

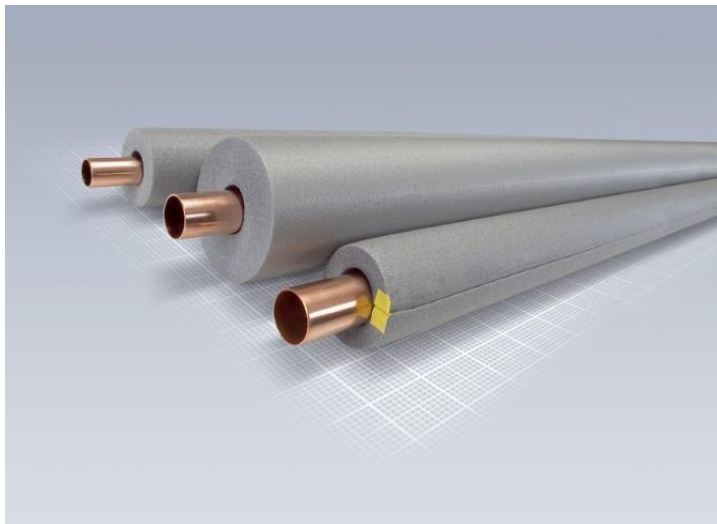


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**Tubolit DG Plus, Tubolit DG, Tubolit DG B1,  
Tubolit S Plus, Tubolit AR Fonowave, Tubolit AR Fonoblok, Tubolit S**  
*(polyethylene insulation for heating and plumbing installations)*



**Owner of the EPD:**

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ITB is the verified member of The European Platform for EPD program operators and LCA practitioner [www.eco-platform.org](http://www.eco-platform.org)

**Basic information**

This declaration is the Type III Environmental Product Declaration (EPD) based on EN 15804+A2 and verified according to ISO 14025 by an external auditor. It contains the information on the impacts of the declared construction materials on the environment and their aspects verified by the independent body according to ISO 14025. Basically, comparison or evaluation of EPD data is possible only if all the compared data were created according to EN 15804+A2.

**Life cycle analysis (LCA):** A1-A3, A4-A5, C1-C4 and D modules in accordance with EN 15804+A2  
(Cradle-to-Gate with options)

**The year of preparing the EPD:** 2026

**Product standard:** requirements are defined in customer specifications

**Service Life:** 50 years

**PCR:** ITB-PCR A

**Declared unit:** 1 m<sup>3</sup>

**Reasons for performing LCA:** B2B

**Representativeness:** Poland, European, 2024

## MANUFACTURER

Armacell Poland Sp. z o.o. factory in Środa Śląska is one of 20 owned by Armacell GmbH and is specialized in production of technical insulation systems (ArmaFlex, Armafix, Tubolit), protective systems (Arma-Check), metallic protective systems (Okabell), acoustic insulation systems (ArmaFlex and Tubolit), fire protection systems (ArmaFlex). Armacell International GmbH is a producer of flexible insulation foams for the equipment insulation market and a provider of engineered foams which operates two main businesses:



Fig.1. A view of factory in Środa Śląska (Poland)

- Advanced Insulation develops flexible foams for the insulation of technical equipment utilised for the transport of energy - such as heating, ventilation & air conditioning (HVAC) and heating & plumbing (H&P) in residential and commercial construction, process lines in the heavy- and oil & gas industry, equipment in transportation, as well as, acoustics.
- Engineered Foams develops high-performance foams for the use in a broad range of end markets including transportation, automotive, wind energy, sports and construction.

## PRODUCTS DESCRIPTION

Tubolit insulation products covered by EPD are flexible, closed-cell extruded materials made of polyethylene. The specification and application of the Tubolit insulation products are listed in Table 1.

Table 1. Specification of the Tubolit insulation products manufactured by Armacell Poland Sp. z o. o.

| Product name        | Features:<br>T: thickness<br>D: density<br>W: weight<br>C: conductivity | Material information                                                                                                                                                                                                                                                            | Colour |
|---------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Tubolit AR Fonoblok | T: 5 mm<br>D: 25,7 kg/m <sup>3</sup><br>W: 0.261 kg/m<br>C: 0.045 W/m·K | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Self-adhesive coating on tapes: pressure-sensitive adhesive coating on modified acrylate basis with mesh structure. covered with polyethylene foil.                            | blue   |
| Tubolit AR Fonowave | T: 9 mm<br>D: 44 kg/m <sup>3</sup><br>W: 0.130 kg/m<br>C: 0.045 W/m·K   | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Foil coating on outer surface for additional protection of insulation surface. Specially wave-shaped inner surface provides excellent acoustical performance on plastic pipes. | blue   |

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|                 |                                                                            |                                                                                                                                                                                                                                                                                            |                                   |
|-----------------|----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Tubolit S       | T: 6-27mm<br>D: 28 kg/m <sup>3</sup><br>W: 0.035 kg/m<br>C: 0.04 W/m·K     | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Foil coating on outer surface for additional protection of insulation surface. <del>Foil coating on inner surface for better sleeve-on installation.</del>                                | foam: grey;<br>foil: blue and red |
| Tubolit S Plus  | T: 4 mm<br>D: 39,2 kg/m <sup>3</sup><br>W: 0.0245 kg/m<br>C: 0.045 W/m·K   | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Foil coating on outer surface for additional protection of insulation surface. Foil coating on inner surface for better sleeve-on installation.                                           | foam: grey;<br>foil: blue and red |
| Tubolit DG      | T: 5-30 mm<br>D: 21,9 kg/m <sup>3</sup><br>W: 0.035 kg/m<br>C: 0.04 W/m·K  | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Insulation / protection of pipes (heating system pipes, domestic hot and cold water pipes) and other parts of heating and plumbing installations (incl. elbows, fittings, flanges, etc.). | grey                              |
| Tubolit DG Plus | T: 6-27 mm<br>D: 26,3 kg/m <sup>3</sup><br>W: 0.035 kg/m<br>C: 0.038 W/m·K | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Insulation / protection of pipes (heating system pipes, domestic hot and cold water pipes) and other parts of heating and plumbing installations (incl. elbows, fittings, flanges, etc.). | grey                              |
| Tubolit DG B1   | T: 5-30 mm<br>D: 21,1 kg/m <sup>3</sup><br>W: 0.052 kg/m<br>C: 0.04 W/m·K  | Foam material based on polyethylene. Factory made polyethylene foam (PEF) according to EN 14313. Flexible, closed-cell extruded insulation material to reduce heat losses on heating and plumbing installations.                                                                           | grey                              |

### LIFE CYCLE ASSESSMENT (LCA) – general rules applied

#### Unit

The declared unit is 1 m<sup>3</sup> of Tubolit products produced in Środa Śląska (Poland).

#### System boundary

The life cycle analysis of the declared products covers “Product Stage” A1-A3, A4-A5, C1-C4+D modules in accordance with EN 15804+A2 and ITB PCR A v.1.6 (cradle to gate with options). Energy and water consumption, emissions as well as information on generated wastes were inventoried and were included in the calculation. It can be assumed that the total sum of omitted processes does not exceed 5% of all impact categories. In accordance with EN 15804+A2, machines and facilities

(capital goods) required for the production as well as transportation of employees were not included in LCA.

## Allocation

The allocation rules used for this EPD are based on general ITB's document PCR A. Production of the polyethylene foam based products is a direct process (as presented in Figure 2) conducted in the manufacturing plant located in Środa Śląska (Poland). Input and output data from the production is inventoried and allocated to the production on the mass basis. The declaration covers a wide range of Tubolit polyethylene foam based products. Their production resources and processing stages are basically similar, so it is possible to average the production by product weight.

## System limits

Minimum 99.0% input materials and 100% energy consumption (electricity, gas, other) were inventoried in a processing plant and were included in the calculation. In the assessment, all significant parameters from gathered production data are considered, i.e. all material used per formulation, utilized thermal energy, and electric power consumption, direct production waste and available emission measurements. Tires consumption for transport was not considered. Substances with a percentage share of less than 0.1% of total mass were excluded from the calculations. The packaging products (wooden pallets) are included.

## Modules A1 and A2: Raw materials supply and transport

The modules A1 and A2 represent the extraction and processing of raw materials (mainly polymers and PCR) and transport to the production site. Polyethylene, PCR, stabilizer, isobutane, copolymer and other chemicals, packaging materials (stretch foil, pallets, carton boxes) come from both Polish and foreign suppliers. Means of transport include trucks with load: <10t, 10 – 16t and >16t. For calculation purposes Polish and European fuel averages were applied.

## Module A3: Production

The production of Tubolit insulation is a process performed by four automated production lines in factory in Środa Śląska. Raw material (PE) and additives are weighed, mixed and then extruded with the addition of a blowing agent (isobutane). After cooling and cutting, product is being packed and transferred for seasoning. Afterwards ready-to-use product is prepared for transport to customer. The production scheme of Tubolit insulation is shown in Fig 2 The production process is depicted schematically as can be seen below, the production process is waste-free. All waste returns to the production cycle.

