Environmental Product Declaration of Greencor sheet, Hicem & Hilux board

In accordance with EN 15804 and ISO 14025

RAMCO INDUSTRIES LTD.(RIL)

June 2019

EPD registration number:	S-P-01410
Publication date:	2019.06.07
Validity date:	2024.06.06
Geographical scope:	India

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1. Introduction

This current declaration aims to provide the effects measurable and verifiable for the environmental assessment of 1 m^2 of fibre cement product (Greencor, Hicem and Hilux) manufactured at Ramco Industries Ltd. (RIL)

Ramco Industries Ltd. (RIL) is one of the leading building material manufacturer company in South Asia and has been on the forefront of innovation answering perplexing challenges with defensive solutions. Ramco's first plant to manufacture roofing sheet was set up at Arakkonam, Tamil Nadu in 1967. Apart from the Arakkonam plant, the company operates eight modern plants manufacturing high quality fibre cement roofing sheets in India today. The present aggregate capacity for Fibre Cement Sheet manufacture in India is over 7 lakh tons per annum.

Ramco Industries Ltd introduced the Ramco Hilux Calcium Silicate Board, a versatile building material, using technology from the A & A Corporation, Japan. These boards are rapidly replacing conventional building materials such as Gypsum boards, Plywood & Plaster of Paris across the international markets by virtue of their sheer versatility. RIL enables an age of Green Buildings and supporting a truly sustainable future resource.

Life Cycle Assessment approach is one of the key tool for evaluating and assessing the environmental impacts associated with resource consumption, energy consumption, emissions, effluent and solid waste generation during the life span of the product. It means the study helps in identifying the "hot-spots" with respect to various environment parameters at various stages of production process value chain.

The EPD is declared for a fibre cement product manufactured at 2 locations (Arakkonam & Keshwana) of RIL.

The LCA conducted is in accordance with PCR 2012:01 version 2.3 Construction products and construction services (EN 15804) for preparation of Environmental Product Declaration (EPD) in The International EPD System.

2. General Information

2.1 EPD, PCR, LCA Information

Table 1 EPD Information

Programme	**The International EPD® System,** www.environdec.com
Program operator	EPD International AB Box 210 60, SE- 100 31 Stockholm, Sweden.
Declaration holder	Mr. A Anantharaj "Auras Corporate Centre" 98-A, Dr. Radhakrishnan Road Mylapore, Chennai - 600 004 Tamil Nadu, India Email: cpd@ril.co.in; asb@ril.co.in; raj@ril.co.in
Product	Fibre Cement Product, CPC Code: 3752
Reference standards	IS0 14025:2006; 1SO 14001; 1SO 14040/44 EN 15804:2012

Table 2 PCR Information

Reference PCR	PCR 2012:01 Construction products and construction services, version 2.3 in compliant with EN 15804
Date of Issue	
Period of Validity	

Table 3 Verification Information

Demonstration of verification	External, independent verification
Third party verifier	Sunil Kumar C S, Senior Consultant, India Email: cssunil67@gmail.com

Table 4 LCA Information

Title	Environmental Product Declaration of Greencor sheet, Hicem & Hilux board
Preparer	Dr. Rajesh Kumar Singh Thinkstep Sustainability Solutions Pvt. Ltd. 421, MIDAS, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai, India - 400059 Email: rajesh.singh@thinkstep.com
Reference standards	ISO 14040/44 standard

2.2 Reference Period of EPD Data

The reference period for the data used within this EPD is the year April' 2017 – March' 2018

2.3 Geographical Scope of EPD Application

The geographical scope of this EPD is India.

2.4 Additional Information about EPD

RIL manufactures Greencor Roofing Sheet, Hicem Fibre Cement Board and Hilux Calcium Silicate Board of varying thicknesses at their Arakkonam and Keshwana plants. The EPD is declared for 1 m^2 of Fibre cement Product of varying thicknesses for the year April 2017 – March 2018. The target group of EPD are Green Building Certification Program holders and consultants, customers, project developers, statutory agencies and government.

This EPD is in accordance with ISO 14025 and EN 15804. EPD of construction products may not be comparable if they do not comply with EN 15804. Product Category Rules (PCR) used for the assessment of the environmental performance of fibre cement product is PCR 2012:01 Construction products and construction services, version 2.3, in compliant with EN 15804 in The International EPD System.

The environmental impacts are calculated on the basis of the functional unit wherein each flow related to material consumption, energy consumption, emissions, effluent and waste is scaled to the reference flow.

The processes listed below for the production of the final product including primary packaging is included. The processes which are mandatory to be included in plant operation, in particular are:

- Raw material production (mining and crushing)
- Mixing of raw material
- Production
- Pre- heating and/or autoclave
- Storage and Dispatch of the fibre cement product manufactured.

The installation of fibre cement product in buildings is not included whereas end of life is included. Inbound transportation of raw materials, fuel and outbound transportation of fibre cement product is included.

