CLAY TILES AND FITTINGS

ENVIRONMENTAL PRODUCT DECLARATION

ISO 14025:2006 and EN 15804+A2:2019

ASTM INTERNATIONAL

LUDOWICI is pleased to present this Environmental Product Declaration (EPD) for their clay tiles and fittings. This EPD was developed in compliance with ISO 14025 and EN 15804 and has been verified by Lindita Bushi, Ph.D., Athena Sustainable Materials Institute.

The LCA and the EPD were prepared by Vertima Inc. The EPD includes cradle-to-grave life cycle assessment (LCA) results.

For more information about LUDOWICI, visit https://ludowici.com/.

For any explanatory material regarding this EPD, please contact the program operator.

1. GENERAL INFORMATION

PCR GENERAL INFORMATION	
Reference PCR	IBU (2024) 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 PCR Guidance-Texts for Building-Related Products and Services, From the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU) - Part B: Requirements on the EPD for Bricks, 01/08/2024 v6
The PCR review was conducted by:	*The Institut Bauen und Umwelt e.V. Advisory Board*

EPD GENERAL INFORMATION		
Program Operator	ASTM 100 Barr Harbor Drive, West Conshohocken, PA 19428, USA www.astm.org	
Declared Products	Barrel tile Shingle tile Interlocking tile Shake tile Slate tile	
EPD Registration Number 802	**EPD Date of Issue** 2024-10-17	**EPD Period of Validity** 5 years
EPD Recipient Organization	Ludowici 4757 Tile Plant Road New Lexington, OH 43764 USA	LUDOWICI®

EPD Type/Scope and Declared Unit Facility-specific cradle-to-grave EPD with declared unit of one (1) metric ton (or 1,000 kg) of clay tiles and fittings.			**Year of Reported Manufacturer Primary Data** 2023
Geographical Scope North America	**LCA Software** OpenLCA v.2.1.1	**LCI Databases** Ecoinvent v3.9.1 and US LCI	**LCIA Methodology** EN 15804+A2, TRACI 2.1 CED (LVH), v1.0

This LCA and EPD were prepared by:	Vertima Inc. www.vertima.ca
This EPD and LCA were independently verified in accordance with ISO 14025:2006, ISO 14040:2006 and ISO 14044:2006, as well as EN 15804+A2, which is the core PCR. ☐ Internal ☒ External	*Lindita Bushi* (signature) Lindita Bushi, Ph.D. Athena Sustainable Materials Institute

LIMITATIONS

Environmental declarations within the same product category but from different programs may not be comparable [1].

The owner of the declaration shall be liable for the underlying information and evidence.

2. Product System Description

Ludowici is a US manufacturer of clay tiles and fittings. Tiles are mostly used as a roofing material but can also be used for wall and floor coverings. Its manufacturing facility is based in New Lexington, Ohio (USA).

2.1. PRODUCT DESCRIPTION

Ludowici offers a wide range of tiles. Depending on the final colors and texture, the tiles are sold under specific brand names. This study covers the following categories of tiles, as well as their clay accessories and fittings:

- Barrel tile: Clay roof tiles with a curved pan and a curved cover that overlap and fit together to form a water-shedding roof assembly.
- Shingle tile: Shingle tiles (slabs of clay) come in various sizes, surface textures and colors. Ludowici texture options range from rustic, rough and rugged appearances to tiles with smooth clean lines for a more refined look. These tiles are installed with a triple head lap to ensure proper water shedding is achieved when installed.
- Interlocking tile: Flat interlocking tiles are designed with stiffening ribs on the back of the tile and an interlocking weather channel that allows for proper water shedding and drainage while increasing the tiles' vertical exposure. This allows for less pieces per square (100 sq. ft) and lighter installed weights.
- Shake tile: Shake clay roof tiles use various methods to introduce scoring, brushing and pressed bark texture into the clay surface to mimic wood roofing products. The clay tiles are then glazed in various colors to mimic the look of weathered wood shingles.
- Slate tile: Slate clay roof tiles use various methods to introduce chiseled stone and quarried slate texture into the clay surface to slate/stone roofing products. The clay tiles are then glazed in various colors to mimic the look of slate/stone.

Barrel tile Shingle tile Interlocking tile Shake tile Slate tile

Ludowici’s tiles commercial names

Category	Commercial names
Barrel tile	13-1/4" Spanish Tile, 18-3/8" Spanish Tile, Scandia Tile, Seville Tile, T-12 Spanish, Cubana Tile, Greek Tile, Italia Tile, Palm Beach Mission Tile, 14" Straight Barrel Mission Tile, 16" Straight Barrel Mission Tile, 18" Straight Barrel Mission Tile, 14" Tapered Mission Tile
Shingle tile	Antique, Brittany, Calais, Colonial, Cotswold, Cottage, Crude, Flat Slab, Georgian, Greenwich, Norman, Provincial, Rustic Colonial, Colonial Old Style
Interlocking tile	Americana 14, American 16, Classic 14, Classic 16, French, Lanai 14, Lanai 16, Morando Closed Shingle, Williamsburg 14, Williamsburg 16, Century Shake, LudoShake, LudoSlate, Jamestown, LWIOT, EAOT, Tilestone, K-English, Heritage Closed Shingle, NeXclad 14, NeXclad 16, NeXclad True
Shake tile	Century Shake, LudoShake, Jamestown, EAOT, Colonial, Colonial Old
Slate tile	LudoSlate, Cotswold, Lexington Slate, Duke Memorial Tile, Yale Memorial Tile

2.2. MATERIAL COMPOSITION

Materials	Minimum - maximum	Average
	% for one declared unit	% for one declared unit
Shale	85.9% - 89.1%	86.7%
Clay	9.5% - 9.9%	9.6%
Glaze	0.0% - 4.1%	2.7%
Barium carbonate	0.9% - 1.0%	1.0%
TOTAL	**100.0%**	**100.0%**

The recycled content of the tiles is 0%. The average product is calculated based on 2023 annual production data (on mass) of all the tiles manufactured on site and their composition.

