piep.pt \| geral@piep.pt |
| **Programme operator:** | EPD®<br>THE INTERNATIONAL EPD® SYSTEM | The International EPD® System EPD International AB Box 210<br>60 SE-100 31 Stockholm Sweden<br>www.environdec.com\|info@environdec.com |
| **Third party verifier:** | Greenize<br>Maximize your green side | ELISABET AMAT  |
| **Accredited by:** | The International EPD® system | |

Independent third-party verification of the declaration and data, according to ISO 14025:2006:
☐ EPD process certification ☒ EPD verification
Procedure for follow-up of data during EPD validity involves third party verifier:
☐Yes ☒ No

PCR review was conducted by: The Technical Committee of the International EPD System. See www.environdec.com for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.

**PRODUCT CATEGORY RULES (PCR):**

- CEN standard EN 15804 serve as the core Product Category Rules (PCR)
- PCR 2019:14 Construction products, version 1.3.4
- C-PCR-005 Thermal Insulation Products (EN 16783:2017)(2024-05-03)

# Company’s profile

GRAZIMAC is a leading Portuguese company specializing in the production of durable, easy-to-use, and versatile thermal insulation panels. Their products provide effective solutions for construction, combining straightforward installation with high performance. The company's mission is to deliver construction solutions that enhance comfort, promote energy savings, and ensure long-lasting durability.

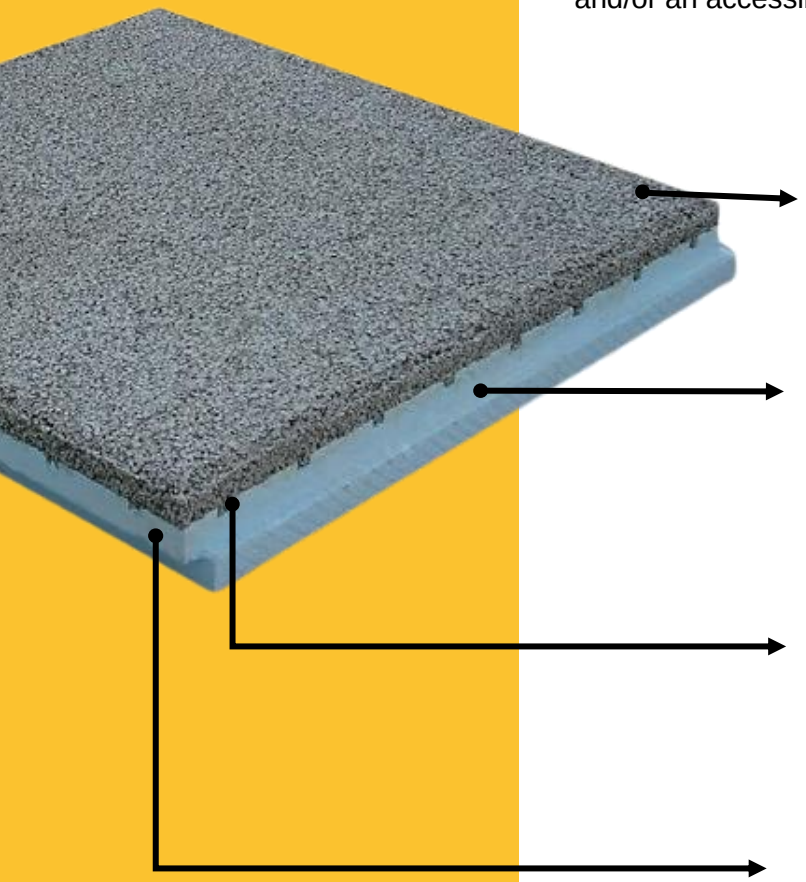
GRAZIMAC's industrial processes are environmentally friendly, with all production waste reintegrated into the manufacturing cycle.

GRAZIMAC is committed to continuous improvement, focusing on enhancing existing products and developing new ones. The company invests significantly in research and development, forming partnerships with leading scientific and technological entities to drive innovation.



# Product information

The Grisol® thermal insulation panels are designed specifically for roofs, terraces and facades. Each panel is constituted by extruded polystyrene (XPS) thermal insulation with integral protective finishing screed, combined with a separation layer, providing insulation, mechanical protection and/or an accessible surface.



## Structure of a typical Grisol® Thermal Insulation Panel

### 1. Enhanced Screed

This layer provides mechanical protection and is made from selected aggregates reinforced with fibres and additives, enhancing resistance and durability.

### 2. Thermal Insulation Layer

The thermal insulation layer consists of extruded polystyrene (XPS) made using chlorine-free expanding gas (without CFCs or HCFCs). This layer offers low thermal conductivity, excellent thermal resistance, high compressive strength, dimensional stability, low water absorption, and resistance to acid and alkaline chemicals.

### 3. Mechanical Key and Adhesive

This feature enhances the adhesion between the mortar layer and the XPS, thereby improving the panel's overall integrity.

### 4. Shiplap edge profile

The panels are designed with a perimeter cut at half thickness, which eliminates discontinuities in the insulating layer and prevents thermal bridges. This feature reduces the risk of surface condensation and mould growth.

# Product information



## Thermal Insulation Panels Grisol® range

**Grisol® P2** is a modified cement mortar roof panel with porous finishing, made from aggregate screed with a predominant grain size of 2 to 4 mm, reinforced with polypropylene (PP) fibres to enhance mechanical properties.

**Grisol® S** is a modified cement mortar roof panel for with smooth finishing, made from aggregate mortar with a predominant grain size of up to 2 mm, also reinforced with PP fibres to enhance mechanical properties.

**Grisol® CO2System** is a modified cement mortar roof panel with highly porous finishing, made from aggregate screed with a 2 to 6 mm grain size, reinforced with polypropylene (PP) fibres and additional components that enable CO2 absorption from the atmosphere. Through a natural process called carbonation, the absorbed CO2 is transformed into carbonate minerals. This process, part of the geological or inorganic carbon cycle occurs in the presence of water, fixing carbon from CO2 gas molecules into a stable, solid form. In the end, these panels can absorb up to 18% of their weight in CO2.




**Grisol® PureNOx** is a modified cement mortar roof panel with porous finishing, made from aggregate screed with a 2 to 4 mm grain size, reinforced with polypropylene (PP) fibres and additional components with air-decontaminating capabilities which eliminate nitrogen oxides (NOx) through photocatalytic activity. In this process, light activates the catalytic activity in the mortar, allowing it to absorb and oxidise contaminants, converting them into harmless substances like carbon dioxide, water, and inorganic ions. Additionally, PureNOx panels feature also a self-cleaning effect, oxidising and eliminating surface stains. The hydrophilic surface of these panels further supports self-cleaning when exposed to rain or humidity.



# Product information

## Thermal Insulation Panels Grisol® range



**Grisol® F P2** is a modified cement mortar facade panel with porous finishing, made from aggregate screed with a predominant grain size of 2 to 4 mm, reinforced with polypropylene (PP) fibres to enhance mechanical properties. These thermal insulation panels can be applied to exterior surfaces of masonry or concrete walls, providing both thermal insulation and a finished appearance. This solution offers an excellent performance against climatic cycles, solar exposure, humidity variations, and freeze-thaw cycles. Additionally, the modular design facilitates easy application and enhances labour efficiency.

**Grisol® F S** is a modified cement mortar facade panel for  with smooth finishing, made from aggregate mortar with a predominant grain size of up to 2 mm, also reinforced with PP fibres to enhance mechanical properties.



