Declaration Owner

Comet Granito Private Limited
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Product

Ceramic Tile
(CSI Code 09 31 00)

Functional Unit

The functional unit is 1 m^2 of tile, installed and maintained for 75-years

EPD Number and Period of Validity

SCS-EPD-10237
EPD Valid August 15, 2024, through August 14, 2029

Product Category Rule

PCR for Building-Related Products and Services, Institut Bauen und Umwelt e.V. (IBU) - Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2019, Version 1.4, 15.04.2024

IBU PCR Part B: Requirements on the EPD for Ceramic Tiles and Panels. Version 2.0 May 2023.

Program Operator

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Declaration Owner:	Comet Granito Private Limited
Address:	SR NO 168,169.AT:RATAVIRDA,TALUKA:WANKANER,DIST:MORBI GUJARAT - INDIA
Declaration Number:	SCS-EPD-10237
Declaration Validity Period:	EPD Valid August 15, 2024 through August 14, 2029
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Riley Tesman, SCS Global Services; Keith Killpack, SCS Global Services
LCA Software and LCI database:	OpenLCA v2.1.1 software and the Ecoinvent v3.9 database
Product RSL:	75 Years
Markets of Applicability:	Global
EPD Type:	Facility-specific EPD of ceramic tiles
EPD Scope:	Cradle-to-Grave
LCIA Method and Version:	EN 15804 v3.1
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Lindita Bushi Lindita Bushi, Ph.D., Athena Sustainable Materials Institute
Part A Product Category Rule:	IBU Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2019. Version 1.4, 15.04.2024.
Part A PCR Review conducted by:	SVR Technical Committee
Part B Product Category Rule:	IBU PCR Guidance for Building-Related Products and Services Part B: Requirements on the EPD for Ceramic Tiles and Panels. Version 2. May 2023.
Part B PCR Review conducted by:	SVR Technical Committee
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Lindita Bushi Lindita Bushi, Ph.D., Athena Sustainable Materials Institute
Declaration Contents:	

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and EN 15804+A2.*

Scope of Results Reported: *The PCR requirements limit the scope of the LCA metrics such that the results exclude environmental and social performance benchmarks and thresholds, and exclude impacts from the depletion of natural resources, land use ecological impacts, ocean impacts related to greenhouse gas emissions, risks from hazardous wastes and impacts linked to hazardous chemical emissions.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

In accordance with ISO 21930:2017, EPDs are comparable only if they comply with the core PCR, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

1. Company Description

Comet Granito Pvt. Ltd is a Morbi based leading manufacturer of qualitative vitrified tiles. After laying down foundation stone in 2000, the company has emerged as one of the top brands with its consistent quality assurance. The company produces high qualitative flooring and wall tiles with the amalgamation of modern and ancient trends of designing. It utilises the high-tech machines to produce the most fascinating products.

2. Product

2.1. PRODUCT DESCRIPTION

Comet Granito's ceramic tiles are fully vitrified, non-porous, and glazed. They are made using a body formula composed of a mix of clays, feldspars, and other components. Available in variety of sizes, surfaces and designs. These tiles feature high mechanical strength, frost resistance, very low water absorption, and abrasion resistant characteristics. Manufactured at the company's production facility in Gujarat, India the ceramic tiles are used in residential and commercial spaces for floor and wall applications.

2.2 APPLICATION

Comet Granito ceramic tile products are ideal for both floor and wall applications. Ceramic tile is available in a variety of sizes, surfaces, and designs.

2.3 TECHNICAL DATA

Technical specifications for the ceramic tile product are summarized in Table 1.

Table 1. *Product technical data for the ceramic tile products produced by Comet Granito.*

Parameter	Value	Unit
Tile Type (Porcelain, pressed floor, mosaic, quarry, gauged, or glass)	Ceramic	-
Class (ISO 13006)	B1a GL*	-
Grade (Standard or second)	Standard	mm
Facial area (60*120 cm)	5.12	m^2
Thickness	20	mm
Product Weight	38.4	kg/m^2
Dimensional Categories (Natural, calibrated or rectified)	Rectified	

*These labels are used to categorize ceramic tiles under the ISO 13006 standard. B1a = water absorption of less than 0.5% (ceramic); GL = glazed

2.4 DELIVERY STATUS

The product is delivered packaged in cardboard boxes and plastic straps. Multiple boxes are stacked on pallets and wrapped in plastic film.