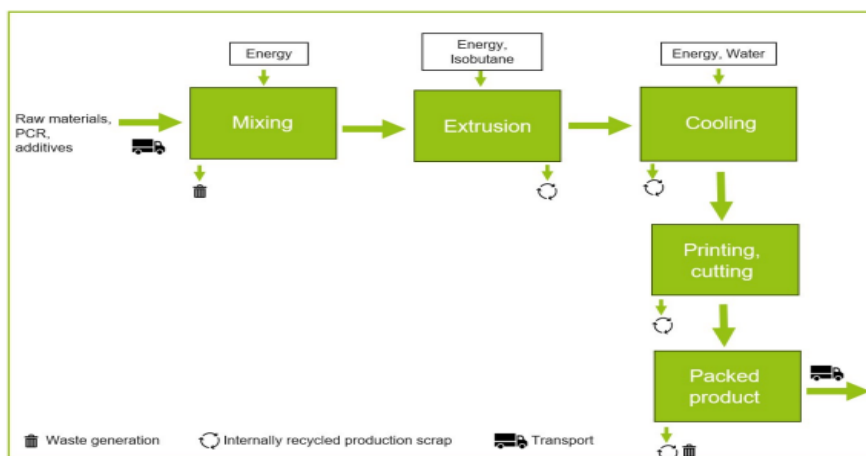


Fig. 1 Manufacturing process scheme (A3)

#### **A4: Transport to construction site**

The Tubolit insulation products are delivered to Polish as well as foreign construction sites. An average distance of 750 km from the factory gate to a construction site is assumed. Means of transport include 24t loaded lorry with 100% capacity utilization and fuel consumption of 35 l per 100 km.

#### **A5: Installation process**

Considered environmental burdens are associated with the use of ancillary materials such as a cleaning agent, an adhesive and hand tools recommended by Producer (see the producer's manual). Generation of off-cuts amounting to 1% of the product is assumed.

#### **C1-C4 and D Modules: End-of-life scenario**

At the end-of-life the Tubolit insulation products are deconstructed with the use of electrical tools. It is assumed that 98% of the polyethylene foam is recovered, of which 30% undergo recycling. 30% is subjected to incineration (energy recovery) while the remaining material is forwarded to landfill in the form of mixed construction and demolition wastes. In module C2 transport distance of 75 km on 16 t loaded lorry with 100% capacity utilization and fuel consumption of 25 l per 100 km is considered. Environmental burdens declared in module C4 are associated with waste-specific emissions to air and groundwater via landfill gas incineration and landfill leachate. Benefits resulting from the recycling of the polyethylene foam and thermal energy production (alternative for fuel oil) are included in module D. The caloric value of 40 MJ/kg has been adopted.

*Table 2. End-of-life scenario for the Tubolit insulation products manufactured by Armacell Poland Sp. z o. o.*

| <b>Material</b>   | <b>Material recovery</b> | <b>Recycling</b> | <b>Energy recovery</b> | <b>Landfilling</b> |
|-------------------|--------------------------|------------------|------------------------|--------------------|
| Polyethylene foam | 98%                      | 30%              | 30%                    | 40%                |

#### **Data collection period**

The data for manufacture of the declared products refer to period between 01.01.2024 – 31.12.2024 (1 year). The life cycle assessments were prepared for Poland and Europe as reference area.

#### **Data quality**

The data selected for LCA originate from ITB-LCI questionnaires completed by Armacell S.A. and verified during input data audit. No data collected is older than five years and no generic datasets used are older than ten years. The representativeness, completeness, reliability, and consistency is judged as good. The background data for the processes come from the following resources database Ecoinvent v.3.10.

#### **Assumptions and estimates**

The impacts of the representative products were aggregated using weighted average.

#### **Calculation rules**

LCA was performed using Excel tool developed in accordance with EN15804+A2 and with the EF 3.1. method. No mass balance approach was used. The biogenic C content in product is less than 5%.

### Additional information

Polish electricity (Ecoinvent v 3.10 supplemented by actual national KOBIZE data) emission factor used is 0.597 kg CO<sub>2</sub>/kWh (National for 2024). As a general rule, no particular environmental or health protection measures other than those specified by law are necessary.

### LIFE CYCLE ASSESSMENT (LCA) – Results

#### Declared unit

The declaration refers to declared unit (DU) – 1 m<sup>3</sup> of specific Tubolit products produced in Poland. The following life cycle modules (Table 3) were included in the analysis. The following Tables 4-31 show the environmental impacts of the life cycle of selected modules (A1-A5+C1-C4+D) for specific Tubolit types.

*Table 3 System boundaries for the environmental characteristic of the product.*

| Environmental assessment information (MD – Module Declared, MND – Module Not Declared, INA – Indicator Not Assessed) |           |               |                                |                                   |           |             |        |             |               |                        |                       |                           |             |                  |          |                                    |                                               |
|----------------------------------------------------------------------------------------------------------------------|-----------|---------------|--------------------------------|-----------------------------------|-----------|-------------|--------|-------------|---------------|------------------------|-----------------------|---------------------------|-------------|------------------|----------|------------------------------------|-----------------------------------------------|
| Product stage                                                                                                        |           |               | Construction process           |                                   | Use stage |             |        |             |               |                        |                       |                           | End of life |                  |          |                                    | Benefits and loads beyond the system boundary |
| Raw material supply                                                                                                  | Transport | Manufacturing | Transport to construction site | Construction-installation process | Use       | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | Deconstruction demolition | Transport   | Waste processing | Disposal | Reuse-recovery-recycling potential |                                               |
| A1                                                                                                                   | A2        | A3            | A4                             | A5                                | B1        | B2          | B3     | B4          | B5            | B6                     | B7                    | C1                        | C2          | C3               | C4       | D                                  |                                               |
| MD                                                                                                                   | MD        | MD            | MD                             | MD                                | MND       | MND         | MND    | MND         | MND           | MND                    | MND                   | MD                        | MD          | MD               | MD       | MD                                 |                                               |

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**Table 4 Life cycle assessment (LCA) results for specific product TUBOLIT S – environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D         |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|-----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 6.48E+01  | 3.84E+00 | 1.62E+01 | 8.48E+01  | 4.36E+00 | 1.74E+00  | 3.57E-02 | 1.74E-01 | 2.56E+01 | 1.51E+00 | -2.91E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 9.09E+01  | 3.83E+00 | 1.62E+01 | 1.11E+02  | 4.36E+00 | 2.00E+00  | 3.57E-02 | 1.74E-01 | 2.51E+01 | 1.51E+00 | -2.86E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -2.81E+01 | 2.50E-03 | 5.61E-02 | -2.81E+01 | 2.84E-03 | -2.51E-01 | 1.30E-04 | 1.13E-04 | 5.24E-01 | 1.08E-03 | -5.42E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 2.56E-01  | 1.25E-03 | 2.38E-03 | 2.60E-01  | 1.43E-03 | 2.96E-03  | 5.38E-06 | 5.70E-05 | 4.52E-03 | 8.08E-05 | -6.84E-03 |
| Stratospheric ozone depletion potential                             | eq. kg CFC 11          | 3.63E-06  | 7.62E-08 | 1.34E-07 | 3.84E-06  | 8.66E-08 | 5.94E-08  | 2.15E-10 | 3.46E-09 | 7.36E-07 | 3.64E-09 | -1.25E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 3.64E-01  | 1.20E-02 | 1.81E-01 | 5.57E-01  | 1.36E-02 | 1.70E-02  | 4.21E-04 | 5.45E-04 | 5.04E-01 | 1.00E-03 | -2.88E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 2.77E-02  | 2.56E-04 | 2.89E-02 | 5.69E-02  | 2.90E-04 | 2.52E-03  | 6.75E-05 | 1.16E-05 | 1.41E-03 | 1.50E-05 | -1.91E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 7.80E-02  | 4.04E-03 | 2.58E-02 | 1.08E-01  | 4.59E-03 | 2.73E-03  | 5.96E-05 | 1.84E-04 | 2.75E-01 | 3.34E-03 | -8.66E-03 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 7.73E-01  | 4.39E-02 | 2.26E-01 | 1.04E+00  | 4.99E-02 | 2.44E-02  | 5.23E-04 | 2.00E-03 | 2.86E+00 | 4.09E-03 | -8.70E-02 |
| Potential for photochemical ozone synthesis                         | eq. kg NMVOC           | 4.85E-01  | 1.88E-02 | 6.82E-02 | 5.72E-01  | 2.13E-02 | 9.62E-03  | 1.49E-04 | 8.54E-04 | 7.07E-01 | 1.78E-03 | -5.11E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 6.61E-04  | 1.25E-05 | 7.14E-06 | 6.80E-04  | 1.42E-05 | 1.18E-05  | 1.60E-08 | 5.69E-07 | 2.39E-05 | 3.18E-07 | -3.29E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 2.44E+03  | 5.38E+01 | 2.84E+02 | 2.78E+03  | 6.12E+01 | 4.52E+01  | 6.30E-01 | 2.45E+00 | 3.69E+01 | 3.14E+00 | -4.39E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 4.03E+01  | 2.60E-01 | 5.13E+00 | 4.57E+01  | 2.96E-01 | 8.17E-01  | 1.19E-02 | 1.18E-02 | 1.25E+00 | 1.49E-02 | -1.66E+00 |

