NSF Product Category Rule
for Environmental Product Declarations

NSF/ASTM 1105-25

Clay Masonry Products

UNCPC 3731 and 3735
CSI Master Format 04 21 00, 32 14 16, and 09 63 13

Program Operator: NSF
National Center for Sustainability Standards
Valid through September 30, 2030
ncss@nsf.org

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NSF

Revised by NSF staff with assistance from

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No participation fees were charged by NSF to interested parties. NSF ensured that reasonable representation among the members of the PCR committee was achieved and potential conflicts of interest were resolved prior to commencing this PCR development. Each member has signed a legal document stating that they have no conflicts of interest.

PCR revision history

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Unit abbreviations

The following table is provided as a reference for unit abbreviations for common forms of measurement used within NSF documents.

Time	**second**	**s**
	minute	min
	hour	h
	day	d
	week	wk
	month	mo
	year	yr
Length	inch	in.
	foot	ft
	yard	yd
	micrometer	µm
	nanometer	nm
	millimeter	mm
	centimeter	cm
	meter	m
	kilometer	km
	miles	mi
Liquid measure	milliliter	mL
	liter	L
	liters per day	LPD
	liters per minute	LPM
	ounce	oz
	pint	pt
	quart	qt
	gallon	gal
	gallons per minute	GPM
	gallons per day	GPD
Weight	microgram	µg
	picogram	pg
	nanogram	ng
	milligram	mg
	centigram	cg
	gram	g
	kilogram	kg
	pound	lb
	ton	t
	metric ton	mt

Miscellaneous	British Thermal Unit	BTU
	horsepower	hp
	degrees Kelvin	°K
	kilowatt	kW
	kilowatt hours	kWh
	kilowatt-peak	kWp
	megajoule	MJ
	pounds per square inch	psi
	short ton	st

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Foreword

The product group includes manufactured masonry units made by forming and firing prepared mixtures of clay, shale and other materials. These are generically known as clay brick, clay brick pavers, and structural clay tile.

This edition of the PCR contains the following revisions:

- This edition includes a full review of the document with changes made to align with the ISO 21930 and EPA EPD requirements.

Suggestions for improvement of this guideline are welcome. Comments should be sent to ncss@nsf.org, or c/o NSF, National Center for Sustainability Standards, PO Box 130140, Ann Arbor, Michigan 48113-0140, USA.

About the Brick Industry Association

The BIA is the national trade association representing manufacturers and distributors of clay brick and suppliers of related products and services. Since its founding in 1934, the association has been the nationally recognized authority on clay brick construction.

BIA promotes the clay brick industry by providing tools to member companies to help increase sales and to differentiate brick from other wall cladding materials. BIA safeguards the clay brick industry by helping to ensure that member companies can operate and produce brick in the most conducive legislative and regulatory environment possible.

About the NSF National Center for Sustainability Standards

Through the NCSS, NSF develops life cycle-based, multi-attribute sustainability standards, protocols, and PCRs for various industries including building products and materials, furniture, carpet and flooring, fabrics, wallcoverings, roofing membranes, green chemicals, electronics, and water and wastewater.

The NCSS will continue to add to its growing portfolio while providing education, outreach, and innovation support to private industry, trade associations, government and academia to foster a consensus-based approach toward conformity assessment in the sustainability field. Visit nsfsustainability.org or contact ncss@nsf.org.

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1 Scope

Per ISO 21930:2017 Clause 1, with the following additions:

This PCR will be used in North America.

This sub-category PCR addresses the clay brick, clay brick pavers, and structural clay tile products listed in Table 1, hereafter referred to as clay masonry products. Products not listed in Table 1 are excluded from this PCR. These products may be found under UN CPC 3731 and 3735 and in CSI Master Format divisions 04 21 00, 32 14 16, and 09 63 13. This PCR documents the goal and scope of LCAs for this product category in order to produce EPDs according to ISO 14025:2006 [1] and ISO 21930:2017. [1] This PCR includes the life cycle Modules A1-A3 (cradle-to-gate), with options to include additional modules as desired (cradle-to-gate with options) in accordance with ISO 21930:2017 Clause 5.2.2. Rules for producing EPDs with a cradle-to-grave scope (life cycle Modules A1-A3, A4-A5, B1-B7, and C1-C4) are also provided, as is information on Module D. The modules included in an EPD must be clearly stated. Options covered by this PCR include:

- **cradle-to-gate EPD**: Life cycle Modules A1-A3 include mandatory production stages of the raw materials supply and manufacture of clay masonry products. Modules A1-A3 are required for all EPDs produced using this PCR. Results shall be reported based on a declared unit.
- **cradle-to-gate with options EPD**: Cradle-to-gate with options EPDs include the mandatory Modules A1-A3. Common options include Module A4 (transportation to construction site), Module A5 (construction assembly/installation), Module B2 (use maintenance), Modules C1-C4 (end-of-life), and Module D (benefits and loads beyond the system boundary). Results shall be reported based on a declared unit or functional unit according to ISO 21930:2017 Clause 5.2.2.
- **cradle-to-grave EPD**: Covers all life cycle modules including Modules A1-A3 (mandatory production phase), Modules A4-A5 (construction), Modules B1-B7 (use), Modules C1-C4 (end-of-life), and optionally Module D (benefits and loads beyond the system boundary). Results shall be reported based on a functional unit.

See Figure 1 for more details. The definition of clay masonry products covered by this PCR is specifically outlined in Section 1.1.

This PCR is valid through September 30, 2030.

[1] International Organization for Standardization. Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland. <iso.org>

1.1 Product scope

Per ISO 21930:2017 [1] Clause 1, with the following additions.

Clay brick, clay brick pavers, and structural clay tile are manufactured masonry units made by forming and firing prepared mixtures of clay, shale, and other materials to a high enough temperature to create amorphous material in a vitreous (glassy) or ceramic bonding phase. Materials such as organic pore forming agents, glass, etc., are sometimes used as a minority component, typically at levels less than 25% by mass. The resulting products are commonly used to construct interior and exterior walls, and interior and exterior paving applications, though other uses are not precluded by this PCR. This product group includes the products listed in Table 1, which also lists applicable standards and specifications for products covered by this PCR. The components used to manufacture the clay masonry products are specified within the aforementioned standards.