For specific properties and performance data, please consult the following link: www.ludowici.com.

2.3. PACKAGING

Ludowici’s tiles are shrink-wrapped with polyethylene film and cardboard and are stacked on wood pallets. Wood pallets and cardboard can be recycled where services are available.

3. LCA Calculation Rules

3.1. DECLARED UNIT

The selected declared unit (DU) for this study is **one (1) metric ton (or 1,000 kg) of clay tiles and fittings.**

Item	Minimum - maximum	Average
	For all tiles manufactured	per declared unit
Coverage - Area density (kg/m^2)	23.2 – 105.5	56.0
Coverage – number of tiles (tiles/m^2)	10.1 – 44.6	19.5
Product density	2,500 kg/m^3	
Reference service life	75 years (with a 75-year manufacturer warranty from the manufacturer)[1]	
Approvals and certifications[2]	• Miami-Dade NOA No: 12-0904.14 • State of Florida Approval No: FL 13777 • ASTM C1167 Grade 1 Roof Tile With Water Absorption Less Than 2% • Class A Fire Rated • IAPMO UES ER-452	

[1] Ludowici offers a 75-year warranty for all tiles against color fading and manufacturing defects. Their data shows that some products have been in place for over 100 years and are still performing exceptionally well. The higher temperature and longer cycle used in their firing process ensure superior durability and resistance, setting the tiles apart in longevity and reliability.

[2]A complete list of certifications and approvals can be found in the product data sheets, available at https://ludowici.com/resources/technical-documentation/.

3.2. PRODUCTION AVERAGE

The average product is calculated based on 2023 annual production data (on mass) of all the tiles manufactured on site and their composition.

3.3. SYSTEM BOUNDARIES

The system boundaries are **cradle-to-grave**, i.e., cover all the following life cycle stages, as illustrated in Table 1: Raw materials extraction (A1), Transport to factory (A2), Product manufacturing (A3), Transport to site (A4), Installation (A5), Use stage (B1 to B7), End-of-life (C1 to C4) and Module D. **Table 1** presents the stages included in the system boundaries and Figure 1 presents the process flow diagram for the tiles under study.

Table 1: Description of the system boundary life cycle stages and related information modules

Upstream processes	Core processes		Downstream processes													
PRODUCTION STAGE			CONSTRUC-TION PROCESS STAGE		USE STAGE							END-OF-LIFE STAGE				D
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Product distribution	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste	Disposal	Benefits and burdens beyond the system
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Key: X = included; MND = module not declared (excluded)