**Table 5 Life cycle assessment (LCA) results for specific product TUBOLIT S– additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit              | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|-------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235      | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh              | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless     | INA   | INA   | INA   | INA |

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**Table 6 Life cycle assessment (LCA) results for specific product TUBOLIT S- the resource use (DU: 1 m<sup>3</sup>)**

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 3.61E+02 | 9.12E-01 | 2.54E+01 | 3.87E+02 | 1.04E+00 | 5.16E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 2.69E+02 | 0.00E+00 | 0.00E+00 | 2.69E+02 | 0.00E+00 | 2.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 6.30E+02 | 9.12E-01 | 2.54E+01 | 6.57E+02 | 1.04E+00 | 7.86E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.12E+03 | 5.38E+01 | 2.84E+02 | 1.45E+03 | 6.12E+01 | 3.20E+01 | 6.30E-01 | 2.45E+00 | -5.82E+02 | -4.90E+02 | -5.70E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 1.32E+03 | 0.00E+00 | 0.00E+00 | 1.32E+03 | 0.00E+00 | 1.32E+01 | 0.00E+00 | 0.00E+00 | 6.72E+02  | 4.93E+02  | -3.82E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 2.44E+03 | 5.38E+01 | 2.84E+02 | 2.78E+03 | 6.12E+01 | 4.52E+01 | 6.30E-01 | 2.45E+00 | 3.69E+01  | 3.14E+00  | -4.39E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.41E+01 | 2.46E-02 | 2.62E-02 | 1.41E+01 | 2.80E-02 | 1.92E-02 | 5.67E-05 | 1.12E-03 | 9.34E+00  | 1.13E-03  | -9.59E+00 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 6.14E+00 | 3.11E-04 | 1.24E-04 | 6.14E+00 | 3.53E-04 | 6.14E-02 | 2.85E-07 | 1.41E-05 | 2.70E-04  | 2.12E-05  | -3.30E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.41E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 1.03E+00 | 7.15E-03 | 7.62E-01 | 1.80E+00 | 8.12E-03 | 2.27E-02 | 1.78E-03 | 3.25E-04 | 3.00E-02  | -4.66E-02 | -4.57E-02 |

**Table 7 Life cycle assessment (LCA) results for specific product TUBOLIT S – waste categories (DU: 1 m<sup>3</sup>)**

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 3.64E+00 | 7.75E-02 | 3.10E+00 | 6.81E+00 | 8.80E-02 | 6.83E-02 | 7.15E-03 | 3.52E-03 | 1.18E-01 | 5.54E-03 | -1.92E-01 |
| Non-hazardous waste           | kg   | 8.62E+02 | 1.64E+00 | 1.42E+02 | 1.01E+03 | 1.86E+00 | 1.01E+01 | 3.29E-01 | 7.44E-02 | 1.15E+01 | 6.26E+01 | -1.36E+01 |
| Radioactive waste             | kg   | 3.48E-03 | 1.72E-05 | 4.10E-05 | 3.54E-03 | 1.95E-05 | 4.85E-05 | 9.24E-08 | 7.80E-07 | 2.38E-04 | 7.74E-07 | -2.82E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 5.80E-02 | 4.04E-04 | 3.42E+00 | 3.48E+00 | 4.59E-04 | 3.48E-02 | 4.93E-06 | 1.84E-05 | 7.27E-03 | 5.30E-05 | -8.15E-03 |
| Materials for energy recovery | kg   | 2.00E-04 | 3.41E-06 | 2.75E-01 | 2.76E-01 | 3.88E-06 | 2.76E-03 | 7.00E-09 | 1.55E-07 | 1.01E-06 | 2.17E-07 | -6.39E-06 |
| Exported Energy               | MJ   | 4.16E+00 | 2.24E-02 | 2.07E-01 | 4.39E+00 | 2.55E-02 | 9.58E-02 | 4.80E-04 | 1.02E-03 | 7.11E-01 | 6.61E-04 | -1.89E-01 |



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**Table 8 Life cycle assessment (LCA) results for specific product TUBOLIT S PLUS– environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D         |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|-----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 8.01E+01  | 4.48E+00 | 1.62E+01 | 1.01E+02  | 4.36E+00 | 1.74E+00  | 3.57E-02 | 1.74E-01 | 2.56E+01 | 1.51E+00 | -2.91E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 1.14E+02  | 4.47E+00 | 1.62E+01 | 1.34E+02  | 4.36E+00 | 2.00E+00  | 3.57E-02 | 1.74E-01 | 2.51E+01 | 1.51E+00 | -2.86E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -4.33E+01 | 2.91E-03 | 5.61E-02 | -4.33E+01 | 2.84E-03 | -2.51E-01 | 1.30E-04 | 1.13E-04 | 5.24E-01 | 1.08E-03 | -5.42E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 4.14E-01  | 1.46E-03 | 2.38E-03 | 4.18E-01  | 1.43E-03 | 2.96E-03  | 5.38E-06 | 5.70E-05 | 4.52E-03 | 8.08E-05 | -6.84E-03 |
| Stratospheric ozone depletion potential                             | eq. kg CFC 11          | 4.40E-06  | 8.89E-08 | 1.34E-07 | 4.62E-06  | 8.66E-08 | 5.94E-08  | 2.15E-10 | 3.46E-09 | 7.36E-07 | 3.64E-09 | -1.25E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 4.90E-01  | 1.40E-02 | 1.81E-01 | 6.85E-01  | 1.36E-02 | 1.70E-02  | 4.21E-04 | 5.45E-04 | 5.04E-01 | 1.00E-03 | -2.88E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 3.83E-02  | 2.98E-04 | 2.89E-02 | 6.75E-02  | 2.90E-04 | 2.52E-03  | 6.75E-05 | 1.16E-05 | 1.41E-03 | 1.50E-05 | -1.91E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 1.06E-01  | 4.71E-03 | 2.58E-02 | 1.37E-01  | 4.59E-03 | 2.73E-03  | 5.96E-05 | 1.84E-04 | 2.75E-01 | 3.34E-03 | -8.66E-03 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 1.03E+00  | 5.13E-02 | 2.26E-01 | 1.31E+00  | 4.99E-02 | 2.44E-02  | 5.23E-04 | 2.00E-03 | 2.86E+00 | 4.09E-03 | -8.70E-02 |
| Potential for photochemical ozone synthesis                         | eq. kg NMVOC           | 5.71E-01  | 2.19E-02 | 6.82E-02 | 6.61E-01  | 2.13E-02 | 9.62E-03  | 1.49E-04 | 8.54E-04 | 7.07E-01 | 1.78E-03 | -5.11E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 7.46E-04  | 1.46E-05 | 7.14E-06 | 7.68E-04  | 1.42E-05 | 1.18E-05  | 1.60E-08 | 5.69E-07 | 2.39E-05 | 3.18E-07 | -3.29E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 2.86E+03  | 6.28E+01 | 2.84E+02 | 3.21E+03  | 6.12E+01 | 4.52E+01  | 6.30E-01 | 2.45E+00 | 3.69E+01 | 3.14E+00 | -4.39E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 5.28E+01  | 3.03E-01 | 5.13E+00 | 5.82E+01  | 2.96E-01 | 8.17E-01  | 1.19E-02 | 1.18E-02 | 1.25E+00 | 1.49E-02 | -1.66E+00 |

**Table 9 Life cycle assessment (LCA) results for specific product TUBOLIT S PLUS– additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit              | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|-------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235      | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh              | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless     | INA   | INA   | INA   | INA |

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*Table 10 Life cycle assessment (LCA) results for specific product TUBOLIT S PLUS- the resource use (DU: 1 m<sup>3</sup>)*

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 5.11E+02 | 1.06E+00 | 2.54E+01 | 5.37E+02 | 1.04E+00 | 5.16E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 3.93E+02 | 0.00E+00 | 0.00E+00 | 3.93E+02 | 0.00E+00 | 2.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 9.04E+02 | 1.06E+00 | 2.54E+01 | 9.30E+02 | 1.04E+00 | 7.86E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.46E+03 | 6.28E+01 | 2.84E+02 | 1.80E+03 | 6.12E+01 | 3.20E+01 | 6.30E-01 | 2.45E+00 | -5.82E+02 | -4.90E+02 | -5.70E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 1.40E+03 | 0.00E+00 | 0.00E+00 | 1.40E+03 | 0.00E+00 | 1.32E+01 | 0.00E+00 | 0.00E+00 | 6.72E+02  | 4.93E+02  | -3.82E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 2.86E+03 | 6.28E+01 | 2.84E+02 | 3.21E+03 | 6.12E+01 | 4.52E+01 | 6.30E-01 | 2.45E+00 | 3.69E+01  | 3.14E+00  | -4.39E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.40E+01 | 2.87E-02 | 2.62E-02 | 1.40E+01 | 2.80E-02 | 1.92E-02 | 5.67E-05 | 1.12E-03 | 9.34E+00  | 1.13E-03  | -9.59E+00 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 7.37E+00 | 3.63E-04 | 1.24E-04 | 7.37E+00 | 3.53E-04 | 6.14E-02 | 2.85E-07 | 1.41E-05 | 2.70E-04  | 2.12E-05  | -3.30E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.41E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 1.35E+00 | 8.34E-03 | 7.62E-01 | 2.12E+00 | 8.12E-03 | 2.27E-02 | 1.78E-03 | 3.25E-04 | 3.00E-02  | 4.66E-02  | -4.57E-02 |

