NIRO GRANITE
THE SWISS-QUALITY TILE

VERIFIED by SCS GLOBAL SERVICES
ENVIRONMENTAL PRODUCT DECLARATION
BASED ON LCA

Declaration Owner

Niro Ceramic Group
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Product

Porcelain Tile
(CSI Code 09 31 00)

Functional Unit

The functional unit is one square meter of floor covering provided and maintained for a period of 75 years.

EPD Number and Period of Validity

SCS-EPD-08646
EPD Valid January 30, 2023 through January 29, 2028

Product Category Rule

PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. Sept. 2018.

PCR Guidance for Building-Related Products and Services Part B: Flooring EPD Requirements. Version 2. UL Environment. May 2018.

Program Operator

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SCSglobal SERVICES

Declaration Owner:	Niro Ceramic Group
Address:	Lot 2, Persiaran Sultan, Seksyen 15, 40200 Shah Alam, Selangor, Malaysia
Declaration Number:	SCS-EPD-08646
Declaration Validity Period:	EPD Valid January 30, 2023 through January 29, 2028
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Sevda Alanya Rosenbaum, Ph.D., SCS Global Services
LCA Software and LCI database:	OpenLCA v1.10 software and the Ecoinvent v3.8 database
Product RSL:	Various
Markets of Applicability:	Global
EPD Type:	Product-Specific
EPD Scope:	Cradle-to-Grave
LCIA Method and Version:	CML-IA and TRACI 2.1
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☒ internal ☐ external
LCA Reviewer:	Gerard Mansell, Ph.D., SCS Global Services
Part A Product Category Rule:	PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. Sept. 2018
Part A PCR Review conducted by:	Lindita Bushi, PhD (Chair); Hugues Imbeault-Tétreault, ing., M.Sc.A.; Jack Geibig
Part B Product Category Rule:	PCR Guidance for Building-Related Products and Services Part B: Flooring EPD Requirements. Version 2. UL Environment. May 2018.
Part B PCR Review conducted by:	Jack Geibig (chair), Ecoform; Thomas Gloria, Industrial Ecology Consultants; Thaddeus Owen
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Declaration Contents:	1. Niro Ceramic Group ..... 2 2. Product ..... 2 3. LCA Calculation Rules ..... 9 4. LCA: Scenarios and Additional Technical Information ..... 14 5. LCA: Results ..... 17 6. LCA: Interpretation ..... 22 7. Additional Environmental Information ..... 22 8. References 23

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and 21930.*

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. Niro Ceramic Group

Niro Ceramic Group has come to be known for our commitment to excellent quality and inspiring designs. Since its inception, Niro Ceramic Group has bolstered its international presence with a network spanning over 100 countries and serves as the point of contact for its customers, partners and stakeholders. Niro Ceramic Group offers a variety of products, from porcelain to ceramic tiles. The company started as a pioneer in the tile industry producing homogeneous tiles in Switzerland in 1979. The rapid growth in the Asian markets has led to the establishment of Niro Ceramic Malaysia in 1988, which later expanded to over 100 markets worldwide including Indonesia, China, Vietnam, Spain, India, and the Philippines.

2. Product

2.1. PRODUCT DESCRIPTION

The Niro Ceramic Group's porcelain tile products are produced in a variety of sizes, surface finishes and designs sold under two brand names, Niro Granite and Portino. Manufactured at the company's production facility in Indonesia and Malaysia, the porcelain tiles are used in residential and commercial spaces for floor and wall applications.

2.2 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.