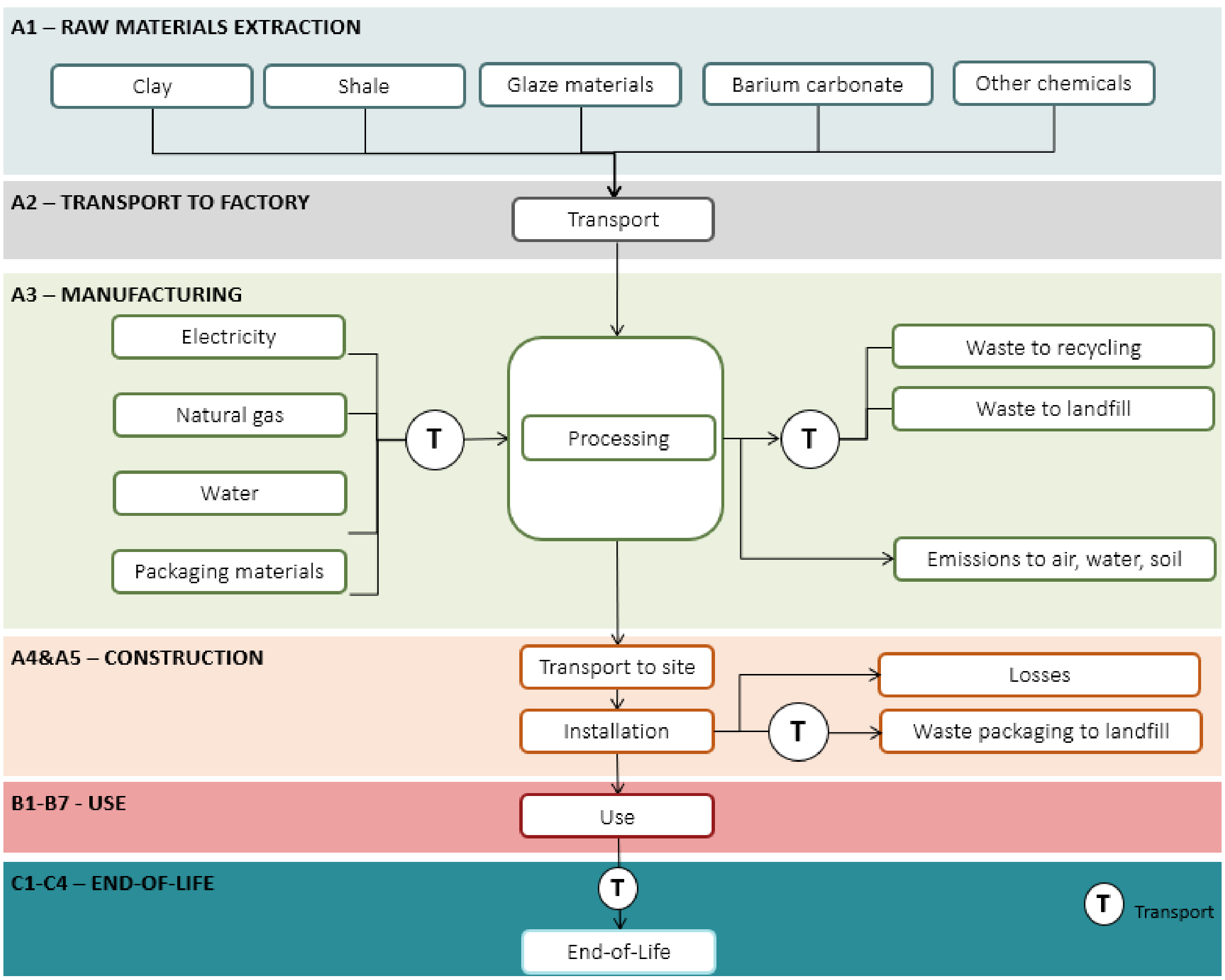


Figure 1: System boundaries of cradle-to-grave LCA of Ludowici's tiles and fittings produced in New Lexington, Ohio.

Life Cycle Stages

Raw materials extraction (module A1): This life cycle stage includes the extraction and transformation of raw materials included in the tiles: shale, clay, glaze materials, barium carbonate and chemicals used.

Transport to factory (module A2): This life cycle stage includes all transport of raw materials from Ludowici's suppliers to Ludowici's plant, mostly by truck. Main inputs, clay and shale are sourced in quarries located in Ohio.

Manufacturing (module A3): Tiles are made in New Lexington, Ohio, and production data are representative of the 2023 production year.

This life cycle stage includes energy (electricity and natural gas), water consumption and wastewater treatment, packaging materials to make tiles ready for shipment, emissions to air and water, waste treatment of waste generated during the manufacturing process, including tile losses that are sent to recycling and used as road fill. The distance to the waste management facility is 32 km, as per the US EPA WARM model [13].

Product distribution and installation (modules A4 and A5): This stage includes the transport of the tiles by truck to the clients in North America. Destinations are known by region/states and are representative of 2023 shipments. Tiles are installed using tools common to everyday practice and installation was excluded from this study. Losses on construction sites is assumed to be 3%. A5 includes the wastage of construction products (additional production and transportation processes to compensate for the 3% loss of wastage of products). Waste treatment of the used packaging and its transport to the disposal site was include in A5.

Use stage (B1 to B7): No energy or water is required for the use phase of the product (B1), and no maintenance is necessary for it to function. If a tile is damaged, it can be replaced, and it can be washed for aesthetic purposes. Maintenance is considered negligible. It is assumed that there is no need for repair, replacement, or refurbishment during the lifespan of the tiles considered in this study (modules B3 to B5), given the 75-year warranty provided by Ludowici. Additionally, there is no operational energy or water use associated with the tiles (modules B6 and B7). Therefore, no processes were modeled for the use stage of the tiles.

End-of-life stage (C1 to C4): This life cycle stage includes transport of the tiles to their end-of-life processing facilities and their final disposal. The product is assumed to be dismantled manually and transported to a waste management center. Waste treatment of tiles is based on the US EPA 2018 fact sheet – Table 8/ C&D Debris Management by Destination[9]. The distance to the waste management facility is 32 km [13].

Module D: As 15% of the tiles are assumed to be reused directly at the end the reference service life, results of module D have been calculated as 15% of results of A1-A3 multiplied by -0.15.

3.4. CUT-OFF CRITERIA

In this EPD, no flows were excluded. It should be noted that no data on the manufacturing of production equipment, buildings and other capital goods, daily transport of the employees, office work, business trips and other activities from Ludowici's employees were included in the model. The model only considers the processes associated with infrastructure that are already included in the ecoinvent unit processes.

3.5. ALLOCATION

ISO 14040 allocation procedure states that whenever possible, allocation should be avoided by collecting data related to the process under study or by expanding the product system. According to ISO 14040, step 2 consists of partitioning the inputs and outputs between the different products in a way that reflects the physical relationship between them.

For this LCA, data were provided for the whole year and all the products, consequently no allocation was needed to perform this LCA.

For re-use, recycling, and recovery, the system boundaries were defined at the point where waste reaches its end state and is ready for its next use. In other words, a cut-off approach was employed, as further processing of the recycled material is considered part of raw material preparation for another product system (open loop recycling).

3.6. DATA SOURCES AND QUALITY REQUIREMENTS

Data Quality Parameter	Data Quality Discussion
Source of manufacturing data: Description of sources of data	Manufacturing data was collected from one manufacturing plant located in New Lexington, Ohio, for the 2023 production year. This data included: total annual mass of products produced at the manufacturing plant: specific product composition; raw materials and fuels entering the product production process; transport distance of materials and fuels, electricity consumption, water consumption, emissions to water at the manufacturing plant, and packaging. Fuel energy content (LHV) were provided by the ecoinvent process database. Emissions to air from the industrial process were estimated with external documentation. A sensitivity analysis was performed on the data used for air emissions. The assumptions used in this analysis were deemed relevant and were therefore retained in the base scenario for the study's results.
Source of secondary data: Description of sources of raw material, energy source, transport, waste and packaging data	Data used for raw materials was taken from ecoinvent. In priority, background data was taken from ecoinvent 3.9.1 “cut-off” datasets representative of the United States or North America. When appropriate, the grid mix was changed for the grid mix of the province or country where production takes place. Otherwise, ecoinvent data representative of the global market or the “rest-of-the-world” was selected as proxies. Transport data was taken from the US LCI [11] database, which is specific to a North American context.
Geographical representativeness	The manufacturing facility is based in Ohio; hence electricity consumption is based on the Reliability First Corporation (US-RFC) grid mix and natural gas consumption from the United States supply. Geographical correlation of the material supply and the selected datasets are largely representative of the same area. When this was not possible, datasets representing a larger geographical area were used.
Temporal representativeness	Primary data was collected to be representative of the full year (2023). Datasets selected were not always published within the last ten years. Nevertheless, ecoinvent and US LCI remain the reference LCI databases.
Technological representativeness	Primary data, obtained from the manufacturer, is representative of the current technologies and materials used by this company.
Completeness	All relevant process steps were considered and modeled to satisfy the goal and scope. Cut-off criteria were respected.