2.5 MATERIAL COMPOSITION

Although the tiles are produced in various styles, all are composed of similar materials. The average composition of a ceramic tile and packaging material at the manufacturing facility is presented in Table 2. The composition data is provided by weight and material for the product, including product packaging. Also presented are the product components as a percent of total mass.

Table 2. *Material ingredient summary for the ceramic tile products and packaging by mass (per 1 m^2 of final product) and as a percentage of total mass.*

Material	Mass	
	Final Product (kg)	Percent Mass of Final Product
Ball Clay	4.70	12%
China Clay	5.60	15%
Soda Feldspar	14.1	37%
Potash Feldspar	11.3	29%
Talc	0.35	1%
STPP	0.05	0%
CMC	0.05	0%
Frit	1.80	5%
Zircosil	0.45	1%
Total	**38.4**	**100%**

2.6 MANUFACTURING

The manufacturing process of ceramic tiles involves several key steps. Initially, raw materials (clay, feldspar, frit and silica) are refined and mixed to create a homogenous blend—the tile body. This mixture is then transformed into the desired tile shape through processes such as pressing, extrusion, or slip casting, where a liquid slurry known as slip, consisting of water and finely ground raw materials, is poured into molds. Following this, the formed tiles undergo a drying phase to remove excess moisture before entering the high-temperature firing process, typically above 1200°C (2200°F), which vitrifies the materials, ensuring durability. Finally, a glazing step may be included for color, texture, and additional protection. Quality control checks are conducted to verify size, shape, color, and overall durability. Finally, the tiles are packaged for distribution.

2.7 ENVIRONMENT AND HEALTH DURING MANUFACTURING

Comet Granito's ceramic tiles are manufactured at ISO 9001 and ISO 14001 conformant facilities.

2.8 PRODUCT INSTALLATION

Installation of the product is accomplished using hand tools, mortar, and adhesives. The impacts associated with packaging disposal are included with the installation phase as per PCR requirements.

2.9 PACKAGING

The products are packaged for shipment using corrugated boxes, pallets, shrink film, plastic straps and labels.

Table 3. *Material content for the product packaging in kg per square meter of tile.*

Packaging Type	Final Product (kg)	Percent Mass of Final Product
Corrugated Box	2.00	61.0%
Wooden Pallet	0.50	15.5%
Metal Pallet	0.75	23.0%
Corner	9.67×10^{-4}	0.0300%
Strapping Roll	0.012	0.370%
Paper Sheet	0.003	0.100%
Total	**3.26**	**100%**

2.10 CONDITIONS OF USE

No special conditions of use are noted. The only routine maintenance is regular sweeping and cleaning using detergent and water. The maintenance life cycle phase was modeled over the 75-yr Reference Service Life. The PCR specifies weekly cleaning using 0.2 mL detergent and 0.1 L water per square meter of ceramic tile.

2.11 ENVIRONMENT AND HEALTH DURING USE

There are no known harmful substances or emissions associated with the use of the product.

2.12 PRODUCT REFERENCE SERVICE LIFE

The reference service life (RSL) of the products is assumed to be 75 years, assuming the ceramic tile will last for the building lifetime.

2.13 EXTRAORDINARY EFFECTS

There are no known extraordinary effects from fire, water, or mechanical destruction associated with the product.

2.14 RE-USE PHASE

The flooring products are not reused at end-of-life.

2.15 DISPOSAL

At end-of-life, per the PCR, 70% of the products are recycled and 30% are disposed of in a landfill.

2.16 FURTHER INFORMATION

Further information on the product can be found on the manufacturer's website, https://www.granicer.in

3. LCA Calculation Rules

3.1 FUNCTIONAL UNIT

The functional unit used in the study is defined as 1 m^2 of ceramic tile covering, installed and maintained over a 75-year period.

Table 4. *Functional unit and reference flow information for ceramic tile products.*

Name	Unit	Amount
Functional Unit	m^2	1
Mass	kg	38.4
Thickness	m	0.02
Gross Density	kg/m^3	1,920

3.2 SYSTEM BOUNDARY

The scope of the EPD is cradle-to-grave, including raw material extraction, processing of raw materials, product manufacture and packaging, distribution, product use and maintenance, and disposal stages. The life cycle stages included in the EPD scope are described in Table 5.

