Environmental Product Declaration

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:

GRP Ballast Board

from

Complete Composite Systems Ltd

Programme:	The International EPD® System, www.environdec.com
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General information

Programme information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
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Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product Category Rules (PCR): EPD International Product Category Rules (PCR) for construction products (PCR 2019:14 v1.2.5). The product group classification for the assessed products is UN CPC 36990.
PCR review was conducted by: The Technical Committee of the International EPD System. See https://www.environdec.com/about-us/the-international-epd-system-about-the-system for a list of members. Review chair: Claudia Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat https://www.environdec.com/contact-us.
Life Cycle Assessment (LCA)
LCA accountability: Dr Matthew Fishwick, Fishwick Environmental Ltd
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☒ EPD verification by individual verifier Third-party verifier: Dr Hüdai Kara – Managing Director at Metsims Sustainability Consulting Approved by: The International EPD® System
Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☒ No

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 units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply

identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

Company information

Owner of the EPD: Complete Composite Systems Ltd (CCS).

Contact: Ron Brown, Technical Director, Graylands, 503 Broadway, Letchworth, England, SG6 3PT, United Kingdom. +44(0)1462 379000. info@completecomposites.co.uk.

Description of the organisation: Complete Composite Systems Ltd designs, manufactures and markets quality composite and engineered plastic products.

Name and location of production site(s): The product assessed in this study is manufactured by a confidential contract manufacturer of Complete Composite Systems Ltd.

Product information

Product name: GRP Ballast Board.

Product identification: GRP Ballast Board.

Product description: GRP Composite Ballast Boards are a glass-fibre reinforced polyester (GRP) ballast board that offers reduced weight for easier installation, while retaining the strength to remain undamaged during transport and to resist damage when under load. GRP Ballast Boards are suitable for a multitude of uses, such as retaining ballast and protecting railway tracks and trackside facilities on embankments from rockfall and snowslide. The interlocking boards slot into steel or composite posts to form a barrier. They are fabricated from isophthalic polyester pultruded profiles, whilst vinyl ester is the resin system used to resist the corrosive attack to the posts due to the alkaline nature of concrete. Both resin systems are fire retardant, and contain UV inhibitors, whilst the outer surface of the profiles are encapsulated within a polyester surface veil, ensuring excellent weatherability, and no long-term drop-off in strength.

UN CPC code: The product group classification for the assessed product is UN CPC 36990.

Geographical scope: Europe.

Further product information: https://www.completecomposites.co.uk/

LCA information

Functional unit / declared unit: One unit of standard size GRP Ballast Board (13.1 kg).

Reference service life: n/a

Time representativeness: 2022.