*Table 11 Life cycle assessment (LCA) results for specific product TUBOLIT S PLUS – waste categories (DU: 1 m<sup>3</sup>)*

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 5.56E+00 | 9.04E-02 | 3.10E+00 | 8.75E+00 | 8.80E-02 | 6.83E-02 | 7.15E-03 | 3.52E-03 | 1.18E-01 | 5.54E-03 | -1.92E-01 |
| Non-hazardous waste           | kg   | 9.15E+02 | 1.91E+00 | 1.42E+02 | 1.06E+03 | 1.86E+00 | 1.01E+01 | 3.29E-01 | 7.44E-02 | 1.15E+01 | 6.26E+01 | -1.36E+01 |
| Radioactive waste             | kg   | 4.83E-03 | 2.00E-05 | 4.10E-05 | 4.89E-03 | 1.95E-05 | 4.85E-05 | 9.24E-08 | 7.80E-07 | 2.38E-04 | 7.74E-07 | -2.82E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 8.89E-02 | 4.71E-04 | 3.42E+00 | 3.51E+00 | 4.59E-04 | 3.48E-02 | 4.93E-06 | 1.84E-05 | 7.27E-03 | 5.30E-05 | -8.15E-03 |
| Materials for energy recovery | kg   | 2.66E-04 | 3.98E-06 | 2.75E-01 | 2.76E-01 | 3.88E-06 | 2.76E-03 | 7.00E-09 | 1.55E-07 | 1.01E-06 | 2.17E-07 | -6.39E-06 |
| Exported Energy               | MJ   | 5.71E+00 | 2.62E-02 | 2.07E-01 | 5.94E+00 | 2.55E-02 | 9.58E-02 | 4.80E-04 | 1.02E-03 | 7.11E-01 | 6.61E-04 | -1.89E-01 |

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**Table 12 Life cycle assessment (LCA) results for specific product TUBOLIT DG – environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D         |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|-----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 6.69E+01  | 3.55E+00 | 1.60E+01 | 8.64E+01  | 4.36E+00 | 1.74E+00  | 3.57E-02 | 1.74E-01 | 2.56E+01 | 1.51E+00 | -2.91E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 9.95E+01  | 3.54E+00 | 1.60E+01 | 1.19E+02  | 4.36E+00 | 2.00E+00  | 3.57E-02 | 1.74E-01 | 2.51E+01 | 1.51E+00 | -2.86E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -3.50E+01 | 2.31E-03 | 5.59E-02 | -3.49E+01 | 2.84E-03 | -2.51E-01 | 1.30E-04 | 1.13E-04 | 5.24E-01 | 1.08E-03 | -5.42E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 3.33E-01  | 1.16E-03 | 2.34E-03 | 3.36E-01  | 1.43E-03 | 2.96E-03  | 5.38E-06 | 5.70E-05 | 4.52E-03 | 8.08E-05 | -6.84E-03 |
| Stratospheric ozone depletion potential                             | eq. kg CFC 11          | 3.89E-06  | 7.04E-08 | 1.43E-07 | 4.11E-06  | 8.66E-08 | 5.94E-08  | 2.15E-10 | 3.46E-09 | 7.36E-07 | 3.64E-09 | -1.25E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 4.21E-01  | 1.11E-02 | 1.80E-01 | 6.13E-01  | 1.36E-02 | 1.70E-02  | 4.21E-04 | 5.45E-04 | 5.04E-01 | 1.00E-03 | -2.88E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 3.24E-02  | 2.36E-04 | 2.89E-02 | 6.16E-02  | 2.90E-04 | 2.52E-03  | 6.75E-05 | 1.16E-05 | 1.41E-03 | 1.50E-05 | -1.91E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 9.07E-02  | 3.74E-03 | 2.57E-02 | 1.20E-01  | 4.59E-03 | 2.73E-03  | 5.96E-05 | 1.84E-04 | 2.75E-01 | 3.34E-03 | -8.66E-03 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 8.96E-01  | 4.06E-02 | 2.25E-01 | 1.16E+00  | 4.99E-02 | 2.44E-02  | 5.23E-04 | 2.00E-03 | 2.86E+00 | 4.09E-03 | -8.70E-02 |
| Potential for photochemical ozone synthesis                         | eq. kg NMVOC           | 5.11E-01  | 1.74E-02 | 6.73E-02 | 5.95E-01  | 2.13E-02 | 9.62E-03  | 1.49E-04 | 8.54E-04 | 7.07E-01 | 1.78E-03 | -5.11E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 6.88E-04  | 1.16E-05 | 7.23E-06 | 7.07E-04  | 1.42E-05 | 1.18E-05  | 1.60E-08 | 5.69E-07 | 2.39E-05 | 3.18E-07 | -3.29E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 2.56E+03  | 4.97E+01 | 2.84E+02 | 2.90E+03  | 6.12E+01 | 4.52E+01  | 6.30E-01 | 2.45E+00 | 3.69E+01 | 3.14E+00 | -4.39E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 4.58E+01  | 2.40E-01 | 5.12E+00 | 5.11E+01  | 2.96E-01 | 8.17E-01  | 1.19E-02 | 1.18E-02 | 1.25E+00 | 1.49E-02 | -1.66E+00 |

**Table 13 Life cycle assessment (LCA) results for specific product TUBOLIT DG– additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit              | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|-------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235      | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh              | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless     | INA   | INA   | INA   | INA |

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**Table 14 Life cycle assessment (LCA) results for specific product TUBOLIT DG- the resource use (DU: 1 m<sup>3</sup>)**

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 4.43E+02 | 8.43E-01 | 2.54E+01 | 4.69E+02 | 1.04E+00 | 5.16E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 3.33E+02 | 0.00E+00 | 0.00E+00 | 3.33E+02 | 0.00E+00 | 2.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 7.75E+02 | 8.43E-01 | 2.54E+01 | 8.02E+02 | 1.04E+00 | 7.86E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.25E+03 | 4.97E+01 | 2.71E+02 | 1.57E+03 | 6.12E+01 | 3.20E+01 | 6.30E-01 | 2.45E+00 | -5.82E+02 | -4.90E+02 | -5.70E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 1.32E+03 | 0.00E+00 | 1.29E+01 | 1.33E+03 | 0.00E+00 | 1.32E+01 | 0.00E+00 | 0.00E+00 | 6.72E+02  | 4.93E+02  | -3.82E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 2.56E+03 | 4.97E+01 | 2.84E+02 | 2.90E+03 | 6.12E+01 | 4.52E+01 | 6.30E-01 | 2.45E+00 | 3.69E+01  | 3.14E+00  | -4.39E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.55E+01 | 2.28E-02 | 2.56E-02 | 1.56E+01 | 2.80E-02 | 1.92E-02 | 5.67E-05 | 1.12E-03 | 9.34E+00  | 1.13E-03  | -9.59E+00 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 7.14E+00 | 2.87E-04 | 1.24E-04 | 7.14E+00 | 3.53E-04 | 6.14E-02 | 2.85E-07 | 1.41E-05 | 2.70E-04  | 2.12E-05  | -3.30E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.41E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 1.17E+00 | 6.61E-03 | 7.62E-01 | 1.93E+00 | 8.12E-03 | 2.27E-02 | 1.78E-03 | 3.25E-04 | 3.00E-02  | 4.66E-02  | -4.57E-02 |

**Table 15 Life cycle assessment (LCA) results for specific product TUBOLIT DG – waste categories (DU: 1 m<sup>3</sup>)**

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 4.61E+00 | 7.16E-02 | 3.10E+00 | 7.78E+00 | 8.80E-02 | 6.83E-02 | 7.15E-03 | 3.52E-03 | 1.18E-01 | 5.54E-03 | -1.92E-01 |
| Non-hazardous waste           | kg   | 8.38E+02 | 1.51E+00 | 1.42E+02 | 9.82E+02 | 1.86E+00 | 1.01E+01 | 3.29E-01 | 7.44E-02 | 1.15E+01 | 6.26E+01 | -1.36E+01 |
| Radioactive waste             | kg   | 4.05E-03 | 1.59E-05 | 4.02E-05 | 4.11E-03 | 1.95E-05 | 4.85E-05 | 9.24E-08 | 7.80E-07 | 2.38E-04 | 7.74E-07 | -2.82E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 7.24E-02 | 3.73E-04 | 3.42E+00 | 3.49E+00 | 4.59E-04 | 3.48E-02 | 4.93E-06 | 1.84E-05 | 7.27E-03 | 5.30E-05 | -8.15E-03 |
| Materials for energy recovery | kg   | 2.31E-04 | 3.16E-06 | 2.75E-01 | 2.76E-01 | 3.88E-06 | 2.76E-03 | 7.00E-09 | 1.55E-07 | 1.01E-06 | 2.17E-07 | -6.39E-06 |
| Exported Energy               | MJ   | 5.31E+00 | 2.18E-02 | 2.17E-01 | 5.55E+00 | 2.68E-02 | 1.01E-01 | 5.04E-04 | 1.07E-03 | 7.46E-01 | 6.94E-04 | -1.98E-01 |