Table 5. *The modules and unit processes included in the scope for the ceramic tile product system.*

Module	Module description from the PCR	Unit Processes Included in Scope
A1	Extraction and processing of raw materials, any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Extraction and processing of raw materials for the ceramic tile components.
A2	Transport (to the factory)	Transport of component materials to the manufacturing facilities.
A3	Manufacturing, including ancillary material production and packaging	Manufacturing of tile products and packaging (including upstream unit processes).
A4	Transport (to the building site)	Transport of product (including packaging) to the building site.
A5	Construction, installation process. Includes materials used in installation	Impacts from installation and packaging disposal are included in this phase.
B1	Product use	Use of the tile in a commercial building setting. There are no associated emissions or impacts from the use of the product.
B2	Product maintenance	Maintenance of products over the 75-year estimated service life (ESL), including periodic cleaning.
B3	Product repair	The tile is not expected to require repair over its lifetime.
B4	Product replacement	The tile product is not expected to require repair over its lifetime.
B5	Product refurbishment	The tile is not expected to be replaced over its lifetime.
B6	Operational energy use by technical building systems	There is no operational energy use associated with the use of the product.
B7	Operational water use by technical building systems	There is no operational water use associated with the use of the product.
C1	Deconstruction/ demolition	Demolition of the product is accomplished using hand tools with no associated emissions and negligible impacts.
C2	Transport (to waste processing)	Transport of tile product to waste treatment at end-of-life.
C3	Waste processing for reuse, recovery and/or recycling	There is no waste processing associated with the end-of-life of the tile product.
C4	Disposal	Disposal of tile product in municipal landfill (30%) and recycle (70%).
D	Reuse-recovery-recycling potential	Benefits and loads associated with the recycling of the tile product at the end-of-life.

3.3 ESTIMATES AND ASSUMPTIONS

- Specific inventory data for the engobe used as a slip during product manufacturing process were unavailable. Representative data for similar materials (mixture of aluminum oxide, potassium hydroxide, silica sand, and sodium oxide) were used to model the product system.
- The default international scenario from the IBU PCR Part B was used to model transportation distance (6520 km) from the manufacturing facility to the construction site.
- For final disposal of the packaging material, material is assumed to be transported 50 km to waste treatment facility.
- For final disposal of the ceramic tile product at end-of-life, all materials are assumed to be transported a distance of 20 km to waste treatment plant and an additional 30 km from the treatment plant to the final destination as outlined by the IBU PCR Part B.
- Primary data for the installation module were not available, therefore materials and amounts were modeled using the second scenario outlined in the IBU PCR Part B.
- Material loss during the installation module were assumed to be negligible.
- Primary data for the maintenance module were not available, therefore materials and amounts were modeled using the recommendations in the IBU PCR Part B.

The PCR requires the results for several inventory flows related to construction products to be reported including energy and resource use and waste and outflows. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted taking into account this limitation.

3.4 CUT-OFF CRITERIA

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact are included in the inventory. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results. No known flows are deliberately excluded from this EPD.

3.5 DATA SOURCES

Primary data were provided for the manufacturing facility and select suppliers. The sources of secondary LCI data are the Ecoinvent database.

Table 6. *Data sources for the ceramic tile products.*

Flow	Dataset	Data Source	Publication Date
Raw materials			
Ball Clay	market for clay | clay | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
China Clay	market for kaolin | kaolin | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
Soda Feldspar	market for feldspar | feldspar | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
Potash Feldspar	market for feldspar | feldspar | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
Talc	talc production, crushed, for mill | talc, crushed, for mill | Cutoff, U - IN	Ecoinvent v3.9, Custom Process	2023
Sodium Tripolyphosphate	market for sodium tripolyphosphate | sodium tripolyphosphate | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
CMC	market for carboxymethyl cellulose, powder | carboxymethyl cellulose, powder | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
Frit	market for frit, for ceramic tile | frit, for ceramic tile | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
Zircosil	heavy mineral sand quarry operation | zircon | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Energy and Water			
Electricity	electricity voltage transformation from high to medium voltage | electricity, medium voltage | Cutoff, U - IN-Western grid	Ecoinvent v3.9.1	2023
Natural Gas	market for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Diesel	market for diesel, burned in diesel-electric generating set, 10MW | diesel, burned in diesel-electric generating set, 10MW | Cutoff, U - GLO	Ecoinvent v3.9.1	2023
Coal	heat production, hard coal briquette, stove 5-15kW | heat, central or small-scale, other than natural gas | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Water	tap water production, conventional treatment | tap water | Cutoff, U - IN	Ecoinvent v3.9.1	2023
Treated Water	market for water, deionised | water, deionised | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Packaging			
Corrugated Box	corrugated board box production | corrugated board box | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Wooden Pallet	EUR-flat pallet production | EUR-flat pallet | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Metal Pallet	steel production, converter, low-alloyed | steel, low-alloyed | Cutoff, U - IN	Ecoinvent v3.9.1	2023
Corner	polyethylene production, linear low density, granulate | polyethylene, linear low density, granulate | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Strapping Roll	polypropylene production, granulate | polypropylene, granulate | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Paper Sheet	market for kraft paper | kraft paper | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Transportation			
Road Transport	transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, U - RoW	Ecoinvent v3.9.1	2023
Ocean Transport	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U - GLO	Ecoinvent v3.9.1	2023