This PCR specifically excludes fly ash brick (ASTM C1790 [2]), firebox brick (ASTM C1261) and high-alumina refractory brick (ASTM C27) typically used in industrial applications.

Table 1
Clay masonry products-related standards

Products per installation scenario	ASTM specification	Name of Standard
vertical installation – clay brick and structural clay tile	facing brick	ASTM C216, *Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)* CSA A82, *Fired masonry brick made from clay or shale*
	hollow brick	ASTM C652, *Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)* CSA A82, *Fired masonry brick made from clay or shale*
	building brick	ASTM C62, *Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)* CSA A82, *Fired masonry brick made from clay or shale*
	chemical-resistant brick	ASTM C279, *Specification for Chemical-Resistant Masonry Units*
	glazed brick (single fired)	ASTM C1405, *Specification for Glazed Brick (Single Fired, Brick Units)*
	glazed brick (double fired)	ASTM C126, *Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units*

[2] ASTM International. 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428. <astm.org>

Table 1
Clay masonry products-related standards

Products per installation scenario	ASTM specification	Name of Standard
vertical installation – clay brick and structural clay tile	sewer brick	ASTM C32, *Specification for Sewer and Manhole Brick (Made from Clay or Shale)*
	structural clay load-bearing wall tile	ASTM C34, *Standard Specification for Structural Clay Load-Bearing Wall Tile*
	structural clay non-loadbearing tile	ASTM C56, *Standard Specification for Structural Clay Nonloadbearing Tile*
	structural clay facing tile	ASTM C212, *Standard Specification for Structural Clay Facing Tile*
	structural glazed facing tile	ASTM C126, *Specification for Ceramic Glazed Structural Facing Tile, Facing Brick, and Solid Masonry Units*
	industrial chimney lining brick	ASTM C980, *Standard Specification for Industrial Chimney Lining Brick*
vertical installation – thin brick	thin veneer brick	ASTM C1088, *Standard Specification for Thin Veneer Brick Units Made from Clay or Shale*
horizontal installation – clay brick pavers	pedestrian and light traffic paving brick	ASTM C902, *Standard Specification for Pedestrian and Light Traffic Paving Brick*
	heavy vehicular paving brick	ASTM C1272, *Specification for Heavy Vehicular Paving Brick*
	industrial floor brick	ASTM C410, *Specification for Industrial Floor Brick*

2 Normative references

The following documents are referred to in the text. For undated references, the latest edition of the referenced document (including any amendments) applies.

2022 ACLCA, *PCR Open Standard, Process and Methods Toolkit, Guidance for Determining EPD Types and Calculating and Communicating Data Specificity Through the Supply Chain* [3]

ASTM C32, *Standard Specification for Sewer and Manhole Brick (made from Clay or Shale)* [2]

ASTM C34, *Standard Specification for Structural Clay Load-Bearing Wall Tile* [2]

ASTM C56, *Standard Specification for Structural Clay Nonloadbearing Tile* [2]

ASTM C62, *Standard Specification for Building Brick (Solid Masonry Units made from Clay or Shale)* [2]

ASTM C126, *Standard Specification for Ceramic Glazed Structural Facing Tile, Facing Brick, and Solid Masonry Units* [2]

ASTM C212, *Standard Specification for Structural Clay Facing Tile* [2]

ASTM C216, *Standard Specification for Facing Brick (Solid Masonry Units made from Clay or Shale)* [2]

ASTM C279, *Standard Specification for Chemical-Resistant Masonry Units* [2]

ASTM C410, *Standard Specification for Industrial Foor Brick* [2]

ASTM C652, *Standard Specification for Hollow Brick (Hollow Masonry Units made from Clay or Shale*) [2]

ASTM C902, *Standard Specification for Pedestrian and Light Traffic Paving Brick* [2]

ASTM C980, *Standard Specification for Industrial Chimney Lining Brick* [2]

ASTM C1088, *Standard Specification for Thin Veneer Brick Units Made from Clay or Shale* [2]

ASTM C1232, *Standard Terminology for Masonry* [2]

ASTM C1272, *Standard Specification for Heavy Vehicular Paving Brick* [2]

ASTM C1405, *Standard Specification for Glazed Brick (Single Fired, Brick Units)* [2]

CSA A82, *Fired Masonry Brick made from Clay or Shale* [4]

ISO 14025:2006, *Environmental Labels and Declarations – Type III Environmental Declarations – Principles and Procedures* [1]

ISO 14027:2017, *Environmental Labels and Declarations – Development of Product Category Rules* [1]

ISO 14040:2006/AMD 1:2020, *Environmental Management – Life Cycle Assessment – Principles and Framework* [1]

[3] American Center for Life Cycle Assessment. 6900 Wisconsin Avenue, Unit 30953, Bethesda, MD 20824. <aclca.org>

[4] CSA Group. 178 Rexdale Boulevard, Toronto, ON M9W 1R3, Canada. <csagroup.org>

ISO 14044:2006/AMD 1:2007/AMD 2:2020, *Environmental Management – Life Cycle Assessment – Requirements and Guidelines* [1]

ISO 14071:2014, *Environmental Management – Life Cycle Assessment – Critical Review Processes and Reviewer Competencies: Additional Requirements and Guidelines to ISO 14044:2006* [1]

ISO 21930:2017, *Sustainability in Buildings and Civil Engineering Works – Core Rules for Environmental Product Declarations of Construction Products and Services* [1]

US EPA, Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI 2.2) [5]

US LCI Database Project Development Guidelines [6]

3 Terms and definitions

Per ISO 21930:2017 [1] Clause 3, with the following additions.

brick: *(noun)* Ceramic product(s) manufactured primarily from clay, shale, or other similar naturally occurring earthy substances and subjected to a heat treatment at elevated temperatures (firing). Additives or recycled materials are permitted to be included at the option of the manufacturer. The heat treatment must develop an amorphous material with fired bond, glassy or ceramic, between the particulate constituents to provide the strength and durability requirements of this specification.

