The Light Rebar Company

EPD INTERNATIONAL EPD SYSTEM

Environmental Product Declaration

Multiple products EPDs based on the average results for the product group

Braided Composite Rebars

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-0026879:002	2025-11-12	2030-11-12	2025-11-21

General information

Programme information

EPD owner:	LRC | The Light Rebar Company® | Travessa dos Mártires, Nº12 4800-054 Guimarães | https://thelrc.eu/en/
LCA accountability:	Bruna Machado | Catarina Silva | Daniel Ribeiro | Hector Nunes | Inês Costa from Centre for Innovation in Polymer Engineering (PIEP) Universidade do Minho, Campus de Azurém, Edifício 15 4800-058 Guimarães – PORTUGAL www.piep.pt | geral@piep.pt
Programme operator:	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com|info@environdec.com
Third party verifier:	Martijn van Hövell from SGS Global martijn.vanhovell@sgs.com
Approved 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: Rob Rouwette, start2see and Noa Meron, thinkstep anz. The review panel may be contacted via the Secretariat www.environdec.com/contact.

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

PRODUCT CATEGORY RULES (PCR):

- CEN standard EN 15804 serve as the core Product Category Rules (PCR)
- PCR 2019:14 Construction products, version 2.0.1

Company profile

The Light Rebar Company® is a company dedicated to producing and marketing GFRP (Glass Fibre Reinforced Polymer), known as BCR (Braided Composite Rebar), as a cutting-edge alternative to conventional steel. Originally designed for the construction sector, BCR is a highly versatile material with applications that extend into agriculture and fishing, positioning it as a disruptive solution and a key driver of change in the materials industry.

The BCR is a patented, innovative reinforcement solution featuring a braided textile structure with axial reinforcement. It is a multifunctional structure using different fibre types strategically distributed to meet specific mechanical and physical demands. This design enhances performance while reducing production costs. The BCR offers several advantages over traditional steel rebar, including greater strength, price stability, lightweight, corrosion resistance, longer service life, and improved logistics. The company collaborates with public and private entities in Portugal, along with academic and technical institutions, to develop solutions that enhance the safety, resilience, and efficiency of infrastructure projects.

Company profile

The Light Rebar Company®'s mission is to supply excellent products to our customers, driven by the pursuit of measurable gains to all stakeholders and continued development, with a culture of excellence and sustainability.

The Light Rebar Company®'s vision is to be the benchmark supplier of manufactured products, as a provider of goods and developer of leading-edge solutions, delivering outstanding value-for-money and quality of products and services.

The Light Rebar Company® core values — Leadership, Responsibility, and Commitment — guide everything we do. We pursue excellence in both technical and non-technical areas, act responsibly toward people, the environment, and our clients' needs, and honour all agreements with ethics, integrity, and dedication. Through timely delivery and consistent quality, we build trust with every partner and customer.

The Light Rebar Company® is certified under ISO 9001, demonstrating its commitment to consistent quality management and continuous improvement.

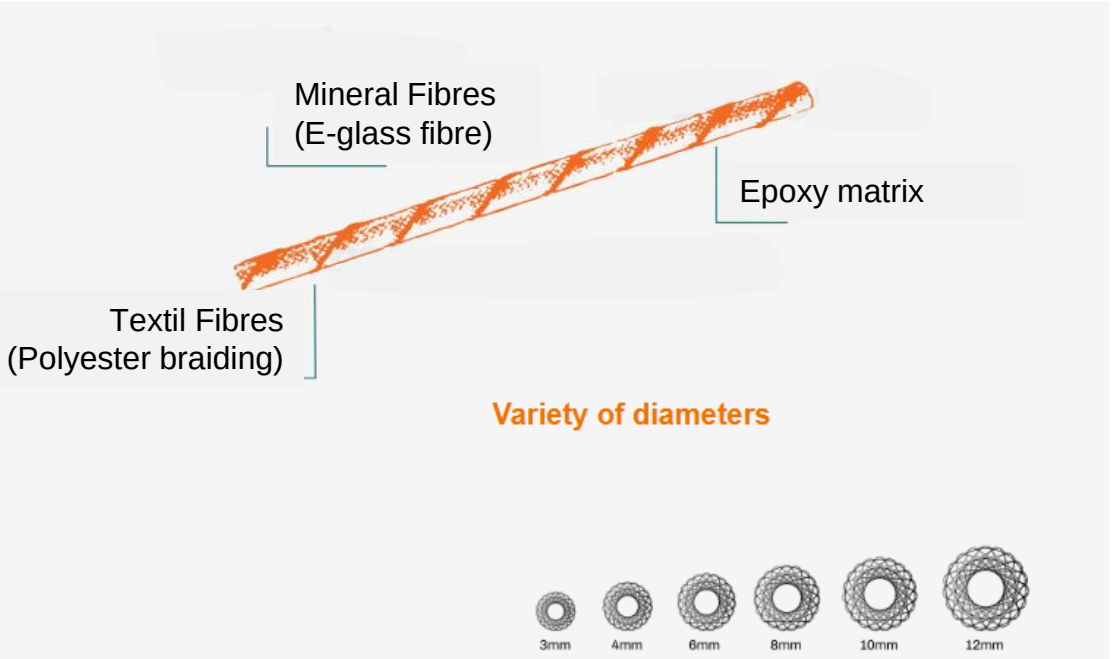
TÜVRheinland CERTIFIED
Management System
ISO 9001:2015
www.tuv.com
ID 9000035319

Product information

The BCR is the designation for rebars. The fibreglass reinforced polymer product line is particularly suitable for reinforcing all types of concrete products and construction that require lightweight, corrosion resistance, electromagnetic resistance and improved logistical scenarios.