# Product information

## Thermal Insulation Panels Grisol® properties

| Property | Performance | Standard |
|---|---|---|
| Perpendicular tensile strength (after aging and freeze-thaw cycles) | >80kPa | EAD 041827-00-0401 |
| Fire Reaction | E | Euroclasse |

## Thermal Insulation Properties

| Property | Product | Unit | Standard |
|---|---|---|---|
| Compression resistance | 300 | kPa | EN 13164 |
| Thermal Conductivity (esp. ≤ 40mm) | 0.033 | W/(m$^2$.K) | EN13164 |
| Thermal Conductivity (esp. 50mm to 80mm) | 0.035 | W/(m$^2$.K) | EN 13164 |
| Thermal Conductivity (esp. ≥ 100mm) | 0.037 | W/(m$^2$.K) | EN 13 164 |
| Dimensional stability | <0.5 | % | EAD 041827-00-0401 |
| Fire Reaction | E | Euroclasse | |

# Product information

## Mortar Properties

| Property | Reference | | Unit | Standard |
|---|---|---|---|---|
| | P2 \| $CO_2$System \| Pure$NO_X$ | S | | |
| **Nominal density** | 1875 | 1975 | Kg/$m^3$ | EN 1015-10 |
| **Flexural resistance** | >3.1 | >3.2 | N/$mm^2$ | EN 1015-11 |
| **Compression resistance** | >10.0 | >13.0 | N/$mm^2$ | EN 1015-11 |
| **Long-term immersion water absorption** | <4.0 | <4.0 | %w/w | EAD 041827-00-0401 |





# LCA information

**Functional Unit**
The functional unit (FU) is one (1) m2 of Grisol® thermal insulation panels used over 25 years.
The FU was selected based on the performance of the most representative product, to GRAZIMAC sales and production for 2023. In this context, the reference “P2 40_25” was chosen as the best-selling product of the year. This insulation panel has a thickness of 40.0 mm for the thermal insulation layer and 25.0 mm for the mortar layer. This panel has a weight of 52.9 kg and a thermal conductivity of 0.033 W/m·K.
This report covers multiple products manufactured by GRAZIMAC that share similar characteristics and are produced under the same manufacturing conditions.

**System Boundaries**
This LCA study follows a “cradle-to-grave and module D” approach. Therefore, the defined system boundaries include modules A1-A3, A4-A5, B, C and D.

**Time Representativeness**
January 2023 – December 2023

**Geographical Scope**
Europe

**EPD Type**



Multiple products

**Software**



SimaPro
Version 9.6.0.1

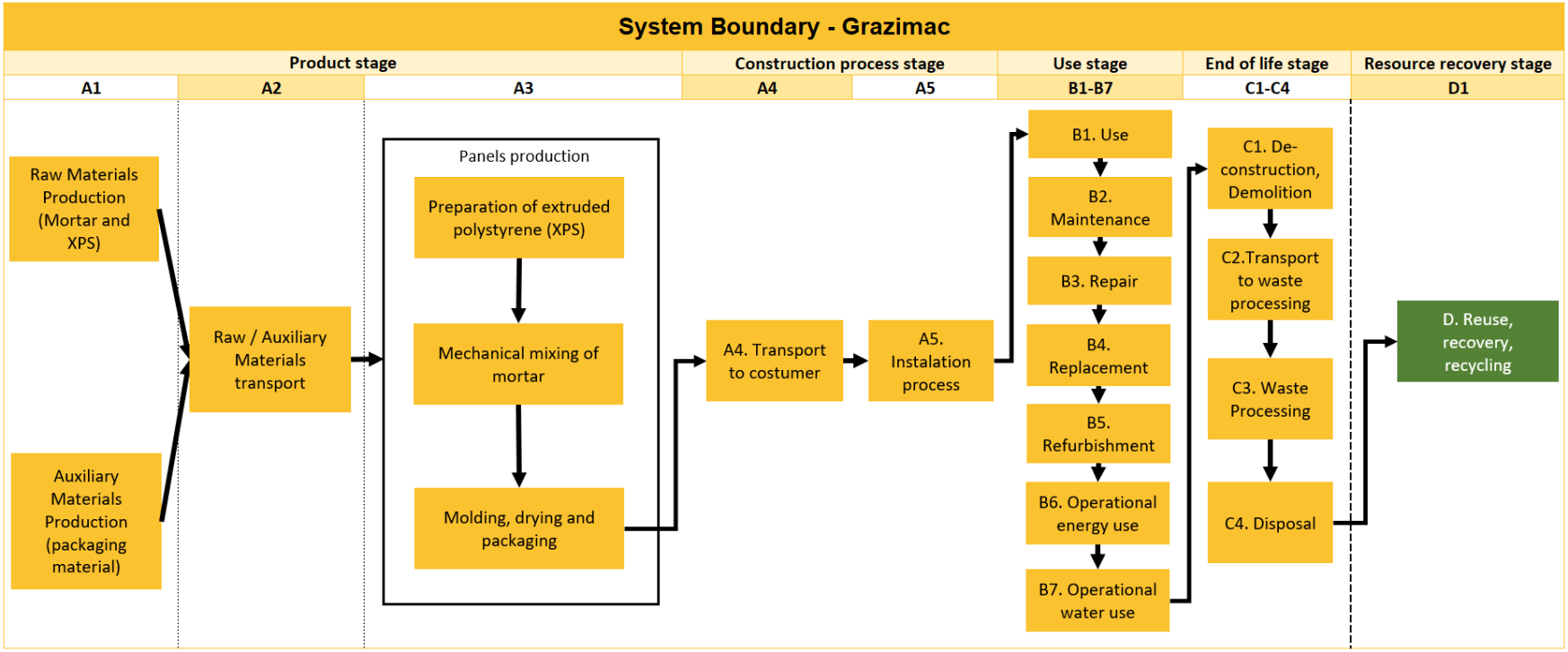
**Database**



Ecoinvent 3.10

# LCA information

## System diagram



# LCA information

## Description of examined Modules

### A1: Raw and auxiliary Material Production

This assessment considers the production of all raw materials needed to comply the FU, namely XPS, cement, aggregates, additives, PP fibres and glue. The XPS, cement, aggregates, and glue are produced by a Portuguese company, the additive liquid adjuvant came from Spain, the additive Air-entraining agent came from Italy, and the PP fibres came from a German company.

The production of auxiliary materials needed to package the final products is also included. In the packaging stage, LDPE film and paper labels are used. Both materials are produced by a Portuguese company. Some pallets are also needed in the distribution of the final products; however, they are not considered in this assessment due to their continuous reusable condition.

### A2: Raw and auxiliary materials transport

This study considers the distances and types of transport for each raw and auxiliary material. All distances were provided by GRAZIMAC company and the transportation type were selected based on the most probable scenarios, according to GRAZIMAC´s sensibility.

| Raw or auxiliary material | Distance (km) | Type of transportation |
|---|---|---|
| **XPS** | 135.0 | Truck 7.5 metric ton |
| **Cement** | 30.4 | Truck 28 metric ton |
| **Aggregates** | 53.7 | Truck 32 metric ton |
| **Additive - Liquid admixture** | 614.0 | Truck 24 metric ton |
| **Additive Air-entraining agent** | 2065.0 | Truck 24 metric ton |
| **PP fibres** | 2301.0 | Truck 24 metric ton |
| **Glue** | 97.6 | Truck 24 metric ton |
| **LDPE film** | 14.4 | Truck 24 metric ton |
| **Paper labels** | 46.3 | Truck 24 metric ton |
| **Diesel** | 1.5 | Light commercial vehicle |

## A3: Manufacturing

The Preparation of extruded polystyrene (XPS) is the beginning of the manufacturing process. In this step, the XPS panels are prepared and cut to fit in the final products. This step consumes mainly energy and produces some residues, which are sold to other companies.