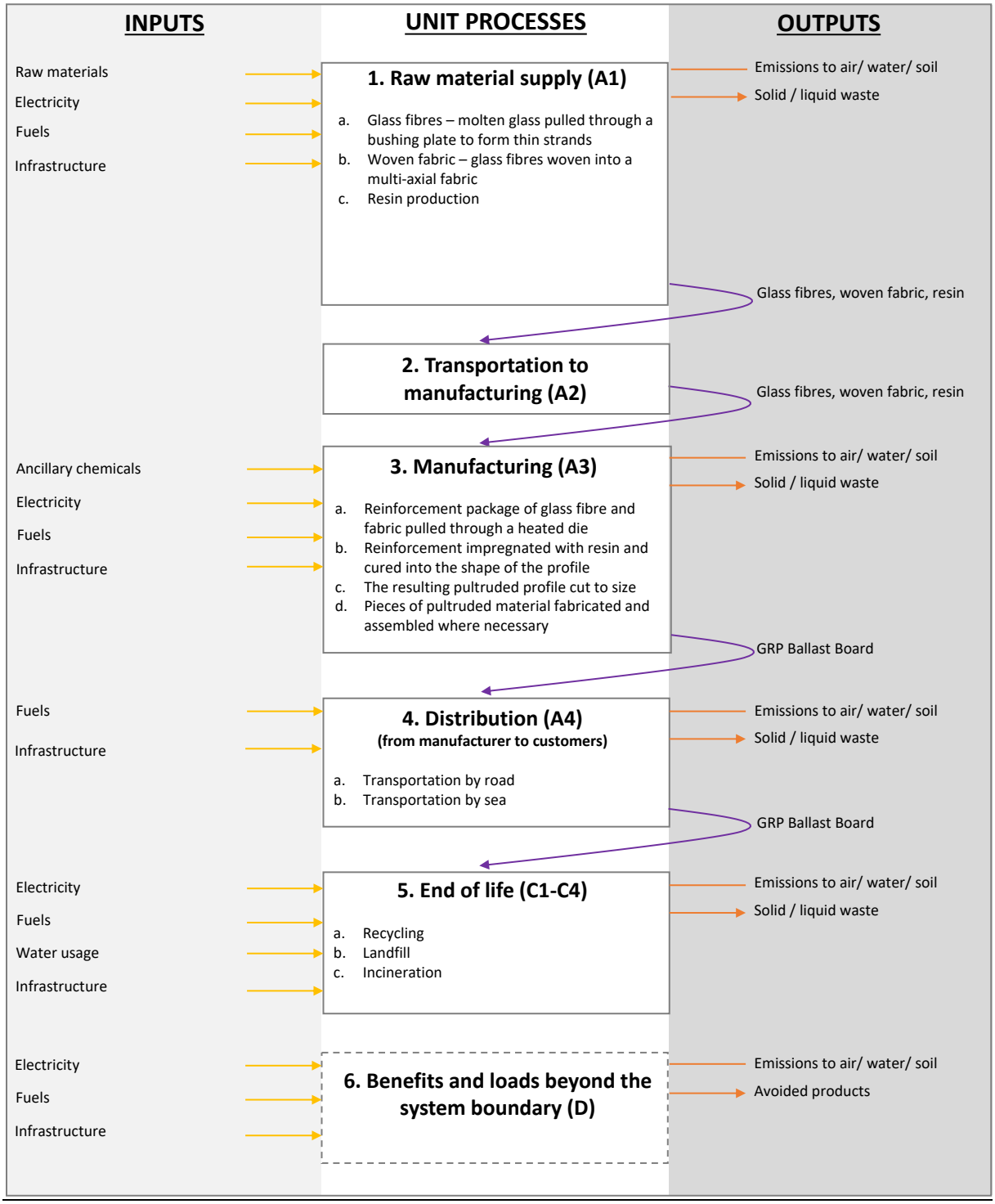
Database(s) and LCA software used: All secondary data were from Eugeos' 15804+A2_IA v4.1 extended version of ecoinvent v3.6 (cut-off), the LCA software openLCA (version 1.10.3) and Microsoft Excel were used for modelling.

Description of system boundaries: The system boundary of a product system determines the unit processes to be included in the LCA study and which data as inputs and/or outputs to/from the system can be omitted. In this LCA study and resulting EPD, the system boundary includes extraction/cultivation of raw materials, processing of raw materials, production of the finished product, end-of-life and all transportation and waste stages until the grave stage. This “cradle-to-gate with options” boundary comprises the following modules given in EN 15804:2012+A2:2019: the product, construction, and end-of-life stages and benefits/loads beyond the system boundary (modules A1-A4, C1-C4, D).

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	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	GLO	GLO	GLO	GLO	-	-	-	-	-	-	-	-	Europe				Europe
Specific data used	10%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

System diagram:



Yellow line = input of material/energy, orange line = output of waste/direct emission, purple line = output of product/co-product, arrowhead on line = transportation stage considered.

Module A1 – raw material supply, comprising:

- Extraction and production of all raw materials for the production of GRP Ballast Board, including:
  - Reuse of products or materials from a previous product system;
  - Processing of secondary materials used as input for manufacturing the product, but not including those processes that are part of the waste processing in the previous product system;
  - Generation of electricity, steam, and heat from primary energy resources, also including their extraction, refining and transport; and
  - Energy recovery and other recovery processes from secondary fuels, but not including those processes that are part of waste processing in the previous product system.

Module A2 – transport, comprising:

- Transportation of raw materials to manufacturing site from direct suppliers, i.e. from previous production or extraction process.

Module A3 – manufacturing:

- Manufacturing of GRP Ballast Board units ready for transportation to customer, including:
- Production and use of operating and auxiliary materials consumed;
- Production of intermediate packaging materials, incl. such that are necessary to protect the products during their transport from the manufacturing site to the project site;
- Direct emissions to air, water or soils; and
- Treatment of waste generated from the manufacturing and assembly of main parts.

Module A4 – transport:

- Transportation of GRP Ballast Board from manufacturing site to the project site.

Module A5 – construction-installation process (excluded):

- This module is excluded due to uncertainty in the scenario details. It is not known the type of posts used, whether these posts were already existing before installation of GRP Ballast Board, or the type and quantity of material used to fix posts into the ground.

Module C1-C4 – end-of-life:

- GRP Ballast Board are removed using a manual process.
- Transportation of deconstructed GRP Ballast Board from the project site to the waste processing site.
- Waste processing and disposal via incineration with energy recovery, recycled, and landfill.