3.6 DATA QUALITY

The data quality assessment addressed the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 7. *Data quality assessment for the ceramic tile product system.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage Age of data and the minimum length of time over which data should be collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 5 years. All of the data used represented an average of at least one year's worth of data collection. Manufacturer-supplied data (primary data) are based on annualized production for 2022.
Geographical Coverage Geographical area from which data for unit processes should be collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Electricity use for product manufacture is modeled using representative data for India. Surrogate data used in the assessment are representative of global or European operations. Data representative of global or European operations are considered sufficiently similar to actual processes. Data representing product disposal based on regional statistics.
Technology Coverage Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations.
Precision Measure of the variability of the data values for each data expressed (e.g., variance)	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the tile products. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness Qualitative assessment of the degree to which the data set reflects the true population of interest (i.e., geographical coverage, time period, and technology coverage)	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Consistency Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used; with a bias towards Ecoinvent v3.9.1 data where available. Different portions of the product life cycle are equally considered; however, it must be noted that final disposition of the product is based on assumptions of current average practices.
Reproducibility Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data Description of all primary and secondary data sources	Data representing energy use at Comet Granito's facility in Gujarat, India represent an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. For secondary LCI datasets v3.9.1 LCI data are used.
Uncertainty of the Information Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the ceramic products is low. Actual supplier data for upstream operations was not available for all suppliers and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

3.7 PERIOD UNDER REVIEW

The data provided captures 11 months of facility manufacturing, representing April 2023 to February 2024

3.8 GEOGRAPHIC REPRESENTATIVENESS

The product is manufactured at the Comet Granito facility in Gujarat, India and distributed internationally.

3.9 ALLOCATION

Annualized material and energy use data were provided by the manufacturer for an 11-month span ranging from April 2023 to February 2024 for the facility. Total facility production of ceramic tile was provided and used to allocate resource use (e.g., electricity, LPG, water), waste/co-products, and emissions released at the manufacturing facility to the products based on total annual production by area.

Impacts from transportation were allocated based on the mass of material and distance transported.

3.10 COMPARABILITY

The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.

4. LCA: Scenarios and Additional Technical Information

4.1 PRODUCT FLOW DIAGRAM

A flow diagram of the product system, illustrating the production processes and life cycle phases included in the scope of the EPD is provided below.