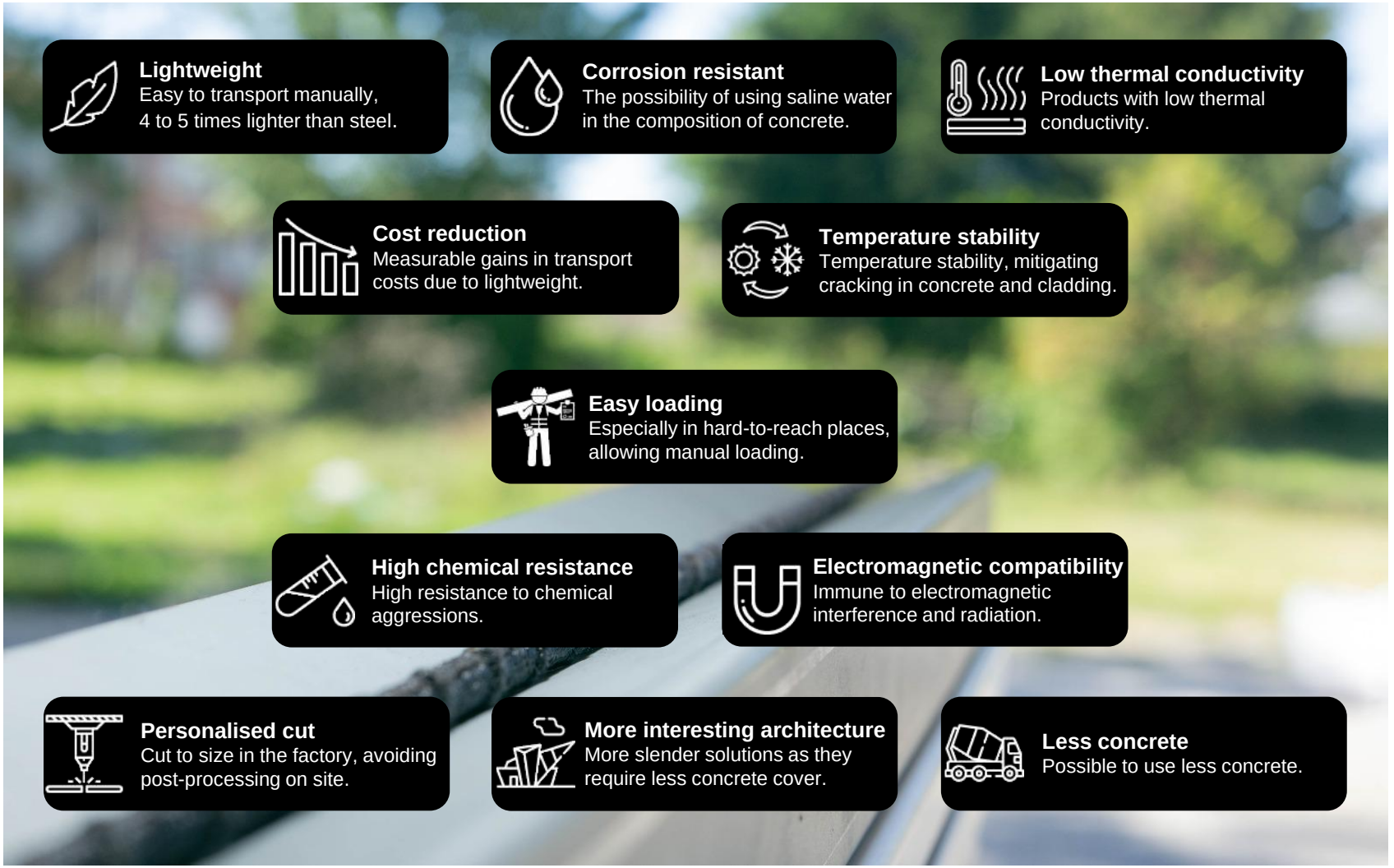
UN CPC code: 369 (Other plastics products)

Structure of a typical BCR



Product information

BCR properties



Product information

BCR properties

Property	Value
Young's Modulus	>50 GPa
Ultimate Tensile Strength	>1200 MPa
Density	2+0.3 g/cm^3
Tensile elongation	5.24 %
Reference service life (RSV)	100 years

Rebar diameter (mm)	Weight of 1 m (kg)	Percentage produced in 2024
3.00	2.00E-02	0.52%
4.00	3.00E-02	3.85%
6.00	7.00E-02	35.71%
8.00	1.20E-01	37.04%
10.00	1.90E-01	14.01%
12.00	2.60E-01	8.87%

BCR Applications

- Permanent concrete reinforcement;
- Structures close to seawater, including but not limited to, coastal defences and harbours;
- Roads and pavements, especially when subjected to salt and grit;
- Infrastructure slabs;
- Slope stabilisation;
- Wet or corrosion-sensitive areas;
- Areas requiring electromagnetic compatibility (EMC);
- Projects requiring electrical and/or thermal insulation.

LCA information

Declared Unit
The Declared unit (DU) is the production of one (1) meter of BCR.

The DU was selected as the most appropriate unit, considering the functionality and performance of the products under study, as produced by The Light Rebar Company® in 2024. This EPD is a multi-product EPD, based on the average results for the product group.

This report covers multiple products manufactured by The Light Rebar Company® that share similar characteristics and are produced under the same manufacturing conditions.

System Boundaries
The system boundaries of this study are defined in accordance with the requirements of EN 15804:2012+A2:2019/AC:2021 and PCR 2019:14 for construction products. This assessment follows a cradle-to-grave approach, including module D, and incorporates additional considerations for the end-of-life stage.
The construction and maintenance of infrastructure and equipment, the end-of-life of capital goods, and waste from administration, laboratories, or offices were excluded from the LCA.