Module D – reuse, recovery, recycling potential:

- Net benefits and loads arising from the recycling of materials and/or recovery of energy from the product.

<u>Cut-off criteria and exclusions:</u>

In the process of building an LCI it is typical to exclude items considered to have a negligible contribution to results. In order to do this in a consistent and robust manner there must be confidence that the exclusion is fair and reasonable. To this end, cut-off criteria were defined in this study, which allow items

to be neglected if they meet the criteria. In accordance with EPD International's PCR for construction products (PCR 2019:14), exclusions could be made if they were expected to be within the below criteria:

- A process can be excluded if it contributes to <1% of the total mass or energy input of a unit process;
- A maximum of 5% of the total mass or energy of the lifecycle can be excluded; and
- The excluded process doesn't meet the following exceptions:
  - Significant effects on energy use in extraction, use or disposal;
  - Significant environmental relevance (i.e. likely to contribute to an increase/decrease in impacts of more than 1%); and
  - Are classed as hazardous waste.

The follow exclusions from the scope of the study were made:

- Human and animal energy inputs to processes;
- Transport of employees to and from their normal place of work and business travel;
- Environmental impacts associated with support functions (e.g. R&D, marketing, finance, management etc.);
- Composite posts required for installation of GRP Ballast Board – although the impact of these ancillary products can be calculated using conversion factors provided in additional information of the EPD; and
- All excavation and filling activities required for installation.

Allocation procedures:

For cases where there is more than one product in the system being studied, EPD International's PCR for construction products (PCR 2019:14) prescribes the following procedure for the allocation of material and energy flows and environmental emissions.

- In the first instance, allocation should be avoided, by process sub-division.
- Where these methods are not applicable, the ISO 14040/44 requires that allocation reflects the physical relationships of the different products or functions. Allocation based on physical relationships such as mass or energy is a practical interpretation of this and is an approach often used in LCA.
- For some processes, allocation based on mass is not considered appropriate and, in these cases, economic allocation is used.

In this study, allocation procedures for multi-product processes followed the approach above. In terms of co-product allocation of generic data, the main database used, ecoinvent v3.6 (cut-off), defaults to an economic allocation for most processes. However, in some cases a mass-based allocation is used, where there is a direct physical relationship. The allocation approach of specific ecoinvent modules is documented on their website and method reports (see www.ecoinvent.org).

In this study a "cut-off" method (aka recycled content or 100:0 approach) was applied to all cases of end-of-life allocation, including in the case of generic data, where the ecoinvent v3.6 with a cut-off by classification end-of-life allocation method was used. In this approach, environmental burdens and benefits of recycled / reused materials and recovered energy are given to the product system consuming them, rather than the system providing them and are quantified based on recycling content of the material under investigation. The cut-off point is where an end-of-waste state is reached, including any sorting, cleaning, and processing of waste prior to recycling, reuse, or energy recovery, following the "polluter pays principle". This is a common approach in LCA for materials where there is a loss in inherent properties during recycling, the supply of recycled material exceeds demand and recycled content of the product is independent of whether it is recycled downstream. It is in

conformance with the ISO standards on LCA, EN 15804, EN 15978 and is prescribed in EPD International's PCR for construction products (PCR 2019:14). The exception to the use of this end-of-life allocation method was for module D, where net loads and benefits beyond the system boundary, are presented separately. The end-of-waste status for GRP Ballast Board, which is assumed to be 100% incinerated with energy recovery (with thermal efficiency >60%), is prior to incineration.

Data sources:

Quantitative and qualitative data were collected for all processes within the system boundary and these data were used to compile the LCI. These comprised specific data (primary data) and generic data (secondary data). To explain the distinction between these categories, specific data directly refer to the product under investigation, for example the amount of electricity consumed at a Complete Composite Systems' contract manufacturer's site. Generic data do not directly refer to the product under investigation but refer to a similar process and fulfil the data quality criteria defined for this study.

Primary/specific data were sought as a preference and were collected from Complete Composite Systems' contract manufacturers. These specific data were collected using data collection sheets via an iterative process and represent a time period from 2022.04.01 to 2023.03.31. Generic data were collected for all other lifecycle stages from Eugeos' 15804+A2_IA v4.1 extended version of ecoinvent v3.6 (cut-off).

Secondary/generic data were chosen to be to be as geographically specific as possible, however, this was not always possible. In these cases, a geography was selected to match the technology, feedstock source etc., as closely as possible.

Note that no energy values were calculated from volumes or masses of fuels by the LCA practitioners as they were provided in units of energy, however, volume and mass to energy unit conversions have been carried out in the ecoinvent v3.6 (cut-off) database and for this the lower heating value was used throughout.