4. Life Cycle Assessment Results

4.1. RESULTS TABLES

Results are presented for **one (1) metric ton (1,000 kg) of clay tiles and fittings.** It should be noted that Life Cycle Impact Assessment (LCIA) results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Indicator	Unit	A1	A2	A3	A1 - A3	A4	A5	B1-B7	C1	C2	C3	C4	D
EN 15804+A2													
AP	mol H+ eq	2.63E-01	3.86E-02	8.92E-01	1.19E+00	3.89E+00	1.53E-01	0	0	5.00E-02	0	7.10E-02	-1.79E-01
GWP-total	kg CO2 eq	3.61E+01	6.24E+00	4.90E+02	5.32E+02	8.43E+02	4.21E+01	0	0	1.06E+01	0	1.04E+01	-7.98E+01
GWP-biogenic	kg CO2 eq	2.39E-01	6.64E-02	-1.77E+01	-1.74E+01	9.19E+00	1.32E-01	0	0	1.14E-01	0	9.61E-02	2.61E+00
GWP-fossil	kg CO2 eq	3.58E+01	6.17E+00	5.07E+02	5.49E+02	8.34E+02	4.20E+01	0	0	1.04E+01	0	1.03E+01	-8.24E+01
GWP-luluc	kg CO2 eq	2.80E-02	1.25E-03	8.02E-02	1.10E-01	1.73E-01	8.51E-03	0	0	2.15E-03	0	7.27E-03	-1.64E-02
ETP-fw	CTUe	3.13E+03	1.77E+02	5.34E+03	8.64E+03	2.44E+04	1.00E+03	0	0	3.04E+02	0	2.09E+02	-1.30E+03
EP-fw	kg P eq	1.25E-02	9.12E-06	7.44E-02	8.69E-02	1.26E-03	2.65E-03	0	0	1.57E-05	0	2.61E-03	-1.30E-02
EP-m	kg N eq	4.19E-02	1.79E-02	2.17E-01	2.76E-01	1.69E+00	6.01E-02	0	0	2.19E-02	0	2.66E-02	-4.14E-02
EP-t	mol N eq	4.73E-01	1.96E-01	2.17E+00	2.84E+00	1.87E+01	6.46E-01	0	0	2.41E-01	0	2.84E-01	-4.26E-01
HTP-c	CTUh	4.59E-08	1.43E-10	1.33E-07	1.79E-07	1.99E-08	6.81E-09	0	0	2.47E-10	0	7.07E-09	-2.69E-08
HTP-nc	CTUh	3.23E-06	3.51E-07	2.10E-06	5.68E-06	2.73E-05	9.95E-07	0	0	3.84E-07	0	1.19E-07	-8.52E-07
IRP	kBq U-235 eq	1.50E+00	5.10E-04	8.82E+01	8.97E+01	7.08E-02	2.69E+00	0	0	8.80E-04	0	2.75E-01	-1.35E+01
SQP	Pt	1.05E+03	2.98E-02	3.25E+02	9.80E+02	3.09E-01	1.16E-01	0	0	2.55E-02	0	6.59E+00	-5.33E+02
ODP	kg CFC11 eq	1.63E-06	5.50E-10	6.65E-07	3.94E-06	3.09E-08	8.79E-11	0	0	2.54E-09	0	3.54E-09	-1.22E-06
PM	disease inc.	5.57E-06	3.13E-10	3.16E-06	1.71E-05	4.28E-07	1.40E-07	0	0	3.70E-08	0	2.03E-08	-1.55E-06
POCP	kg NMVOC eq	1.63E-01	2.10E-04	2.63E-01	1.24E+00	6.21E-02	3.70E-04	0	0	5.43E-03	0	1.35E-03	-2.09E-01
ADPF	MJ	6.00E+02	4.66E-01	1.33E+03	3.28E+03	1.32E+02	4.71E-02	0	0	1.09E+01	0	3.10E+00	-1.34E+03
ADPE	kg Sb eq	1.00E-03	7.06E-09	1.60E-04	1.56E-03	6.18E-08	7.97E-09	0	0	5.10E-09	0	2.01E-07	-2.13E-04
WDP	m3 depriv.	2.27E+01	7.90E-04	1.06E+02	1.46E+02	6.45E-02	1.97E-03	0	0	5.31E-03	0	1.37E-01	-1.28E+01

AP: Acidification; **GWP-total**: Climate change; **GWP-biogenic**: Climate change - Biogenic; **GWP-fossil**: Climate change - Fossil; **GWP-luluc**: Climate change - Land use and Land use change; **Ecotox-fw**: Ecotoxicity, freshwater; **EP-fw**: Eutrophication, freshwater; **EP-m**: Eutrophication, marine; **EP-t:** Eutrophication, terrestrial; **HT-c**: Human toxicity, cancer; **HT-nc**: Human toxicity, non-cancer; **Ion.**: Ionizing radiation; **Land**: Land use; **ODP**: Ozone depletion; **PM**: Particulate matter; **POCP**: Photochemical ozone formation; **ADF-f**: Resource use, fossils; **ADP-m**: Resource use, minerals and metals; **WDP**: Water use.