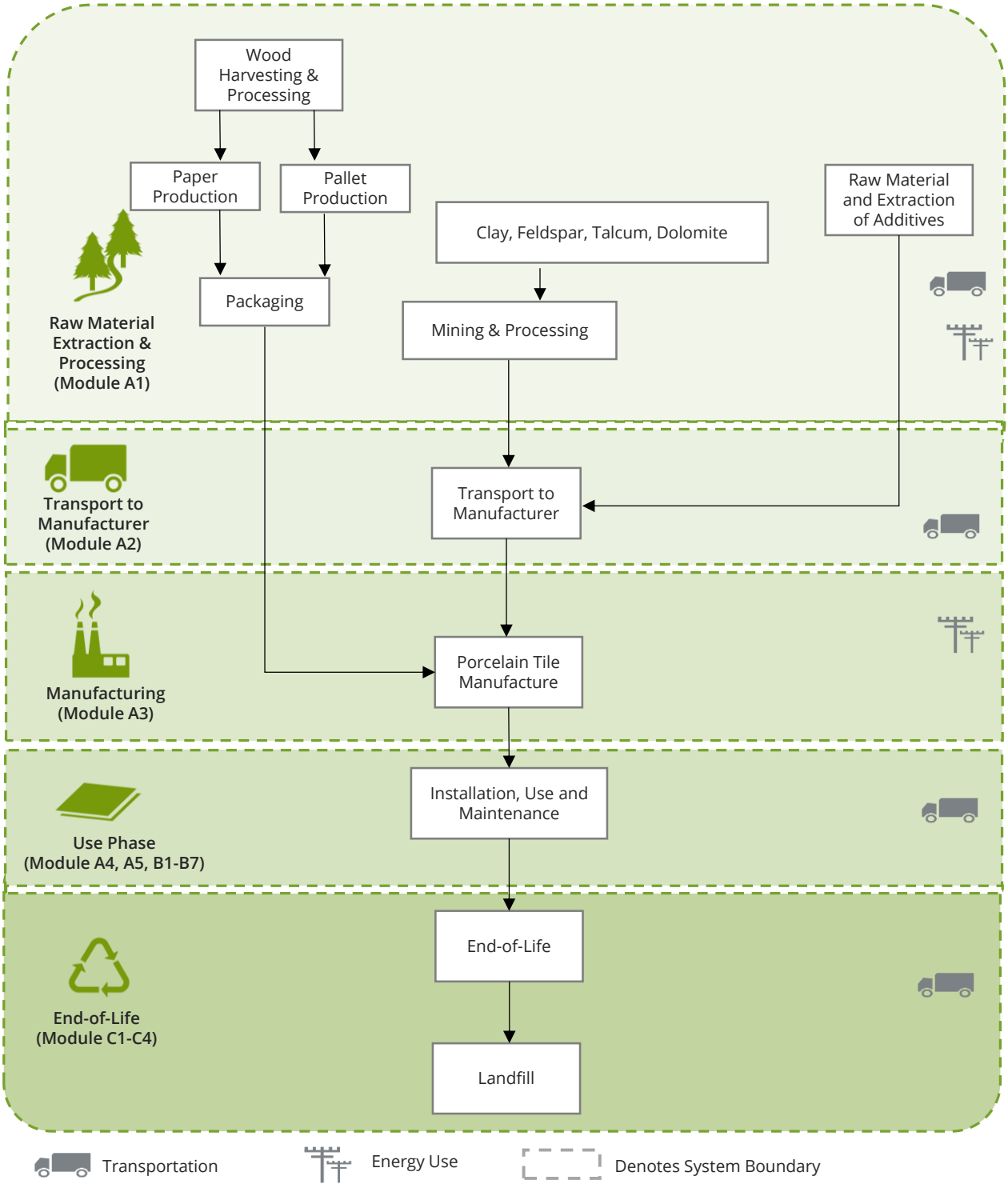
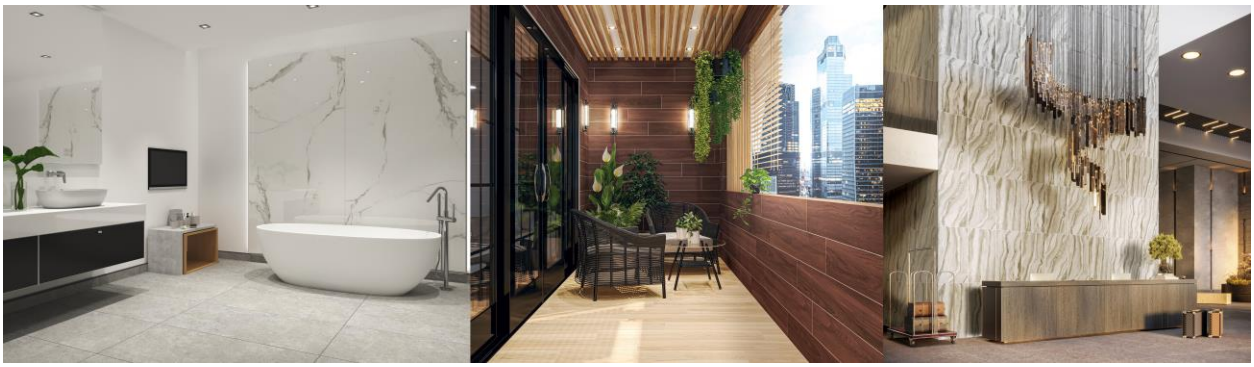


Figure 1. *Flow diagram for the life cycle of the porcelain tile product.*



2.3 APPLICATION

Niro Ceramic Group's porcelain tile products are ideal for both floor and wall applications. Porcelain tile is available in a variety of sizes, surfaces, and designs.

2.4 DECLARATION OF METHODOLOGICAL FRAMEWORK

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.

Cut-off and allocation procedures are described below and conform to the PCR and ISO standards.

Table 1. *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	MND

X = included | MND = Module Not Declared

2.5 TECHNICAL DATA

Technical specifications for the porcelain tile product are summarized in Table 2 for Indonesia and Malaysia facilities. The porcelain tile product dimensions range from 75 mm to 1200 mm at the Indonesia plant, and 200mm to 1200 mm at the Malaysia plant.

Table 2. *Product technical data for the porcelain tile products produced at the Indonesia and the Malaysia facilities.*

Parameter	Unit	Indonesia	Malaysia
Tile Type (Porcelain, pressed floor, mosaic, quarry, gauged, or glass)	-	Porcelain tiles	Porcelain tiles
Grade (Standard or second)	-	First	First
Facial Area	mm^2	360,000	360,000
Thickness	mm	8.5 up to 11.3	7.5 up to 11.5
Product Weight	g/m^2	17,000 to 27,000	18,000 to 27,000
Dimensional Categories (Natural, calibrated, or rectified)	-	Rectified	Rectified

2.6 MARKET PLACEMENT/APPLICATION RULES

Technical specifications of the flooring products are summarized in the following sections. Detailed product performance results can be found on the manufacturer's website, https://niroceramic.com.

2.7 MATERIAL COMPOSITION

The porcelain tile product is mainly constituted of clay, feldspar, minerals and additives. The average material composition of a porcelain tile and packaging material at facilities located in Indonesia and Malaysia are presented in Table 3 and Table 4, respectively.

Table 3. *Material composition for the porcelain tile products and packaging by mass (per 1 m^2) and as a percentage of total mass for the Indonesia facility.*

Component	Material	kg/m^2	Percent
Product			
Body	Feldspar	14.2	53.6%
	Clay	9.8	37.0%
	Scrap (internal)	1.1	4.1%
	Talcum	0.4	1.4%
	Dolomite	0.3	1.3%
	Other	0.3	1.2%
Surface	Glaze	0.4	1.4%
	Colorant/ink	0.1	0.2%
Product Total		**26.6**	**100%**

Table 4. *Material composition for the porcelain tile products and packaging by mass (per 1 m^2) and as a percentage of total mass for the Malaysia facility.*

Component	Material	kg/m^2	Percent
Product			
Body	Feldspar	13.4	51.3%
	Clay	9.0	34.4%
	Talcum	0.4	1.4%
	Scrap (internal)	2.8	10.6%
	Other	0.2	0.7%
Surface	Glaze	0.3	1.0%
	Colorant/ink	0.2	0.6%
Product Total		**26.2**	**100%**

No substances required to be reported as hazardous are associated with the production of this product.