brick, building: *(noun)* Brick for load-resisting or other purposes where appearance properties such as texture or color are not important (formerly called "common brick"). (ASTM C1232)

brick, chemical-resistant: *(noun)* Brick suitable for use in chemical environments where resistance to thermal shock may be a consideration, usually used in conjunction with chemical-resistant mortars. (ASTM C1232)

brick, facing: *(noun)* Brick for general purposes where appearance properties such as color, texture, and chippage are important. (ASTM C1232)

brick, firebox: *(noun)* Brick intended for use as the lining in the fireboxes of residential fireplaces. (ASTM C1232)

brick, floor: *(noun)* Brick with physical properties related to resistance to chemicals, thermal and mechanical shock, or absorption, or combinations of these, used as finished floor surfaces in industrial applications. (ASTM C1232)

brick, glazed: *(noun)* Brick with a ceramic glaze finish fused to the body of the brick by firing.

brick, hollow: *(noun)* Brick whose net cross-sectional area in any plane parallel to the surface containing cores, cells, or deep frogs is less than 75% of its gross cross-sectional area measured in the same plane. (modified from ASTM C1232)

[5] Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI), US Environmental Protection Agency. 1200 Pennsylvania Avenue NW, Washington, DC 20004. <EPA.gov>

[6] National Renewable Energy Laboratory, US Department of Energy, Office of Energy Efficiency and Renewable Energy. 901 D Street SW, Suite 930, Washington, DC 20024. <nrel.gov>

brick, paving: *(noun)* Brick made to provide the wearing surface of highways, streets, driveways, walkways, patios, and similar applications. (ASTM C1232)

brick, sewer: *(noun)* Low absorption, abrasive-resistant brick intended for use in drainage structures. (ASTM C1232)

brick, thin veneer: *(noun)* Brick with a thickness (width) of less than 2 $^{5}/_{8}$ in. (66.7 mm) for use in adhered or fastened veneer applications. (ASTM C1088)

clay: *(noun)* An earthy or stony mineral aggregate consisting essentially of hydrous silicates of alumina, plastic when sufficiently pulverized and wetted, rigid when dry, and vitreous when fired to a sufficiently high temperature. (ASTM C1232)

consumptive water use: Water removed from available supplies without return to a water resource system (e.g. water used in manufacturing, agriculture, and food preparation that is not returned to a stream, river, or water treatment plant).

cutoff criteria: Specification of the amount of material or energy flow or the level of environmental significance associated with unit processes of a product system to be excluded from an LCA study (adapted from ISO 14044).

data, background/secondary: Indirectly measured, calculated, or obtained quantified value of a unit process or activity and related information within a product system (ISO 14040:2006, Clause 3.28) or organization, not based on specific original source measurements. (ISO 21930:2017)

data, foreground/primary: Quantified value of a unit process or an activity obtained from a direct measurement, or a calculation based on indirect measurements at its original source. (ISO 21930:2017)

facility-specific EPD: An EPD that covers a single manufacturer and a single facility for the last facility in the production chain. (ACLCA)

fire clay: *(noun)* A sedimentary clay of low flux content. (ASTM C1232)

hazardous waste: Waste identified as hazardous according to regulations applicable in the market for which the EPD is valid. For the US market, wastes are hazardous if they are regulated under the RCRA. [7] See also 40 CFR 261.33. [8] For the Canadian market, wastes are hazardous if they are regulated under the Canadian Environmental Protection Act, [9] 1999 Regulations.

Note. Hazardous waste does not include radioactive waste, see ISO 21930:2017, Clause 7.2.14.

industry-average EPD: An EPD that reports the impacts for a product which is an average of data provided by multiple manufacturers in a clearly defined sector and/or geographical area. Also called “sector-average EPD.” (ACLCA)

loss on ignition (LOI): The LOI is the weight loss when the dried brick is fired. This loss in weight is primarily due to the natural decomposition of the clay mineral on heating. The thermal decomposition of other minor accessory minerals can also contribute to the LOI.

[7] Resource and Recovery Act, US Environmental Protection Agency. <epa.gov/rcra>

[8] Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration. 7 G Street NW, Suite A-734, Washington, DC 20401. <ecfr.gov>

[9] Department of Justice, Government of Canada. 284 Wellington Street, Ottawa, ON K1A 0H8, Canada. <laws.justice.gc.ca>

manufacturer-average EPD: An EPD that covers a product or products from a single manufacturer, and that reports environmental impacts based on an average of data from multiple facility locations for the last facilities in the production chain. (ACLCA)

net consumables: Items used during manufacturing, such as lubricants, grease and oils, product molds etc.

non-hazardous waste: Commercial/industrial waste that is not hazardous (e.g. sawdust).

product-average EPD: An EPD that covers a group of similar products from one or more sites of one company or multiple companies, or an EPD that groups similar products using averaged environmental performance data across Modules A1-A3. Products included in an average EPD should be within ± 10% of the mean impact per reported environmental impact category (ISO 21930:2017, Clause 5.3). A product-average EPD shall also include a product description explaining the variation in the composition or performance of the products that the EPD represents. (ACLCA)

product-specific EPD: An EPD that covers a single product. Given that the distinguishing benefit of a product-specific EPD is its accuracy of environmental impact results (by avoiding product-to-product variability), an EPD may also be considered product-specific if it covers a group of similar products that share equivalent material and performance characteristics such that their environmental impacts per declared unit are sufficiently equivalent. (ACLCA)

recovered material: *(noun)* Material that would have otherwise been disposed of as waste or used for energy recovery but has instead been collected and recovered as a material input, in lieu of new primary material, for a recycling or a manufacturing process. (ISO 14021), e.g. grog.

shale: *(noun)* A thinly stratified, consolidated, sedimentary clay with well-marked cleavage parallel to the bedding. (ASTM C1232)

surface clay: *(noun)* An unconsolidated, unstratified clay, occurring on the surface. (ASTM C1232)

tile, loadbearing: *(noun)* Tile for use in masonry constructions designed to carry superimposed loads. (ASTM C1232)

tile, non-loadbearing: *(noun)* Tile for use in masonry constructions carrying no superimposed loads. (ASTM C1232)

tile, structural clay: *(noun)* Hollow fired-clay masonry building units with parallel cells or cores or both (ASTM C1232)

tile, structural clay facing: *(noun)* Tile designed for use in interior and exterior unplastered walls, partitions or columns. (ASTM C1232)

waste: *(noun)* Substances or objects which the holder intends or is required to dispose of. (ISO 14040)