Time Representativeness
January 2024 - December 2024

Geographical Scope
Europe

EPD Type

Multiple products

Software

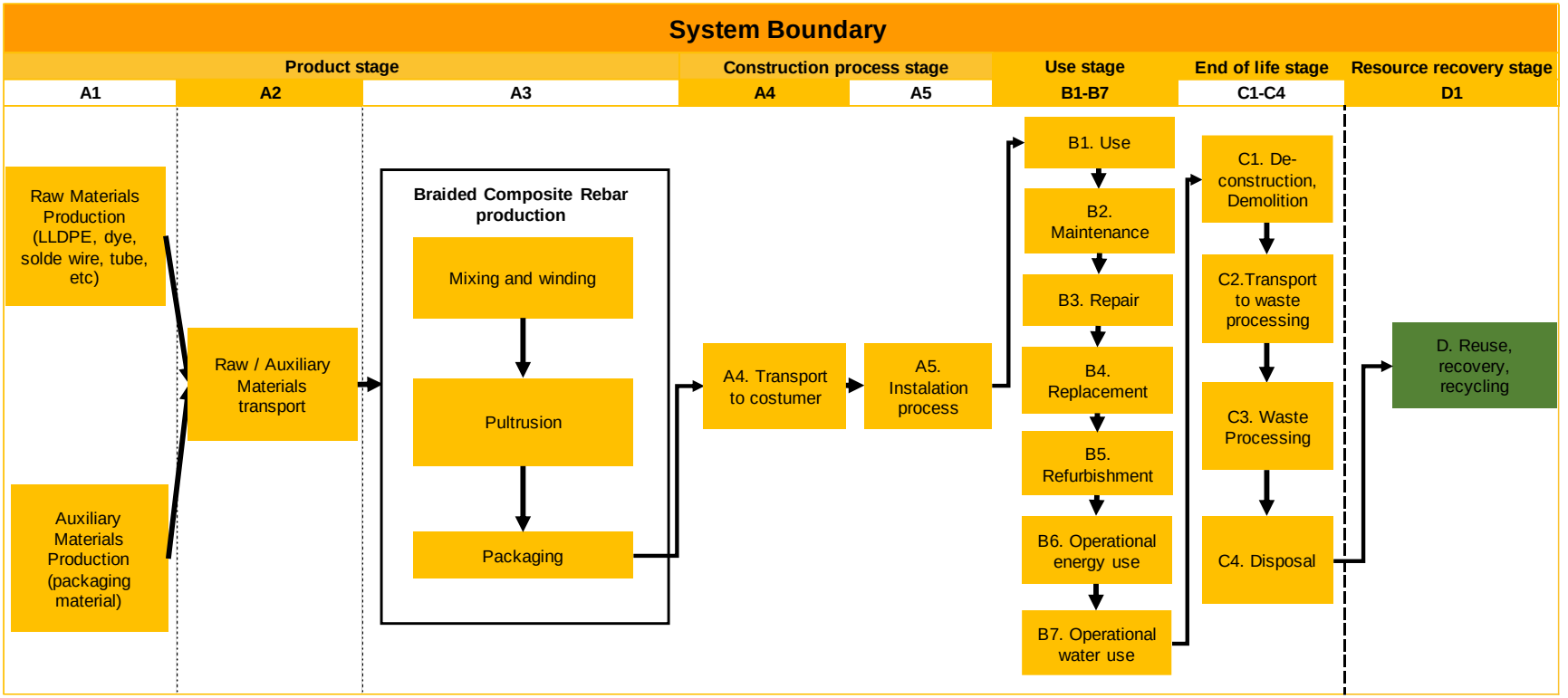
SimaPro
Version 9.6.0.1

Database

Ecoinvent 3.10

LCA information

System diagramme



LCA information

Description of examined Modules

A1: Raw and auxiliary material production

This assessment considers the production of all raw materials needed to comply with the DU, namely E-glass fibre, epoxy matrix, and polyester braiding. The glass fibres are manufactured in Thailand, the polyester fibres in Portugal, and the epoxy resin and additives in Germany. The modelling of the different components, based on their respective Material Safety Data Sheet (MSDS), is presented in section 3.3.1.2 Raw Material Modelling.

A2: Raw and auxiliary materials transport

This study examines the distances and types of transportation for each raw and auxiliary material, as outlined in the table below. All distances were provided by The Light Rebar Company®, and the transportation type was selected based on the most probable scenarios, according to The Light Rebar Company®'s sensibility.

Raw or auxiliary material	Distance (km)	Type of transportation
Glass fibres	6.00+E01	Truck 24.0 metric ton
	1.51E+04	Container ship
	3.60E+01	Truck 24.0 metric ton
Epoxy resin supplier 1	1.91E+03	Truck 3.5 metric ton
Epoxy resin supplier 2	1.93E+03	Truck 3.5 metric ton
Epoxy hardener	1.91E+03	Truck 3.5 metric ton
Epoxy curing agent	1.93E+03	Truck 3.5 metric ton
Epoxy catalyst supplier 1	1.91E+03	Truck 3.5 metric ton
Epoxy catalyst supplier 2	1.93E+03	Truck 3.5 metric ton
Epoxy catalyst	1.93E+03	Truck 3.5 metric ton
Polyester fibres supplier 1	3.30+E00	Truck 24.0 metric ton
Polyester fibres supplier 2	3.30+E00	Truck 24.0 metric ton
Polyester fibres supplier 3	3.30+E00	Truck 24.0 metric ton
Packaging tape	1.04E+01	Light commercial vehicle

LCA information

Description of examined Modules

A3: Mixing and winding

At this step, the epoxy resin is mixed with additives and catalysts to optimise its curing and adhesion properties. The mixing is performed in dedicated tanks equipped with systems that ensure compound homogeneity and prevent the formation of air bubbles. This is a fully manual process and does not involve any energy consumption.

Winding consists of transferring the reinforcement fibres, which are supplied packaged in yarn winding cones, onto special cones compatible with the equipment. The original yarn winding cones cannot be used directly in the process; therefore, the fibres are rewound to these dedicated cones to enable their proper feeding into the pultrusion line. The cones are then placed on the creel system, allowing controlled unwinding and accurate guidance of the fibres into the resin bath.