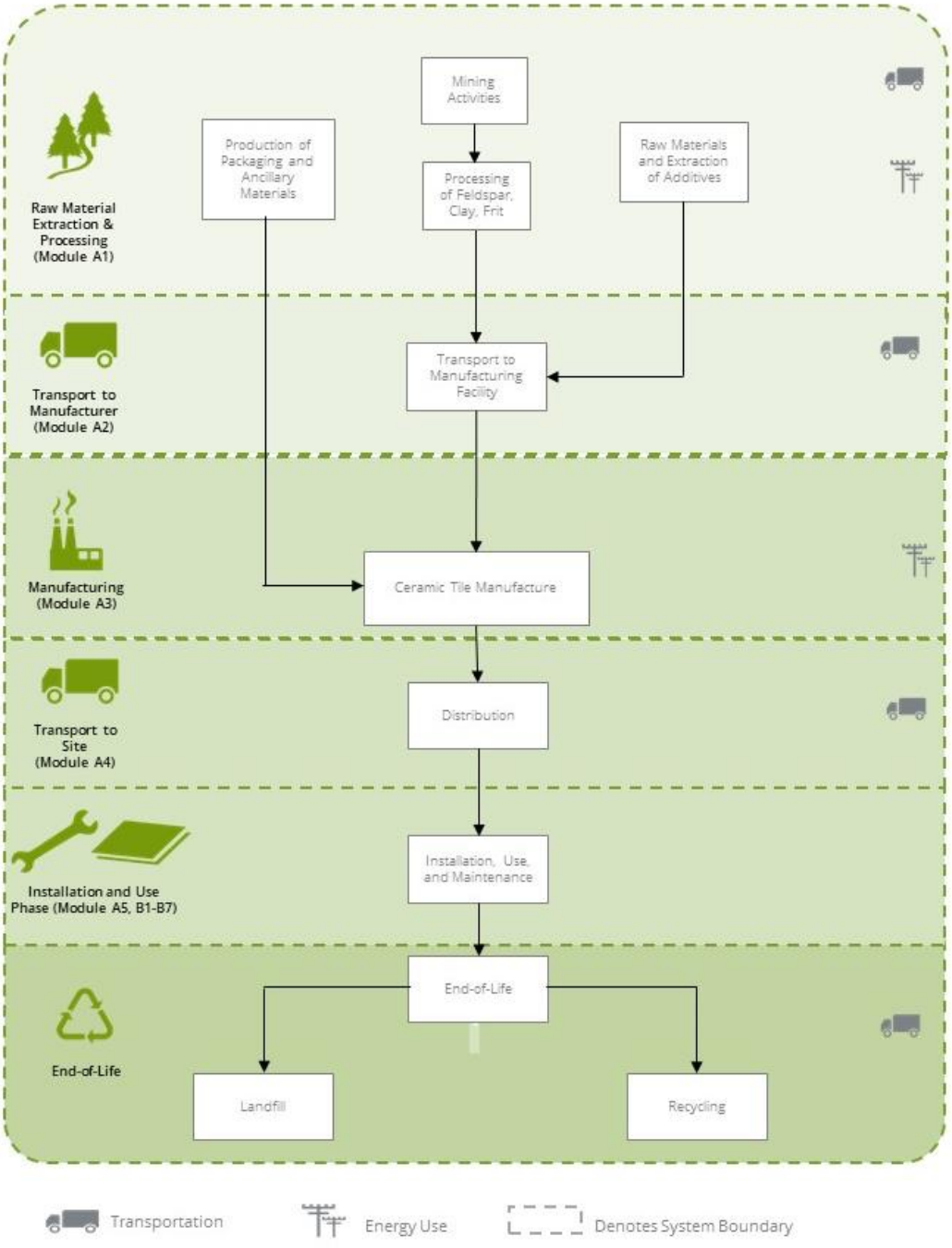

Figure 1. *Flow diagram for the life cycle of the ceramic tile product.*

4.2 CHARACTERISTIC PRODUCT PROPERTIES OF BIOGENIC CARBON

Table 8. *Biogenic Carbon Content at factory gate.*

Biogenic Carbon	Unit	Value
Biogenic carbon content in product	kg C	0
Biogenic carbon content in packaging	kg C	-1.46

4.3 TRANSPORT TO THE BUILDING SITE (A4)

Table 9. *Transport to the building site (A4).*

Parameter	Value	Unit
Liters of Fuel Ship	68,000	l/100 km
Liters of Fuel Truck	35	l/100 km
Ship Transport distance to UAE from port	2,048	km
Ship Transport distance to Saudi Arabia from port	4,630	km
Ship Transport distance to USA from port	29,144	km
Ship Transport distance to China from port	12,131	km
Ship Transport distance to Colombia from port	19,076	km
Ship Transport distance to Indonesia from port	4,654	km
Ship Transport distance to United Kingdom from port	13,427	km
Ship Transport distance to Vietnam from port	7,038	km
Ship Transport distance to Cyprus from port	6,667	km
Ship Transport distance to Taiwan from port	9,723	km
Ship Transport distance to Poland from port	15,094	km
Ship Transport distance to Russia from port	13,149	km
Truck Transport distance to port km	180	km
Truck Transport distance port to site km	300	km
Capacity utilization (including empty runs) %	70	%
Gross density of products transported kg/m^3	1,920	kg/m^3
Capacity utilization volume factor	1	-

4.4 INSTALLATION INTO THE BUILDING (A5)

Installation of the product is included in the life cycle analysis. The installation guidelines outlined by scenario 2 in the IBU Part B: Ceramic tiles and panels PCR was used for modeling the Installation (A5) module.

Table 10. *Installation into the building (A5).*

Parameter	Value	Unit
Mortar	0.5	kg
Dispersion Adhesive	2.5	kg
Polysulfide	0.07	kg
Water Use	0.12	kg
Electricity consumption	0	kWh
Material Loss	0	kg
Packaging waste (Landfill)	3.26	kg
Dust in the air	0	kg
VOC in the air	0	kg

4.5 USE PHASE (B1-B7)

Use stage (B1)

No impacts occur during product use.

Maintenance stage (B2)

Use and maintenance of the product are included in the life cycle analysis. The PCR Part B recommended cleaning scenario was adopted to model the product maintenance stage.