2.8 MANUFACTURING

The first step of the porcelain tile manufacturing process is milling process, where raw material is ground and mixed with water. After milling, the material becomes a slip (liquid slurry). The next step is the spraying and drying, where material turns into powder. The drying process takes place after tiles are pressed. Porcelain tiles can be glazed; glazing occurs after drying and before tiles are sent to the firing process. Tiles are fired at high temperatures in a roller kiln to generate durable and non-porous tiles. The kiln is fueled by natural gas to achieve temperatures above 1200°C. The final processes include squaring and chamfering of the tiles, and packaging.

2.9 PACKAGING

The products are packaged for shipment using carton boxes and wooden pallets.

Table 5. *Material content for the flooring product packaging in kg per square meter of flooring for the Indonesia and the Malaysia facilities.*

Packaging Type	kg/m²	Percent
Corrugated	0.06	12%
Wood pallet	0.43	88%
Packaging Total	**0.49**	**100%**

2.10 PRODUCT INSTALLATION

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

2.11 USE CONDITIONS

No special conditions of use are noted.

2.12 PRODUCT REFERENCE SERVICE LIFE

Reference service life (RSL) of the products is assumed to be 75 years assuming the porcelain tile will last for the building lifetime.

2.13 RE-USE PHASE

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

2.14 DISPOSAL

At end-of-life, the products are disposed of in a landfill.

2.15 FURTHER INFORMATION

Further information on the product can be found on the manufacturer's website, https://niroceramic.com.

3. LCA Calculation Rules

3.1 FUNCTIONAL UNIT

The functional unit used in the study is defined as 1 m^2 of floor covering installed for use over a 75-year period.

Table 6. *Functional unit and reference flow information for porcelain tile products.*

Name	Unit	Value	
		Indonesia	Malaysia
Functional Unit	m^2	1	
Mass	kg	26.6	26.2

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 7.

Table 7. *The modules and unit processes included in the scope for the porcelain 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 flooring components.
A2	Transport (to the factory)	Transport of component materials to the manufacturing facilities.
A3	Manufacturing, including ancillary material production and packaging	Manufacturing of flooring 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 flooring 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 flooring is not expected to require repair over its lifetime.
B4	Product replacement	The flooring product is not expected to require repair over its lifetime.
B5	Product refurbishment	The flooring 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 flooring product to waste treatment at end-of-life.
C3	Waste processing for reuse, recovery and/or recycling	Product is landfilled at the end-of-life.
C4	Disposal	Disposal of flooring product in municipal landfill.
D	Reuse-recovery-recycling potential	Module Not Declared

3.3 PRODUCT SPECIFIC CALCULATION FOR USE PHASE

The floor is cleaned using a dust mop and water. Tile Council of North America (TCNA) recommended cleaning regime was adopted to model the product maintenance stage.

3.4 UNITS

All data and results are presented using SI units.