4 Abbreviated terms

Per ISO 21930:2017 [1] Clause 4. with the following additions:

ACLCA American Center for Life Cycle Assessment
AMD amendment (ISO)
ANSI American National Standards Institute
AP acidification potential
AR5 Fifth Assessment Report (IPCC)
AR6 Sixth Assessment Report (IPCC)
ASTM ASTM International
B2B business-to-business
B2C business-to-consumer
CAS Chemical Abstract Services
CFR Code of Federal Regulations
CSA CSA Group
DQA Data quality assessment
eGRID Emissions & Generation Resource Integrated Database
EN European Standards
EP eutrophication potential
EPA Environmental Protection Agency
EPD environmental product declaration
ESL estimated service life
EU European Union
GHG greenhouse gas
GWP global warming potential
HUD US Department of Housing and Urban Development
IPCC Intergovernmental Panel on Climate Change
ISO International Organization for Standardization
LCA life cycle assessment
LCI life cycle inventory
LCIA life cycle impact assessment
LOI loss on ignition
NERC North American Electric Reliability Corporation
NIST National Institute of Standards and Technology
ODP ozone depletion potential
PCR product category rule
POCP photochemical ozone creation potential
RCRA Resource and Recovery Act
RSL reference service life
SF smog formation
SFP smog formation potential
SI International System (units)

TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
US	United States
USLCI	United States Life Cycle Inventory
VOC	volatile organic compounds
WARM	Waste Reduction Model

5 General aspects

5.1 Objectives of this PCR

Per ISO 21930:2017 [1] Clause 5.1, with the following additions.

The primary objective of this subcategory PCR is to provide rules for the application of ISO 21930:2017 to create Type III EPDs for clay masonry products identified in Table 1 of this PCR.

Additional objectives include:

- accurately assess the emissions and environmental aspects associated with clay masonry products production
- provide a means for clay masonry product producers and other stakeholders to use EPDs as a tool to benchmark the environmental aspects and potential environmental impacts of clay masonry products production
- encourage the publication and use of upstream LCA data associated with materials and resources used in clay masonry products production
- promote consistency of EPDs for clay masonry products with applicable guidance related to PCRs and EPDs for affiliated materials
- ensure that EPDs for clay masonry products are eligible to earn credit under green rating systems, labeling programs, and green construction codes.

5.2 Life cycle stages and their information modules

5.2.1 General

Per ISO 21930:2017 [1] Clause 5.2.1, with the following clarifications:

This PCR establishes requirements for the assessment and reporting of life cycle impacts associated with the production of clay masonry products identified in Section 1 of this PCR. System boundaries of the product system shall be defined to be consistent with Section 5.2.2 of this PCR using the life cycle stages and modules defined in Figure 1. EPDs shall include at a minimum the life cycle phases from Modules A1-A3. All other information modules under this PCR are optional, including Module D, except as noted in Figure 1. The modules included in an EPD must be clearly stated.

Figure 1

Common life cycle stages and their information modules [Source: 21930:2017, as modified]

LIFE CYCLE STAGES	PRODUCTION (A1-A 3)			CONSTRUCTION (A4-A5)		USE (B1-B7)							END-OF-LIFE (C1-C4)				BENEFITS & LOADS BEYOND SYSTEM BOUNDARY (D)
Information Modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport to site	Assembly/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
Cradle-to-gate	*Required*			*Excluded*		*Excluded*							*Excluded*				*Excluded*
Cradle-to-gate w/end-of-life	*Required*			*Excluded*		*Excluded*							*Required*				*Optional*
Cradle-to-gate w/options	*Required*			*Optional*		*Optional*							*Optional*				*Optional*
Cradle-to-grave	*Required*			*Required*		*Required*							*Required*				*Optional*

5.2.2 Types of EPDs with respect to lifecycle stages covered

Per ISO 21930:2017 [1] Clause 5.2.2, with the following clarifications:

EPDs of clay masonry products produced under this PCR shall conform to one of the following types:

- **cradle-to-gate EPD**: Life cycle Modules A1-A3 include mandatory production stages of the raw materials supply and manufacture of clay masonry products. Modules A1-A3 are required for all EPDs produced using this PCR. Results shall be reported based on a declared unit.
- **cradle-to-gate with options EPD**: Cradle-to-gate with options EPDs include the mandatory Modules A1-A3, with additional optional modules reported. Common options include Module A4 (transportation to construction site), Module A5 (construction assembly/installation), Module B2 (use maintenance), and Modules C1-C4 (end-of-life). Results shall be reported based on a declared unit or functional unit according to ISO 21930:2017 Clause 5.2.2. Optional information modules reported beyond the gate shall be based on scenarios that shall be described in the EPD according to ISO 21930:2017 Clauses 7.1.7.3 to 7.1.7.5.
- **cradle-to-grave EPD**: Covers all life cycle modules including Modules A1-A3 (mandatory production phase), A4-A5 (construction), Modules B1-B7 (use), and Modules C1-C4 (end-of-life). Results shall be reported based on a functional unit. Modules reported beyond the gate shall be based on scenarios that shall be described in the EPD according to ISO 21930:2017 Clauses 7.1.7.3 to 7.1.7.5. If no activity is expected in an information module, then the scenario and assessment of the module must reflect this rather than declaring the module not relevant or not applicable for a cradle-to-grave EPD.

Module D (benefits and loads beyond the system boundary), which provides supplementary environmental information, may also be reported in any of the allowable EPD types, consistent with ISO 21930:2017 Clause 5.2.2. If Module D is declared, information Modules C1-C4 (end-of-life) shall also be declared.

5.2.3 Use of scenarios for assessment of information modules beyond the production stage

Per ISO 21930:2017 [1] Clause 5.2.3.

5.3 Average EPDs for groups of similar products

Per ISO 21920 [1] Clause 5.3, with the following additions.