Regular sweeping and cleaning using detergent and water are the only routine maintenance required for the product and there are no impacts associated with the use of the products, other than product maintenance. The product system's maintenance life cycle phase was modeled over the 75-yr Reference Service Life.

Table 11. *Maintenance parameters for the ceramic tile products, per 1 m^2 of flooring (B2).*

Material	Amount	Frequency		Over the 75-yr estimated service lifetime (RSL)
Detergent	0.2 mL	52	times/year	780 mL
Water	0.1 L	52	times/year	390 L
Electricity consumption	0.0 kWh			
Other energy carriers	0 MJ			
Material loss	0 kg			

Repair/Replacement/Refurbishment stages (B3 - B5)

Product repair and refurbishment are not relevant during the lifetime of the product and is not replaced over the 75-year ESL of the assessment.

Table 12. *Reference Service Life*

RSL	Value	Unit
Reference service life	75	Years
Life span	75	years
Life span according to the manufacturer	-	years

Building operation stage (B6 – B7)

There is no operational energy or water use associated with the use of the product.

4.6 END OF LIFE PHASE (C1-C4)

Specific data regarding the recycling rate of materials in the product at end-of-life was outlined in the IBU Part B PCR. It is estimated 30% is disposed of via landfill while 70% is recycled. Any benefits and loads of recycling remaining are calculated in Module D, although it is considered outside the system boundary. Under the IBU Part B guidance it was assumed that 70% recycled tiles are recycled by crushing of ceramic tile. Recycled ceramic tiles were modeled in Module D considering the transport of tiles and the crushing to produce gravel.

Table 13. *End-of-life (C1-C4).*

Parameter	Value	Unit

Collected separately waste type	26.9	kg
Collected as mixed construction waste	11.5	kg
Reuse	0	kg
Recycling	26.9	kg
Energy Recovery	0	kg
Landfilling	11.5	kg

5. LCA: Results

Results of the Life Cycle Assessment are presented below. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. All LCA results are stated to three significant figures in agreement with the PCR for this flooring product and therefore the sum of the total values may not exactly equal 100%.

Impact categories analyzed using the EF v3.1 EN15804 suite of characterization methods and characterization factors are presented in Table 14, below. The choice of methods and indicators used in the assessment are based on the requirements of the PCR. It should be noted that the LCIA results presented below are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Additionally, the environmental relevance of LCIA results are not affected by LCI functional unit calculation, system wide averaging, aggregation and allocation.

Table 14. *Environmental Indicators*

EF v3.1 EN 15804 Impact Category	Units
Climate change (**GWP**) – total	kg CO2 eq.
Climate change (**GWP**) – fossil	kg CO2 eq.
Climate change (**GWP**) – biogenic	kg CO2 eq.
Depletion potential of the stratospheric ozone layer (**ODP**)	kg CFC-11 eq.
Formation potential of tropospheric ozone (**POCP**)	kg NMVOC eq.
Acidification potential, Accumulated Exceedance (**AP**)	mol H+ eq.
Eutrophication (**EP**) - freshwater	kg P eq.
Eutrophication (**EP**) - marine	kg. N eq.
Eutrophication (**EP**) - terrestrial	mol N eq.
Water use (**WDP**)	m^3
Depletion of abiotic resources (**ADPe**) - minerals and metals	kg Sb eq
Depletion of abiotic resources (**ADPf**) - fossil fuels	MJ, net calorific value
Particulate matter emissions (**PM**)	Disease incidence
Ionizing radiation, human health (**IRP**)	kBq U235 eq.
Ecotoxicity (**ETP**), freshwater	CTUe
Human toxicity, cancer effects (**HTP-c**)	CTUh
Human toxicity, non-cancer effects (**HTP-nc**)	CTUh
Soil quality (**SQP**)	Dimensionless

These impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.

The following inventory parameters, specified by the PCR, are also reported. The tile products do not contain significant amounts of bio-based materials, biogenic carbon emissions and removals are not declared.

Table 15. *Life Cycle Inventory Parameters*

Resources	Unit	Waste and Outflows	Unit
PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	**HWD**: Hazardous waste disposed	kg
PERM: Use of renewable primary energy resources used as raw materials	MJ, net calorific value	**NHWD**: Non-hazardous waste disposed	kg
PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	**RWD**: Radioactive waste disposed	kg
PENRE: Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	**CRU:** Components for re-use	kg
PENRM: Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	**MFR:** Materials for recycling	kg
PENRT: Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	**MER:** Materials for energy recovery	kg
SM: Use of secondary material	kg	**EE:** Exported energy	MJ, net calorific value
RSF: Use of renewable secondary fuels	MJ, net calorific value		
NRSF: Use of non-renewable secondary fuels	MJ, net calorific value		
FW: Net use of freshwater	m^3		

The scope of this EPD is cradle-to-grave, including raw material extraction, processing of raw materials, product manufacture and packaging, distribution, product use and maintenance, and disposal stages. The life cycle phases included in the product system boundary are shown below.