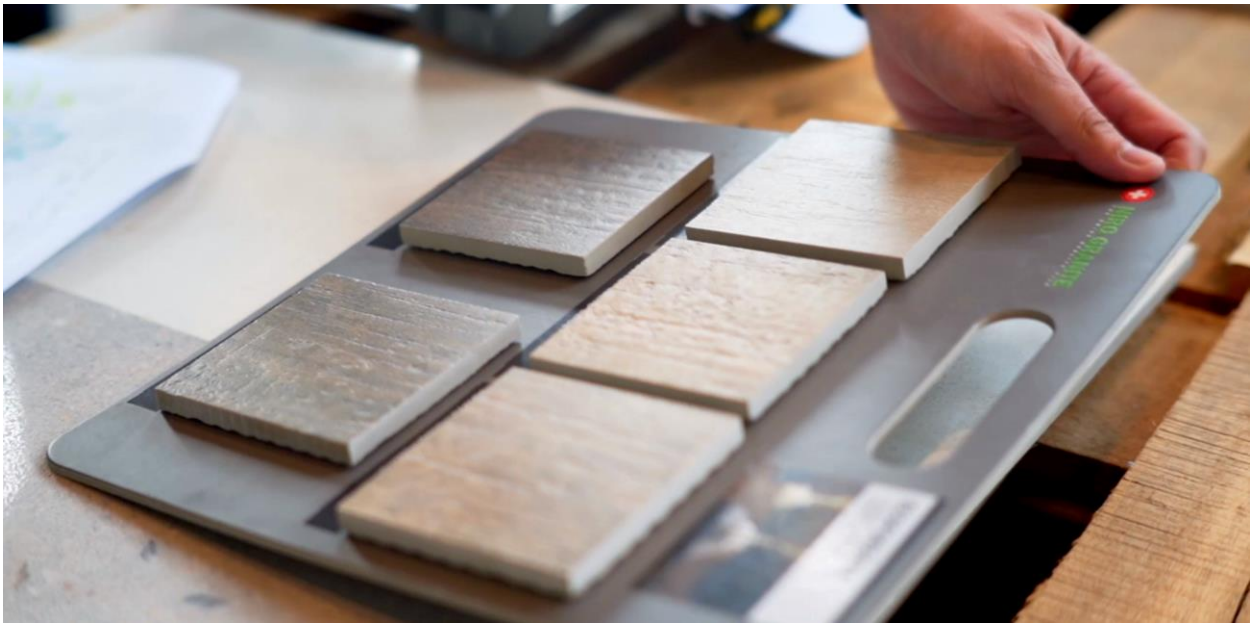
3.5 ESTIMATES AND ASSUMPTIONS

- The porcelain tile products manufactured at facilities located in Malaysia and Indonesia are analyzed in this study. Representative electricity supply mix data from Ecoinvent database were used to represent electricity use at the facilities.
- Life cycle inventory data for the glaze were not available in the Ecoinvent database. The frit production process, "Frit production, for ceramic tile | frit, for ceramic tile | Cutoff, U – GLO", was used as a surrogate to represent the glaze component, which is described as the main component of nearly all ceramic glazes in the Ecoinvent database.
- Disposal of the product packaging is modeled based on regional statistics regarding municipal solid waste generation and disposal data provided in UL PCR Part A for Indonesia and Malaysia facilities. Paper packaging waste disposal data for Malaysia was retrieved from UNEP report, which includes end-of-life recycling rates for packaging materials. No components of the product are assumed to be recycled at end-of-life.
- Installation loss was assumed to be 4.5% in line with TNCA study, and product waste is assumed to be landfilled.
- For final disposal of the packaging material and porcelain tile product at end-of-life, all materials are assumed to be transported 161 km by diesel truck to either a landfill, incineration facility, or material reclamation facility (for recycling). Datasets representing disposal in a landfill and waste incineration are from Ecoinvent.

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.

3.6 CUT-OFF RULES

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.



3.7 DATA SOURCES

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

Table 8. *Data sources for the porcelain tile products.*

Flow	Dataset	Data Source	Publication Date
Raw materials			
Feldspar	market for feldspar | feldspar | Cutoff, U	Ecoinvent v3.8	2021
Clay	market for clay | clay | Cutoff, U	Ecoinvent v3.8	2021
Talcum	market for clay | clay | Cutoff, U	Ecoinvent v3.8	2021
Glaze	frit production, for ceramic tile | frit, for ceramic tile | Cutoff, U	Ecoinvent v3.8	2021
Colorant	market for titanium dioxide | titanium dioxide | Cutoff, U - RoW	Ecoinvent v3.8	2021
Dolomite	dolomite production | dolomite | Cutoff, U	Ecoinvent v3.8	2021
Engobe	process generated based on composition	Ecoinvent v3.8	2021
Ink	market for printing ink, offset, without solvent, in 47.5% solution state | printing ink, offset, without solvent, in 47.5% solution state | Cutoff, U- RoW	Ecoinvent v3.8	2021
Kaolin	market for kaolin | kaolin | Cutoff, U	Ecoinvent v3.8	2021
STPP	market for sodium tripolyphosphate | sodium tripolyphosphate | Cutoff, U	Ecoinvent v3.8	2021
Deflocculant	sodium metasilicate pentahydrate production, 58% active substance, powder | Cutoff, U - RoW	Ecoinvent v3.8	2021
Lignosulphonate	market for chemical, organic | chemical, organic | Cutoff, U	Ecoinvent v3.8	2021
Flocculant	market for polyacrylamide | polyacrylamide | Cutoff, U cationic resin production | cationic resin | Cutoff, U	Ecoinvent v3.8	2021
Coagulant	market for polyaluminium chloride | polyaluminium chloride | Cutoff, U	Ecoinvent v3.8	2021
Zircon	market for zircon, 50% zirconium | zircon, 50% zirconium | Cutoff, U	Ecoinvent v3.8	2021
Organic chemical	chemical production, organic | chemical, organic | Cutoff, U - GLO	Ecoinvent v3.8	2021
Polyacrylamide	polyacrylamide production | polyacrylamide | Cutoff, U - GLO	Ecoinvent v3.8	2021
Mortar	market for cement mortar | cement mortar | Cutoff, U - RoW	Ecoinvent v3.8	2021
Grout	market for cement mortar | cement mortar | Cutoff, U - RoW	Ecoinvent v3.8	2021
Acrylate	market for acrylic binder, without water, in 34% solution state | acrylic binder, without water, in 34% solution state | Cutoff, U - RoW	Ecoinvent v3.8	2021
Energy and Water			
Electricity	market for electricity, medium voltage | electricity, medium voltage | Cutoff, U - MY	Ecoinvent v3.8	2021
Electricity	market for electricity, medium voltage | electricity, medium voltage | Cutoff, U - ID	Ecoinvent v3.8	2021
Natural Gas	heat production, natural gas, at industrial furnace >100kW | heat, district or industrial, natural gas | Cutoff, U - RoW	Ecoinvent v3.8	2021
Diesel	diesel, burned in building machine | diesel, burned in building machine | Cutoff, U - LO	Ecoinvent v3.8	2021
Light Fuel Oil	heat production, light fuel oil, at boiler 100kW condensing, non-modulating | heat, central or small-scale, other than natural gas | Cutoff, U - RoW	Ecoinvent v3.8	2021
Packaging			
Carton Box	market for corrugated board box | corrugated board box | Cutoff, U	Ecoinvent v3.8	2021
Pallet	market for EUR-flat pallet | EUR-flat pallet | Cutoff, U-GLO	Ecoinvent v3.8	2021
Transportation			
Road transport	transport, freight, lorry 16-32 metric ton, EURO4	Ecoinvent v3.8	2021
Ocean transport	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U- GLO	Ecoinvent v3.8	2021

3.8 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 9. *Data quality assessment for the porcelain 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 old (typically 2016). 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 2021.
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 Indonesia and Malaysia. 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 is 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)	The precision of results is 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 the production of the flooring 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 the 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 v3.8 data where available. Different portions of the product life cycle are equally considered; however, it must be noted that the final disposition of the product is based on assumptions of current average practices in Asia.
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 Niro Ceramic Group's facilities in Indonesia and Malaysia 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 v3.8 LCI data are used.
Uncertainty of the Information Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products and packaging 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 is high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

3.9 PERIOD UNDER REVIEW

The period of review is calendar year 2021.