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**Table 16 Life cycle assessment (LCA) results for specific product TUBOLIT DG PLUS– environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D         |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|-----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 6.60E+01  | 4.10E+00 | 1.62E+01 | 8.63E+01  | 4.36E+00 | 1.74E+00  | 3.57E-02 | 1.74E-01 | 2.56E+01 | 1.51E+00 | -2.91E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 8.92E+01  | 4.09E+00 | 1.62E+01 | 1.10E+02  | 4.36E+00 | 2.00E+00  | 3.57E-02 | 1.74E-01 | 2.51E+01 | 1.51E+00 | -2.86E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -2.52E+01 | 2.67E-03 | 5.61E-02 | -2.52E+01 | 2.84E-03 | -2.51E-01 | 1.30E-04 | 1.13E-04 | 5.24E-01 | 1.08E-03 | -5.42E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 2.63E-01  | 1.34E-03 | 2.38E-03 | 2.67E-01  | 1.43E-03 | 2.96E-03  | 5.38E-06 | 5.70E-05 | 4.52E-03 | 8.08E-05 | -6.84E-03 |
| Stratospheric ozone depletion potential                             | eq. kg CFC<br>11       | 3.52E-06  | 8.14E-08 | 1.34E-07 | 3.74E-06  | 8.66E-08 | 5.94E-08  | 2.15E-10 | 3.46E-09 | 7.36E-07 | 3.64E-09 | -1.25E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 3.68E-01  | 1.28E-02 | 1.81E-01 | 5.61E-01  | 1.36E-02 | 1.70E-02  | 4.21E-04 | 5.45E-04 | 5.04E-01 | 1.00E-03 | -2.88E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 2.80E-02  | 2.73E-04 | 2.89E-02 | 5.72E-02  | 2.90E-04 | 2.52E-03  | 6.75E-05 | 1.16E-05 | 1.41E-03 | 1.50E-05 | -1.91E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 7.81E-02  | 4.32E-03 | 2.58E-02 | 1.08E-01  | 4.59E-03 | 2.73E-03  | 5.96E-05 | 1.84E-04 | 2.75E-01 | 3.34E-03 | -8.66E-03 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 7.75E-01  | 4.69E-02 | 2.26E-01 | 1.05E+00  | 4.99E-02 | 2.44E-02  | 5.23E-04 | 2.00E-03 | 2.86E+00 | 4.09E-03 | -8.70E-02 |
| Potential for photochemical ozone synthesis                         | eq. kg<br>NMVOC        | 4.67E-01  | 2.01E-02 | 6.82E-02 | 5.55E-01  | 2.13E-02 | 9.62E-03  | 1.49E-04 | 8.54E-04 | 7.07E-01 | 1.78E-03 | -5.11E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 6.38E-04  | 1.34E-05 | 7.14E-06 | 6.58E-04  | 1.42E-05 | 1.18E-05  | 1.60E-08 | 5.69E-07 | 2.39E-05 | 3.18E-07 | -3.29E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 2.35E+03  | 5.75E+01 | 2.84E+02 | 2.69E+03  | 6.12E+01 | 4.52E+01  | 6.30E-01 | 2.45E+00 | 3.69E+01 | 3.14E+00 | -4.39E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 3.98E+01  | 2.78E-01 | 5.13E+00 | 4.52E+01  | 2.96E-01 | 8.17E-01  | 1.19E-02 | 1.18E-02 | 1.25E+00 | 1.49E-02 | -1.66E+00 |

**Table 17 Life cycle assessment (LCA) results for specific product TUBOLIT DG PLUS– additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit                 | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|----------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease<br>incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235         | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe                 | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh                 | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh                 | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless        | INA   | INA   | INA   | INA |

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**Table 18 Life cycle assessment (LCA) results for specific product TUBOLIT DG PLUS- the resource use (DU: 1 m<sup>3</sup>)**

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 3.44E+02 | 9.74E-01 | 2.54E+01 | 3.70E+02 | 1.04E+00 | 5.16E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 2.40E+02 | 0.00E+00 | 0.00E+00 | 2.40E+02 | 0.00E+00 | 2.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 5.84E+02 | 9.74E-01 | 2.54E+01 | 6.10E+02 | 1.04E+00 | 7.86E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.09E+03 | 5.75E+01 | 2.84E+02 | 1.43E+03 | 6.12E+01 | 3.20E+01 | 6.30E-01 | 2.45E+00 | -5.82E+02 | -4.90E+02 | -5.70E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 1.26E+03 | 0.00E+00 | 0.00E+00 | 1.26E+03 | 0.00E+00 | 1.32E+01 | 0.00E+00 | 0.00E+00 | 6.72E+02  | 4.93E+02  | -3.82E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 2.35E+03 | 5.75E+01 | 2.84E+02 | 2.69E+03 | 6.12E+01 | 4.52E+01 | 6.30E-01 | 2.45E+00 | 3.69E+01  | 3.14E+00  | -4.39E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.35E+01 | 2.63E-02 | 2.62E-02 | 1.36E+01 | 2.80E-02 | 1.92E-02 | 5.67E-05 | 1.12E-03 | 9.34E+00  | 1.13E-03  | -9.59E+00 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 4.97E+00 | 3.32E-04 | 1.24E-04 | 4.97E+00 | 3.53E-04 | 6.14E-02 | 2.85E-07 | 1.41E-05 | 2.70E-04  | 2.12E-05  | -3.30E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.41E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 1.01E+00 | 7.64E-03 | 7.62E-01 | 1.78E+00 | 8.12E-03 | 2.27E-02 | 1.78E-03 | 3.25E-04 | 3.00E-02  | -4.66E-02 | -4.57E-02 |

**Table 19 Life cycle assessment (LCA) results for specific product TUBOLIT DG PLUS – waste categories (DU: 1 m<sup>3</sup>)**

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 4.82E+00 | 8.28E-02 | 3.10E+00 | 8.00E+00 | 8.80E-02 | 6.83E-02 | 7.15E-03 | 3.52E-03 | 1.18E-01 | 5.54E-03 | -1.92E-01 |
| Non-hazardous waste           | kg   | 8.09E+02 | 1.75E+00 | 1.42E+02 | 9.53E+02 | 1.86E+00 | 1.01E+01 | 3.29E-01 | 7.44E-02 | 1.15E+01 | 6.26E+01 | -1.36E+01 |
| Radioactive waste             | kg   | 3.46E-03 | 1.83E-05 | 4.10E-05 | 3.52E-03 | 1.95E-05 | 4.85E-05 | 9.24E-08 | 7.80E-07 | 2.38E-04 | 7.74E-07 | -2.82E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 5.98E-02 | 4.31E-04 | 3.42E+00 | 3.48E+00 | 4.59E-04 | 3.48E-02 | 4.93E-06 | 1.84E-05 | 7.27E-03 | 5.30E-05 | -8.15E-03 |
| Materials for energy recovery | kg   | 2.00E-04 | 3.65E-06 | 2.75E-01 | 2.76E-01 | 3.88E-06 | 2.76E-03 | 7.00E-09 | 1.55E-07 | 1.01E-06 | 2.17E-07 | -6.39E-06 |
| Exported Energy               | MJ   | 4.27E+00 | 2.40E-02 | 2.07E-01 | 4.50E+00 | 2.55E-02 | 9.58E-02 | 4.80E-04 | 1.02E-03 | 7.11E-01 | 6.61E-04 | -1.89E-01 |