In the mechanical mixing of the mortar step, all the materials required for mortar production are combined, using mainly energy and water. The materials mixed include cement, aggregates, additive liquid adjuvant, additive air-entraining agent, and PP fibre. Any mortar residues produced are subsequently incorporated into the next batch of mortar on the same production line, ensuring consistent characteristics.

After preparing XPS and mortar, the Grisol® insulation panels are assembled in a metal mould, using mainly glue and energy, and then dried naturally (without energy consumption) for 48 hours to ensure the solidification and optimal mechanical properties. Once dried, the panels are stacked on pallets and wrapped in LPDE film, with an identification labels on paper.

## A4: Transportation of the product to the customer

In this study considers an average transport distance of approximal 150 km between the manufacturing plant and GRAZIMAC´s main clients using a truck with a maximum capacity of 24 metric tonnes.

| Scenario information | Unit (Expressed per functional unit) |
|---|---|
| Vehicle type used for transport | Trucks with a maximum capacity of 24 metric tonnes, belonging to the EURO6 category |
| Distance | 150 km |
| Capacity utilisation (including empty returns) | 50 % |
| Bulk density of transported products | 821 kg/m$^3$ |
| Volume capacity utilisation factor | Not applicable |

## A5: Installation of the product

The installation of Grisol® thermal insulation panels is done manually, requiring no additional products, energy, or water. However, this module accounts for packaging waste, with both the LDPE film and paper labels sent to recycling.

| Scenario information | Unit (Expressed per functional unit) |
|---|---|
| No materials, water, or energy were needed. | - |
| LPDE film from packaging to recycling | 7.00E-03 kg |
| Paper labels from packaging to recycling | 3.87E-03 kg |
| There are no direct emissions to ambient air, soil and water | - |



## B1: Use of the product

None of the Grisol® thermal insulation panels consume additional materials, energy, or water during their usage phase. However, the Grisol® CO2System panels absorb CO2 due to their enhanced carbonation capacity, resulting in a positive impact on the environment. The same happens with the PureNOX thermal insulation panels from Grisol® range, which absorb NOx due to their photocatalytic capacity. The CO2 or NOx absorption capacity of 1 m² of Grisol® panels are 9.20E+00 kg CO2 for 25 mm mortar, 1.25E+01 kg CO2 for 35mm mortar and 3.33E-06 kg NOx for all thicknesses respectively.



## B2: Maintenance of the product

Grisol® thermal insulation panels are maintenance-free, resulting in no additional environmental impacts at this stage. Additionally, Grisol® products have an intended working life of 25 years.



## B3: Repair of the product

Grisol® thermal insulation panels do not need repair, during their lifespan, so no additional environmental impacts are related to this stage.



## B4: Replacement of the product

According to the producer, there are no predicted replacements for the product during its lifespan. Even so, if a panel is damaged the process is straightforward: the damaged slab should be manually removed and replaced with a new one without using additional materials, energy or water.



## B5: Refurbishment of the product

The renovation phase does not apply to Grisol® products.



## B6: Operational energy use

Grisol® thermal insulation panels do not need energy during their use phase.

## B7: Operational water use

Grisol® thermal insulation panels do not require water during their use phase.

## C1: Deconstruction/demolition of the product

According to the Portuguese Pre-Demolition Audit Guide, Grisol® thermal insulation panels can be manually removed during the initial stage of the demolition process. Therefore, no environmental impacts are expected during this phase.

## C2: Transport to a waste processing unit

This study considers an average transport distance of approximately 20 km between the installation site and the sorting and recovery centre using a truck with a maximum capacity of 24 metric tonnes.

| Scenario information | Unit (Expressed per functional unit) |
|---|---|
| Vehicle type used for transport | Trucks 24 metric tonnes, EURO6 category |
| Distance | 20 km |
| Capacity utilisation (including empty returns) | 50 % |
| Bulk density of transported products | 821 kg/m$^3$ |
| Volume capacity utilisation factor | Not applicable |

## C3: Waste processing

At this stage, the mortar and XPS from the end-of-life (EoL) panels are manually separated on-site, ensuring proper material recovery as outlined in the Portuguese Demolition Guide and supported by Sartipi et al. (2024). Consequently, no environmental impacts are reported for this module.

## C4: Disposal of the final product as waste

It has been established that 63% of the collected thermal insulation panels will be sent to landfill. This percentage was sourced from the Reporte Comunitário RCD 2022 published by the Portuguese Environment Agency (APA)

## D: Reuse, recovery, and recycling potential

According to the same APA report, 37% of construction and demolition waste is recycled. This information was used to define Module D.

| Processes | Unit (Expressed per functional unit of components products ) |
|---|---|
| Process specified by type of material | 52.87 kg collected separately (51.50 from mortar and 1.37 from XPS) |
| | 0 kg collected with mixed construction waste |
| Recovery system | 0 kg for re-use |
| | 19.56 kg for recycling (19.05 from mortar and 0.51 from XPS) |
| | 0 kg for energy recovery |
| Disposal | 33.3 kg product or material for final deposition |
| Other assumptions for the scenario | There are no other assumptions on this scenario |

# LCA information

Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results):

| | Product Stage | | | Construction process stage | | Use stage | | | | | | | End-of-life stage | | | | Resource recovery stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction – installation process | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | Deconstruction/ demolition | Transport | Waste processing | Disposal | Reuse, recovery, recycling potentials |
| **Module** | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D1** |
| **Modules Declared** | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × |
| **Geography** | **EU** | **EU** | **PT** | **EU** | **EU** | **EU** | **EU** | **EU** | **EU** | **EU** | **EU** | **EU** | **PT** | **PT** | **PT** | **PT** | **PT** |
| **Specific data used** | **37%** | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Variation – Products[1]** | **81%** | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Variation - Sites** | **0%** | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

[1] Maximum variation of products for all impact categories can be seen in Additional environmental information section.

# LCA information

## Additional information

**Allocation Procedure and Cut-off Criteria**

This study adheres to international standards ISO 14040:2006 and ISO 14044:2006, aiming to avoid allocations whenever possible. However, when necessary, mass allocation was applied using an attributional modelling approach.
All inputs and outputs of the unit processes with available data are included in this study. When data were insufficient, no unit process was omitted by more than 1% of total mass and energy flows. In total, excluded input and output flows do not exceed 5% of energy usage or mass.

**Allocation Assumptions and Limitations**

**The following assumptions were made in this study:**

- The data provided by GRAZIMAC refer to the calendar year of 2023.
- This study excludes the construction and maintenance of the infrastructure and capital goods.
- The process to produce all raw and auxiliary materials were modelled using data available in commercial databases.
- No Material Safety Data Sheet (MSDS) was provided for the aggregates (rice rock and sand), paper and LDPE packaging film. Consequently, these materials were modelled using general information.
- The $CO_2$ aggregate is a by-product, with its environmental impacts determined through economic allocation based on market value of both the main product and the by-product.
- During the production process, mortar waste and sludge from mould washing are generated and reintegrated into the production cycle. Because of this reintegration, no environmental impacts from these waste streams have been considered.
- LDPE film and cardboard tube waste is generated during the packaging process. This waste is recycled by an external entity, and the environmental impacts of this recycling process are accounted according to the polluters pay principle.
- The environmental impacts associated with XPS, the additive Air-entraining agent, and glue used in the module A3 were taken from the respective Environmental Product Declarations (EPDs), provided by the manufacturers of these raw materials.
- For the transportation of raw and auxiliary materials and final product, when exact transport routes were not provided, Google Maps was used.