3.10 ALLOCATION

The total facility production volume of porcelain tile was provided and used to allocate resource use (e.g., electricity, natural gas, water), waste, and emissions released at the manufacturing facility to the products based on total annual production in square meters. There were no coproducts generated for the porcelain tile manufacturing process and therefore no coproduct allocation was necessary. Impacts from transportation were allocated based on the mass of material and distance transported.

3.11 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

Delivery and Installation stage (A4 - A5)

Distribution of the flooring products to the point of sale is included in the assessment. Parameters used for modeling the distribution of the porcelain tile products to global distribution centers in Africa, Asia, Europe, the Middle East, and North America based on data from the manufacturer are presented in Table 10. Weighted average transportation distances are calculated based on sales, to represent regional transportation distances. A distance of 800 km is assumed for transport by diesel truck from the distribution center to the point of installation, consistent with PCR guidance.

Table 10. *Product distribution parameters by transport mode and consumer market (A4).*

	Distance (km)	Fuel utilization (L/100km)	Capacity utilization (%)	Distance (km)	Fuel utilization (g/tkm)	Capacity utilization (%)
Indonesia						
Indonesia	869	18.7	76%	-	2.5	65%
Europe	800	18.7	76%	15,857	2.5	65%
United Kingdom	800	18.7	76%	18,249	2.5	65%
Singapore	800	18.7	76%	1,094	2.5	65%
China	800	18.7	76%	5,096	2.5	65%
Japan	800	18.7	76%	6,724	2.5	65%
Asia (other)	800	18.7	76%	2,847	2.5	65%
Middle East	800	18.7	76%	7,708	2.5	65%
Africa	800	18.7	76%	7,724	2.5	65%
Malaysia						
Europe	800	18.7	76%	16,204	2.5	65%
United Kingdom	800	18.7	76%	16,706	2.5	65%
Singapore	821	18.7	76%	-	2.5	65%
China	800	18.7	76%	6,087	2.5	65%
India	800	18.7	76%	5,250	2.5	65%
Japan	800	18.7	76%	6,970	2.5	65%
Malaysia	848	18.7	76%	6	2.5	65%
Asia (other)	800	18.7	76%	3,788	2.5	65%
North America	800	18.7	76%	26,663	2.5	65%
Middle East	800	18.7	76%	6,934	2.5	65%

Installation of the product is accomplished using hand tools with no associated emissions and negligible impacts. The impacts associated with packaging disposal are included with the installation phase as per PCR requirements.

Table 11. *Installation parameters for the porcelain tile products, per 1 m^2 of flooring (A5).*

Parameter	Value		Unit
	Indonesia	Malaysia	
Mortar	4.07	4.07	kg
Grout	0.21	0.21	kg
Acrylate	0.04	0.04	kg
Net freshwater consumption, tap water, installation solution	0.40	0.40	L
Product loss	1.18	1.17	kg
Waste materials at the construction site before waste processing, generated by product installation	1.67	1.66	kg
Packaging waste, carton box	0.06	0.06	kg
Packaging waste, pallet	0.43	0.43	kg
Biogenic carbon contained in packaging	0.28	0.28	kg CO_2 eq
Direct emissions	N/A	N/A	kg
VOC emissions	N/A	N/A	µg/m^3

The VOC emissions shall be determined in accordance to "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers-Version 1.2" CA Specification 01350.

Use stage (B1)

No impacts are associated with the use of the product over the Reference Service Lifetime.

Maintenance stage (B2)

The maintenance stage was modeled based on guidelines recommended by TCNA.

Table 12. *Maintenance parameters for the porcelain tile products, per 1 m^2 of flooring (B2).*

Name	Frequency		Over the 75-yr estimated service lifetime (RSL)	
Maintenance cycle (Dust mop)	365	times/year	27,375	cycles/RSL
Maintenance cycle (Damp mop)	36	times/year	2,700	cycles/RSL
Net freshwater consumption	0.78	L/m2/year	59	L/RSL

Repair/Refurbishment stage (B3; B5)

Product repair and refurbishment are not relevant during the lifetime of the product.

Replacement stage (B4)

The material is not replaced over the 75-year ESL of the assessment.

Building operation stage (B6 – B7)

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

Disposal stage (C1 - C4)

The disposal stage includes the demolition of the products (C1); transport of the flooring products to waste treatment facilities (C2); waste processing (C3); and associated emissions as the product degrades in a landfill (C4). For the product, no emissions are generated during demolition while no waste processing is required for landfill disposal. Results for these stages (C1 & C3) are reported as zero for the product system.

Transportation of waste materials at end-of-life (*C2*) assumes a 161 km average distance to disposal, consistent with UL Part A PCR requirement .

Disposal of the product packaging is modeled based on regional statistics regarding municipal solid waste generation and disposal data provided in UL PCR Part A for Indonesia and Malaysia facilities (Table 13). Paper packaging waste disposal data for Malaysia was retrieved from UNEP report. The data include end-of-life recycling rates of packaging. No components of the product are assumed to be recycled.

Table 13. *Recycling rates for materials at end-of-life by the consumer market.*

Material	Recycling rate (%)	
Packaging		
Recycling Rates	Indonesia	Malaysia
Paper & Pulp	5%	50%
Wood pallet	5%	4%
Disposal of Non-recyclables		
Landfill	100%	100%

Table 14. *End-of-life disposal scenario parameters for the porcelain tile product.*

Parameter	Value	
	Indonesia	Malaysia
Assumptions for scenario development	100% landfill	100% landfill
Collection process- Collected with mixed construction waste	100%	100%
Collected with mixed construction waste (kg)	30.6	30.3
Recovery	n/a	n/a
Landfill disposal (kg)	30.6	30.3
Removals of biogenic carbon (kg CO_2 eq)	n/a	n/a

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%.