Indicator	Unit	A1	A2	A3	A1 - A3	A4	A5	B1-B7	C1	C2	C3	C4	D
TRACI 2.1													
GWP_{100}-AR5(1)	kg CO_2 eq.	3.47E+01	6.05E+00	4.97E+02	5.37E+02	8.45E+02	4.22E+01	0	0	1.05E+01	0	1.00E+01	-8.06E+01
GWP_{100}-AR4(2)	kg CO_2 eq.	3.41E+01	6.02E+00	4.89E+02	5.29E+02	8.42E+02	4.19E+01	0	0	1.05E+01	0	9.81E+00	-7.94E+01
AP	kg SO2 eq.	2.28E-01	7.48E-02	1.24E+00	1.54E+00	6.80E+00	2.51E-01	0	0	8.84E-02	0	6.39E-01	-2.31E-01
EP	kg N eq.	1.19E-01	5.36E-03	6.13E-01	7.37E-01	5.16E-01	6.38E-02	0	0	6.66E-03	0	2.62E-02	-1.11E-01
ODP	kg CFC-11 eq.	1.76E-06	2.07E-08	8.70E-06	1.05E-05	2.87E-06	4.01E-07	0	0	3.57E-08	0	2.59E-07	-1.57E-06
SFP	kg O_3 eq.	2.48E+00	2.09E+00	1.67E+01	2.13E+01	1.85E+02	6.21E+00	0	0	2.42E+00	0	1.64E+00	-3.19E+00
FFD	MJ Surplus	6.61E+01	1.19E+01	9.07E+02	9.86E+02	1.64E+03	7.90E+01	0	0	2.04E+01	0	2.82E+01	-1.48E+02
GWP: Global Warming Potential; **AP**: Acidification Potential; **EP**: Eutrophication Potential; **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **FFD**: Fossil Fuel Depletion Potential.													

(1): GWP 100, excludes biogenic CO2 removals and emissions associated with biobased products and packaging; 100-year time horizon. GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).[7]

(2): GWP 100, excludes biogenic CO2 removals and emissions associated with biobased products and packaging; 100-year time horizon. GWP factors are provided by the IPCC 2007 Fourth Assessment Report (AR4). [6]

Indicator	Unit	A1	A2	A3	A1 - A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Resource use													
PERE	MJ, LHV	2.56E+01	1.57E-01	4.36E+02	4.62E+02	2.18E+01	1.45E+01	0	0	2.71E-01	0	3.67E+00	-6.93E+01
PERM	MJ, LHV	0	0	0	0	0	0	0	0	0	0	0	0
PERT	MJ, LHV	2.56E+01	1.57E-01	4.36E+02	4.62E+02	2.18E+01	1.45E+01	0	0	2.71E-01	0	3.67E+00	-6.93E+01
PENRE	MJ, LHV	3.96E+02	8.13E+01	2.47E+03	2.95E+03	1.13E+04	4.27E+02	0	0	1.40E+02	0	1.93E+02	-4.43E+02
PENRM	MJ, LHV	0	0	0	0	0	0	0	0	0	0	0	0
PENRT	MJ, LHV	3.96E+02	8.13E+01	2.47E+03	2.95E+03	1.13E+04	4.27E+02	0	0	1.40E+02	0	1.93E+02	-4.43E+02
SM	MJ, LHV	0	0	0	0	0	0	0	0	0	0	0	0
RSF	MJ, LHV	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ, LHV	0	0	0	0	0	0	0	0	0	0	0	0
FW	m^3	5.39E-01	1.00E-03	1.55E+00	2.09E+00	1.39E-01	3.96E-02	0	0	1.73E-03	0	2.19E-01	-3.13E-01

PERE: Renewable Primary Resources Used as Energy Carrier (Fuel); **PERM**: Renewable Primary Resources with Energy Content Used as Material; **PERT**: Renewable Primary Resources Total; **PENRE**: Non-Renewable Primary Resources Used as Energy Carrier (Fuel); **PENRM**: Non-Renewable Primary Resources with Energy Content Used as Material; **PENRT**: Non-Renewable Primary Resources Total; **SM**: Secondary Materials; **RSF**: Renewable Secondary Fuels; **NRSF**: Non-Renewable Secondary Fuels; **FW**: Use of Net Fresh Water Resources.

Indicator	Unit	A1	A2	A3	A1 - A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Output flows and waste categories													
HWD(1)	kg	1.38E+02	5.28E-02	3.73E+02	5.11E+02	7.31E+00	1.56E+01	0	0	9.08E-02	0	6.41E+00	-7.67E+01
NHWD(2)	kg	4.50E+00	7.88E-02	1.21E+01	1.67E+01	1.09E+01	2.01E+00	0	0	1.36E-01	0	8.52E+02	-2.51E+00
HLRW(3)	m^3	1.99E-08	6.08E-12	7.19E-07	7.39E-07	8.42E-10	2.22E-08	0	0	1.05E-11	0	3.49E-09	-1.11E-07
ILLRW(4)	m^3	1.05E-07	3.61E-11	6.36E-06	6.47E-06	4.99E-09	1.94E-07	0	0	6.20E-11	0	1.89E-08	-9.70E-07
CRU	kg	0	0	0	0	0	0	0	0	0	1.50E+02	0	0
MFR	kg	0	0	3.60E+02	3.60E+02	0	0	0	0	0	0	0	-5.40E+01
MER	kg	0	0	0	0	0	0	0	0	0	0	0	0
EE	MJ, LHV	0	0	0	0	0	0	0	0	0	0	0	0
HWD: Hazardous Waste Disposed; **NHWD**: Non-Hazardous Waste Disposed; **RWD**: Radioactive Waste Disposed; **HLRW**: High-Level Radioactive Waste, Conditioned, to Final Repository; **ILLRW**: Intermediate and Low-Level Radioactive Waste, Conditioned, to Final Repository; **CRU**: Components for Re-use; **MFR**: Materials for Recycling; **MER**: Materials for Energy Recovery; **EE**: Exported Energy													

(1): Calculated from life cycle inventory results, based on datasets classified under "treatment and disposal of hazardous waste." The manufacturer does not generate hazardous waste.