Table 16. *Life cycle phases included in the product system boundary.*

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

X = included | MND = Module Not Declared

Modules B1, B3, B4, B5, B6, and B7 are not associated with any impact and are therefore declared as zero. In addition, modules C1 and C3 are likewise not associated with any impact as the products are expected to be manually deconstructed. In the interest of space and table readability, these modules are not included in the results presented below. Module D is declared but is considered outside the system boundary.

Table 17. *Life Cycle Impact Assessment (LCIA) results for the ceramic tile products over a 75-yr time horizon. Results reported in MJ are calculated using lower heating values.*

Impact	A1	A2	A3	A4	A5	B2	C2	C4	D
GWP - Total (kg CO2 eq)	6.00	0.646	17.5	7.26	1.40	2.95	0.366	0.110	-3.93
	17%	2%	48%	20%	4%	8%	1%	0%	
GWP - Biogenic Carbon (kg CO2 eq)	0.0143	0.000170	0.215	0.00159	0.00474	0.00666	$9.62x10^{-5}$	0.000041	-0.00994
	6%	0%	89%	1%	2%	3%	0%	0%	
GWP - Fossil (kg CO2 eq)	5.98	0.646	17.3	7.25	1.40	2.76	0.366	0.110	-3.91
	17%	2%	48%	20%	4%	8%	1%	0%	
GWP- Land Use Change (kg CO2 eq)	0.00869	0.000340	0.0353	0.00472	0.00109	0.184	0.000190	0.000180	-0.00596
	4%	0%	15%	2%	0%	78%	0%	0%	
ODP (kg CFC-11 eq)	$6.57x10^{-7}$	$1.02x10^{-8}$	$1.58x10^{-7}$	$1.12x10^{-7}$	$3.68x10^{-8}$	$2.13x10^{-7}$	$5.79x10^{-9}$	$2.68x10^{-9}$	$-4.56x10^{-7}$
	55%	1%	13%	9%	3%	18%	0%	0%	
AP (mol H+-Eq)	0.0432	0.00279	0.0964	0.126	0.00740	0.0185	0.00158	0.000740	-0.0291
	15%	1%	32%	43%	2%	6%	1%	0%	
EP - Marine (kg N-Eq)	0.00262	$5.25x10^{-5}$	0.00517	0.000410	0.000390	0.00112	$2.98x10^{-5}$	$9.97x10^{-6}$	-0.00181
	27%	1%	53%	4%	4%	11%	0%	0%	
EP – Freshwater (kg P-Eq)	0.00801	0.00104	0.0141	0.0334	0.00164	0.00552	0.000590	0.000290	-0.00520
	12%	2%	22%	52%	3%	9%	1%	0%	
EP - Terrestrial (mol N-Eq)	0.0853	0.0111	0.124	0.368	0.0172	0.0403	0.00628	0.0031	-0.0553
	13%	2%	19%	56%	3%	6%	1%	0%	
POCP (kg NMVOC-Eq)	0.0267	0.00381	0.0701	0.1038	0.00567	0.0115	0.00216	0.00104	-0.0172
	12%	2%	31%	46%	3%	5%	1%	0%	
WDP (m^3)	4.85	0.0434	3.07	0.366	0.53	3.91	0.0246	0.0106	-3.37
	38%	0%	24%	3%	4%	31%	0%	0%	
ADPe (kg Sb eq)	0.000380	$2.13x10^{-6}$	0.000110	$1.52x10^{-5}$	$1.30x10^{-5}$	$3.27x10^{-5}$	$1.21x10^{-6}$	$2.22x10^{-7}$	-0.000270
	69%	0%	20%	3%	2%	6%	0%	0%	
ADPEf (MJ, net calorific)	77.0	9.20	181	96.2	16.9	45.0	5.22	2.32	-50.0
	18%	2%	42%	22%	4%	10%	1%	1%	
PM (Disease incidence)	$4.30x10^{-7}$	$5.28x10^{-8}$	$1.76x10^{-6}$	$3.97x10^{-7}$	$7.89x10^{-8}$	$2.01x10^{-7}$	$2.99x10^{-8}$	$1.57x10^{-8}$	$-2.83x10^{-7}$
	14%	2%	59%	13%	3%	7%	1%	1%	
IRP (kBq U235-Eq)	0.469	0.00777	0.435	0.0643	0.0462	0.183	0.00441	0.00179	-0.323
	39%	1%	36%	5%	4%	15%	0%	0%	
ETP (freshwater) (CTUe)	64.4	5.01	68.2	49.9	15.3	44.7	2.84	1.22	-44.4
	26%	2%	27%	20%	6%	18%	1%	0%	
HTP-c (CTUh)	$6.03x10^{-9}$	$2.95x10^{-10}$	$4.63x10^{-8}$	$3.22x10^{-9}$	$1.58x10^{-9}$	$2.25x10^{-9}$	$1.67x10^{-10}$	$5.36x10^{-11}$	$-4.18x10^{-9}$
	10%	0%	77%	5%	3%	4%	0%	0%	
HTP-nc (CTUh)	$2.81x10^{-7}$	$6.60x10^{-9}$	$2.99x10^{-7}$	$4.92x10^{-8}$	$1.85x10^{-8}$	$4.90x10^{-8}$	$3.74x10^{-9}$	$8.16x10^{-10}$	$-1.94x10^{-7}$
	40%	1%	42%	7%	3%	7%	1%	0%	
SQP (dimensionless)	154	5.45	279	33.0	25.4	35.3	3.09	3.9	-105.4
	29%	1%	52%	6%	5%	7%	1%	1%	