5.3.1 Specificity of manufacturing data

Manufacturing data specificity concerns the determination and reporting of specifically what activities/unit processes are included in the manufacturing stage (Module A3) for a particular product and which instead fall within the upstream Modules A1-A2. Manufacturing data specificity requires that an EPD be classified as one (and only one) of the following:

- **industry-average EPD**: Where an EPD represents an average of data from multiple manufacturers in a defined product sector and/or geographical area.
- **manufacturer-average EPD**: Where an EPD covers a single product or group of products produced by a single manufacturer using an average of data from multiple facility locations.
- **facility-specific EPD**: Where an EPD covers a single manufacturer and a single facility at which the final product is manufactured.

This PCR allows the reporting of Modules A1-A3 in a single module for system boundaries other than cradle-to-gate. See Figure 2 for a depiction of the unit processes that occur in Modules A1-A3.

An industry-average EPD may be developed under this PCR. Requirements for industry-average EPDs given in ISO 21930:2017 [1] Clause 5.3 shall apply, with the following additions:

- Report the robustness of the study by reporting the percent of the industry that participated, either by percent of manufacturers or by percent of annual production.
- Indicate the method used to calculate each information module (A1-A3, etc.). In the cases where plant grouping averages are reported, the EPD must include the geographic range of the production facilities.
- Include a mix of small medium and large operations to reflect changes in scale within the industry.
- Represent a mix of technologies currently in production use.
- Include manufacturers from a mix of geographical locations.
- Include in the EPD a list of all manufacturers who provided primary data for the LCA.
- Require the submission of primary data for at least one production facility for a manufacturer to be listed as a participant to the industry-average EPD.
- Manufacturers seeking to align their individual Type III EPDs against a Type III industry-wide average EPD shall have participated in the production of that industry-wide average EPD.
- The development of an industry-average EPD shall not be used to actively exclude specific companies. Actions taken to notify potential stakeholders of participation in the process shall be documented.

A manufacturer may apply to the program operator for retroactive participation in an already published industry-average EPD by providing the information and data required of original participants to the LCA practitioner. The program operator, the primary sponsor, and the LCA practitioner of the industry-average EPD shall confer together to reach a consensus on how to proceed. However, this shall not automatically trigger a recalculation of the industry-average impacts. The effect of the additional data on the industry-average EPD shall be estimated, and a decision made on the need to update the EPD.

For manufacturer-average EPDs, instances will likely occur where products are made at multiple manufacturing locations or travel to different distribution or retail centers. Where a company operates more than one manufacturing facility, EPDs produced under this PCR shall be on a facility-specific basis unless one or both of the following requirements are met:

- The EPD represents a worst-case scenario of the facilities included in the EPD (i.e. resulting in the most conservative product impacts).
- Analysis is provided that demonstrates that the range of impacts between similar products made at the individual manufacturing facilities varies by less than 10%.

For manufacturer-average EPDs that meet the above stated requirements, a weighted average of production volume at each facility, site, or both shall be utilized for calculation purposes. For example, if Site A manufactures 80% of the product system covered by the EPD and each kilogram of product manufactured requires 5 MJ of energy, whereas Site B makes 20% of the product and each kilogram of product manufactured requires 10 MJ of energy, the average energy used per kilogram would be 6 MJ [(80%*5) + (20%*10)]. The same logic would apply for transportation distances.

5.3.2 Specificity of products

An EPD shall report its product-specificity consistent with the requirements of ACLCA *Guidance for Determining EPD Types and Calculating and Communicating Data Specificity Through the Supply Chain* (2022). [3] An EPD shall indicate its specificity using one of the following terms:

- product-average EPD
- product-specific EPD.

For greater transparency, product-specific EPDs are preferred.

Clay masonry products are produced from a mixture of clay, shale, and additives that remain uniform across the various types and sizes of masonry produced by a manufacturer. As such, this PCR allows the grouping of a broad range of masonry products and categories (e.g. thin brick, pavers) that vary by *(a)* dimension and mass per functional unit and/or *(b)* installation within the same EPD. Per the BIA report "Clay Brick & Structural Clay Tiles, Clay Brick Pavers, and Thin Brick Life Cycle Assessment" (2025) [10] products that vary only by color can be grouped together.

This PCR requires that a baseline product for each category of masonry be identified, and a set of conversion factors be calculated for each additional masonry product in the EPD (see Section 9.5.1). All products in an EPD must be listed in Tables 19 through 21 along with the required data and the calculated conversion factors.

EPDs with multiple products and categories shall be considered product-specific only when all of the following criteria are met:

- identified baseline products are each based on data for a single product from a single manufacturer
- each product listed in Tables 19 through 21 has an individual conversion factor that is based on data from a single product from the same manufacturer.

  Note. Clay masonry products that vary only by color may be grouped together under a single conversion factor based on their physical dimensions, as per the BIA report "An Industry-Average LCA of Clay Masonry Products." [10]

All EPDs not meeting the requirements for a product-specific EPD shall be considered a product-average EPD. Examples of average EPD groupings for clay brick, clay brick pavers, and structural clay tile may include, but not are not limited to:

- type of clay masonry products manufacturing method (e.g. thin brick manufacturing method, single-fired vs. double-fired)
- type of unit (e.g. face brick, paving brick, or structural clay tile, etc.)
- average for North American production.

Rules specific to averaging are spelled out in ISO 21930:2017 Clause 5.3. In all cases, the average must be carried out using a weighted average based on the annual production.

5.4 Use of EPDs for construction products

Per ISO 21930:2017 [1] Clause 5.4, with the following clarifications and additions.

This PCR is intended to be used to create EPDs for use in B2B communication. If the EPD is intended for use in the B2C marketplace, the provisions of ISO 14025:2006 [1] Clause 9 apply.

The manufacturer, or group of manufacturers, of the construction product is the sole owner of the EPD and is responsible for developing the EPD of the construction product according to this PCR. Only the manufacturer or group of manufacturers is authorized to declare the environmental performance of the construction product using an EPD.

[10] The Brick Industry Association. 12007 Sunrise Valley Drive, Suite 430, Reston, VA 20191. <gobrick.com>

5.5 Comparability of EPDs for construction products

Per ISO 21930:2017 [1] Clause 5.5, with the following additions.