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**Table 20 Life cycle assessment (LCA) results for specific product TUBOLIT DG B1– environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D         |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|-----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 6.64E+01  | 3.60E+00 | 1.62E+01 | 8.62E+01  | 4.36E+00 | 1.74E+00  | 3.57E-02 | 1.74E-01 | 2.56E+01 | 1.51E+00 | -2.91E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 9.70E+01  | 3.60E+00 | 1.62E+01 | 1.17E+02  | 4.36E+00 | 2.00E+00  | 3.57E-02 | 1.74E-01 | 2.51E+01 | 1.51E+00 | -2.86E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -3.30E+01 | 2.34E-03 | 5.61E-02 | -3.30E+01 | 2.84E-03 | -2.51E-01 | 1.30E-04 | 1.13E-04 | 5.24E-01 | 1.08E-03 | -5.42E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 3.14E-01  | 1.18E-03 | 2.38E-03 | 3.17E-01  | 1.43E-03 | 2.96E-03  | 5.38E-06 | 5.70E-05 | 4.52E-03 | 8.08E-05 | -6.84E-03 |
| Stratospheric ozone depletion potential                             | eq. kg CFC 11          | 3.82E-06  | 7.16E-08 | 1.34E-07 | 4.02E-06  | 8.66E-08 | 5.94E-08  | 2.15E-10 | 3.46E-09 | 7.36E-07 | 3.64E-09 | -1.25E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 4.08E-01  | 1.13E-02 | 1.81E-01 | 6.00E-01  | 1.36E-02 | 1.70E-02  | 4.21E-04 | 5.45E-04 | 5.04E-01 | 1.00E-03 | -2.88E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 3.12E-02  | 2.40E-04 | 2.89E-02 | 6.04E-02  | 2.90E-04 | 2.52E-03  | 6.75E-05 | 1.16E-05 | 1.41E-03 | 1.50E-05 | -1.91E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 8.76E-02  | 3.80E-03 | 2.58E-02 | 1.17E-01  | 4.59E-03 | 2.73E-03  | 5.96E-05 | 1.84E-04 | 2.75E-01 | 3.34E-03 | -8.66E-03 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 8.68E-01  | 4.13E-02 | 2.26E-01 | 1.14E+00  | 4.99E-02 | 2.44E-02  | 5.23E-04 | 2.00E-03 | 2.86E+00 | 4.09E-03 | -8.70E-02 |
| Potential for photochemical ozone synthesis                         | eq. kg NMVOC           | 5.02E-01  | 1.76E-02 | 6.82E-02 | 5.88E-01  | 2.13E-02 | 9.62E-03  | 1.49E-04 | 8.54E-04 | 7.07E-01 | 1.78E-03 | -5.11E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 6.81E-04  | 1.18E-05 | 7.14E-06 | 7.00E-04  | 1.42E-05 | 1.18E-05  | 1.60E-08 | 5.69E-07 | 2.39E-05 | 3.18E-07 | -3.29E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 2.53E+03  | 5.06E+01 | 2.84E+02 | 2.86E+03  | 6.12E+01 | 4.52E+01  | 6.30E-01 | 2.45E+00 | 3.69E+01 | 3.14E+00 | -4.39E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 4.43E+01  | 2.44E-01 | 5.13E+00 | 4.97E+01  | 2.96E-01 | 8.17E-01  | 1.19E-02 | 1.18E-02 | 1.25E+00 | 1.49E-02 | -1.66E+00 |

**Table 21 Life cycle assessment (LCA) results for specific product TUBOLIT DG B1– additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit              | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|-------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235      | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh              | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless     | INA   | INA   | INA   | INA |

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**Table 22 Life cycle assessment (LCA) results for specific product TUBOLIT DG B1- the resource use (DU: 1 m<sup>3</sup>)**

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 4.21E+02 | 8.57E-01 | 2.54E+01 | 4.47E+02 | 1.04E+00 | 5.16E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 3.15E+02 | 0.00E+00 | 0.00E+00 | 3.15E+02 | 0.00E+00 | 2.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 7.35E+02 | 8.57E-01 | 2.54E+01 | 7.61E+02 | 1.04E+00 | 7.86E+00 | 5.92E-02 | 4.15E-02 | 9.20E+00  | 4.70E-02  | -1.12E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.21E+03 | 5.06E+01 | 2.84E+02 | 1.54E+03 | 6.12E+01 | 3.20E+01 | 6.30E-01 | 2.45E+00 | -5.82E+02 | -4.90E+02 | -5.70E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 1.32E+03 | 0.00E+00 | 0.00E+00 | 1.32E+03 | 0.00E+00 | 1.32E+01 | 0.00E+00 | 0.00E+00 | 6.72E+02  | 4.93E+02  | -3.82E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 2.53E+03 | 5.06E+01 | 2.84E+02 | 2.86E+03 | 6.12E+01 | 4.52E+01 | 6.30E-01 | 2.45E+00 | 3.69E+01  | 3.14E+00  | -4.39E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.57E+01 | 2.31E-02 | 2.62E-02 | 1.58E+01 | 2.80E-02 | 1.92E-02 | 5.67E-05 | 1.12E-03 | 9.34E+00  | 1.13E-03  | -9.59E+00 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 6.81E+00 | 2.92E-04 | 1.24E-04 | 6.81E+00 | 3.53E-04 | 6.14E-02 | 2.85E-07 | 1.41E-05 | 2.70E-04  | 2.12E-05  | -3.30E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.41E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 1.13E+00 | 6.71E-03 | 7.62E-01 | 1.90E+00 | 8.12E-03 | 2.27E-02 | 1.78E-03 | 3.25E-04 | 3.00E-02  | 4.66E-02  | -4.57E-02 |

**Table 23 Life cycle assessment (LCA) results for specific product TUBOLIT DG B1 – waste categories (DU: 1 m<sup>3</sup>)**

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 4.50E+00 | 7.28E-02 | 3.10E+00 | 7.67E+00 | 8.80E-02 | 6.83E-02 | 7.15E-03 | 3.52E-03 | 1.18E-01 | 5.54E-03 | -1.92E-01 |
| Non-hazardous waste           | kg   | 8.32E+02 | 1.54E+00 | 1.42E+02 | 9.76E+02 | 1.86E+00 | 1.01E+01 | 3.29E-01 | 7.44E-02 | 1.15E+01 | 6.26E+01 | -1.36E+01 |
| Radioactive waste             | kg   | 3.89E-03 | 1.61E-05 | 4.10E-05 | 3.95E-03 | 1.95E-05 | 4.85E-05 | 9.24E-08 | 7.80E-07 | 2.38E-04 | 7.74E-07 | -2.82E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 6.88E-02 | 3.79E-04 | 3.42E+00 | 3.49E+00 | 4.59E-04 | 3.48E-02 | 4.93E-06 | 1.84E-05 | 7.27E-03 | 5.30E-05 | -8.15E-03 |
| Materials for energy recovery | kg   | 2.25E-04 | 3.21E-06 | 2.75E-01 | 2.76E-01 | 3.88E-06 | 2.76E-03 | 7.00E-09 | 1.55E-07 | 1.01E-06 | 2.17E-07 | -6.39E-06 |
| Exported Energy               | MJ   | 4.90E+00 | 2.11E-02 | 2.07E-01 | 5.13E+00 | 2.55E-02 | 9.58E-02 | 4.80E-04 | 1.02E-03 | 7.11E-01 | 6.61E-04 | -1.89E-01 |



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**Table 24 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOWAVE– environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D         |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|-----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 1.01E+02  | 6.49E+00 | 2.70E+01 | 1.35E+02  | 7.27E+00 | 2.91E+00  | 5.95E-02 | 2.91E-01 | 4.27E+01 | 2.52E+00 | -4.85E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 1.32E+02  | 6.48E+00 | 2.70E+01 | 1.65E+02  | 7.26E+00 | 3.34E+00  | 5.95E-02 | 2.90E-01 | 4.18E+01 | 2.52E+00 | -4.76E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -3.29E+01 | 4.22E-03 | 9.35E-02 | -3.28E+01 | 4.73E-03 | -4.18E-01 | 2.17E-04 | 1.89E-04 | 8.73E-01 | 1.79E-03 | -9.04E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 2.78E-01  | 2.12E-03 | 3.97E-03 | 2.84E-01  | 2.38E-03 | 4.93E-03  | 8.96E-06 | 9.51E-05 | 7.54E-03 | 1.35E-04 | -1.14E-02 |
| Stratospheric ozone depletion potential                             | eq. kg CFC 11          | 5.36E-06  | 1.29E-07 | 2.24E-07 | 5.71E-06  | 1.44E-07 | 9.89E-08  | 3.58E-10 | 5.77E-09 | 1.23E-06 | 6.07E-09 | -2.08E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 4.96E-01  | 2.03E-02 | 3.01E-01 | 8.18E-01  | 2.27E-02 | 2.83E-02  | 7.01E-04 | 9.08E-04 | 8.40E-01 | 1.67E-03 | -4.80E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 3.70E-02  | 4.33E-04 | 4.82E-02 | 8.56E-02  | 4.84E-04 | 4.20E-03  | 1.13E-04 | 1.94E-05 | 2.35E-03 | 2.51E-05 | -3.19E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 1.05E-01  | 6.84E-03 | 4.29E-02 | 1.54E-01  | 7.65E-03 | 4.55E-03  | 9.94E-05 | 3.06E-04 | 4.59E-01 | 5.56E-03 | -1.44E-02 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 1.05E+00  | 7.44E-02 | 3.77E-01 | 1.50E+00  | 8.32E-02 | 4.06E-02  | 8.71E-04 | 3.33E-03 | 4.77E+00 | 6.82E-03 | -1.45E-01 |
| Potential for photochemical ozone synthesis                         | eq. kg NMVOC           | 7.35E-01  | 3.18E-02 | 1.14E-01 | 8.80E-01  | 3.56E-02 | 1.60E-02  | 2.49E-04 | 1.42E-03 | 1.18E+00 | 2.96E-03 | -8.51E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 1.03E-03  | 2.12E-05 | 1.19E-05 | 1.06E-03  | 2.37E-05 | 1.97E-05  | 2.66E-08 | 9.49E-07 | 3.98E-05 | 5.29E-07 | -5.48E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 3.70E+03  | 9.11E+01 | 4.73E+02 | 4.26E+03  | 1.02E+02 | 7.53E+01  | 1.05E+00 | 4.08E+00 | 6.15E+01 | 5.23E+00 | -7.32E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 5.58E+01  | 4.40E-01 | 8.54E+00 | 6.48E+01  | 4.93E-01 | 1.36E+00  | 1.98E-02 | 1.97E-02 | 2.08E+00 | 2.48E-02 | -2.77E+00 |