A3: Pultrusion

After mixing and winding, fibreglass strands are pulled from rolls and aligned. They pass through a resin bath containing epoxy resin, which saturates the fibres. Simultaneously, a polyester cord is braided around the glass fibre bundle. Next, the resin-impregnated fibres enter a heated mould that shapes and cures the material. The heat causes the epoxy resin to harden (cure), forming a solid composite profile. The final product is then pulled out continuously and cut to the desired length.

A3: Packaging

After the pultrusion process, the profiles undergo a packaging stage to prepare them for shipment. First, the continuous profiles are cut to the required lengths according to customer specifications. A quality inspection is then performed to detect any surface defects, cracks, or dimensional deviations. Once approved, the rebars are grouped and secured using adhesive tape, which is the standard packaging method and includes the brand identification.

LCA information

Description of examined Modules

A4: Transportation to customer

At this point, this study considers an average transport distance of approximately 3.16E+01 km between the manufacturing plant and The Light Rebar Company®'s main clients using a truck with a maximum capacity of 24 metric tonnes. It is assumed that the truck is always fully loaded on the outbound trip and returns empty, resulting in an effective load factor of 50%.

Scenario information	Unit (Expressed per DU)
Vehicle type used for transport	Trucks with a maximum capacity of 24 metric tonnes, belonging to the EURO6 category
Distance	3.16E+01 km
Capacity utilisation (including empty returns)	50 %
Bulk density of transported products	3.60E-01 kg/m^3
Volume capacity utilisation factor	Not applicable

A5: Installation of the product

During this stage, the BCRs are installed on-site as structural reinforcement elements within reinforced concrete structures, replacing conventional steel rebars. The BCR form the reinforcement framework into which concrete is subsequently poured. Installation is carried out manually, using only light hand tools. The rebars are secured in place with approximately 5 g of nylon zip straps per DU to ensure proper positioning during concrete casting. No excavation, heavy machinery, or additional concrete works are required beyond standard construction practice. Packaging residues from the BCR delivery (packaging tape) are sorted and sent for recycling, following typical site waste management procedures. Material losses during installation are considered negligible.

Scenario information	Unit (Expressed per DU)
Ancillary materials for installation (specified by material);	nylon zip lock
Packaging tape	3.39E-04 kg
Water use	ND
Quantitative description of energy type (regional mix) and consumption during the installation process	ND
Output materials (specified by type) as a result of waste processing at the building site, e.g. of collection for recycling, for energy recovery, or disposal (specified by route)	0 kg
Direct emissions to ambient air, soil and water	0 kg

LCA information

Description of examined Modules

B1: Use of the product

During use, the BCR acts as a reinforcement element within concrete structures, replacing conventional steel rebars. Once embedded in concrete, they do not consume energy, water, or other resources during operation. No environmental impacts are associated with this phase.

B2: Maintenance of the product

The BCR does not require regular maintenance, cleaning, or surface treatment throughout their RSL. Therefore, no impacts are included for this module.

B3: Repair of the product

Given the material's durability and corrosion resistance, repair of the BCR is not expected.

B4: Replacement of components

Replacement of the fibreglass reinforcement rods is not expected during the RSL of the structure. Consequently, no impacts are modelled for this module.

B5: Refurbishment of the product

Refurbishment does not apply to this type of embedded product, as the rods cannot be recovered or renewed without demolition of the structure.

LCA information

Description of examined Modules

B6: Operational energy use

The BCR do not require energy during their use phase. Consequently, no energy consumption or associated impacts are reported.

RSL information	Unit	Value / Description
RSL	years	100
Declared product properties (before installation)	—	As specified by the manufacturer
Design application parameters (e.g. load, exposure)	—	Indoor or embedded in concrete
Maintenance and repair	—	Not required
Replacement	—	Not required
Operational conditions	—	Stable environment within concrete
End-of-life condition	—	Product remains embedded

B7: Operational water use

The product does not involve water use or emissions to water during operation. Therefore, no impacts are assigned to this module.

C1: Deconstruction/demolition of the product

At the end of the service life, the concrete structure containing the BCR is demolished using conventional mechanical methods. The rebars are not removed before demolition, as they remain fully embedded within the concrete matrix. Energy consumption for this process is assigned according to the PCR 2019:14 v2.0 default values for reinforced concrete: 10 kWh of diesel per tonne of material demolished.

LCA information

Description of examined Modules

C2: Transport of the product as waste to a waste processing unit

Demolished material is assumed to be transported 80 km to a recycling or sorting facility using a 16–32 tonne lorry (EURO 5, 50% load factor) for materials not destined for incineration.

Scenario information	Unit (Expressed per DU)
Vehicle type used for transport	Trucks 24 metric tonnes, EURO5 category
Distance	80 km
Capacity utilisation (including empty returns)	50 %
Bulk density of transported products	2200 kg/m^3
Volume capacity utilisation factor	Not applicable

C3: Waste processing

At the sorting facility, concrete is crushed and separated for potential recycling as secondary aggregate. No recovery or recycling of the GFRP rebars is expected due to their full integration within the concrete matrix and contamination after demolition. Default PCR values are applied for energy use: 1.8 kWh diesel for loading/unloading, 2.2 kWh electricity for mechanical sorting, and 2.0 kWh diesel for concrete crushing per tonne of material processed.

C4: Disposal of the final product as waste

All residual inert materials from the product are disposed of **100% in a landfill.** No portion of the material is recycled, recovered, or used for backfilling operations, and therefore, no credits for avoided products or recycling are applied. Energy consumption for compaction and disposal is assumed to be 1.6 kWh of diesel per tonne, based on PCR reference data. No specific emissions from material decomposition are expected, as the material is inert and fully encapsulated within the concrete matrix.

LCA information

Description of examined Modules

D: Reuse, recovery, and recycling potential of the products at their EoL

No direct reuse, recycling, or energy recovery is assumed for the BCRs themselves, as they remain physically embedded within the concrete structure and cannot be separated without significant material degradation.