If the intended use of the EPD is for comparison purposes between different building products, the entire life cycle shall be included, including the use and end-of-life stages. In such situations the functional unit shall be used as the reference unit, not the declared unit.

This PCR defines a functional unit for clay masonry products in Section 7.1.2. However, depending upon the application, other characteristics of clay masonry products should be considered when making comparisons. Fire rating, thermal properties, and acoustic performance may be important in characterizing the performance of clay masonry assemblies.

5.6 Documentation

Per ISO 21930:2017 [1] Clause 5.6. See Sections 8 and 10 for additional guidance.

6 PCR development and use

Per ISO 21930:2017 [1] Clause 6, with the following additions.

This PCR document is effective for five (5) yr from the latest date of publication and shall be open for revision at that time. If at any time, relevant changes in the product category or other relevant factors have occurred (for example, the evolution of LCA methodology in ISO 21930:2017), the document will be revised. See Section 5.5 for comparability.

This PCR was formally developed by a panel of representatives of clay masonry products industry members and manufacturers, raw material suppliers, standards development groups, regulators, and other interested parties and conforms to ISO 21930:2017 requirements. This panel interacted with NSF and members of the BIA and its member companies. The list of participating companies and representatives is included in the foreword.

Appropriate LCIA methodologies were selected based on typical manufacturing and assembly region of the expected users of this PCR (North America) and will be addressed herein.

7 PCR for LCA

7.1 Methodological Framework

7.1.1 LCA modeling and calculation

Per ISO 21930:2017 [1] Clauses 7.1.1, with the following addition.

The system boundary shall follow both the modularity and polluter pays principle.

7.1.2 Functional unit

The functional unit defines the way in which the identified functions and performance characteristics of the products are quantified. The primary purpose of the functional unit is to provide a reference by which product, material, and energy flows (input and output data) of a construction product's LCA results, and any other information are normalized to produce data expressed on a common basis. Requirements for the functional unit given in ISO 21930:2017 [1] Clause 7.1.2 shall apply, with the following modifications:

A functional unit shall be used for system boundaries that include the use phase, including cradle-to-gate with options and cradle-to-grave. Functional units by product type as installed are given in Table 2.

Table 2
Clay masonry products functional unit information

Name	Value
functional unit – clay brick, structural clay tile	1 m^2 of vertically installed clay brick (or structural clay tile) using 0.95 cm ($^3/_8$ in.) mortar joints for the estimated life of the building
functional unit – thin brick	1 m^2 of vertically installed thin brick using 0.95 cm ($^3/_8$ in.) mortar joints for the estimated life of the building
functional unit – clay brick paver	1 m^2 of horizontally installed clay brick paver using 3.2 mm ($^1/_8$ in.) sand joints for the estimated life of the installed surface.

The reference flow inputs shall include all materials necessary to install a functional unit of clay masonry product. For example, include the mortar and brick ties used for the installation of clay brick in a vertical setting (see Section 7.1.7.3.3.) Reference flows should comply with Section 7.1.7.3.3.

7.1.3 Declared unit

Per ISO 21930:2017 [1] Clause 7.1.3, with the following clarifications.

EPDs covering the cradle-to-gate life-cycle stages (A1-A3) shall use a declared unit. EPDs covering cradle-to-gate with options shall use a declared unit only if the use phase is not included in scope. The declared unit shall be 1 mt (1,000 kg) of clay masonry products that is ready for shipment. Data may additionally be presented per cubic yard.

7.1.4 Reference service life

Per ISO 21930:2017 [1] Clause 7.1.4, with the following clarifications.

For EPDs that include Module B (use), the RSL for clay masonry products shall be 150 yr, as shown in Table 3. To facilitate comparisons at the whole building level, impacts reported in the EPD shall be based on a 75-yr ESL of a building. However, the service life of clay masonry products routinely exceeds the ESL of 75-yr, and they can be salvaged, reclaimed and reused. As such, the reported cradle-to-grave impacts in an EPD would be identical for buildings with an ESL of up to 150 yr.

Table 3
Reference service life

Name	Value	Unit
Reference Service Life (RSL) – Clay Masonry Products	150	yr
Reference in use conditions		

To acknowledge this, an EPD published under this PCR shall include the following statement in the EPD:

> *"Once installed, clay masonry products last the life of a building, and they can be salvaged, reclaimed, or recycled for future construction after a building is demolished. The RSL for clay masonry established by this PCR is 150 years, but masonry products can and do last longer. While the impacts presented in this EPD are calculated for an ESL of 75 years, the cradle-to-grave impacts in an EPD would be identical for buildings with an ESL up to 150 years."*

7.1.5 System boundary with nature

Per ISO 21930:2017 [1] Clause 7.1.5, with the following additions.

Capital goods and infrastructure shall be excluded from the system boundary.