3. Product Description and System Boundaries

3.1 Product Identification and Usage

Fibre cement board product is generally made by preheating and autoclave the slurry prepared from mixing the raw materials like silica, cellulose fibre, cement, additives etc. with water. This method gives the sheet uniform thickness. The present declaration is conducted for 1 m^2 of fibre cement board product manufactured at Arakkonam and Keshwana locations of RIL.

Greencor is new age non-asbestos roofing material made with the finest quality Portland cement, natural mineral binders and synthetic fibres which gives an exceptional properties and edge over metal roofing sheet.

The Hicem boards are manufactured using cement, cellulose fibres and special additives as per IS:14862- 2000 in a laminar process to give a stable crystalline structure which makes the board durable and dimensionally stable and provides superior sound and thermal insulation properties.

Ramco's flagship product in the green line up is Hilux. It is a calcium silicate board made from siliceous and calcareous material reinforced with cellulose fibres. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. Hilux finds niche applications across wide spectrum of industries including Pharma, Hospitality, Textile, Engineering, Information Technology and Medical care.

The location for the fibre cement board production details have been presented in the table 5.

Table 5 Production Location of RIL

	Arakkonam	Arakkonam	Keshwana
Product	Greencor	Hicem	Hilux
Total Production (Kg)	3945720	30050518	23623000
Thermal Conductivity (W/mK)	0.18	0.18	0.15
Density (kg/m^3)	1350	1200	900
Thickness (mm)	6	4, 6, 8, 10, 12, 16 & 18	6, 8, 10 & 12

Greencor and Hicem production data have been taken from Arrakonam plant and Hilux production data has been taken from Keshwana plant.

Declaration of the main products components and/or materials

The fibre cement product is made up of silica sand, cellulose fibre, Portland cement, fly ash and so on.

At the date of issue of this declaration, there is no "Substance of Very High Concern" (SVHC) in concentration above 0.1% by weight, and neither do their packaging, following the European REACH regulation (Registration, Evaluation, Authorization and Restriction of Chemicals).

3.2 Product Manufacturing

The main steps in fibre cement board manufacturing process are:

3.2.1 Raw Material Mixing

Mix of raw materials (silica, fly ash, lime, cellulose fibre and Portland cement) to form a slurry to which additives and other compounds are added depending on the desired properties.

3.2.2 Production

Composite production by Hatschek process through deposition of slurry on a porous fabric belt positioned on a series of support rolls depending on the desired thickness (from 4 to 18 millimeters).

3.2.3 Pre- heating and/or Autoclave

Moisture is mostly drained off by the application of vacuum to the slurry and product final shape and dimensions are obtained.

3.2.4 Storage and Dispatch

The fibre cement product is then stored in warehouses which is then dispatched to the corresponding locations.