# LCA information

## Additional information

- Trucks with a capacity of 16 to 32 tons, belonging to the EURO6 category were considered, as this category represented approximately 60% of the trucks circulating in Europe in 2023.
- The $CO_2$ absorption capacity of 1 m² of Grisol® panels was determined based on a confidential report conducted by the University of Oviedo. The $NO_x$ absorption capacity is determined following ISO 22197-1:2007.
- It should be noted that, although $CO_2$ and NOx absorption in Module B has been accounted for in some products, the conversion factors provided only apply to Modules A1-A3. Therefore, this absorption is not reflected in the presented values.

**The results of the study are subject to the following limitations:**

- It is essential to acknowledge that there may be additional limitations not covered in this section, due to a lack of knowledge at the time of this report. The report cannot be held accountable for these unaddressed limitations.
- The databases used have inherent limitations regarding the variety of materials available, which may introduce some uncertainties to the simulations of the production process.
- Some raw materials are highly complex, with insufficient information in their Safety Data Sheets (SDS), which can bring some uncertainties in the modelling process.
- In an industrial context, the type of truck employed may vary depending on the quantity of raw materials ordered or specific customer requests.
- GRAZIMAC does not always oversee the type of truck used, as part of the transportation is subcontracted to logistics companies.
- Actual transport routes used may differ from those suggested by Google Maps.

**Background data and data quality**

This study used primary data provided by GRAZIMAC. However, complete and detailed information for every stage, as well as for all selected inputs and outputs, was not always available. Therefore, certain theoretical assumptions were made to refine the data used.

The data considered in this study pertains to the year 2023 and was supplied by the client.

The SimaPro software (version 9.6.0.1, Amsterdam, Netherlands) and the Ecoinvent database (version 3.10, Zurich, Switzerland) were used as secondary data sources. The Ecoinvent database was referenced where data was unavailable, could not be generated from other sources, or related to processes involving third parties.

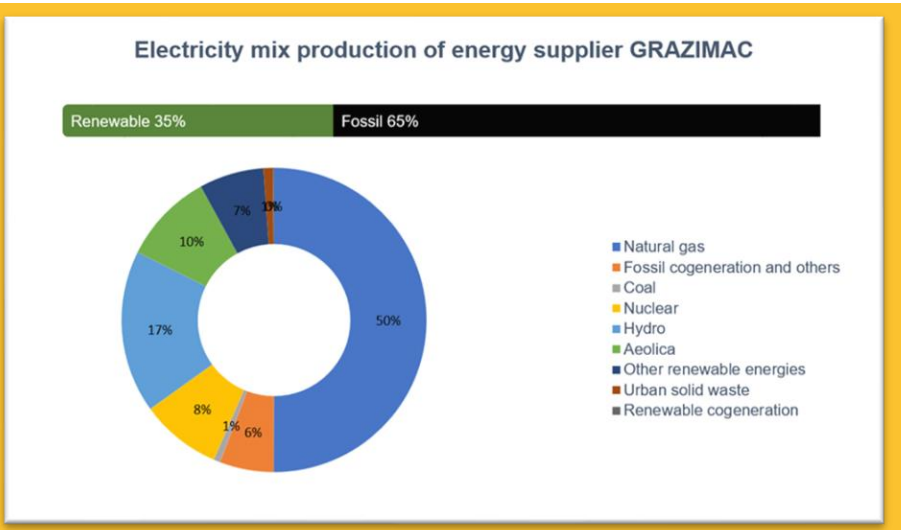
# LCA information

## Additional information

In this study, the energy consumption by GRAZIMAC was modelled in alignment with the company´s specific requirements and specifications. In 2023, GRAZIMAC | Materiais de Construção, Lda utilised energy from both on-site solar panels and an external electricity supply. The solar panels accounted for 58% of the total energy consumption, while the remaining 42% was obtained from the external energy supplier.

For on-site energy generation from solar panels, the dataset was chosen for its accurate representation of the photovoltaic system's characteristics, based on the technical specifications provided by GRAZIMAC.

For external energy, this study used the GRAZIMAC's energy bill. This modelling was incorporated energy inputs specific to Portugal from Ecoinvent (version 3.10).




The emissions of 1 kWh of energy consumed by Grazimac (electric grid + solar panels) is 0.197 kg of $CO_2$.

## Comparability

- The EPD owner has the sole ownership, liability, and responsibility for the EPD.

- EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional unit); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

# Content information

| Product Components | | Weight, Kg | Post-consumer recycled material, weight-% of product | Biogenic material, weight-% of product | Biogenic material, kg C/Functional unit |
|---|---|---|---|---|---|
| **Reinforced Mortar layer** | Cement | 1.14E+01 | 0 | 0 | 0 |
| | Aggregates | 3.54E+01 | 0 | | |
| | Additive – liquid adjuvant | 7.70E-02 | 0 | 0 | 0<br>0 |
| | Additive - entraining agent | 2.15E-04 | 0 | 0 | 0 |
| | PP fibre | 6.20E-01 | 0 | 0 | 0 |
| | Glue | 5.40E-02 | 0 | 0 | 0 |
| **Thermal insulation layer** | XPS | 1.37E+00 | 20-30% | 0 | 0 |
| **Sum** | | 4.89E+01[1] | 20-30% | 0 | 0 |

| Packaging materials | Weight, kg | Weight-% (versus the product) | Biogenic material, kg C/Functional unit |
|---|---|---|---|
| LDPE film | 1.50E-02 | 0.03% | 0.00E+00 |
| Paper label | 7.00E-03 | 0.01% | 3.00E-03[2] |
| **Sum** | 2.20E-02 | 0.04% | 3.00E-03 |

None of the components in Grisol® insulation panels contain substances from the List of Substances of Very High Concern (SVHC) at concentrations exceeding 0.1% of the product's weight.

[1]To this value, 4 kg of water must be added, representing the amount retained in the mortar during the cement hydration process. This water is not included in the table, as it is not considered a constituent material but rather a reactant in the chemical process. As a result, the final weight of the thermal insulation panel is 52.9 kg.
[2] This value was calculated based on information from Wu et al. (2022).

# Results of the environmental performance indicators

## Mandatory impact category indicators according to EN 15804 (based on EF 3.1)

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks. Usage of results from A1-A3 without considering the results of module C is not encouraged

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GWP-total** | **kg $CO_2$ eq.** | 1.82E+01 | 1.22E+00 | 4.24E-03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.61E-01 | 0 | 9.05E-02 | -1.16E+01 |
| **GWP-fossil** | **kg $CO_2$ eq.** | 1.80E+01 | 1.22E+00 | 4.04E-03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.61E-01 | 0 | 9.04E-02 | -1.56E+00 |
| **GWP-biogenic** | **kg $CO_2$ eq.** | 1.60E-01 | 3.90E-04 | 1.96E-04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.15E-05 | 0 | 3.03E-05 | -1.01E+01 |
| **GWP-luluc** | **kg $CO_2$ eq.** | 5.27E-03 | 2.99E-05 | 1.37E-06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.94E-06 | 0 | 4.44E-06 | 6.84E-04 |
| **ODP** | **kg CFC11 eq.** | 5.85E+00 | 2.48E-08 | 3.21E-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.27E-09 | 0 | 1.34E-09 | -1.99E-09 |
| **AP** | **mol H+ eq.** | 2.73E-02 | 1.42E-03 | 8.40E-06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.87E-04 | 0 | 8.22E-04 | -7.68E-03 |
| **EP-freshwater** | **kg P eq.** | 2.36E-02 | 1.02E-06 | 3.74E-08 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.35E-07 | 0 | 3.25E-07 | -1.03E-06 |
| **EP-marine** | **kg N eq.** | 9.65E-03 | 3.14E-04 | 3.33E-06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.15E-05 | 0 | 3.73E-04 | -1.52E-03 |
| **EP-terrestrial** | **mol N eq.** | 8.75E-02 | 3.44E-03 | 3.52E-05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.54E-04 | 0 | 4.09E-03 | -1.64E-02 |
| **POCP** | **kg NMVOC eq.** | 3.47E-02 | 3.07E-03 | 1.23E-05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.06E-04 | 0 | 1.24E-03 | -6.28E-03 |
| **ADPe [3]** | **kg Sb eq.** | 4.16E-02 | 4.02E-08 | 1.69E-09 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.30E-09 | 0 | 3.58E-09 | -1.69E-07 |
| **ADPf [3]** | **MJ** | 1.02E+02 | 1.61E+01 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.12E+00 | 0 | 1.16E+00 | -3.69E+00 |
| **WDP [3]** | **$m^3$ depriv.** | 2.57E+00 | 1.69E-02 | 1.49E-04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.22E-03 | 0 | 1.66E-03 | 2.49E-03 |