**Table 25 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOWAVE– additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit              | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|-------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235      | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh              | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless     | INA   | INA   | INA   | INA |

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**Table 26 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOWAVE- the resource use (DU: 1 m<sup>3</sup>)**

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 4.34E+02 | 1.54E+00 | 4.23E+01 | 4.78E+02 | 1.73E+00 | 8.60E+00 | 9.86E-02 | 6.91E-02 | 1.53E+01  | 7.83E-02  | -1.86E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 3.18E+02 | 0.00E+00 | 0.00E+00 | 3.18E+02 | 0.00E+00 | 4.49E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 7.53E+02 | 1.54E+00 | 4.23E+01 | 7.96E+02 | 1.73E+00 | 1.31E+01 | 9.86E-02 | 6.91E-02 | 1.53E+01  | 7.83E-02  | -1.86E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.55E+03 | 9.11E+01 | 4.73E+02 | 2.11E+03 | 1.02E+02 | 5.33E+01 | 1.05E+00 | 4.08E+00 | -9.70E+02 | -8.17E+02 | -9.51E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 2.15E+03 | 0.00E+00 | 0.00E+00 | 2.15E+03 | 0.00E+00 | 2.21E+01 | 0.00E+00 | 0.00E+00 | 1.12E+03  | 8.22E+02  | -6.37E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 3.70E+03 | 9.11E+01 | 4.73E+02 | 4.26E+03 | 1.02E+02 | 7.54E+01 | 1.05E+00 | 4.08E+00 | 6.15E+01  | 5.23E+00  | -7.32E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.91E+01 | 4.17E-02 | 4.36E-02 | 1.92E+01 | 4.67E-02 | 3.19E-02 | 9.46E-05 | 1.87E-03 | 1.56E+01  | 1.89E-03  | -1.60E+01 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 7.96E+00 | 5.26E-04 | 2.07E-04 | 7.96E+00 | 5.89E-04 | 1.02E-01 | 4.75E-07 | 2.36E-05 | 4.49E-04  | 3.54E-05  | -5.50E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.35E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 1.43E+00 | 1.21E-02 | 1.27E+00 | 2.71E+00 | 1.35E-02 | 3.79E-02 | 2.97E-03 | 5.42E-04 | 5.00E-02  | 7.77E-02  | -7.61E-02 |

**Table 27 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOWAVE – waste categories (DU: 1 m<sup>3</sup>)**

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 5.36E+00 | 1.31E-01 | 5.16E+00 | 1.07E+01 | 1.47E-01 | 1.14E-01 | 1.19E-02 | 5.87E-03 | 1.96E-01 | 9.24E-03 | -3.19E-01 |
| Non-hazardous waste           | kg   | 1.41E+03 | 2.77E+00 | 2.37E+02 | 1.65E+03 | 3.10E+00 | 1.68E+01 | 5.48E-01 | 1.24E-01 | 1.91E+01 | 1.04E+02 | -2.26E+01 |
| Radioactive waste             | kg   | 4.58E-03 | 2.90E-05 | 6.84E-05 | 4.68E-03 | 3.25E-05 | 8.08E-05 | 1.54E-07 | 1.30E-06 | 3.96E-04 | 1.29E-06 | -4.69E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 6.86E-02 | 6.83E-04 | 5.70E+00 | 5.76E+00 | 7.65E-04 | 5.80E-02 | 8.22E-06 | 3.06E-05 | 1.21E-02 | 8.84E-05 | -1.36E-02 |
| Materials for energy recovery | kg   | 2.70E-04 | 5.78E-06 | 4.59E-01 | 4.59E-01 | 6.47E-06 | 4.59E-03 | 1.17E-08 | 2.59E-07 | 1.69E-06 | 3.61E-07 | -1.06E-05 |
| Exported Energy               | MJ   | 5.49E+00 | 3.79E-02 | 3.44E-01 | 5.87E+00 | 4.25E-02 | 1.60E-01 | 8.01E-04 | 1.70E-03 | 1.18E+00 | 1.10E-03 | -3.15E-01 |

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**Table 28 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOBLÖK – environmental impacts (DU: 1 m<sup>3</sup>)**

| Indicator                                                           | Unit                   | A1        | A2       | A3       | A1-A3     | A4       | A5        | C1       | C2       | C3       | C4       | D        |
|---------------------------------------------------------------------|------------------------|-----------|----------|----------|-----------|----------|-----------|----------|----------|----------|----------|----------|
| Global Warming Potential                                            | eq. kg CO <sub>2</sub> | 7.30E+01  | 4.03E+00 | 1.73E+01 | 9.43E+01  | 4.65E+00 | 1.86E+00  | 3.81E-02 | 1.86E-01 | 2.73E+01 | 1.61E+00 | 3.10E+01 |
| Greenhouse potential - fossil                                       | eq. kg CO <sub>2</sub> | 9.21E+01  | 4.03E+00 | 1.73E+01 | 1.13E+02  | 4.65E+00 | 2.14E+00  | 3.81E-02 | 1.86E-01 | 2.68E+01 | 1.61E+00 | 3.05E+01 |
| Greenhouse potential - biogenic                                     | eq. kg CO <sub>2</sub> | -2.18E+01 | 2.62E-03 | 5.99E-02 | -2.17E+01 | 3.02E-03 | -2.68E-01 | 1.39E-04 | 1.21E-04 | 5.59E-01 | 1.15E-03 | 5.78E-01 |
| Global warming potential - land use and land use change             | eq. kg CO <sub>2</sub> | 1.76E-01  | 1.32E-03 | 2.54E-03 | 1.79E-01  | 1.52E-03 | 3.16E-03  | 5.73E-06 | 6.08E-05 | 4.82E-03 | 8.62E-05 | 7.29E-03 |
| Stratospheric ozone depletion potential                             | eq. kg CFC 11          | 3.82E-06  | 8.00E-08 | 1.43E-07 | 4.04E-06  | 9.23E-08 | 6.33E-08  | 2.29E-10 | 3.69E-09 | 7.85E-07 | 3.89E-09 | 1.33E-06 |
| Soil and water acidification potential                              | eq. mol H <sup>+</sup> | 3.43E-01  | 1.26E-02 | 1.93E-01 | 5.49E-01  | 1.45E-02 | 1.81E-02  | 4.49E-04 | 5.81E-04 | 5.38E-01 | 1.07E-03 | 3.07E-02 |
| Eutrophication potential - freshwater                               | eq. kg P               | 2.54E-02  | 2.69E-04 | 3.08E-02 | 5.65E-02  | 3.10E-04 | 2.69E-03  | 7.20E-05 | 1.24E-05 | 1.51E-03 | 1.60E-05 | 2.04E-03 |
| Eutrophication potential - seawater                                 | eq. kg N               | 7.16E-02  | 4.25E-03 | 2.75E-02 | 1.03E-01  | 4.90E-03 | 2.91E-03  | 6.36E-05 | 1.96E-04 | 2.94E-01 | 3.56E-03 | 9.24E-03 |
| Eutrophication potential - terrestrial                              | eq. mol N              | 7.27E-01  | 4.62E-02 | 2.41E-01 | 1.01E+00  | 5.33E-02 | 2.60E-02  | 5.58E-04 | 2.13E-03 | 3.05E+00 | 4.36E-03 | 9.28E-02 |
| Potential for photochemical ozone synthesis                         | eq. kg NMVOC           | 5.27E-01  | 1.97E-02 | 7.27E-02 | 6.20E-01  | 2.28E-02 | 1.03E-02  | 1.59E-04 | 9.11E-04 | 7.54E-01 | 1.90E-03 | 5.45E-02 |
| Potential for depletion of abiotic resources - non-fossil resources | eq. kg Sb              | 7.47E-04  | 1.32E-05 | 7.61E-06 | 7.68E-04  | 1.52E-05 | 1.26E-05  | 1.70E-08 | 6.07E-07 | 2.55E-05 | 3.39E-07 | 3.50E-05 |
| Abiotic depletion potential - fossil fuels                          | MJ                     | 2.66E+03  | 5.65E+01 | 3.03E+02 | 3.02E+03  | 6.52E+01 | 4.82E+01  | 6.72E-01 | 2.61E+00 | 3.93E+01 | 3.34E+00 | 4.69E+02 |
| Water deprivation potential                                         | eq. m <sup>3</sup>     | 3.90E+01  | 2.73E-01 | 5.47E+00 | 4.48E+01  | 3.15E-01 | 8.71E-01  | 1.27E-02 | 1.26E-02 | 1.33E+00 | 1.59E-02 | 1.77E+00 |

**Table 29 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOBLÖK – additional impacts indicators (DU: 1 m<sup>3</sup>)**

| Indicator                                                        | Unit              | A1-A3 | A4-A5 | C1-C4 | D   |
|------------------------------------------------------------------|-------------------|-------|-------|-------|-----|
| Particulate matter                                               | disease incidence | INA   | INA   | INA   | INA |
| Potential human exposure efficiency relative to U235             | eg. kBq U235      | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for ecosystems                  | CTUe              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (cancer effects)     | CTUh              | INA   | INA   | INA   | INA |
| Potential comparative toxic unit for humans (non-cancer effects) | CTUh              | INA   | INA   | INA   | INA |
| Potential soil quality index                                     | dimensionless     | INA   | INA   | INA   | INA |