The following environmental impact category indicators are reported using characterization factors based on the CML-IA and U.S. EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts – TRACI 2.1.

Table 15. *Environmental Indicators*

CMLI-A Impact Category	Unit	TRACI 2.1 Impact Category	Unit
Global Warming Potential **(GWP)**	kg CO_2 eq	Global Warming Potential **(GWP)**	kg CO_2 eq
Depletion potential of the stratospheric ozone layer **(ODP)**	kg CFC 11 eq	Ozone Depletion Potential **(ODP)**	kg CFC 11 eq
Acidification Potential of soil and water **(AP)**	kg SO_2 eq	Acidification Potential **(AP)**	kg SO_2 eq
Eutrophication Potential **(EP)**	kg PO_4^{3-} eq	Eutrophication Potential **(EP)**	kg N eq
Photochemical Oxidant Creation Potential **(POCP)**	kg C_2H_4 eq	Smog Formation Potential **(SFP)**	kg O_3 eq
Abiotic depletion potential **(ADP-elements)** for non-fossil resources	kg Sb eq	Fossil Fuel Depletion Potential **(FFDP)**	MJ Surplus, LHV
Abiotic depletion potential **(ADP-fossil fuels)** for fossil resources	MJ, LHV	-	-

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.

Table 16. *Life Cycle Inventory Parameters*

Resources	Unit	Waste and Outflows	Unit
RPR_E: Renewable primary resources used as energy carrier (fuel)	MJ, LHV	**HWD:** Hazardous waste disposed	kg
RPR_M: Renewable primary resources with energy content used as material	MJ, LHV	**NHWD:** Non-hazardous waste disposed	kg
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	MJ, LHV	**HLRW:** High-level radioactive waste, conditioned, to final repository	kg
$NRPR_M$: Non-renewable primary resources with energy content used as material	MJ, LHV	**ILLRW:** Intermediate- and low-level radioactive waste, conditioned, to final repository	kg
SM: Secondary materials	MJ, LHV	**CRU:** Components for re-use	kg
RSF: Renewable secondary fuels	MJ, LHV	**MR:** Materials for recycling	kg
NRSF: Non-renewable secondary fuels	MJ, LHV	**MER:** Materials for energy recovery	kg
RE: Recovered energy	MJ, LHV	**EE:** Recovered energy exported from the product system	MJ, LHV
FW: Use of net freshwater resources	m^3	-	-

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. Additionally, as the flooring products do not contain significant amounts of bio-based materials, biogenic carbon emissions and removals are not declared. Module D is not declared. In the interest of space and table readability, these modules are not included in the results presented below.

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

CML-IA	A1	A2	A3	A4	A5	B2	C2	C4
GWP (kg CO_2 eq)	1.84	0.360	12.6	3.73	1.31	$1.95x10^{-2}$	0.831	0.317
	9%	2%	60%	18%	6%	0%	4%	2%
ODP (kg CFC-11 eq)	$3.57x10^{-7}$	$6.19x10^{-8}$	$6.49x10^{-7}$	$6.48x10^{-7}$	$6.06x10^{-8}$	$1.07x10^{-9}$	$1.45x10^{-7}$	$7.76x10^{-8}$
	18%	3%	32%	32%	3%	0%	7%	4%
AP (kg SO_2 eq)	$1.07x10^{-2}$	$2.45x10^{-3}$	$2.99x10^{-2}$	$1.46x10^{-2}$	$3.66x10^{-3}$	$8.35x10^{-5}$	$3.24x10^{-3}$	$2.06x10^{-3}$
	16%	4%	45%	22%	5%	0%	5%	3%
EP (kg $(PO_4)^{3-}$ eq)	$3.25x10^{-3}$	$4.19x10^{-4}$	$3.57x10^{-2}$	$3.36x10^{-3}$	$2.43x10^{-3}$	$4.39x10^{-5}$	$7.49x10^{-4}$	$6.67x10^{-4}$
	7%	1%	77%	7%	5%	0%	2%	1%
POCP (kg C_2H_4 eq)	$6.27x10^{-4}$	$7.31x10^{-5}$	$1.55x10^{-3}$	$4.96x10^{-4}$	$2.04x10^{-4}$	$3.85x10^{-6}$	$1.10x10^{-4}$	$8.44x10^{-5}$
	20%	2%	49%	16%	6%	0%	4%	3%
ADP_E (kg Sb eq)	$8.21x10^{-5}$	$1.15x10^{-6}$	$6.86x10^{-6}$	$1.29x10^{-5}$	$4.76x10^{-6}$	$2.18x10^{-7}$	$2.89x10^{-6}$	$1.05x10^{-6}$
	73%	1%	6%	12%	4%	0%	3%	1%
ADP_F (MJ eq)	24.4	5.25	157	55.2	9.00	0.225	12.3	7.40
	9%	2%	58%	20%	3%	0%	5%	3%
TRACI 2.1	**A1**	**A2**	**A3**	**A4**	**A5**	**B2**	**C2**	**C4**
GWP (kg CO_2 eq)	1.83	0.360	12.4	3.72	1.28	$1.94x10^{-2}$	0.830	0.315
	9%	2%	60%	18%	6%	0%	4%	2%
ODP (kg CFC-11 eq)	$4.03x10^{-7}$	$8.25x10^{-8}$	$8.49x10^{-7}$	$8.63x10^{-7}$	$8.08x10^{-8}$	$1.41x10^{-9}$	$1.93x10^{-7}$	$1.03x10^{-7}$
	16%	3%	33%	34%	3%	0%	7%	4%
AP (kg SO_2 eq)	$1.10x10^{-2}$	$2.73x10^{-3}$	$3.07x10^{-2}$	$1.70x10^{-2}$	$4.10x10^{-3}$	$8.25x10^{-5}$	$3.79x10^{-3}$	$2.42x10^{-3}$
	15%	4%	43%	24%	6%	0%	5%	4%
EP (kg $(PO_4)^{3-}$ eq)	$6.18x10^{-3}$	$4.11x10^{-4}$	$8.09x10^{-2}$	$4.07x10^{-3}$	$5.49x10^{-3}$	$9.49x10^{-5}$	$9.07x10^{-4}$	$1.02x10^{-3}$
	6%	0%	82%	4%	6%	0%	1%	1%
SFP (kg O_3 eq)	0.153	$5.82x10^{-2}$	0.464	0.408	$7.88x10^{-2}$	$8.85x10^{-4}$	$9.09x10^{-2}$	$5.88x10^{-2}$
	12%	4%	35%	31%	6%	0%	7%	5%
FFDP (MJ Surplus)	2.73	0.752	20.1	7.89	0.984	$2.16x10^{-2}$	1.76	1.05
	8%	2%	57%	22%	3%	0%	5%	3%