**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; **WDP** = Water (user) deprivation potential.

## Additional mandatory and voluntary impact category indicators

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GWP-GHG[4]** | **kg $CO_2$ eq.** | 1.79E+01 | 1.22E+00 | 4.11E-03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.61E-01 | 0 | 9.06E-02 | -1.58E+00 |

[3] The results of this environmental impact indicator should be interpreted cautiously, as there are significant uncertainties associated with these findings and limited experience with the indicator.

[4] GWP-GHG indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide emissions and uptake and biogenic carbon stored in the product, with characterization factors (CFs) based on IPCC (2013).

# Resource use indicators

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PERE** | **MJ** | 7.92E+00 | 5.68E-02 | 9.90E-04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.50E-03 | 0 | 5.49E-03 | 3.79E-01 |
| **PERM** | **MJ** | 3.16E-02 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0.00E+00 | 0.00E+00 |
| **PERT** | **MJ** | 7.95E+00 | 5.68E-02 | 9.90E-04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.50E-03 | 0 | 5.49E-03 | 3.79E-01 |
| **PENRE** | **MJ** | 2.08E+02 | 1.61E+01 | 5.25E-06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.12E+00 | 0 | 1.16E+00 | -3.69E+00 |
| **PENRM** | **MJ** | 3.97E-01 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0.00E+00 | 0.00E+00 |
| **PENRT** | **MJ** | 2.09E+02 | 1.61E+01 | 5.25E-06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.12E+00 | 0 | 1.16E+00 | -3.69E+00 |
| **SM** | **kg** | 3.86E-03 | 7.97E-06 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.05E-06 | 0 | 2.35E-06 | -1.44E-05 |
| **RSF** | **MJ** | 9.12E-03 | 6.96E-07 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9.19E-08 | 0 | 4.46E-07 | -2.37E-06 |
| **NRSF** | **MJ** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0.00E+00 | 0.00E+00 |
| **FW** | **$m^3$** | 3.37E+00 | 4.12E-04 | 6.53E-06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.44E-05 | 0 | 4.02E-05 | 1.07E-05 |

**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.

# Waste indicators and output flow indicators

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HWD** | **kg** | 1.84E-01 | 7.97E-04 | 1.33E-04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.05E-04 | 0 | 5.56E-04 | -4.41E-02 |
| **NHWD** | **kg** | 1.77E+01 | 6.43E-02 | 4.47E-03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8.49E-03 | 0 | 1.38E-02 | -2.89E+01 |
| **RWD** | **kg** | 2.87E-04 | 1.51E-06 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.99E-07 | 0 | 7.11E-08 | -1.96E-07 |
| **CRU** | **kg** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0.00E+00 | 0.00E+00 |
| **MFR** | **kg** | 2.96E-03 | 3.91E-07 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.16E-08 | 0 | 3.30E-08 | -1.55E-07 |
| **MER** | **kg** | 2.64E-06 | 3.93E-09 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.19E-10 | 0 | 4.06E-09 | -2.98E-08 |
| **EEE** | **MJ** | 8.00E-02 | 8.83E-04 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.17E-04 | 0 | 2.55E-05 | -6.46E-05 |
| **EET** | **MJ** | 1.56E-01 | 1.53E-03 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.02E-04 | 0 | 9.61E-06 | -1.13E-04 |

**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; **EET** = Exported thermal energy

# Additional environmental impacts

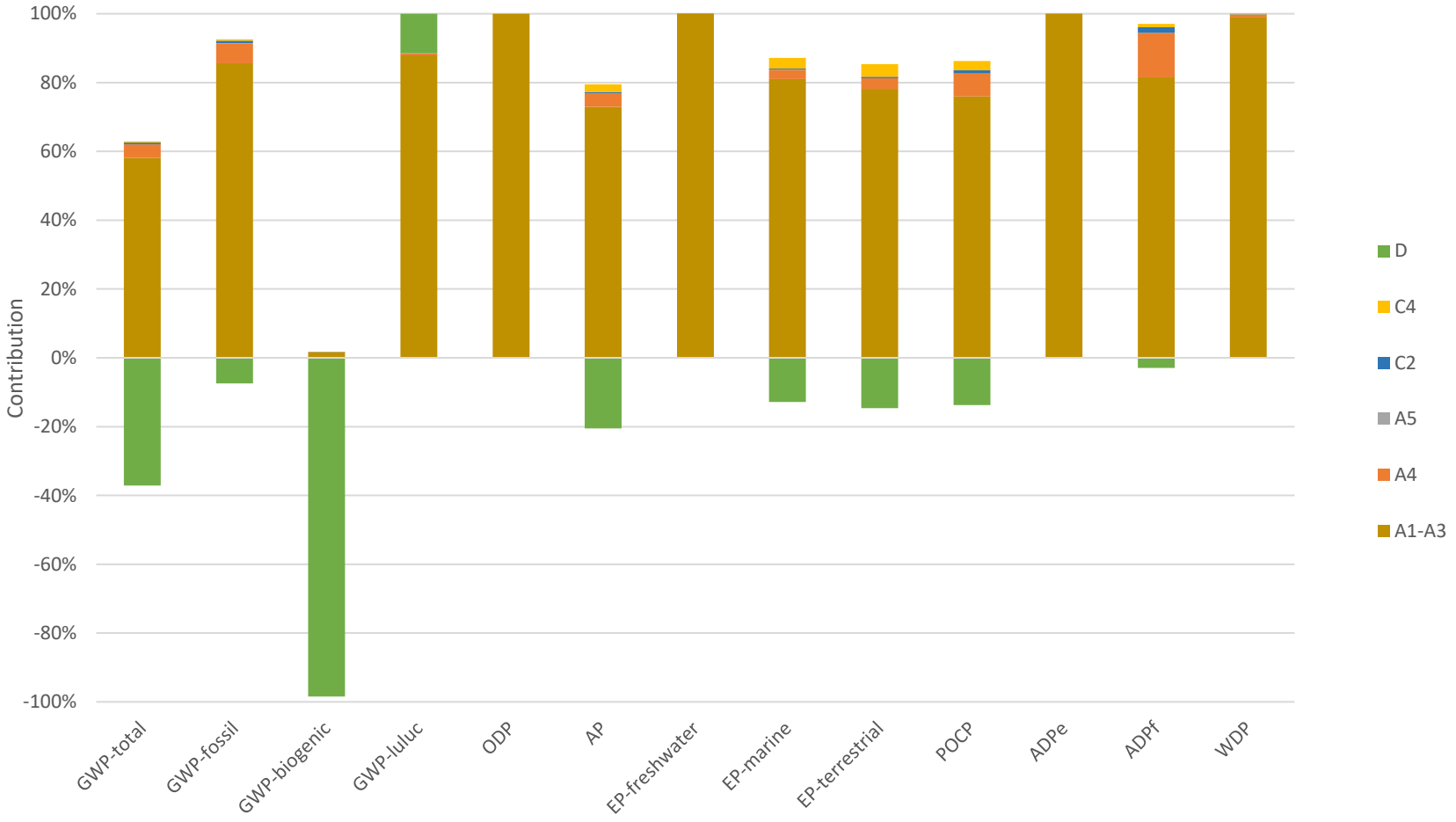
| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PM** | **Disease incidence** | 3.79E-07 | 7.19E-08 | 1.66E-10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9.50E-09 | 0 | 2.31E-08 | -1.08E-07 |
| **IR**[5] | **kBq U235 eq** | 5.11E-01 | 2.19E-03 | 2.82E-05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.89E-04 | 0 | 1.23E-04 | 4.39E-03 |
| **ETP-fw** [6] | **CTUe** | 1.09E+01 | 5.50E-01 | 1.81E-02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.26E-02 | 0 | 5.46E-02 | -5.02E-01 |
| **HTP-c** [6] | **CTUh** | 5.00E-08 | 8.54E-11 | 3.09E-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.13E-11 | 0 | 1.98E-11 | 7.00E-10 |
| **HTP-nc**[6] | **CTUh** | 1.86E-07 | 8.11E-09 | 2.63E-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.07E-09 | 0 | 1.24E-10 | -1.39E-08 |
| **SQP** | **Dimensionless** | 2.31E+01 | 3.59E-02 | 1.41E-03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.75E-03 | 0 | 1.37E+00 | -2.70E+00 |