Table 18. *Resource use for the ceramic tile products over a 75-yr time horizon. Results reported in MJ are calculated using lower heating values.*

Resources	Unit	A1	A2	A3	A4	A5	B2	C2	C4	D
PERE	MJ	8.33	0.116	51.6	0.957	0.91	14.9	0.0660	0.0250	-5.76
		11%	0%	67%	1%	1%	19%	0%	0%	
PERM	MJ	0	0	0	0	0	0	0	0	0
PERT	MJ	8.33	0.116	51.6	0.957	0.91	14.9	0.0660	0.0250	-5.76
		11%	0%	67%	1%	1%	19%	0%	0%	
PENRE	MJ	75.9	9.14	179	95.5	16.8	44.7	5.18	2.30	-49.3
		6%	8%	54%	5%	14%	12%	1%	0%	
PENRM	MJ	0	0	0	0	0	0	0	0	0
PENRT	MJ	75.9	9.14	179	95.5	16.8	44.7	5.18	2.30	1.44
		6%	8%	54%	5%	14%	12%	1%	0%	
SM	kg	1.92	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0
FW	m^3	0.172	0.00115	0.0918	0.00913	0.0125	0.464	0.000650	0.00651	-0.120
		7.7%	0.6%	2.8%	0.2%	8.2%	80.2%	0.1%	0.2%	

Table 19. *Waste flows for the ceramic tile products over a 75-yr time horizon.*

Wastes and outflows	Unit	A1	A2	A3	A4	A5	B2	C2	C4	D
HWD	kg	0	0	0	0	0	0	0	0	0
NHWD	kg	0	0	0.78	0	3.26	0	0	11.52	0
		0%	0%	5%	0%	21%	0 %	0%	74%	0
RWD	kg	0	0	0	0	0	0	0	0	0
CRU	kg	0	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	0	0	26.88	0
		0%	0%	0%	0%	0%	0%	0%	100%	0
MER	kg	0	0	0	0	0	0	0	0	0
EE	MJ	0	0	0	0	0	0	0	0	0

6. LCA: Interpretation

The contribution analysis showed that the product manufacturing (A3) is the largest contributing stage to the global warming potential impact category, with about 51% contribution to total GWP. The next largest contributing phases include the raw material (A1) stage and distribution (A4) stage during the life cycle of the ceramic product with percentages of 17% and 15% respectively. The largest contributors during the manufacturing process is from the use of coal for the kiln. The largest contributors during the raw material phase are from the production of frit while the impact of sea transportation has an important influence on the product distribution (A4). Similarly, a majority of the remaining impact categories are dominated by the product manufacturing (A3), raw material (A1), and the distribution (A4) life cycle stages with some additional significant contribution from the maintenance (B2) stage in impact categories including abiotic depletion and GWP for land use.

7. Additional Environmental Information

Comet Granito's ceramic tiles are manufactured at ISO 9001 and ISO 14001 conformant facilities. More information can be found on their website: https://www.granicer.in

8. References

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