Table 18. *Life Cycle Impact Assessment (LCIA) results for the porcelain tile products over a 75-yr time horizon for the Malaysia facility. Results reported in MJ are calculated using lower heating values.*

CML-IA	A1	A2	A3	A4	A5	B2	C2	C4
GWP (kg CO_2 eq)	2.28	1.17	16.2	4.05	1.26	$1.95x10^{-2}$	0.831	0.314
	9%	4%	62%	15%	5%	0%	3%	1%
ODP (kg CFC-11 eq)	$2.84x10^{-7}$	$2.03x10^{-7}$	$9.94x10^{-7}$	$7.00x10^{-7}$	$6.05x10^{-8}$	$1.07x10^{-9}$	$1.45x10^{-7}$	$7.70x10^{-8}$
	12%	8%	40%	28%	2%	0%	6%	3%
AP (kg SO_2 eq)	$1.55x10^{-2}$	$5.26x10^{-3}$	$3.81x10^{-2}$	$2.34x10^{-2}$	$3.65x10^{-3}$	$8.35x10^{-5}$	$3.24x10^{-3}$	$2.04x10^{-3}$
	17%	6%	42%	26%	4%	0%	4%	2%
EP (kg $(PO_4)3-$ eq)	$4.75x10^{-3}$	$1.12x10^{-3}$	$1.22x10^{-2}$	$4.34x10^{-3}$	$2.35x10^{-3}$	$4.39x10^{-5}$	$7.49x10^{-4}$	$6.61x10^{-4}$
	18%	4%	47%	17%	9%	0%	3%	3%
POCP (kg C_2H_4 eq)	$1.12x10^{-3}$	$1.72x10^{-4}$	$2.14x10^{-3}$	$7.22x10^{-4}$	$1.94x10^{-4}$	$3.85x10^{-6}$	$1.10x10^{-4}$	$8.37x10^{-5}$
	25%	4%	47%	16%	4%	0%	2%	2%
ADP_E (kg Sb eq)	$8.10x10^{-5}$	$3.99x10^{-6}$	$1.65x10^{-5}$	$1.34x10^{-5}$	$4.76x10^{-6}$	$2.18x10^{-7}$	$2.89x10^{-6}$	$1.04x10^{-6}$
	65%	3%	13%	11%	4%	0%	2%	1%
ADP_F (MJ eq)	28.4	17.3	228	59.4	8.98	0.225	12.3	7.33
	8%	5%	63%	16%	2%	0%	3%	2%
TRACI 2.1	**A1**	**A2**	**A3**	**A4**	**A5**	**B2**	**C2**	**C4**
GWP (kg CO_2 eq)	2.28	1.17	16.2	4.05	1.24	$1.95x10^{-2}$	0.831	0.314
	9%	4%	62%	15%	5%	0%	3%	1%
ODP (kg CFC-11 eq)	$2.84x10^{-7}$	$2.03x10^{-7}$	$9.94x10^{-7}$	$7.00x10^{-7}$	$6.05x10^{-8}$	$1.07x10^{-9}$	$1.45x10^{-7}$	$7.70x10^{-8}$
	12%	8%	40%	28%	2%	0%	6%	3%
AP (kg SO_2 eq)	$1.55x10^{-2}$	$5.26x10^{-3}$	$3.81x10^{-2}$	$2.34x10^{-2}$	$3.65x10^{-3}$	$8.35x10^{-5}$	$3.24x10^{-3}$	$2.04x10^{-3}$
	17%	6%	42%	26%	4%	0%	4%	2%
EP (kg $(PO_4)^{3-}$ eq)	$4.75x10^{-3}$	$1.12x10^{-3}$	$1.22x10^{-2}$	$4.34x10^{-3}$	$2.35x10^{-3}$	$4.39x10^{-5}$	$7.49x10^{-4}$	$6.61x10^{-4}$
	18%	4%	47%	17%	9%	0%	3%	3%
SFP (kg O_3 eq)	$1.12x10^{-3}$	$1.72x10^{-4}$	$2.14x10^{-3}$	$7.22x10^{-4}$	$1.94x10^{-4}$	$3.85x10^{-6}$	$1.10x10^{-4}$	$8.37x10^{-5}$
	25%	4%	47%	16%	4%	0%	2%	2%
FFDP (MJ Surplus)	$8.10x10^{-5}$	$3.99x10^{-6}$	$1.65x10^{-5}$	$1.34x10^{-5}$	$4.76x10^{-6}$	$2.18x10^{-7}$	$2.89x10^{-6}$	$1.04x10^{-6}$
	65%	3%	13%	11%	4%	0%	2%	1%