**PM** = Potential incidence of disease due to PM emissions; **IR** = Potential Human exposure efficiency relative to U235; **ETP-fw** = Potential comparative Toxic Unit for ecosystems; **HTP-c** = Potential comparative Toxic Unit for humans (cancerogenic); **HTP-nc** = Potential comparative Toxic Unit for humans (not cancerogenic); **SQP** = Potential soil quality index.

[5] This impact category deals mainly with the eventual impact of low-dose ionizing radiation on the human health of the nuclear fuel cycle. It does not consider effects due to possible
[6] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

# Interpretation

## % Life Cycle Modules Contribution



# Interpretation

The analysis will delve into the main contributors to each impact category, identifying the life cycle phases with the most significant influence on the results.

The LCA of the Grisol® thermal insulation panel, model P2 40_25, highlights that the production phase (A1-A3) is the primary contributor to environmental impacts, particularly in terms of Global Warming Potential (GWP-total), which reaches 18.20 kg $CO_2$ eq/m². This phase is responsible for the vast majority of impacts across all evaluated categories, driven by the resource-intensive and energy-demanding manufacturing processes.

In contrast, the transport phase (A4) has a significantly lower impact, reflecting the relatively short transportation distance of 150 km to the installation site. Likewise, the installation phase (A5) contributes only marginally to the overall results, as it is largely a manual process with negligible resource consumption.

The end-of-life stage (C1-C4) also has a minor contribution to the panel’s overall environmental profile. However, module D, which accounts for material recovery and reuse, introduces considerable benefits, particularly in reducing $CO_2$ emissions. These benefits partially offset the impacts of earlier phases but do not alter the fact that A1-A3 overwhelmingly dominate the lifecycle impacts.

Among the inputs that significantly impact the Grisol® thermal insulation panels, cement and XPS stand out. Cement's production process has a high inherent environmental impact due to its raw material extraction and energy demands. Similarly, XPS, derived from fossil sources, carries considerable environmental impacts.

# Additional environmental information

## Conversion Factor

The conversion factor is used to adjust the environmental impact results of the representative model, ensuring that the impacts of other models are accurately represented. This factor is calculated by dividing the impact value of each specific model by the impact value of the representative model, as demonstrated Equation 1:

$$\text{Conversion Factor} = \frac{\text{Impact of a specific model}}{Impact\ of\ representative\ model} \qquad \text{(Equation 1)}$$

This calculation enables the representative model's impacts to be precisely adjusted, making it possible to obtain the results for the other models.

| A1-A3 | GWP-total | GWP-fossil | GWP-biogenic | GWP-luluc | ODP | AP | EP-freshwater | EP-marine | EP-terrestrial | POCP | ADPe | ADPf | WDP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P2 40/25** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **P2 30/25** | 0.89 | 0.89 | 0.96 | 0.91 | 0.66 | 1.00 | 0.66 | 0.92 | 1.00 | 0.96 | 0.66 | 1.00 | 1.00 |
| **P2 50/25** | 1.08 | 1.08 | 1.03 | 1.06 | 1.25 | 1.00 | 1.25 | 1.06 | 1.00 | 1.03 | 1.25 | 1.00 | 1.00 |
| **P2 60/25** | 1.16 | 1.16 | 1.06 | 1.13 | 1.50 | 1.00 | 1.50 | 1.12 | 1.00 | 1.06 | 1.50 | 1.00 | 1.00 |
| **P2 80/25** | 1.32 | 1.32 | 1.12 | 1.25 | 2.00 | 1.00 | 1.99 | 1.23 | 1.01 | 1.12 | 2.00 | 1.00 | 1.00 |
| **P2 100/25** | 1.48 | 1.49 | 1.18 | 1.38 | 2.50 | 1.00 | 2.49 | 1.35 | 1.01 | 1.17 | 2.50 | 1.00 | 1.00 |
| **P2 120/25** | 1.65 | 1.65 | 1.24 | 1.51 | 3.00 | 1.00 | 2.99 | 1.47 | 1.02 | 1.23 | 3.00 | 1.00 | 1.00 |
| **P2 30/35** | 1.13 | 1.13 | 1.33 | 1.08 | 0.66 | 1.35 | 0.66 | 1.19 | 1.35 | 1.27 | 0.66 | 1.34 | 1.23 |
| **P2 40/35** | 1.24 | 1.24 | 1.37 | 1.17 | 1.00 | 1.35 | 1.00 | 1.27 | 1.35 | 1.31 | 1.00 | 1.34 | 1.23 |
| **P2 50/35** | 1.32 | 1.32 | 1.40 | 1.23 | 1.25 | 1.35 | 1.25 | 1.33 | 1.35 | 1.34 | 1.25 | 1.34 | 1.23 |
| **P2 60/35** | 1.40 | 1.40 | 1.43 | 1.29 | 1.50 | 1.35 | 1.50 | 1.39 | 1.36 | 1.37 | 1.50 | 1.34 | 1.23 |
| **P2 80/35** | 1.57 | 1.57 | 1.49 | 1.42 | 2.00 | 1.35 | 2.00 | 1.50 | 1.36 | 1.43 | 2.00 | 1.34 | 1.23 |
| **P2 100/35** | 1.73 | 1.73 | 1.55 | 1.55 | 2.50 | 1.35 | 2.49 | 1.62 | 1.37 | 1.48 | 2.50 | 1.34 | 1.23 |
| **P2 120/35** | 0.89 | 0.89 | 0.96 | 0.91 | 0.66 | 1.00 | 0.66 | 0.92 | 1.00 | 0.96 | 0.66 | 1.00 | 1.00 |