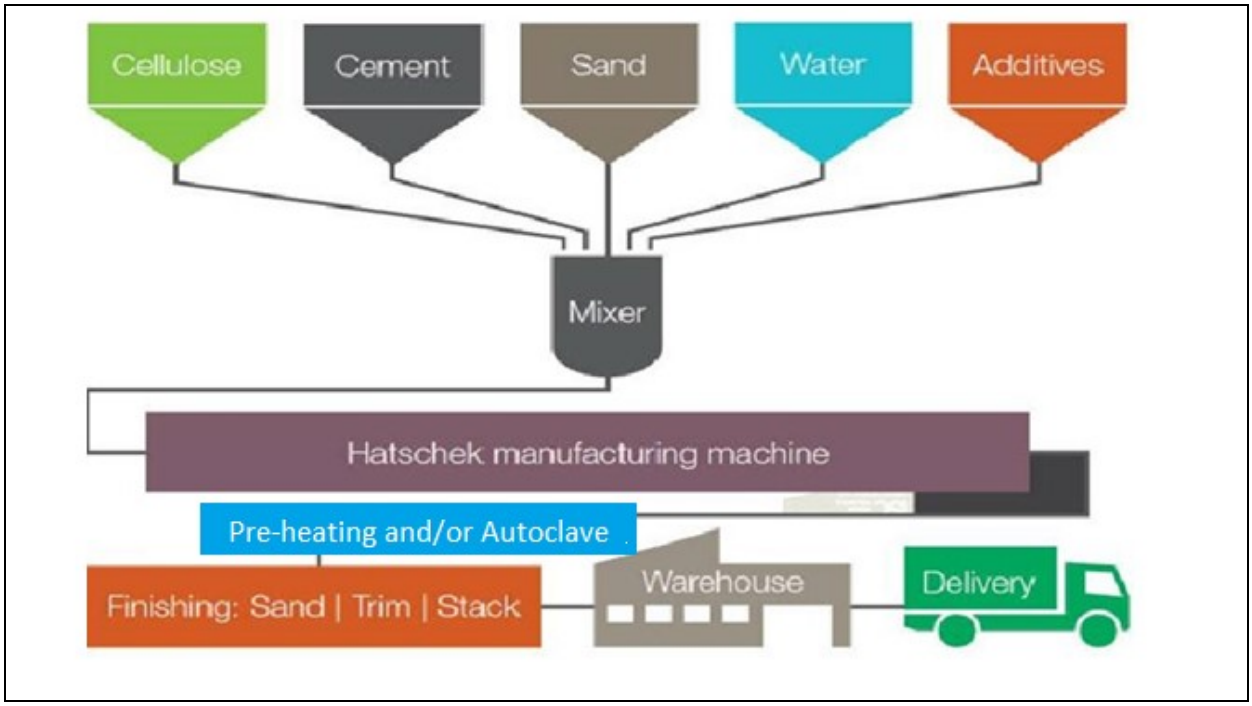


Figure 1 Manufacturing Process Flow Diagram of Fibre Cement Product

3.3 System Boundaries

The LCA model of fibre cement product represents a cradle-to-gate with option system starting from raw materials extraction, processing of fibre cement product (A1 to A3), transport from supplier to the building site (A4) and ending with the end of life of waste (C4). The table below shows the description of the system boundary considered for conducting the LCA of fibre cement product. The environmental impacts of all the other stages in the life cycle of fibre cement product are not assessed (MNA).

Table 6 Description of the system boundary (X = Included in LCA, MNA = Module Not Assessed)

Product Stage			Installation Stage		Use stage							End-of-Life Stage				Benefits beyond system boundary
Raw material supply	Transport	Manufacturing	Transport to building site	Installation into building	Use / application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to EoL	Waste processing for reuse, recovery or recycling	Disposal	Reuse, recovery or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	MNA	MNA	MNA	MNA	MNA	MNA	MNA	MNA	MNA	MNA	MNA	X	MNA

Table 7 summarizes those processes that are included within the system boundaries of the study.

Table 7 Details of System Boundary Included in the Study

Life Cycle stages	Life Cycle sub-stages	Definitions	Module
Materials	Primary raw materials production	Extraction, production of the raw materials such as silica, Portland cement, lime, cellulose etc.	A1
Upstream Transport	Ocean Rail and Road Transport	Transport of the raw materials	A2
Manufacturing	Fibre cement Production by mixing of raw materials.	Manufacturing and processing of fibre cement product	A3
Downstream Transport	Ocean and Road Transport	Average transport of the final product over the entire data collection period without any transport losses	A4
Disposal	Complete Landfill (100%), Allocation was not required	End of life of the waste	C4

All the module stages definitions are weighted average of the time period 2017-2018 and do not represent a particular scenario during the period.

The system boundary does not include:

- Capital equipment and maintenance of production facility
- Maintenance and operation of equipment
- Human labor
- Domestic water uses other than processes
- Use phase of the product

4. LCA

4.1 Information Sources and Data Quality

It is important that data quality is in accordance with the requirements of the LCA's goal and scope. This is essential to the reliability of LCA and achievement of the intended application. The quality of the LCI data for modelling the life cycle stages have been assessed according to ISO 14044 (ISO, 2006b). Data quality is judged by its precision (measured, calculated or estimated), completeness (e.g. are there unreported emissions?), consistency (degree of uniformity of the methodology applied on a LCA serving as a data source) and representativeness (geographical, time period, technology). To cover these requirements and to ensure reliable results, first-hand industry data in combination with consistent, upstream LCA information is used. The datasets have been used in LCA-models worldwide for several years in industrial and scientific applications for internal as well as critically reviewed studies. In the process of providing these datasets, they have been cross-checked with other databases and values from industry and science. RIL provided the most accurate and representative data for Fibre cement production. For all data requirements, primary data were used wherever possible.

4.2 Estimations and Methodology

4.2.1 Allocation procedures

As much as possible, allocation has been avoided by expanding the system boundaries.

4.2.2 Declared unit

The declared unit for the EPD is 1 m^2 of fibre cement product for different thicknesses.

4.2.3 Impact assessment

A list of relevant impact categories and category indicators is defined and associated with the inventory data. Various environmental impacts and emissions are associated with production of fibre cement, from raw material production, transport of materials to manufacturing site to final fibre cement production.

CML 2001 (January 2016) method developed by Institute of Environmental Sciences, Leiden University, Netherlands have been selected for evaluation of environmental impacts. These indicators are scientifically and technically valid.

The estimated impact results are only relative statements which do not indicate the end points of impact categories, exceeding threshold values, safety margins or risks.

A list of relevant impact categories and category indicators is defined and associated with the inventory data. PCR EN 15804 has been used to conduct the LCA. The PCR identifies the following LCI and LCIA.