In line with EN 15804+A2 and PCR 2019:14 v2.0.1, Module D is declared but has no net output flows of secondary materials or energy leaving the product system. Consequently, no additional loads or benefits are reported, and the results for Module D are equal to zero.

Processes	Unit (Expressed per DU of components products)
Process specified by type of material	0 kg collected separately
	2.41E+01 kg collected with mixed construction waste
Recovery system	0 kg for re-use
	0 kg for recycling
	0 kg for energy recovery
Disposal	2.41E+01 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	EU	EU	EU	EU	EU
Specific data used	<10%[1]			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – Products[1]	167%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation - Sites	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

The share of primary data is calculated based on GWP-GHG results. It is a simplified indicator for data quality that supports the use of more primary data, to increase the representativeness of and comparability between EPDs. Note that the indicator does not capture all relevant aspects of data quality and is not comparable across product categories.

[1] Although the share of specific data is <10%, this reflects the dominance of upstream raw material production (A1). All factory processes in A3 were modelled using primary data collected directly from production.

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 production processes for all raw and auxiliary materials were modelled using information provided in the MSDS supplied by The Light Rebar Company®, supplemented with data from commercial databases.
- The client sources epoxy resin and associated reagents from two different suppliers, depending on raw material availability. The epoxy resins are considered equivalent in function, while the reagents may differ chemically. For this study, all resins and reagents used throughout 2024 have been included in the modelling to accurately capture their environmental impacts.
- The Intermediate Bulk Containers (IBCs) used for the transport and storage of the resin components are reused multiple times. For this reason, their associated environmental impacts have not been included in the inventory of this study.
- The cardboard core waste from the packaging tape roll was excluded from the study, as it accounts for less than 1% of the product's total weight, falling below the materiality threshold in accordance with EPD and LCA guidelines.
- Regarding the transport of raw materials, when exact transport routes were not provided, Google Maps was used to estimate distances.

LCA information

Additional information

• In terms of vehicle type, Euro V lorries were assumed for modelling purposes. Although official EU-wide statistics by Euro standard are not available, data from Eurostat (2023) indicate that approximately 85 % of road freight transport (in tonne-kilometres) was carried out by vehicles less than 10 years old. Since Euro VI standards became mandatory for all new heavy-duty vehicles from 2014 onwards, this age distribution suggests that a large share of the current fleet already complies with Euro VI emission limits. Furthermore, the European Automobile Manufacturers' Association (ACEA, 2023) reports that around 53 % of the heavy-duty truck fleet currently operating in the EU meets Euro VI standards. Therefore, the use of Euro V vehicles in this study represents a conservative assumption, ensuring that potential environmental impacts from transport are not underestimated, while remaining consistent with the overall composition of the European truck fleet [8, 9].

• During the construction stage, the BCRs are assumed to be used as reinforcement elements in reinforced concrete structures. The assembly of the rebars is carried out manually, following common construction practice. Each metre of rebar is fixed in place using one nylon zip lock (mass: 5 g) to ensure positioning and spacing before concrete casting. A transport distance of 50 km was considered between the point of purchase of the zip lock and the installation site. No additional equipment, energy consumption, or auxiliary materials are considered for this manual installation process.

• At end-of-life, the BCRs are assumed to remain embedded within the concrete structure and to be removed as part of concrete blocks during demolition. A conservative approach was adopted, considering that each metre of BCR is associated with a concrete volume of 0.1 × 0.1 × 1.0 m (0.01 m^3). This volume was used to estimate the total mass of concrete waste (approximately 24 kg of concrete per metre of rebar, assuming a density of 2400 kg/m^3). The embedded nature of the product means that no separate dismantling or material recovery processes are modelled at this stage.

LCA information

Additional information

Allocation Assumptions and Limitations

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 MSDS, which can bring some uncertainties in the modelling process.

• In the industrial context, the type of truck employed may vary depending on the quantity of raw materials ordered or specific customer requests.

• The Light Rebar Company® 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.

LCA information

Additional information

Data collection and background data

This study used primary data provided by The Light Rebar Company®. 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 pertained to the year 2024 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.

Background data was required for:

- Upstream processes: This includes the production of raw materials, auxiliary materials, and the transportation of materials from suppliers to the manufacturing plant.
- Core processes: Emissions related to energy consumption (e.g. diesel) in core processes used commercial databases based on specific data provided.
- Downstream processes: This includes the transport of the finished product from the manufacturing plant to the construction site.

LCA information

Additional information

Electricity modelling

The electricity mix for The Light Rebar Company® was defined by modelling the electricity supply using the Portuguese residual mix for medium-voltage electricity. Based on the Portuguese residual electricity mix, 1 kWh of electricity results in 5.77E-01 kg CO_2 eq. emissions.

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 on comparability, refer to 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/DU
Polyester fibres	3.69E-03	0%	0%	0
Glass fibres	3.21E-02	0%	0%	0
Epoxy resin	7.10E-03	0%	0%	0
Epoxy hardener	2.07E-03	0%	0%	0
Epoxy curing agent	4.06E-03	0%	0%	0
Epoxy catalyst	2.30E-04	0%	0%	0
Epoxy catalyst	2.99E-05	0%	0%	0
Sum	**4.93E-02**	**0%**	**0%**	**0**

The table values are based on the weighed average composition.

Packaging materials	Weight, kg	Weight-% (versus the product)	Biogenic material, kg C/DU
Packaging tape	3.39E-04	0.77%	0.00E+00

None of the components in BCR contains substances from the List of Substances of Very High Concern (SVHC) at concentrations exceeding 0.1% of the product's weight.

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.