| A1-A3 | GWP-total | GWP-fossil | GWP-biogenic | GWP-luluc | ODP | AP | EP-freshwater | EP-marine | EP-terrestrial | POCP | ADPe | ADPf | WDP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S 30/25** | 1.89 | 1.89 | 1.62 | 1.67 | 3.00 | 1.35 | 2.99 | 1.74 | 1.37 | 1.54 | 3.00 | 1.34 | 1.23 |
| **S 40/25** | 0.91 | 0.91 | 0.96 | 0.91 | 0.66 | 1.01 | 0.66 | 0.95 | 1.00 | 1.00 | 0.66 | 1.06 | 1.10 |
| **S 50/25** | 1.02 | 1.02 | 1.00 | 1.00 | 1.00 | 1.01 | 1.00 | 1.03 | 1.01 | 1.04 | 1.00 | 1.06 | 1.10 |
| **S 60/25** | 1.10 | 1.11 | 1.03 | 1.06 | 1.25 | 1.01 | 1.25 | 1.08 | 1.01 | 1.07 | 1.25 | 1.06 | 1.10 |
| **S 80/25** | 1.19 | 1.19 | 1.06 | 1.13 | 1.50 | 1.01 | 1.50 | 1.14 | 1.01 | 1.10 | 1.50 | 1.06 | 1.10 |
| **S 100/25** | 1.35 | 1.35 | 1.12 | 1.25 | 2.00 | 1.01 | 1.99 | 1.26 | 1.02 | 1.16 | 2.00 | 1.06 | 1.10 |
| **S 120/25** | 1.51 | 1.51 | 1.18 | 1.38 | 2.50 | 1.01 | 2.49 | 1.38 | 1.02 | 1.22 | 2.50 | 1.06 | 1.10 |
| **S 30/35** | 1.67 | 1.67 | 1.25 | 1.51 | 3.00 | 1.01 | 2.99 | 1.49 | 1.02 | 1.27 | 3.00 | 1.06 | 1.10 |
| **S 40/35** | 1.16 | 1.16 | 1.33 | 1.08 | 0.66 | 1.36 | 0.66 | 1.23 | 1.36 | 1.33 | 0.66 | 1.42 | 1.37 |
| **S 50/35** | 1.28 | 1.27 | 1.37 | 1.16 | 1.00 | 1.36 | 1.00 | 1.31 | 1.36 | 1.37 | 1.00 | 1.42 | 1.37 |
| **S 60/35** | 1.36 | 1.36 | 1.40 | 1.23 | 1.25 | 1.36 | 1.25 | 1.37 | 1.36 | 1.40 | 1.25 | 1.42 | 1.37 |
| **S 80/35** | 1.44 | 1.44 | 1.43 | 1.29 | 1.50 | 1.36 | 1.50 | 1.42 | 1.37 | 1.43 | 1.50 | 1.42 | 1.37 |
| **S 100/35** | 1.60 | 1.60 | 1.50 | 1.42 | 2.00 | 1.36 | 2.00 | 1.54 | 1.37 | 1.48 | 2.00 | 1.42 | 1.37 |
| **S 120/35** | 1.76 | 1.76 | 1.56 | 1.55 | 2.50 | 1.36 | 2.49 | 1.66 | 1.37 | 1.54 | 2.50 | 1.42 | 1.37 |
| **PureNOx 30/25** | 1.92 | 1.92 | 1.62 | 1.67 | 3.00 | 1.36 | 2.99 | 1.77 | 1.38 | 1.60 | 3.00 | 1.42 | 1.37 |
| **PureNOx 40/25** | 1.03 | 1.03 | 1.05 | 1.04 | 1.00 | 1.58 | 1.00 | 1.05 | 1.05 | 1.07 | 1.00 | 1.06 | 1.33 |
| **PureNOx 50/25** | 1.03 | 1.03 | 1.05 | 1.04 | 1.00 | 1.58 | 1.00 | 1.05 | 1.05 | 1.07 | 1.00 | 1.06 | 1.33 |
| **PureNOx 60/25** | 1.11 | 1.11 | 1.08 | 1.11 | 1.25 | 1.58 | 1.25 | 1.11 | 1.05 | 1.10 | 1.25 | 1.06 | 1.33 |
| **PureNOx 80/25** | 1.19 | 1.19 | 1.11 | 1.17 | 1.50 | 1.58 | 1.50 | 1.17 | 1.05 | 1.13 | 1.50 | 1.06 | 1.33 |
| **PureNOx 100/25** | 1.35 | 1.35 | 1.17 | 1.30 | 2.00 | 1.58 | 1.99 | 1.29 | 1.06 | 1.18 | 2.00 | 1.06 | 1.33 |
| **PureNOx 120/25** | 1.51 | 1.51 | 1.23 | 1.43 | 2.50 | 1.58 | 2.49 | 1.40 | 1.06 | 1.24 | 2.50 | 1.06 | 1.33 |
| **PureNOx 30/35** | 1.67 | 1.68 | 1.29 | 1.55 | 3.00 | 1.58 | 2.99 | 1.52 | 1.07 | 1.30 | 3.00 | 1.06 | 1.33 |
| **PureNOx 40/35** | 1.17 | 1.17 | 1.39 | 1.14 | 0.66 | 2.14 | 0.66 | 1.27 | 1.42 | 1.36 | 0.66 | 1.42 | 1.68 |
| **PureNOx 50/35** | 1.28 | 1.28 | 1.44 | 1.23 | 1.00 | 2.14 | 1.00 | 1.35 | 1.42 | 1.40 | 1.00 | 1.42 | 1.68 |
| **PureNOx 60/35** | 1.44 | 1.44 | 1.50 | 1.35 | 1.50 | 2.14 | 1.50 | 1.46 | 1.43 | 1.46 | 1.50 | 1.42 | 1.68 |
| **PureNOx 80/35** | 1.60 | 1.60 | 1.56 | 1.48 | 2.00 | 2.14 | 2.00 | 1.58 | 1.43 | 1.52 | 2.00 | 1.42 | 1.68 |
| **PureNOx 100/35** | 1.76 | 1.77 | 1.62 | 1.61 | 2.50 | 2.14 | 2.49 | 1.70 | 1.43 | 1.58 | 2.50 | 1.42 | 1.68 |
| **PureNOx 120/35** | 1.93 | 1.93 | 1.68 | 1.73 | 3.00 | 2.14 | 2.99 | 1.81 | 1.44 | 1.63 | 3.00 | 1.42 | 1.68 |