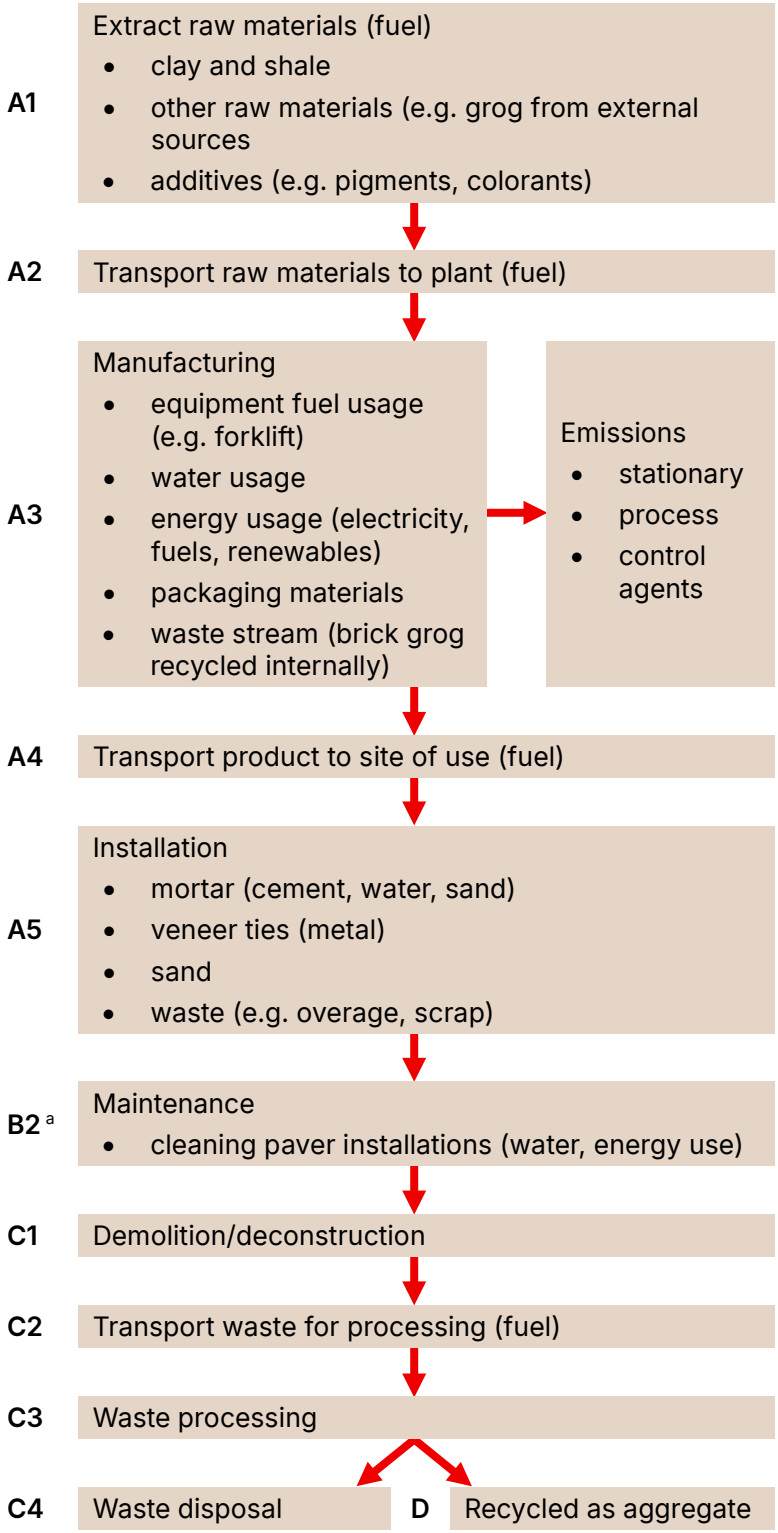
7.1.6 System boundary between products systems

Per ISO 21930:2017 [1] Clause 7.1.6, with the following addition.

The PCR system boundary for clay masonry products is displayed in Figure 2. For further explanation of the boundaries at end-of-life, refer to Sections 7.1.7.5 and 7.1.7.6.

Figure 2

Typical production process for clay masonry products in the US and Canada



[a] B1, B3-B7 have no impacts.

7.1.7 System boundaries and technical information for scenarios

7.1.7.1 General

Per ISO 21930:2017 [1] Clause 7.1.7.1, with the following additions.

Scenarios shall be provided for each module in scope beyond the manufacturing gate (Modules A1-A3). As stated in ISO 21930 Clause 7.1.7.1, "scenarios shall be realistic and be representative of the most likely alternatives. More than one scenario can be presented. A scenario shall allow users to scale the results to assess realistic options. The scenarios used shall be justified in the report." For clay masonry products, relevant aspects of the installation have been defined in the functional unit. While use of the functional unit scenario is required (e.g. 3.2 mm sand joints for a horizontal paver), additional installation scenarios (or scenarios for other modules) may also be evaluated and reported that meet the requirements of this section. The technical scenario information provided in an EPD shall be detailed to enable the user of the EPD to assess whether the scenario assumptions are applicable to the context for which the EPD information is to be used.

7.1.7.2 A1-A3, production stage

Per ISO 21930:2017 [1] Clause 7.1.7.2, with the following clarifications given in sub-sections.

7.1.7.2.1 General

Per ISO 21930:2017 [1] Clause 7.1.7.2.1.

7.1.7.2.2 A1, extraction and upstream production

Per ISO 21930:2017 [1] Clause 7.1.7.2.2, with the following additions.

This information module "extraction and upstream production" covers the extraction and processing of raw materials, and processing of secondary material inputs. For clay masonry products, this includes:

- mining operations involving the extraction of clays and shales
- raw material processing such as crushing or grinding necessary to facilitate transport
- production of other materials such as additives, colorants and lubricants
- production of fuels consumed during mining operations and on-site transport of raw material
- primary energy sources or secondary fuels consumed to generate electricity, steam, or heat used in the extraction, processing, and transportation of raw materials
- waste management from discarded packaging and manufacturing wastage, including transport to recycling or disposal.

Primary data shall be used for Module A1 where mining operations are owned by the manufacturer or co-located with the manufacturer's facilities. Where primary data are not required or available, industry-average data shall be used if available. Where industry-average data are not specific to the data need, secondary data may be used provided sufficient justification is given. The source of data shall be documented in the EPD.

7.1.7.2.3 A2, transport to factory

Per ISO 21930:2017 [1] Clause 7.1.7.2.3, with the additional clarification.

Primary data for the transport of raw materials, including recycled or secondary materials, shall be used. If primary data are not available, industry-average data may be used, as shown in Table 4. Transportation to the

manufacturing facility shall include empty backhauls, as well as to any interim distribution centers or terminals. Data sources for backhauls shall be cited, e.g. US Life Cycle Inventory Database,[6] or alternatively, methods used to account for empty backhauls shall be described.

Table 4

Transportation of raw materials to manufacturer (Module A2)

Name	Value	Unit
clay and shale	(product-specific) or default of 17.4 km	km/kg brick
grog from external sources	(product-specific) or default of 81.2 km	km/kg brick
pigments and other additives	(product-specific) or default of 639.5 km	km/kg brick

Note. Transport of grog sourced internally has a value of zero.

7.1.7.2.4 A3, manufacturing

Per ISO 21930:2024[1] Clause 7.1.7.2.4, the following clarification.