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-total	**kg CO_2 eq.**	4.31E-01	1.00E-03	4.55E-02	0.00E+00	1.69E-02	3.00E-01	3.71E-02	2.69E-03	0.00E+00
GWP-fossil	**kg CO_2 eq.**	4.28E-01	1.00E-03	4.54E-02	0.00E+00	1.68E-02	3.00E-01	3.70E-02	2.69E-03	0.00E+00
GWP-biogenic	**kg CO_2 eq.**	2.86E-03	3.22E-07	6.93E-05	0.00E+00	2.03E-05	9.62E-05	5.66E-05	3.24E-06	0.00E+00
GWP-luluc	**kg CO_2 eq.**	3.25E-04	2.51E-08	8.02E-06	0.00E+00	1.67E-06	7.37E-06	4.36E-05	2.67E-07	0.00E+00
ODP	**kg CFC11 eq.**	1.55E-07	2.04E-11	1.56E-10	0.00E+00	1.60E-09	6.12E-09	1.25E-09	2.56E-10	0.00E+00
AP	**mol H+ eq.**	2.52E-03	3.01E-06	1.94E-04	0.00E+00	6.20E-05	7.47E-04	8.26E-05	9.91E-06	0.00E+00
EP-freshwater	**kg P eq.**	1.19E-05	8.70E-10	1.97E-06	0.00E+00	5.66E-08	2.51E-07	8.68E-07	9.04E-09	0.00E+00
EP-marine	**kg N eq.**	5.20E-04	1.20E-06	7.03E-05	0.00E+00	8.51E-06	2.86E-04	1.71E-05	1.36E-06	0.00E+00
EP-terrestrial	**mol N eq.**	5.60E-03	1.32E-05	3.61E-04	0.00E+00	8.98E-05	3.13E-03	1.89E-04	1.43E-05	0.00E+00
POCP	**kg NMVOC eq.**	2.24E-03	5.36E-06	1.15E-04	0.00E+00	1.61E-04	1.30E-03	1.24E-04	2.56E-05	0.00E+00
ADPe	**kg Sb eq.**	2.46E-05	3.57E-11	1.44E-08	0.00E+00	2.64E-09	9.91E-09	1.43E-09	4.22E-10	0.00E+00
ADPf[1]	**MJ**	7.77E+00	1.32E-02	7.42E-01	0.00E+00	1.04E+00	3.96E+00	8.79E-01	1.67E-01	0.00E+00
WDP[1]	**m^3 depriv.**	1.08E-01	1.29E-05	5.17E-02	0.00E+00	8.11E-04	4.16E-03	1.16E-02	1.29E-04	0.00E+00

GGWP = 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; **WP** = 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-B7	C1	C2	C3	C4	D
GWP-GHG[2]	**kg CO_2 eq.**	4.29E-01	1.00E-03	4.56E-02	0.00E+00	1.70E-02	3.01E-01	3.72E-02	2.72E-03	0.00E+00

[1] 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.
[2] 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).

Results of the environmental performance indicators

Resource use indicators

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PERE	**MJ**	4.41E-01	4.75E-05	2.47E-02	0.00E+00	3.03E-03	1.40E-02	2.26E-02	4.85E-04	0.00E+00
PERM	**MJ**	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
PERT	**MJ**	4.41E-01	4.75E-05	2.47E-02	0.00E+00	3.03E-03	1.40E-02	2.26E-02	4.85E-04	0.00E+00
PENRE	**MJ**	7.77E+00	1.32E-02	7.42E-01	0.00E+00	1.04E+00	3.96E+00	8.79E-01	1.67E-01	0.00E+00
PENRM	**MJ**	7.72E-01	0.00E+00	1.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	**MJ**	7.77E+00	1.32E-02	7.42E-01	0.00E+00	1.04E+00	3.96E+00	8.79E-01	1.67E-01	0.00E+00
SM	**kg**	0.00E+00	0.00E+00	7.43E-04	0.00E+00	3.17E-07	1.97E-06	2.21E-06	5.06E-08	0.00E+00
RSF	**MJ**	1.54E-04	5.94E-10	7.74E-05	0.00E+00	3.85E-08	1.72E-07	5.25E-08	6.15E-09	0.00E+00
NRSF	**MJ**	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
FW	**m^3**	2.68E-03	3.17E-07	1.21E-03	0.00E+00	1.99E-05	1.02E-04	2.87E-04	3.18E-06	0.00E+00

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

Results of the environmental performance indicators

Waste indicators and output flow indicators

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
HWD	**kg**	1.35E-02	6.97E-07	5.44E-04	0.00E+00	4.68E-05	1.97E-04	1.96E-03	7.47E-06	0.00E+00
NHWD	**kg**	1.09E+00	5.42E-05	1.37E-02	0.00E+00	2.48E-03	1.59E-02	3.60E-02	3.96E-04	0.00E+00
RWD	**kg**	1.18E-05	1.26E-09	4.32E-07	0.00E+00	8.08E-08	3.72E-07	1.11E-06	1.29E-08	0.00E+00
CRU	**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
MFR	**kg**	7.32E-05	3.16E-10	5.24E-07	0.00E+00	2.15E-08	9.64E-08	6.91E-08	3.43E-09	0.00E+00
MER	**kg**	2.68E-07	3.10E-12	1.77E-09	0.00E+00	2.09E-10	9.70E-10	1.48E-09	3.34E-11	0.00E+00
EEE	**MJ**	8.14E-03	7.40E-07	2.78E-04	0.00E+00	4.77E-05	2.18E-04	3.82E-03	7.61E-06	0.00E+00
EET	**MJ**	8.82E-03	1.26E-06	1.83E-04	0.00E+00	2.22E-06	3.78E-04	1.54E-04	3.55E-07	0.00E+00

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-B7	C1	C2	C3	C4	D
PM	**Disease incidence**	1.74E-08	8.00E-11	1.82E-09	0.00E+00	4.75E-10	1.97E-08	3.19E-10	7.59E-11	0.00E+00
IR	**kBq U235 eq.**	1.52E-02	1.82E-06	5.34E-04	0.00E+00	1.20E-04	5.39E-04	1.59E-03	1.92E-05	0.00E+00
ETP-fw	**CTUe**	4.90E+00	3.90E-04	5.14E-02	0.00E+00	1.98E-02	1.34E-01	3.53E-02	3.17E-03	0.00E+00
HTP-c[1]	**CTUh**	1.38E-09	5.82E-13	5.11E-12	0.00E+00	2.21E-12	2.27E-11	4.97E-12	3.53E-13	0.00E+00
HTP-nc[1]	**CTUh**	1.18E-08	4.53E-12	4.49E-11	0.00E+00	6.97E-11	1.99E-09	1.84E-10	1.11E-11	0.00E+00
SQP[1]	**Dimensionless**	5.20E-01	3.23E-05	3.07E-02	0.00E+00	2.01E-03	8.86E-03	2.54E-02	3.21E-04	0.00E+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.