1. Potential Environmental Impact (according with EN15804)
   - Global warming potential, GWP (100 years) (kg CO_2 equivalent)
   - Depletion potential of the stratospheric ozone layer, ODP (20 years) (kg CFC-11 equivalent)
   - Acidification potential of soil and water, AP (kg SO_2 equivalent)
   - Eutrophication potential, EP (kg PO_4^{3-} equivalent)
   - Formation potential of tropospheric ozone, POCP (kg Ethene (C_2H_2) equivalent)
   - Abiotic depletion potential (ADP-elements) for non-fossil resources (kg Sb equivalent)
   - Abiotic depletion potential (ADP-fossil fuels) for fossil resources (MJ, net calorific value)
2. Use of Natural Resources (according with EN15804)
   - Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (MJ, net calorific value)
   - Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (MJ, net calorific value)
   - Use of secondary material (kg)
   - Use of renewable secondary fuels (MJ, net calorific value)
   - Use of non- renewable secondary fuels (MJ, net calorific value)
   - Use of net fresh water (m^3)
3. Other Environmental Indicators
   - Hazardous waste (as defined by regional directives) disposed (kg)
   - Non-hazardous waste disposed (kg)
   - Radioactive waste disposed/stored (kg)
   - Components for re-use (kg)
   - Materials for recycling (kg)
   - Materials for energy recovery (kg)
   - Exported energy (MJ)

4.3 Cut Off Rules

Input and output data have been collected through detailed questionnaires which have been developed and refined. In practice, this means that, at least, all material flows going into the fibre cement production

processes (inputs) higher than 1% of the total mass flow (t) or higher than 1% of the total primary energy input (MJ) are part of the system and modelled in order to calculate elementary flows. All material flows leaving the product system (outputs) accounting for more than 1% of the total mass flow is part of the system. All waste output is below 1% by mass, so it is the part of cut off criteria.

4.4 Background Data

All relevant background datasets were taken from the GaBi-8 software database (2018) developed by thinkstep AG. To ensure comparability of results in the LCA, the basic data from the GaBi-8 database were used for fuel, energy, transportation and auxiliary materials.

4.5 Comparability

The EPD is established on the basis of the Product Category Rules (PCR 2012:01 Construction products and construction services, version 2.3, compliant with EN 15804 in The International EPD System.

According to these standards, EPDs do not compare the environmental performance of products in the construction sector. Any comparison of the declared environmental performance of products lies outside the scope of these standards and is suggested to be feasible only if all compared declarations follow equal standard provisions.

4.6 Results

As per PCR this section covers the environmental impacts of 1 m^2 of Greencor Roofing sheet of thicknesses 6 mm, Hicem Fibre Cement Board of thickness: 4 mm, 6 mm, 8 mm, 10 mm, 12 mm, 16 mm and 18 mm and Hilux Calcium Silicate Board of thickness: 6 mm, 8 mm, 10 mm and 12 mm respectively in the sub sections.

4.6.1 Greencor Roofing Sheet: 6 mm

Table 8 (a-c) show the life cycle environmental impacts for 1 m2 of Greencor Roofing Sheet for 6 mm thickness.

Table 8 (a) LCIA for 1 m2 of Greencor Roofing Sheet of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	9.33	0.44	0.13
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	7.32E-11	3.26E-13	1.23E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.047	0.006	0.0007
Eutrophication potential (EP)	kg PO_4^{3-}-eq	3.33E-03	6.48E-04	1.05E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	2.36E-03	4.90E-05	6.08E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	7.45E-06	4.88E-09	4.59E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	64.1	6.07	1.69

(b) Use of Natural Resources analysis for 1 m^2 of Greencor Roofing Sheet of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4

Renewable primary energy as energy carrier	MJ	24.1	0.02	0.20
Renewable primary energy resources as material utilization	MJ	7.18	0	0
Total use of renewable primary energy resources	MJ	31.28	0.02	0.20
Non-renewable primary energy as energy carrier	MJ	65.5	6.07	1.75
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	65.5	6.07	1.75
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.025	0.0001	0.0003

(c) Waste Category for 1 m^2 of Greencor Roofing Sheet of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	2.43E-07	3.84E-10	2.77E-08
Non-hazardous waste	Kg	0.03	0.00004	8.11
Radioactive waste	Kg	5.39E-04	1.74E-06	2.36E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.2 Hicem Fibre Cement Board: 4 mm

Table 9 (a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 4 mm thickness.

Table 9 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 4 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	3.51	0.42	0.08
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	3.92E-11	2.90E-13	7.30E-14
Acidification potential of land and water (AP)	kg SO_2-eq	0.023	0.007	0.0005
Eutrophication potential (EP)	kg PO_4^{3-}-eq	1.62E-03	7.90E-04	6.24E-05

Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	1.13E-03	2.15E-04	3.60E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	3.13E-06	4.53E-09	2.72E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	28	5.69	1

(b) Use of Natural Resources analysis for 1 m^2 of Hicem Fibre Cement Board of thickness 4 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	15.7	0.02	0.12
Renewable primary energy resources as material utilization	MJ	4.64	0	0
Total use of renewable primary energy resources	MJ	20.34	0.02	0.12
Non-renewable primary energy as energy carrier	MJ	28.8	5.69	1.04
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	28.8	5.69	1.04
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.013	0.00009	0.0002

(c) Waste Category for 1 m^2 of Hicem Fibre Cement Board of thickness 4 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	1.58E-07	3.56E-10	1.64E-08
Non-hazardous waste	Kg	0.035	0.00004	4.81
Radioactive waste	Kg	3.04E-04	1.55E-06	1.40E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.3 Hicem Fibre Cement Board: 6 mm

Table 10 (a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 6 mm thickness.