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*Table 30 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOBLOK- the resource use (DU: 1 m<sup>3</sup>)*

| Indicator                                                                                                      | Unit           | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3        | C4        | D         |
|----------------------------------------------------------------------------------------------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|
| Consumption of renewable primary energy - excluding renewable primary energy sources used as raw materials     | MJ             | 2.89E+02 | 9.58E-01 | 2.71E+01 | 3.18E+02 | 1.11E+00 | 5.51E+00 | 6.31E-02 | 4.42E-02 | 9.82E+00  | 5.01E-02  | -1.19E+01 |
| Consumption of renewable primary energy resources used as raw materials                                        | MJ             | 2.12E+02 | 0.00E+00 | 0.00E+00 | 2.12E+02 | 0.00E+00 | 2.87E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Total consumption of renewable primary energy resources                                                        | MJ             | 5.02E+02 | 9.58E-01 | 2.71E+01 | 5.30E+02 | 1.11E+00 | 8.38E+00 | 6.31E-02 | 4.42E-02 | 9.82E+00  | 5.01E-02  | -1.19E+01 |
| Consumption of non-renewable primary energy - excluding renewable primary energy sources used as raw materials | MJ             | 1.15E+03 | 5.65E+01 | 3.03E+02 | 1.51E+03 | 6.52E+01 | 3.41E+01 | 6.72E-01 | 2.61E+00 | -6.21E+02 | -5.23E+02 | -6.08E+01 |
| Consumption of non-renewable primary energy resources used as raw materials                                    | MJ             | 1.50E+03 | 0.00E+00 | 0.00E+00 | 1.50E+03 | 0.00E+00 | 1.41E+01 | 0.00E+00 | 0.00E+00 | 7.17E+02  | 5.26E+02  | -4.08E+02 |
| Total consumption of non-renewable primary energy resources                                                    | MJ             | 2.66E+03 | 5.65E+01 | 3.03E+02 | 3.02E+03 | 6.52E+01 | 4.82E+01 | 6.72E-01 | 2.61E+00 | 3.93E+01  | 3.34E+00  | -4.69E+02 |
| Consumption of secondary materials                                                                             | kg             | 1.60E+01 | 2.59E-02 | 2.79E-02 | 1.60E+01 | 2.99E-02 | 2.04E-02 | 6.05E-05 | 1.19E-03 | 9.97E+00  | 1.21E-03  | -1.02E+01 |
| Consumption of renew. secondary fuels                                                                          | MJ             | 5.53E+00 | 3.27E-04 | 1.32E-04 | 5.54E+00 | 3.77E-04 | 6.55E-02 | 3.04E-07 | 1.51E-05 | 2.87E-04  | 2.27E-05  | -3.52E-04 |
| Consumption of non-renewable secondary fuels                                                                   | MJ             | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00  | 0.00E+00  | 0.00E+00  |
| Net consumption of freshwater                                                                                  | m <sup>3</sup> | 9.99E-01 | 7.51E-03 | 8.13E-01 | 1.82E+00 | 8.66E-03 | 2.42E-02 | 1.90E-03 | 3.47E-04 | 3.20E-02  | 4.97E-02  | -4.87E-02 |

*Table 31 Life cycle assessment (LCA) results for specific product TUBOLIT AR FONOBLOK – waste categories (DU: 1 m<sup>3</sup>)*

| Indicator                     | Unit | A1       | A2       | A3       | A1-A3    | A4       | A5       | C1       | C2       | C3       | C4       | D         |
|-------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Hazardous waste               | kg   | 3.70E+00 | 8.14E-02 | 3.30E+00 | 7.09E+00 | 9.39E-02 | 7.28E-02 | 7.62E-03 | 3.76E-03 | 1.25E-01 | 5.91E-03 | -2.04E-01 |
| Non-hazardous waste           | kg   | 1.04E+03 | 1.72E+00 | 1.51E+02 | 1.19E+03 | 1.98E+00 | 1.07E+01 | 3.51E-01 | 7.93E-02 | 1.22E+01 | 6.68E+01 | -1.45E+01 |
| Radioactive waste             | kg   | 3.14E-03 | 1.80E-05 | 4.38E-05 | 3.21E-03 | 2.08E-05 | 5.17E-05 | 9.86E-08 | 8.32E-07 | 2.54E-04 | 8.26E-07 | -3.00E-04 |
| Components for re-use         | kg   | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00  |
| Materials for recycling       | kg   | 4.50E-02 | 4.24E-04 | 3.65E+00 | 3.69E+00 | 4.90E-04 | 3.71E-02 | 5.26E-06 | 1.96E-05 | 7.75E-03 | 5.66E-05 | -8.69E-03 |
| Materials for energy recovery | kg   | 1.85E-04 | 3.59E-06 | 2.94E-01 | 2.94E-01 | 4.14E-06 | 2.94E-03 | 7.46E-09 | 1.66E-07 | 1.08E-06 | 2.31E-07 | -6.81E-06 |
| Exported Energy               | MJ   | 3.76E+00 | 2.36E-02 | 2.20E-01 | 4.00E+00 | 2.72E-02 | 1.02E-01 | 5.12E-04 | 1.09E-03 | 7.58E-01 | 7.05E-04 | -2.01E-01 |

## Type III Environmental Product Declaration No. 910/2026

### Verification

The process of verification of this EPD is in accordance with ISO 14025. After verification, this EPD is valid for a 5-year-period. EPD does not have to be recalculated after 5 years, if the underlying data have not changed significantly.

|                                                                                                                                                                                                         |                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| The basis for LCA analysis was EN 15804+A2 and ITB PCR A                                                                                                                                                |                                   |
| Independent verification corresponding to ISO 14025 (sub clause 8.1.3.)                                                                                                                                 |                                   |
| <input checked="" type="checkbox"/> external                                                                                                                                                            | <input type="checkbox"/> internal |
| External verification of EPD: Halina Prejzner, PhD. eng.<br>LCI audit and verification: Michał Chwedaczuk, M.Sc. eng.<br>LCA, LCI audit and input data verification: Michał Piasecki, PhD., D.Sc., eng. |                                   |

Note 1: The declaration owner has the sole ownership, liability, and responsibility for the information provided and contained in EPD. Declarations of construction products may not be comparable if they do not comply with EN 15804+A2. For further information about comparability, see EN 15804+A2 and ISO 14025.

Note 2: ITB is a public Research Organization and Notified Body (EC Reg. no 1488) to the European Commission and to other Member States of the European Union designated for the tasks concerning the assessment of building products' performance. ITB acts as the independent, third-party verification organization (ISO 17025/17065/17029). ITB-EPD program is recognized and registered member of The European Platform - Association of EPD program operators and ITB-EPD declarations are registered and stored in the international ECO-PORTAL.

### Normative references

- ITB PCR A General Product Category Rules for Construction Products
- EN 14313 : 2015 Thermal Insulation products for building equipment. Factory made polyethylene foam
- ISO 14025, Environmental labels and declarations – Type III environmental declarations – Principles and procedures
- ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
- ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines
- ISO 15686-1:2011 Buildings and constructed assets – Service life planning – Part 1: General principles and framework
- ISO 15686-8:2008 Buildings and constructed assets – Service life planning – Part 8: Reference service life and service-life estimation
- EN 15804:2012+A2:2019 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products
- ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification
- PN-EN 15942:2012 Sustainability of construction works – Environmental product declarations – Communication format business-to-business
- KOBiZE Wskaźniki emisyjności CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO i pyłu całkowitego dla energii elektrycznej. December 2024
- <https://ecoinvent.org/>

LCA, LCI audit and input data verification  
Michał Piasecki, PhD. D.Sc. C.E. Eng.  
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Head of Thermal Physic, Acoustic and Environment Department  
Agnieszka Winkler-Skalna, PhD. C.E. Eng.  
/Qualified electronic signature/



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# **CERTIFICATE No 910/2026 of TYPE III ENVIRONMENTAL DECLARATION**

Products:

**Tubolit DG Plus, Tubolit DG, Tubolit DG B1, Tubolit S  
Plus, Tubolit AR Fonowave, Tubolit Fonoblock, Tubolit S**

Manufacturer:

**Armacell Poland Sp. z o.o.**

Targowa 2, 55-300 Środa Śląska, Poland

confirms the correctness of the data included in the development of  
Type III Environmental Declaration and accordance with the requirements of the standard

**EN 15804+A2**

**Sustainability of construction works.**

**Environmental product declarations.**

**Core rules for the product category of construction products.**

This certificate, issued on 29<sup>th</sup> January 2026 is valid for 5 years  
or until amendment of mentioned Environmental Declaration

Head of the Thermal Physics, Acoustics  
and Environment Department

*Agnieszka Winkler-Skalna*  
Agnieszka Winkler-Skalna, PhD



Deputy Director  
for Research and Innovation

*Krzysztof Kućzyński*  
Krzysztof Kućzyński, PhD

Warsaw, January 2026