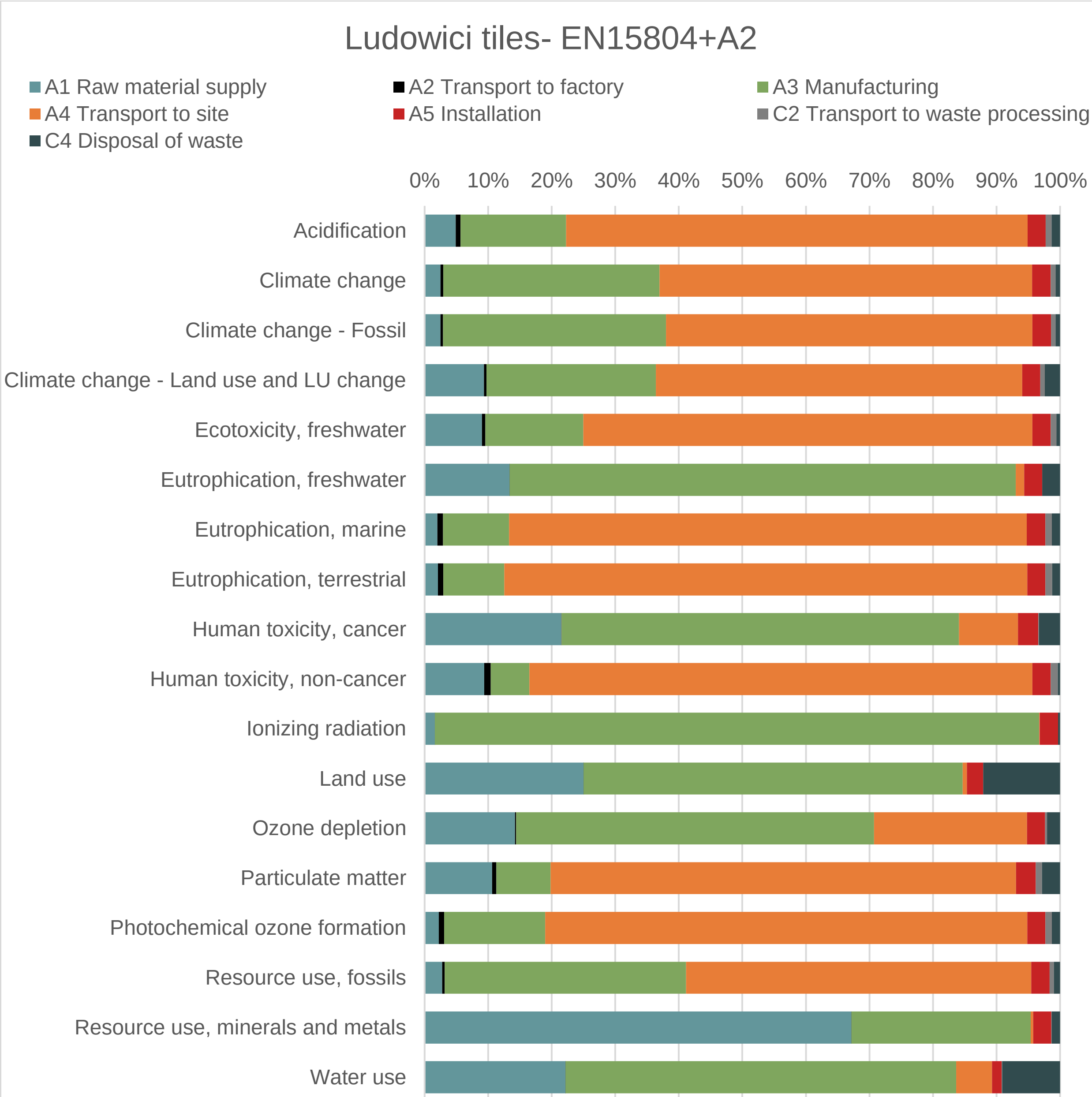
(2): Calculated from life cycle inventory results, based on waste that is neither "hazardous" nor "radioactive" and EPD values.