Table 10 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	5.26	0.63	0.12
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	5.88E-11	4.35E-13	1.09E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.034	0.011	0.0007
Eutrophication potential (EP)	kg PO_4^{3-}-eq	2.44E-03	1.19E-03	9.36E-05
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	1.69E-03	3.23E-04	5.41E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	4.69E-06	6.80E-09	4.08E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	42	8.53	1.5

(b) Use of Natural Resources analysis for 1 m^2 of Hicem Fibre Cement Board of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	23.6	0.02	0.18
Renewable primary energy resources as material utilization	MJ	6.97	0	0
Total use of renewable primary energy resources	MJ	30.57	0.02	0.18
Non-renewable primary energy as energy carrier	MJ	43.21	8.54	1.56
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	43.21	8.54	1.56
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.02	0.00014	0.0003

(c) Waste Category for 1 m^2 of Hicem Fibre Cement Board of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4

Hazardous waste	Kg	2.37E-07	5.34E-10	2.46E-08
Non-hazardous waste	Kg	0.053	0.00005	7.21
Radioactive waste	Kg	4.56E-04	2.32E-06	2.10E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.4 Hicem Fibre Cement Board: 8 mm

Table 11 (a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 8 mm thickness.

Table 11 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 8 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	7.01	0.84	0.15
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	7.85E-11	5.80E-13	1.46E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.045	0.015	0.001
Eutrophication potential (EP)	kg PO_4^{3-}-eq	3.25E-03	1.58E-03	1.25E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	2.26E-03	4.31E-04	7.21E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	6.25E-06	9.07E-09	5.44E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	56.1	11.4	2

(b) Use of Natural Resources analysis for 1 m^2 of Hicem Fibre Board of thickness 8 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	31.4	0.03	0.24
Renewable primary energy resources as material utilization	MJ	9.29	0	0
Total use of renewable primary energy resources	MJ	40.69	0.03	0.24
Non-renewable primary energy as energy carrier	MJ	57.61	11.4	2.07
Non-renewable primary energy as material utilization	MJ	0	0	0

Total use of non-renewable primary energy resources	MJ	57.61	11.4	2.07
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.027	0.0002	0.0004

(c) Waste Category for 1 m^2 of Hicem Fibre Cement Board of thickness 8 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	3.16E-07	7.11E-10	3.28E-08
Non-hazardous waste	Kg	0.071	0.00007	9.62
Radioactive waste	Kg	6.08E-04	3.10E-06	2.80E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.5 Hicem Fibre Cement Board: 10 mm

Table 12 (a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 10 mm thickness.

Table 12 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 10 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	8.77	1.04	0.19
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	9.81E-11	7.24E-13	1.82E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.06	0.02	0.001
Eutrophication potential (EP)	kg PO_4^{3-}-eq	4.06E-03	1.98E-03	1.56E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	2.82E-03	5.39E-04	9.01E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	7.81E-06	1.13E-08	6.81E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	70.10	14.22	2.50

(b) Use of Natural Resources analysis for 1 m^2 of Hicem Fibre Cement Board of thickness 10 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	39.3	0.04	0.30
Renewable primary energy resources as material utilization	MJ	11.6	0	0
Total use of renewable primary energy resources	MJ	50.9	0.04	0.30
Non-renewable primary energy as energy carrier	MJ	72.02	14.2	2.59
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	72.02	14.2	2.59
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.034	0.0002	0.0005

(c) Waste Category for 1 m^2 of Hicem Fibre Cement Board of thickness 10 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	3.95E-07	8.89E-10	4.10E-08
Non-hazardous waste	Kg	0.09	0.00009	12.02
Radioactive waste	Kg	7.60E-04	3.87E-06	3.50E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.6 Hicem Fibre Cement Board: 12mm

Table 13 (a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 12 mm thickness.