Scenario parameters:

Transportation to customer (A4) scenario parameters modelled in this EPD comprise:

- Vehicle type used for transport: >32 tonne EURO 4 lorry (road) and container ship (sea).
- Distance: 1,053 km road and 11,577 km sea.
- Capacity utilisation, including return trips: 37% (road) and 70% (sea).
- Bulk density of transported products: 1,850 kg / m^3.
- Volume capacity utilisation factor: 1.

End-of-life (C1-C4) scenario parameters modelled in this EPD comprise:

- Collection process specific by type: 13.1 kg collected separately and 0 kg collected with mixed construction waste.
- Recovery system specified by type: 0 kg for re-use, 0 kg and 13.1 kg for energy recovery.
- Disposal specific by type: 0 kg product for final disposal (landfill).
- Transportation assumptions: 50 km by municipal waste 21 metric ton lorry.

Benefits and loads beyond the system boundary (D) scenario parameters modelled in this EPD comprise:

- Waste treatment scenario: 100% energy recovery.

- For energy recovery, benefits were calculated assuming UK residual mix electricity and the following assumptions:
  - Conventional incineration with steam cycle electricity generation assumed;
  - Grid electricity the only avoided product; and waste heat not used, to adopt a conservative assumption;
  - Only 35% of the product is combustible (i.e. the resin component) and CV based on that of polyester resin of 35 MJ per kg; and
  - Overall electrical efficiency of energy from waste plant = 20% (minimum for electricity only, ERM, 2006).
- For energy recovery, loads were calculated assuming waste incineration.

Data quality: To ensure the quality of data were sufficient, data quality checks were completed in relation to time-related coverage, geographical coverage, technology coverage, completeness, and representativeness. Data quality indicators were applied using a data quality matrix whereby key data were assigned scores between 1 (best) and 5 (worst). All data scored between 1-3.

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/kg
Polyester resin	4.6	0%	0% and 0 kg C / kg
Glass fibre	6.3	0%	0% and 0 kg C / kg
Glass fibre multi-axial fabric	2.2	0%	0% and 0 kg C / kg
TOTAL	13.1	0%	0% and 0 kg C / kg

No substances that are listed in the “Candidate List of Substances of very high concern for authorisation” are contained in the GRP Ballast Board or the materials used to produce them. GRP Ballast Board contains 0% bio-based material.

Results of the environmental performance indicators

The environmental performance of one unit of standard size GRP Ballast Board is declared and reported using the parameters and units as specified in PCR 2019:14. These life cycle impact assessment results and other environmental results are presented in the tables below per declared unit (one unit of standard size GRP Ballast Board, equal to 13.1 kg), broken down by module.

Mandatory impact category indicators according to EN 15804

Results per one unit of standard size GRP Ballast Board								
Indicator	**Unit**	**A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq.	4.80E+01	2.71E+00	0.00E+00	6.18E-02	1.17E-01	0.00E+00	4.84E-01
GWP-biogenic	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GWP-luluc	kg CO_2 eq.	1.75E-02	1.38E-03	0.00E+00	5.50E-06	2.18E-06	0.00E+00	-8.08E-05
GWP-total	kg CO_2 eq.	4.80E+01	2.71E+00	0.00E+00	6.18E-02	1.17E-01	0.00E+00	4.84E-01
ODP	kg CFC 11 eq.	3.98E-06	5.80E-07	0.00E+00	1.31E-08	8.01E-10	0.00E+00	-2.44E-08
AP	mol H^+ eq.	2.60E-01	5.30E-02	0.00E+00	3.72E-04	3.00E-05	0.00E+00	-7.60E-04
EP-freshwater	kg P eq.	8.42E-03	4.97E-04	0.00E+00	3.40E-06	7.52E-07	0.00E+00	-5.68E-05
EP-marine	kg N eq.	4.00E-02	1.33E-02	0.00E+00	1.59E-04	1.50E-05	0.00E+00	-9.08E-05
EP-terrestrial	mol N eq.	4.07E-01	1.47E-01	0.00E+00	1.74E-03	1.34E-04	0.00E+00	-1.05E-03
POCP	kg NMVOC eq.	1.44E-01	3.97E-02	0.00E+00	6.08E-04	3.35E-05	0.00E+00	-2.94E-04
ADP-minerals&metals*	kg Sb eq.	4.65E-04	3.23E-05	0.00E+00	3.69E-07	4.42E-08	0.00E+00	-2.18E-07
ADP-fossil*	MJ	8.34E+02	3.79E+01	0.00E+00	7.98E-01	2.53E-02	0.00E+00	-4.97E+00
WDP*	m^3	3.15E+02	1.06E+01	0.00E+00	4.85E-01	9.37E-02	0.00E+00	-1.27E+01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption							

** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

***Disclaimer: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive*

waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Additional mandatory and voluntary impact category indicators

Results per one unit of standard size GRP Ballast Board								
Indicator	**Unit**	**A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-GHG[1]	kg CO_2 eq.	4.80E+01	2.71E+00	0.00E+00	6.18E-02	1.17E-01	0.00E+00	4.84E-01
PM	Disease incidence	2.25E-06	1.59E-07	0.00E+00	8.40E-09	2.02E-10	0.00E+00	-1.12E-09
IRP**	kBq U235 eq.	2.37E+00	1.77E-01	0.00E+00	3.76E-03	1.92E-04	0.00E+00	-2.41E-01
ETP-fw*	CTUe	5.00E+01	1.02E+00	0.00E+00	4.16E-03	7.76E-04	0.00E+00	-6.35E-03
HTP-c*	CTUh	2.39E-08	1.13E-09	0.00E+00	6.31E-12	1.90E-11	0.00E+00	8.20E-11
HTP-nc*	CTUh	1.24E-06	3.72E-08	0.00E+00	2.44E-10	1.23E-09	0.00E+00	-4.51E-09
SQP*	dimensionless	7.28E+01	2.90E+01	0.00E+00	7.90E-03	1.04E-03	0.00E+00	-1.14E-02

Note that the LCIA results are relative expressions and do not predict impacts on category end-points, the exceeding of thresholds, safety margins or risks.

Resource use indicators

Results per one unit of standard size GRP Ballast Board								
Indicator	**Unit**	**A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	8.39E+01	3.36E-01	0.00E+00	4.18E-03	2.05E-03	0.00E+00	-2.61E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	8.39E+01	3.36E-01	0.00E+00	4.18E-03	2.05E-03	0.00E+00	-2.61E-01
PENRE	MJ	6.98E+02	3.83E+01	0.00E+00	8.03E-01	2.81E-02	0.00E+00	-8.05E+00
PENRM	MJ	1.63E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	8.61E+02	3.83E+01	0.00E+00	8.03E-01	2.81E-02	0.00E+00	-8.05E+00
SM	kg	9.69E-02	1.47E-02	0.00E+00	1.03E-04	2.70E-05	0.00E+00	-3.31E-04

[1] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

RSF	MJ	3.00E-01	7.98E-03	0.00E+00	7.95E-05	5.15E-05	0.00E+00	-2.39E-03
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	3.50E-01	1.74E-03	0.00E+00	8.65E-05	4.35E-05	0.00E+00	-9.97E-04
Acronyms	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 re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water							

Waste indicators

Results per one unit of standard size GRP Ballast Board								
Indicator	**Unit**	**A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.63E+00	4.51E-02	0.00E+00	2.80E-04	8.79E-04	0.00E+00	-1.50E-02
Non-hazardous waste disposed	kg	4.20E+01	2.44E+00	0.00E+00	8.73E-03	5.44E-02	0.00E+00	6.55E-02
Radioactive waste disposed	kg	7.71E-03	2.61E-04	0.00E+00	6.00E-06	7.60E-08	0.00E+00	-6.01E-05

Output flow indicators

Results per one unit of standard size GRP Ballast Board								
Indicator	**Unit**	**A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
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
Material for recycling	kg	6.66E-02	1.57E-02	0.00E+00	9.00E-05	2.40E-05	0.00E+00	-1.74E-04
Materials for energy recovery	kg	3.34E-03	9.27E-05	0.00E+00	8.97E-07	5.32E-07	0.00E+00	-2.61E-05
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Interpretation

The following conclusions can be drawn from this study:

- The cradle-to-grave carbon footprint of GRP Ballast Board, (per declared unit) was calculated to be 51 kg CO_2e;
- Raw material supply (A1) is the dominant hotspot for almost all impact categories;
- The main contributors to A1 are polyester resin and glass fibre manufacture;
- Manufacturing (A3) is another hotspot for the majority of impact categories, with the exception of ETP-fw, where it is immaterial;
- Transport to consumer (A4) makes a notable contribution for many impact categories, mostly due to sea transport;
- Modules A4, and C1 have a minor to immaterial contribution for all impact categories; and
- Module A2 makes a notable contribution for SQP only.

Additional environmental information

This EPD provides results for one unit of standard size GRP Ballast Board. Impacts results are directly proportional to mass, therefore results for other variants in the product range and associated Complete Composite Systems composite posts can be calculated by dividing the impact result by 13.1 kg and then multiplying by the mass (in kg) of the board or post provided in the product specification.

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