[1] 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

The environmental assessment of BCR products indicates that the raw material production stage (A1) is the main contributor to overall impacts, accounting for about 88.6% of the total within stages A1–A3. Transport to the factory (A2) contributes 10.9%, and manufacturing (A3) only 0.85%. Therefore, material extraction and production dominate the environmental performance, while transport and installation stages (A4 and A5) have a negligible effect.

Within module A1, glass fibre is the dominant contributor (64.3%), followed by epoxy resin (20.6%) and resin additives (5.0%). Polyester yarn (0.9%) and packaging materials (<0.3%) have a minimal impact. This shows that the type and quantity of reinforcement and matrix materials are the main environmental drivers, and improvements could come from using lower-impact resins, recycled glass fibre, or optimized formulations.

When comparing BCR products of different diameters, a clear link is found between product mass and environmental impact—larger diameters cause proportionally higher impacts due to greater material use. Correction factors were developed to extrapolate results for any diameter relative to 1 m of BCR. The analysis confirmed that deviations remain low (<16%), ensuring that DU and average results are representative and compliant with PCR 2019:14 requirements.

Other environmental indicators beyond GWP show similar patterns. The product stage (A1–A3) consumes most of the non-renewable primary energy, while end-of-life transport (C2) adds about a quarter. Renewable energy use is minimal, highlighting reliance on fossil fuels. Non-hazardous waste generation, water use, and resource depletion are also dominated by A1–A3, confirming raw material production as the key environmental hotspot.

End-of-life stages (C1–C4) have a modest but noticeable impact. Transport to waste treatment (C2) is the main contributor due to fuel use, while dismantling, processing, and disposal (C1, C3, C4) have minor effects because of the low material mass and simple treatment. Module D is declared but results in zero values, as no net output flows of secondary materials or energy leave the system.

Interpretation

Overall, the results demonstrate that environmental impacts across all categories are largely associated with the production of raw materials, particularly glass fibre and epoxy resin, which together determine more than 80% of the total life cycle impact. Transport, manufacturing, installation, and packaging play only a marginal role. The contribution of end-of-life processes, though smaller, is sensitive to assumptions regarding distances and treatment routes and therefore warrants transparent documentation in the EPD. From a methodological perspective, the model represents a conservative scenario, assuming negligible recycling or reuse. Consequently, improvement strategies should focus on optimising material formulations, increasing recycled content, adopting renewable energy sources in production, and evaluating circular end-of-life pathways that could reduce the overall environmental burden and enhance module D credits.

In summary, the BCR product family exhibits an environmental profile dominated by material production and upstream energy demand, with all other life cycle stages contributing comparatively little.

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 in 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.

Indicator	BCR diameter (mm)					
	3.00	4.00	6.00	8.00	10.00	12.00
GWP-total	0.20	0.29	0.63	0.95	1.55	2.18
GWP-fossil	0.20	0.29	0.63	0.95	1.55	2.18
GWP-biogenic	0.18	0.25	0.60	0.96	1.58	2.21
GWP-luluc	0.18	0.29	0.64	0.95	1.52	2.20
ODP	0.08	0.35	0.72	0.99	1.30	2.02
AP	0.17	0.26	0.61	0.96	1.57	2.22
EP-freshwater	0.19	0.29	0.64	0.97	1.51	2.15
EP-marine	0.17	0.26	0.61	0.96	1.57	2.22
EP-terrestrial	0.17	0.26	0.61	0.96	1.57	2.23
POCP	0.17	0.28	0.62	0.96	1.55	2.18
ADPe	0.14	0.22	0.58	0.96	1.60	2.29
ADPf	0.20	0.30	0.63	0.95	1.54	2.17
WDP	0.21	0.28	0.60	0.97	1.55	2.23

Additional environmental information

Maximum variation between products

Indicator	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-total	167%	107%	0%	0%	1%	1%	1%	1%	74%
GWP-fossil	167%	107%	0%	0%	1%	1%	1%	1%	83%
GWP-biogenic	170%	107%	0%	0%	1%	1%	1%	1%	237%
GWP-luluc	169%	105%	0%	0%	1%	1%	1%	1%	219%
ODP	185%	107%	0%	0%	1%	1%	1%	1%	71%
AP	172%	90%	0%	0%	1%	1%	1%	1%	104%
EP-freshwater	168%	104%	0%	0%	1%	1%	1%	1%	154%
EP-marine	172%	87%	0%	0%	1%	1%	1%	1%	146%
EP-terrestrial	172%	87%	0%	0%	1%	1%	1%	1%	124%
POCP	171%	88%	0%	0%	1%	1%	1%	1%	75%
ADPe	177%	100%	0%	0%	1%	1%	1%	1%	168%
ADPf	167%	107%	0%	0%	1%	1%	1%	1%	65%
WDP	166%	114%	0%	0%	1%	1%	1%	1%	127%

Additional environmental information

Data sources

Process	Source type	Source	Reference year	Data category	Share of primary data, of GWP-GHG results for A1-A3
Product manufacturing	Collected data	EPD owner	2024	Primary data	0.96%
Electricity consumption during production	Database	Ecoinvent v3.10	2024	Secondary data	0%
Raw material transportation	Database	Ecoinvent v3.10	2024	Secondary data	0%
Transport of packaging materials	Database	Ecoinvent v3.10	2024	Secondary data	0%
Epoixy resin production	Database	Ecoinvent v3.10	2024	Secondary data	0%
Glass fibres production	Database	Ecoinvent v3.10	2024	Secondary data	0%
Epoxy production	Database	Ecoinvent v3.10	2024	Secondary data	0%
Resin additives production	Database	Ecoinvent v3.10	2024	Secondary data	0%
Polyester fibres prodution	Database	Ecoinvent v3.10	2024	Secondary data	0%
Packaging tape production	Database	Ecoinvent v3.10	2024	Secondary data	0%
Other processes	Database	Ecoinvent v3.10	2024	Secondary data	0%
Total share of primary data, of GWP-GHG results for A1-A3					0.40%

Version history

- Version 1.0 | 2025-11-12 | Initial publication of the EPD for the product “Braided Composite Rebars”.
- Version 2.0 | 2025-11-21 | Editorial correction and addition of data quality information.