Table 13 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 12 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	10.50	1.25	0.23
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	1.18E-10	8.69E-13	2.19E-13

Acidification potential of land and water (AP)	kg SO_2-eq	0.067	0.022	0.001
Eutrophication potential (EP)	kg PO_4^{3-}-eq	4.87E-03	2.37E-03	1.87E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	3.39E-03	6.46E-04	1.08E-04
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	9.38E-06	1.36E-08	8.17E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	84.1	17.1	3.01

(b) Use of Natural Resources analysis for 1 m^2 of Fibre Cement Board of thickness 12 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	47.1	0.05	0.36
Renewable primary energy resources as material utilization	MJ	13.9	0	0
Total use of renewable primary energy resources	MJ	61	0.05	0.36
Non-renewable primary energy as energy carrier	MJ	86.42	17.1	3.11
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	86.42	17.1	3.11
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.040	0.0003	0.0006

(c) Waste Category for 1 m^2 of Hicem Fibre Cement Board of thickness 12 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	4.75E-07	1.07E-09	4.92E-08
Non-hazardous waste	Kg	0.11	0.0001	14.4
Radioactive waste	Kg	9.12E-04	4.64E-06	4.20E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.7 Hicem Fibre Cement Board: 16 mm

Table 14(a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 16 mm thickness.

Table 14 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 16 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	14.00	1.67	0.31
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	1.57E-10	1.16E-12	2.92E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.09	0.03	0.002
Eutrophication potential (EP)	kg PO_4^{3-}-eq	6.49E-03	3.16E-03	2.50E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	4.52E-03	8.62E-04	1.44E-04
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	1.25E-05	1.81E-08	1.09E-07
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	112	22.75	4.01

(b) Use of Natural Resources analysis for 1 m^2 of Hicem Fibre Cement Board of thickness 16 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	62.9	0.07	0.49
Renewable primary energy resources as material utilization	MJ	18.6	0	0
Total use of renewable primary energy resources	MJ	81.5	0.07	0.49
Non-renewable primary energy as energy carrier	MJ	115	22.8	4.15
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	115	22.8	4.15
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.054	0.0004	0.0008

(c) Waste Category for 1 m^2 of Fibre Cement Board of thickness 16 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	6.33E-07	1.42E-09	6.56E-08

Non-hazardous waste	Kg	0.14	0.0001	19.23
Radioactive waste	Kg	1.22E-03	6.19E-06	5.60E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.8 Hicem Fibre Cement Board: 18 mm

Table 15 (a-c) show the life cycle environmental impacts for 1 m^2 of Hicem Fibre Cement product for 18 mm thickness.

Table 15 (a) LCIA for 1 m2 of Hicem Fibre Cement Board of thickness 18 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	15.78	1.88	0.35
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	1.77E-10	1.30E-12	3.28E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.101	0.033	0.002
Eutrophication potential (EP)	kg PO_4^{3-}-eq	7.31E-03	3.56E-03	2.81E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	5.08E-03	9.69E-04	1.62E-04
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	1.41E-05	2.04E-08	1.23E-07
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	126.11	25.59	4.51

(b) Use of Natural Resources analysis for 1 m^2 of Hicem Fibre Cement Board of thickness 18 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	70.7	0.07	0.55
Renewable primary energy resources as material utilization	MJ	20.9	0	0
Total use of renewable primary energy resources	MJ	91.6	0.07	0.55
Non-renewable primary energy as energy carrier	MJ	129	25.6	4.67
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	129	25.6	4.67
Use of secondary material	kg	0	0	0

Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.061	0.0004	0.0009

(c) Waste Category for 1 m^2 of Hicem Fibre Cement Board of thickness 18 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	7.12E-07	1.60E-09	7.38E-08
Non-hazardous waste	Kg	0.16	0.0002	21.64
Radioactive waste	Kg	1.37E-03	6.96E-06	6.30E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.9 Hilux Calcium Silicate Board: 6 mm

Table 16 (a-c) show the life cycle environmental impacts for 1 m^2 of Hilux Calcium Silicate product for 6 mm thickness.

Table 16 (a) LCIA for 1 m2 of Hilux Calcium Silicate Board of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	5.09	0.65	0.09
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	5.40E-11	5.07E-13	8.21E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.04	0.006	0.0005
Eutrophication potential (EP)	kg PO_4^{3-}-eq	2.93E-03	7.18E-04	7.02E-05
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	2.10E-03	-1.57E-04	4.05E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	3.20E-06	7.32E-09	3. 06E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	37.4	9.03	1.13

(b) Use of Natural Resources analysis for 1 m^2 of Hilux Calcium Silicate Board of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	37.9	0.03	0.14

Renewable primary energy resources as material utilization	MJ	5.98	0	0
Total use of renewable primary energy resources	MJ	43.88	0.03	0.14
Non-renewable primary energy as energy carrier	MJ	38.5	9.03	1.17
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	38.5	9.03	1.17
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.18	0.0001	0.0002

(c) Waste Category for 1 m^2 of Hilux Calcium Silicate Board of thickness 6 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	2.56E-07	5.78E-10	1.85E-08
Non-hazardous waste	Kg	0.08	0.00006	5.41
Radioactive waste	Kg	4.33E-04	2.70E-06	1.58E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.10 Hilux Calcium Silicate Board: 8 mm

Table 17 (a-c) show the life cycle environmental impacts for 1 m^2 of Hilux Calcium Silicate product for 8 mm thickness.