Table 19. *Resource use and waste flows for the porcelain tile products over a 75-yr time horizon in the Indonesia facility. Results reported in MJ are calculated using lower heating values.*

Resources	A1	A2	A3	A4	A5	B2	C2	C4
RPR_E (MJ)	1.77	$5.83x10^{-2}$	15.7	0.644	0.918	$3.26x10^{-2}$	0.144	0.128
	9%	0%	81%	3%	5%	0%	1%	1%
RPR_M (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$NRPR_E$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
$NRPR_M$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
SM (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW (m^3)	$4.88x10^{-2}$	$6.62x10^{-4}$	$2.23x10^{-2}$	$7.32x10^{-3}$	$6.19x10^{-3}$	$5.94x10^{-2}$	$3.28x10^{-4}$	$8.11x10^{-3}$
	32%	0%	15%	5%	4%	39%	0%	5%
Wastes	**A1**	**A2**	**A3**	**A4**	**A5**	**B2**	**C2**	**C4**
HWD (kg)	$6.36x10^{-5}$	$1.30x10^{-5}$	$1.05x10^{-2}$	$1.48x10^{-4}$	$2.03x10^{-5}$	$2.06x10^{-7}$	$6.62x10^{-6}$	$1.17x10^{-5}$
	1%	0%	98%	1%	0%	0%	0%	0%
NHWD (kg)	2.62	0.241	1.39	2.84	1.83	$2.78x10^{-3}$	0.127	30.7
	7%	1%	3%	7%	5%	0%	0%	77%
HLRW (kg)	$7.09x10^{-6}$	$2.53x10^{-7}$	$3.15x10^{-6}$	$2.83x10^{-6}$	$2.51x10^{-6}$	$3.30x10^{-7}$	$1.27x10^{-7}$	$6.19x10^{-7}$
	42%	1%	19%	17%	15%	2%	1%	4%
ILLRW (kg)	$6.98x10^{-5}$	$3.47x10^{-5}$	$4.57x10^{-5}$	$3.63x10^{-4}$	$3.72x10^{-5}$	$8.83x10^{-7}$	$1.62x10^{-5}$	$4.45x10^{-5}$
	11%	6%	7%	59%	6%	0%	3%	7%
CRU (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR (kg)	0.00	0.00	0.839	0.00	$2.5x10^{-2}$	0.00	0.00	0.00
	0%	0%	97%	0%	3%	0%	0%	0%
MER (kg)	Neg.	Neg.	Neg.	Neg.	Neg.	0.00	Neg.	Neg.
EE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	0.00	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

Table 20. *Resource use and waste flows for the porcelain tile products over a 75-yr time horizon in the Malaysia facility. Results reported in MJ are calculated using lower heating values.*

Resources	A1	A2	A3	A4	A5	B2	C2	C4
RPR_E (MJ)	2.0	0.20	11	0.67	0.92	$3.3x10^{-2}$	0.14	0.13
	13%	1%	73%	4%	6%	0%	1%	1%
RPR_M (MJ)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$NRPR_E$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
$NRPR_M$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
SM (kg)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RSF (MJ)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NRSF (MJ)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FW (m^3)	$5.84x10^{-2}$	$2.27x10^{-3}$	$8.17x10^{-2}$	$7.63x10^{-3}$	$6.18x10^{-3}$	$5.94x10^{-2}$	$3.28x10^{-4}$	$8.04x10^{-3}$
	26.1%	1.0%	36.5%	3.4%	2.8%	26.5%	0.1%	3.6%
Wastes	**A1**	**A2**	**A3**	**A4**	**A5**	**B2**	**C2**	**C4**
HWD (kg)	$6.90x10^{-5}$	$4.54x10^{-5}$	1.79	$1.51x10^{-4}$	$2.03x10^{-5}$	$2.06x10^{-7}$	$3.30x10^{-5}$	$1.16x10^{-5}$
	0%	0%	100%	0%	0%	0%	0%	0%
NHWD (kg)	2.85	0.868	1.89	2.84	1.79	$2.78x10^{-3}$	0.634	30.4
	7%	2%	5%	7%	4%	0%	2%	74%
HLRW (kg)	$7.31x10^{-6}$	$8.74x10^{-7}$	$4.41x10^{-6}$	$2.93x10^{-6}$	$2.50x10^{-6}$	$3.30x10^{-7}$	$6.32x10^{-7}$	$6.14x10^{-7}$
	37%	4%	22%	15%	13%	2%	3%	3%
ILLRW (kg)	$8.12x10^{-5}$	$1.13x10^{-4}$	$6.90x10^{-5}$	$3.92x10^{-4}$	$3.71x10^{-5}$	$8.83x10^{-7}$	$8.09x10^{-5}$	$4.41x10^{-5}$
	10%	14%	8%	48%	5%	0%	10%	5%
CRU (kg)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MR (kg)	0.0	0.0	0.0	0.0	$4.7x10^{-2}$	0.0	0.0	0.0
	0%	0%	0%	0%	100%	0%	0%	0%
MER (kg)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
EE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

6. LCA: Interpretation

The contribution analysis showed that product manufacturing (A3) is the largest contributing stage to the global warming potential impact category, with about 60% and 62% contribution to total GWP at Indonesia and Malaysia facilities, respectively, over the life cycle of the porcelain product. This is mainly due to natural gas used for the firing of the tiles followed by electricity used in manufacturing processes. Similarly, the majority of the impact categories are dominated by the product manufacturing (A3) stage, except for the abiotic depletion potential of elements indicator.

7. Additional Environmental Information

Niro Ceramic Group's porcelain tiles are manufactured at ISO 9001 and ISO 14001 conformant facilities.
Products produced at the Malaysia facility are certified to SIRIM Eco Label License. Both Malaysia and Indonesia facilities are Singapore Green Label certified.

8. References

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