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Data Quality												
Data	Data Quality						Other parameters					
	P	C	TiR	GR	TeR	M						
Raw materials production												
Input							Data type	Source / Reference	Year / Reference period	Geographical representativeness	Technological representativeness	Contribution to the GWP-GHG
Glass fibers	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	21.70%
Epoxy resin	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	11.70%
Epoxy hardener	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	not relevant for 80%
Epoxy Curing Agent	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	not relevant for 80%
Epoxy Catalyst	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	not relevant for 80%
Epoxy catalys	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	not relevant for 80%
Polyester fibers	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	Global	Production	5.76%
Cardboard packaging material	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Plastic packaging	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Floor separator	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Cardboard lid	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Stretch film	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Inner packaging bag	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Roll bag	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Jerrycan	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
IBC container	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%
Packaging tape	1	2	1	2	2	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10	2024	EU	Production	not relevant for 80%

Raw material transport												
Input												
Glass fibers transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Glass fibers transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Glass fibers transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy Resin transport supplier 1	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy Resin transport supplier 2	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy hardener transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy Curing Agent transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy Catalyst transport supplier 1	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy Catalyst transport supplier 2	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Epoxy catalyst transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Polyester fibers transport supplier 1	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Polyester fibers transport supplier 2	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Polyester fibers transport supplier 2	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%
Packaging tape transport	1	1	1	2	1	1	Primary (distance) / secondary (truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%

A3.1 Mixing components (manual)												
Output												
Jerrycan Recycling	1	2	1	2	2	1	Primary (quantity) / secondary (recycling process)	ecoinvent v3.10	2024	EU	Recycling	not relevant for 80%
A3.2 Winding												
Input												
Winding energy consumption	1	1	1	1	1	1	Primary (quantity) / secondary (energy production)	ecoinvent v3.10	2024	Portugal	Energy consumption in LRC process	not relevant for 80%
Output												
Recycling of cardboard waste	1	2	1	2	1	1	Primary (quantity) / secondary (recycling process)	ecoinvent v3.10	2024	EU	Recycling	not relevant for 80%
Plastic packaging recycling	1	2	1	2	2	1	Primary (quantity) / secondary (recycling process)	ecoinvent v3.10	2024	EU	Recycling	not relevant for 80%
A3.2 Pultrusion												
Input												
Pultrusion energy consumption	1	1	1	1	1	1	Primary (quantity) / secondary (energy production)	ecoinvent v3.10	2024	Portugal	Energy consumption in LRC process	not relevant for 80%
Output												
Rejected product	1	2	1	2	2	1	Primary (quantity) / secondary (End-of-life process)	ecoinvent v3.10	2024	Global	Treatment of waste plastic - sanitary landfill	not relevant for 80%
Recycling of polyethylene waste	1	2	1	2	2	1	Primary (quantity) / secondary (recycling process)	ecoinvent v3.10	2024	EU	Recycling	not relevant for 80%
Recycling of cardboard waste	1	2	1	2	2	1	Primary (quantity) / secondary (recycling process)	ecoinvent v3.10	2024	EU	Recycling	not relevant for 80%
A4. Distribution												
Input												
Transportation of packaged rebars to the customer	1	1	1	2	1	1	Secondary (distance and truck process)	ecoinvent v3.10	2024	EU	Transport	not relevant for 80%

A5. Installation of the product												
Input												
Nylon zip lock	1	1	1	2	1	1	Primary (quantity) / secondary (production process)	ecoinvent v3.10/ supplier datasheet	2024	EU	Production	5.61%
Output												
Recycling PP	1	2	1	2	2	1	Primary (quantity) / secondary (recycling process)	ecoinvent v3.10	2024	EU	Recycling	not relevant for 80%
C1. Deconstruction/demolition of the product												
Input												
Diesel (Demolition reinforced concrete)	3	1	1	2	2	1	Secondary	ecoinvent v3.10	2024	Global	Demolition process	not relevant for 80%
C2. Transport of the product as waste to a waste processing unit												
Input												
Transportation of waste	1	1	1	2	1	1	Secondary (distance and truck process)	ecoinvent v3.10	2024	EU	Transport	37.20%
C3. Waste processing of the final product as waste												
Input												
Diesel (Loading and unloading at sorting facility)	3	1	1	2	2	1	Secondary	ecoinvent v3.10	2024	Global	Waste treatment	not relevant for 80%
Electricity (Mechanical sorting)	3	1	1	2	2	1	Secondary	ecoinvent v3.10	2024	Global	Waste treatment	not relevant for 80%
Diesel (Crushing of concrete)	3	1	1	2	2	1	Secondary	ecoinvent v3.10	2024	Global	Waste treatment	not relevant for 80%
C4. Disposal of the final product as waste												
Input												
Diesel (Compacting of inert construction waste for landfills)	3	2	1	2	2	1	Secondary	ecoinvent v3.10	2024	Global	Waste treatment	not relevant for 80%
											Total contribution	81.97%

Results						
Average	1.21	1.52	1.00	1.96	1.58	1.00
DRQ	1.61					

Basic quality