Table 17 (a) LCIA for 1 m2 of Hilux Calcium Silicate Board of thickness 8 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	6.78	0.86	0.12
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	7.20E-11	6.76E-13	1.09E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.05	0.008	0.0007
Eutrophication potential (EP)	kg PO_4^{3-}-eq	3.91E-03	9.57E-04	9.36E-05
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	2.80E-03	-2.90E-04	5.41E-05

Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	4.26E-06	9.76E-09	4.08E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	49.9	12	1.5

(b) Use of Natural Resources analysis for 1 m^2 of Hilux Calcium Silicate Board of thickness 8 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	50.5	0.38	0.18
Renewable primary energy resources as material utilization	MJ	7.98	0	0
Total use of renewable primary energy resources	MJ	58.48	0.38	0.18
Non-renewable primary energy as energy carrier	MJ	51.36	12.05	1.56
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	51.36	12.05	1.56
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.241	0.0002	0.0003

(c) Waste Category for 1 m^2 of Hilux Calcium Silicate Board of thickness 8 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	3.41E-07	7.71E-10	2.46E-08
Non-hazardous waste	Kg	0.11	0.00009	7.21
Radioactive waste	Kg	5.77E-04	3.60E-06	2.10E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.11 Hilux Calcium Silicate Board: 10 mm

Table 18 (a-c) show the life cycle environmental impacts for 1 m^2 of Hilux Calcium Silicate product for 10 mm thickness.

Table 18 (a) LCIA for 1 m2 of Hilux Calcium Silicate Board of thickness 10 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	8.48	1.08	0.15
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	9.00E-11	8.45E-13	1.37E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.06	0.01	0.0009
Eutrophication potential (EP)	kg PO_4^{3-}-eq	4.88E-03	1.20E-03	1.17E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	3.50E-03	-2.61E-04	6.76E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	5.33E-06	1.22E-08	5.10E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	62.4	15	1.88

(b) Use of Natural Resources analysis for 1 m^2 of Hilux Calcium Silicate Board of thickness 10 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	63.15	0.05	0.23
Renewable primary energy resources as material utilization	MJ	9.97	0	0
Total use of renewable primary energy resources	MJ	73.12	0.05	0.23
Non-renewable primary energy as energy carrier	MJ	64.21	15.06	1.94
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	64.21	15.06	1.94
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0
Use of net fresh water	m^3	0.30	0.0003	0.0004

(c) Waste Category for 1 m^2 of Hilux Calcium Silicate Board of thickness 10 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	4.27E-07	9.63E-10	3.08E-08
Non-hazardous waste	Kg	0.14	0.0001	9.02
Radioactive waste	Kg	4.22E-04	4.50E-06	2.63E-05
Components for re-use	kg	0	0	0

Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.6.12 Hilux Calcium Silicate Board: 12 mm

Table 19 (a-c) show the life cycle environmental impacts for 1 m^2 of Hilux Calcium Silicate product for 12 mm thickness.

Table 19 (a) LCIA for 1 m2 of Hilux Calcium Silicate Board of thickness 12 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Global warming potential (GWP)	kg CO_2-eq	10.2	1.3	0.17
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11-eq	1.08E-10	1.01E-12	1.64E-13
Acidification potential of land and water (AP)	kg SO_2-eq	0.07	0.01	0.001
Eutrophication potential (EP)	kg PO_4^{3-}-eq	5.86E-03	1.44E-03	1.40E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg ethene-eq	4.21E-03	-3.13E-04	8.11E-05
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb-eq	6.39E-06	1.46E-08	6.13E-08
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	74.8	18.1	2.25

(b) Use of Natural Resources analysis for 1 m^2 of Hilux Calcium Silicate Board of thickness 12 mm

Parameter	Unit	Module A1-A3	Module A4	Module C4
Renewable primary energy as energy carrier	MJ	75.77	0.06	0.27
Renewable primary energy resources as material utilization	MJ	11.97	0	0
Total use of renewable primary energy resources	MJ	87.74	0.06	0.27
Non-renewable primary energy as energy carrier	MJ	77.05	0.06	0.27
Non-renewable primary energy as material utilization	MJ	0	0	0
Total use of non-renewable primary energy resources	MJ	77.05	0.06	0.27
Use of secondary material	kg	0	0	0
Use of renewable secondary fuels	MJ	0	0	0
Use of non-renewable secondary fuels	MJ	0	0	0