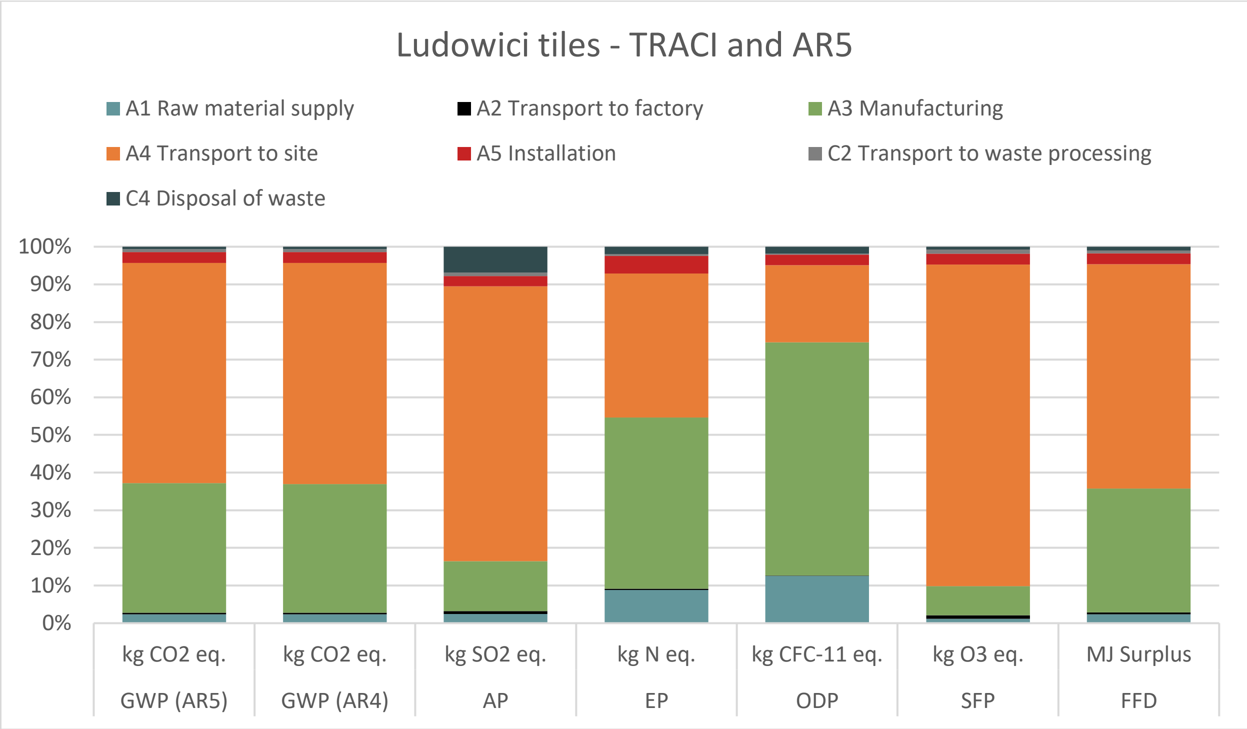
(3): Calculated from life cycle inventory results, based on ecoinvent waste flow "high-level radioactive waste for final repository." The manufacturer does not generate radioactive waste.

(4): Calculated from life cycle inventory results, based on ecoinvent waste flow "low-level radioactive waste for final repository." The manufacturer does not generate radioactive waste.