| A1-A3 | GWP-total | GWP-fossil | GWP-biogenic | GWP-luluc | ODP | AP | EP-freshwater | EP-marine | EP-terrestrial | POCP | ADPe | ADPf | WDP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$CO_2$ 30/25** | 1.04 | 1.04 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.98 | 0.97 | 1.02 | 1.00 | 1.09 | 1.06 |
| **$CO_2$ 40/25** | 1.04 | 1.04 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.98 | 0.97 | 1.02 | 1.00 | 1.09 | 1.06 |
| **$CO_2$ 50/25** | 1.12 | 1.12 | 1.03 | 1.06 | 1.25 | 1.00 | 1.25 | 1.04 | 0.97 | 1.05 | 1.25 | 1.09 | 1.06 |
| **$CO_2$ 60/25** | 1.20 | 1.20 | 1.06 | 1.12 | 1.50 | 1.00 | 1.50 | 1.10 | 0.97 | 1.08 | 1.50 | 1.09 | 1.06 |
| **$CO_2$ 80/25** | 1.36 | 1.36 | 1.12 | 1.25 | 2.00 | 1.00 | 1.99 | 1.22 | 0.98 | 1.14 | 2.00 | 1.09 | 1.06 |
| **$CO_2$ 100/25** | 1.52 | 1.53 | 1.18 | 1.38 | 2.50 | 1.00 | 2.49 | 1.34 | 0.98 | 1.20 | 2.50 | 1.09 | 1.06 |
| **$CO_2$ 120/25** | 1.68 | 1.69 | 1.24 | 1.51 | 3.00 | 1.00 | 2.99 | 1.45 | 0.99 | 1.26 | 3.00 | 1.09 | 1.06 |
| **$CO_2$ 30/35** | 1.19 | 1.18 | 1.33 | 1.08 | 0.66 | 1.35 | 0.66 | 1.17 | 1.31 | 1.31 | 0.66 | 1.47 | 1.32 |
| **$CO_2$ 40/35** | 1.30 | 1.30 | 1.37 | 1.17 | 1.00 | 1.35 | 1.00 | 1.25 | 1.31 | 1.34 | 1.00 | 1.47 | 1.32 |
| **$CO_2$ 50/35** | 1.38 | 1.38 | 1.40 | 1.23 | 1.25 | 1.35 | 1.25 | 1.31 | 1.31 | 1.37 | 1.25 | 1.47 | 1.32 |
| **$CO_2$ 60/35** | 1.46 | 1.46 | 1.43 | 1.29 | 1.50 | 1.35 | 1.50 | 1.37 | 1.32 | 1.40 | 1.50 | 1.47 | 1.32 |
| **$CO_2$ 80/35** | 1.62 | 1.62 | 1.49 | 1.42 | 2.00 | 1.35 | 2.00 | 1.49 | 1.32 | 1.46 | 2.00 | 1.47 | 1.32 |
| **$CO_2$ 100/35** | 1.78 | 1.78 | 1.55 | 1.55 | 2.50 | 1.35 | 2.49 | 1.60 | 1.32 | 1.52 | 2.50 | 1.47 | 1.32 |
| **$CO_2$ 120/35** | 1.94 | 1.94 | 1.62 | 1.67 | 3.00 | 1.35 | 2.99 | 1.72 | 1.33 | 1.58 | 3.00 | 1.47 | 1.32 |
| **F P2 50_15** | 0.82 | 0.82 | 0.63 | 0.88 | 1.25 | 0.62 | 1.25 | 0.77 | 0.62 | 0.69 | 1.25 | 0.63 | 0.75 |
| **F P2 60_15** | 0.90 | 0.90 | 0.66 | 0.95 | 1.50 | 0.62 | 1.49 | 0.82 | 0.62 | 0.72 | 1.50 | 0.63 | 0.75 |
| **F P2 80_15** | 1.06 | 1.07 | 0.72 | 1.07 | 2.00 | 0.62 | 1.99 | 0.94 | 0.63 | 0.78 | 2.00 | 0.63 | 0.75 |
| **F S 50_15** | 0.83 | 0.84 | 0.63 | 0.88 | 1.25 | 0.63 | 1.25 | 0.78 | 0.63 | 0.72 | 1.25 | 0.67 | 0.81 |
| **F S 60_15** | 0.92 | 0.92 | 0.66 | 0.95 | 1.50 | 0.63 | 1.49 | 0.84 | 0.63 | 0.75 | 1.50 | 0.67 | 0.81 |
| **F S 80_15** | 1.08 | 1.08 | 0.73 | 1.07 | 2.00 | 0.63 | 1.99 | 0.96 | 0.63 | 0.81 | 2.00 | 0.67 | 0.81 |

# Additional environmental information

## Maximum variation between products

| | A1-A3 | A4 | A5 | B1 | B2-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| **GWP-total** | 81% | 74% | 0% | 200% | 0% | 0% | 74% | 0% | 74% | 75% |
| **GWP-fossil** | 81% | 74% | 0% | 200% | 0% | 0% | 74% | 0% | 74% | 81% |
| **GWP-biogenic** | 87% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 73% |
| **GWP-luluc** | 62% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 86% |
| **ODP** | 82% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 130% |
| **AP** | 73% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 81% |
| **EP-freshwater** | 82% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | -663% |
| **EP-marine** | 77% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 79% |
| **EP-terrestrial** | 72% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 79% |
| **POCP** | 78% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 80% |
| **ADPe** | 82% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 80% |
| **ADPf** | 80% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | -59% |
| **WDP** | 55% | 74% | 0% | 0% | 0% | 0% | 74% | 0% | 74% | 34% |

# Changes done to the previous version

2025-06-12: Minor editorial changes have been done.

# References


- ISO 14040 (2006). Environmental management — Life cycle assessment — Principles and framework
- ISO 14044 (2006). Environmental management — Life cycle assessment — Requirements and guidelines
- EPD International AB. (2024). Product category rules (PCR) for construction products (PCR 2019:14 version 1.3.4). https://www.environdec.com
- EPD International AB. (2024). Complementary product category rules (C-PCR) C-PCR-005 Thermal insulation products (EN 16783:2017). https://www.environdec.com
- CEN. (2019). EN 15804:2012+A2:2019 - Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products. European Committee for Standardization. https://www.cen.eu
- EPD International AB. (2021). General programme instructions (GPI) for the International EPD System (version v4.0). Retrieved from https://www.environdec.com
- EPD International AB. (2024). General programme instructions (GPI) for the International EPD System (version v5.0). Retrieved from https://www.environdec.com
- Wu, Y., Gao, X., Nguyen, T. T., Wu, J., Guo, M., Liu, W., & Du, C. (2022). Green and low-cost natural lignocellulosic biomass-based carbon fibers—Processing, properties, and applications in sports equipment: A review. Polymers, 14(13), 2591. https://doi.org/10.3390/polym14132591
- Grazimac. (2023). Especificação técnica lajetas 14/1 [PDF]. https://grazimac.pt/wp-content/uploads/2023/02/Especificacao-Tecnica-Lajetas-14-1.pdf
- Laboratório Nacional de Engenharia Civil, I.P., & Agência Portuguesa do Ambiente, I.P. (2022). Guia português de auditorias pré-demolição (Relatório R4). Projeto CLOSER. https://closer.lnec.pt/guide_pt.html
- APA. (2023). Relatório Anual de Resíduos Urbanos 2023. Agência Portuguesa do Ambiente. Retrieved September 10, 2024, from https://apambiente.pt/sites/default/files/_Residuos/Producao_Gest%C3%A3o_Residuos/Dados%20RU/2023/raru_2023.pdf
- Sociedade Ponto Verde. (2024). Relatório e atividades 2023. Sociedade Ponto Verde. Retrieved September 4, 2024, from https://www.pontoverde.pt/assets/docs_publicacoes/20240415171319952 3EP.pdf

- Sartipi, N., Egger, D., Peeters, S. E., & Nasr, F. (2024). Recycling plastics from construction and demolition waste: Current state and challenges. Journal of Polymers and the Environment, 32(2), 479-509. https://doi.org/10.1007/s10924-023-02982-z
- Agência Portuguesa do Ambiente. (2024). Reporte comunitário RCD 2022. Disponível em https://apambiente.pt/sites/default/files/_Residuos/FluxosEspecificosResiduos/RCD/Reporte_comunitario_RCD_2022.pdf
- European Commission, 2010. Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010.
- FIBRAN S.A. (2023). Environmental Product Declaration (EPD) for FIBRANxps. EPD International AB. https://www.environdec.com/library/epd2372
- European Federation of Concrete Admixtures Associations a.i.s.b.l. (2021). Environmental Product Declaration – Concrete admixtures – Air entrainers (EPD-EFC-20210193-IBG1-EN). Institut Bauen und Umwelt e.V. https://ibu-epd.com/en/published-epds/
- Institut Bauen und Umwelt e.V. (2022). Environmental Product Declaration: Planicrete (EPD-DBC-20220148-IBF1-EN). https://ibu-epd.com/en/published-epds/
- European Commission. (n.d.). Road freight transport by vehicle characteristics - Statistics Explained. Eurostat. Retrieved October 10, 2024, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_by_vehicle_characteristics
- Gadaleta, G., De Gisi, S., Todaro, F., D'Alessandro, G., Binetti, S., & Notarnicola, M. (2023). Assessing the sorting efficiency of plastic packaging waste in an Italian material recovery facility: Current and upgraded configuration. Recycling, 8(25), 1-14. https://doi.org/10.3390/recycling8010025