Use of net fresh water	m^3	0.36	0.0003	0.0004

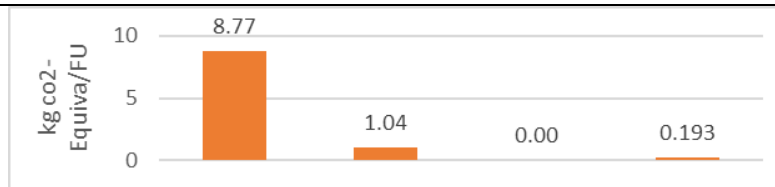
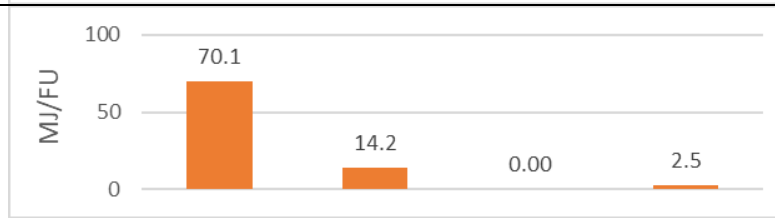
(c) Waste Category for 1 m^2 of Hilux Calcium Silicate Board of thickness 12 mm

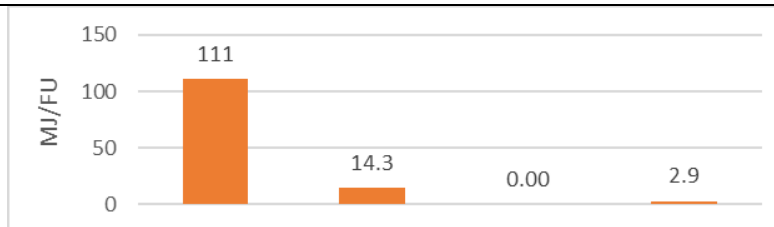
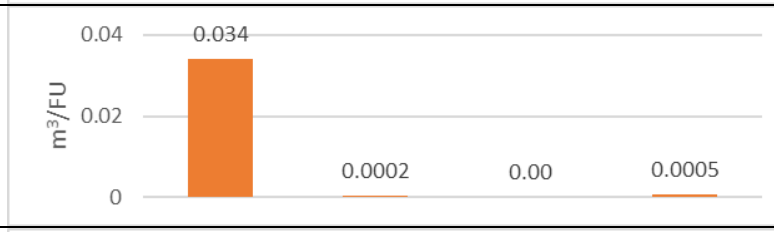
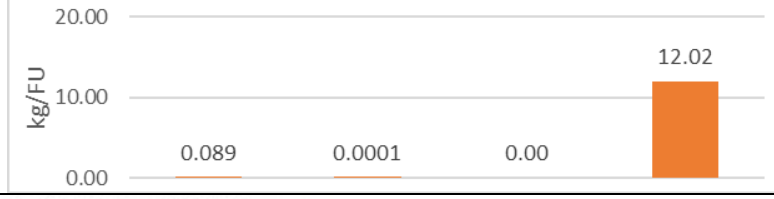
Parameter	Unit	Module A1-A3	Module A4	Module C4
Hazardous waste	Kg	5.12E-07	1.16E-09	3.69E-08
Non-hazardous waste	Kg	0.17	0.0001	10.82
Radioactive waste	Kg	8.66E-04	5.40E-06	3.15E-05
Components for re-use	kg	0	0	0
Materials for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy	MJ	0	0	0

4.7 Interpretation

1 m^2 of fibre cement product (Hicem) with 10 mm thickness is used for interpreting the LCIA results in this section. Other thicknesses are on the basis of relative mass of the fibre cement product for the respective thickness and the same interpretation will apply. The LCIA interpretations of 10 mm thickness fibre cement product are as given below: -

Table 20 Interpretation of most significant contributors to life cycle parameters for 1 m^2 of fibre cement product (Hicem) of thickness 10 mm

	Product (A1-A3)	Transport (A4)	Use (B)	End of life (C4)	Total *Environmental impacts of the product*
Global Warming					10 kg CO2-Equiv/FU
non-renewable resource consumption (1)					86.80 MJ/FU

Energy Consumption (2)		128.2 MJ/FU
Water Consumption (3)		0.035 m³/FU
Waste Production (4)		12.11 kg/FU

[1] This indicator corresponds to the abiotic depletion potential of fossil resources.
[2] This indicator corresponds to the total use of primary energy.
[3] This indicator corresponds to the use of net fresh water.
[4] This indicator corresponds to the sum of hazardous, non-hazardous and radioactive waste disposed.

5. Other Environmental Information

The constituent materials used within our products are responsibly sourced and we apply the principles of Sustainable Development and of Environmental Stewardship as a standard business practice in our operations. Protecting the environment by preserving non-renewable natural resources, increasing energy efficiency, reducing the environmental emissions, limiting the impact of materials transportation to and from our operations is part of our way in doing business.

6. References

- EN 15804:2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- GABI 8: 2017. thinkstep AG; GaBi 8: Software-System and Database for Life Cycle Engineering. Copyright. Leinfelden, Echterdingen, 1992-2017.
- ISO 14020:2001 Environmental labels and declarations - General principles
- ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures
- ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework
- ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines
- Product Category Rules PCR 2012:01 Construction products and construction services, version 2.3 in compliance with EN 15804