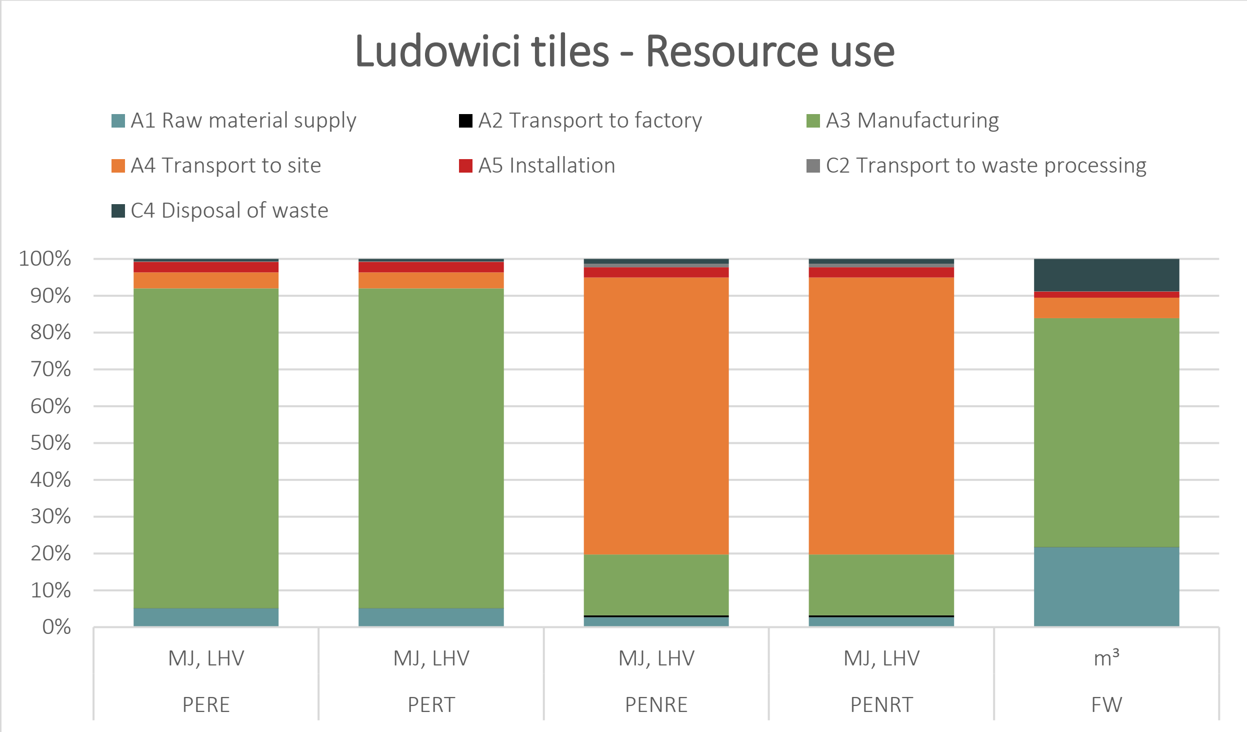
4.2. CONTRIBUTION ANALYSIS

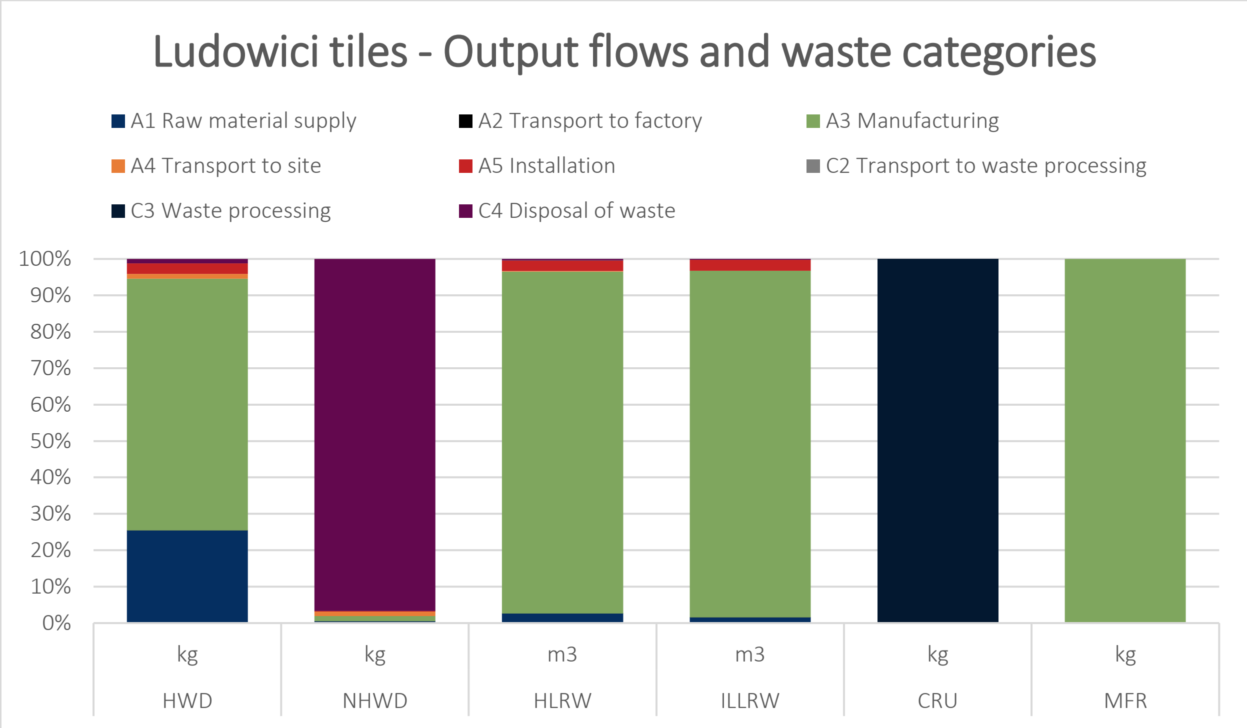
For the production stage (A1 to A3), manufacturing (A3) has the most significant environmental impacts, notably contributing to eutrophication potential (EP), ozone depletion potential (ODP) and water use (WDP). For other environmental indicators, the transport to the site (A4) is the main contributor due to the shipping of the tiles by truck over long distances, leading to higher emissions and resource consumption. The four primary contributors to the product's environmental impacts are transport to site via diesel-powered trucks, transport to site via gasoline-powered trucks, supply and combustion of natural gas for manufacturing, and supply of electricity for manufacturing.





For Resource use indicators, the main contributor to PERE is manufacturing (A3), mostly due to the use of pallets and cardboard made of wood, used as a renewable resource. For PENRE, the fuel used in trucks is the main contributor to the indicator, through Transport to site (A4). Finally, direct consumption of water leads to manufacturing (A3) being the main contributor to freshwater consumption throughout the life cycle. Manufacturing (A3) is the predominant contributor to hazardous waste disposed (HWD), high-level radioactive waste (HLRW), and intermediate- and low-level radioactive waste (ILLRW). These impacts primarily stem from background processes associated with electricity generation from the grid, particularly from nuclear and coal-based power production. For the components for re-use (CRU), the re-use of tiles after dismantling accounts for 100% of the contribution. Landfilling of the remaining tiles is the major contributor to the non-hazardous waste disposed (NHWD) indicator.


Ludowici tiles - Resource use
A1 Raw material supply
A2 Transport to factory
A3 Manufacturing
A4 Transport to site
A5 Installation
C2 Transport to waste processing
C4 Disposal of waste
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MJ, LHV
PERE
MJ, LHV
PERT
MJ, LHV
PENRE
MJ, LHV
PENRT
m³
FW


Ludowici tiles - Output flows and waste categories
A1 Raw material supply
A2 Transport to factory
A3 Manufacturing
A4 Transport to site
A5 Installation
C2 Transport to waste processing
C3 Waste processing
C4 Disposal of waste
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
kg
HWD
kg
NHWD
m3
HLRW
m3
ILLRW
kg
CRU
kg
MFR

5. Additional environmental information

5.1. CONTENT OF REGULATED HAZARDOUS SUBSTANCES

The tiles contain a glaze that may include regulated hazardous substances as listed in the consolidated list of lists from the US EPA. However, these substances are documented in the Safety Data Sheets (SDS) provided by suppliers. They may represent up to 3.7% of the final average product. The low percentage and proper documentation ensure compliance with regulatory standards, minimizing potential environmental and health risks associated with the product's use and disposal.

5.2. RELEASE OF DANGEROUS SUBSTANCES

No dangerous substances are known to be released from the tiles under study. The tiles are considered inherently non-emitting products by LEED® v4 [16].

5.3. OTHER ADDITIONAL ENVIRONMENTAL INFORMATION

No green power, biogas or CO_2 certificates are used in this EPD. The biogenic carbon content of the product and the packaging are respectively 0 and 7.11 kg of biogenic carbon per declared unit.

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EPD

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