For clay masonry product production, the manufacturing information module includes the following:

- generation from primary energy resources of the electricity, steam, heat, and fuels used in clay and shale brick manufacturing, including their extraction, refining and transport
- consumptive use of processing water (refer to ISO 21930:2017 Clause 7.2.13)
- upstream impact of lubricants and other ancillary materials
- processing of raw materials
- emissions from the combustion of secondary fuels and waste used in the manufacturing process
- primary packaging. including transportation and waste, to make product ready for transport
- waste management from manufacturing packaging and manufacturing waste including transport up to the recycler/disposal with an empty back haul
- on-site storage
- manufacturing waste
- LOI, which shall be 6.5% when determining the quantity of input materials
- moisture content, which shall be assumed to be 15% unless actual data are available.

Modules A1-A3 may be reported separately or in total.

The mass of wet clay input required to manufacture 1 kg of fired brick may be calculated using the following formula:

$$\text{mass of input of wet clay per brick} = 1\ \text{kg of fired brick}/(1 - LOI)/(1 - MC)$$

where:

LOI = percent loss on ignition (default is 6.5%)
MC = percent moisture content of wet clay and shale (default is 15%)

Where default values are used, this formula results in a default input of 1.258 kg wet clay and shale input per kilogram of fired clay masonry produced, as shown in Table 5.

Table 5

Clay masonry product material inputs per kilogram brick (including LOI)

Name	Value	Unit
clay and shale [a]	(product-specific) or default of 1.258 kg [b]	kg per kg brick
grog	(product-specific)	kg per kg brick
pigments and other additives	(product-specific)	kg per kg brick

[a] Mass of clay input may be offset by grog usage (external sources only)

[b] Value based on default LOI of 6.5% and mined clay and shale moisture content of 15%

Materials for product packaging shall be presented in Table 6.

Table 6

Materials for packaging per kg clay masonry product

Name	Value	Unit
steel	(product-specific)	kg
wood	(product-specific)	kg
paper	(product-specific)	kg
plastic	(product-specific)	kg
other	(product-specific)	kg

Where primary data are not available for Module A3 air emissions, the values derived from the industry-average LCA and presented in Table 7 shall be used as default data.

Table 7
Emissions from Industry-average LCA

Substance	Value	Unit [a]
carbon dioxide (CO_2)	68.7	lb/fired ton
carbon monoxide (CO)	1.20	lb/fired ton
chlorine	0.00130	lb/fired ton
hydrogen chloride	0.170	lb/fired ton
hydrogen fluoride	0.370	lb/fired ton
lead	1.50E-04	lb/fired ton
mercury	7.50E-06	lb/fired ton
methane	0.0307	lb/fired ton
nitrogen dioxide (NO_2)	0	lb/fired ton
nitrous oxide (N_2O)	0	lb/fired ton
NOx	0.349	lb/fired ton
PM 2.5	0	lb/fired ton
PM 10	0.280	lb/fired ton
PM total	0.960	lb/fired ton
sulfur dioxide (SO_2)	0.670	lb/fired ton
VOCs total	0.0540	lb/fired ton

[a] To convert values given to kg/mt, multiply by 0.5.

7.1.7.2.5 Input of secondary materials or recovered energy

Per ISO 21930:2017 [1] Clause 7.1.7.2.5, with the following addition.

The cut-off method shall be applied when considering materials that cross the boundary of the product system. No burden shall be assigned to secondary material inputs, and no benefits shall be gained from the export of materials for energy recovery, reclaim, or recycling.

7.1.7.2.6 Co-products leaving the system

Per ISO 21930:2017 [1] Clause 7.1.7.2.6.

7.1.7.2.7 Output of waste

Per ISO 21930:2017 [1] Clause 7.1.7.2.7.

7.1.7.2.8 End-of-life scenarios for packaging

Per ISO 21930:2017 [1] Clause 7.1.7.2.8.

7.1.7.3 A4-A5, construction stage

7.1.7.3.1 General

Per ISO 21930:2019[1] Clause 7.1.7.3.1.

Modules A4-A5 may be included in EPDs covering cradle-to-gate with options and must be included in EPDs covering cradle-to-grave.

7.1.7.3.2 A4, Transport to construction site

Per ISO 21930:2017[1] Clause 7.1.7.3.2, with the following clarification.

This module shall include transport from the manufacturing gate to a central warehouse or intermediate storage site, if relevant, and then on to the construction site. The distance to the construction site may be estimated based on weighted average distance to the market for the product.

Where primary data are not available, the default values given in given in Table 8 for transportation to the construction site, including an empty backhaul, shall be used for EPDs declaring Module A4.

Table 8
Transportation to the building site, including empty backhaul (A4)

Name	Value	Unit
fuel type	diesel	
liters of fuel	0.0027224	L/100 km-kg
vehicle type	combination truck	
transport distance	407	km
capacity utilization (including back hauls)	49.88	%
gross density of products transported	(product-specific)	
weight of products transported	(product-specific)	kg
volume of products transported	(product-specific)	m^3
capacity utilization volume factor (equals 1, unless compressed or nested	< 1	

7.1.7.3.3 A5, installation

Per ISO 21930[1] Clause 7.1.7.3.3, with the following additions.

The information module “installation” covers installation of the product into the construction works. The installation scenarios included in this PCR are representative of common applications of clay masonry products. Actual installations may vary from those depicted. These scenarios do not consider additional requirements based on climatic conditions.

The method of installation for clay masonry products is dependent on the type of product. Thin brick, clay brick and structural clay tile are typically installed in a vertically oriented system similar to that shown in Figures 3 and 4. Alternatively, clay brick pavers are used in settings that require installation in a horizonal system, like that shown in Figure 5.

7.1.7.3.3.1 Vertical installations – Thin brick veneer

For the vertical installation of thin brick, the following scenario shall be used when creating an EPD for products using the functional unit of 1 m^2 of vertically installed thin brick. Figure 3 depicts a visual example of a thin brick veneer where items included in the scenario are listed in bold text. The installation scenario for thin brick veneer shall include:

- brick oriented so the exposed face is the stretcher face (i.e. side defined by length and height) as shown in Figure 3
- construction in a single layer with no specialty features
- units placed using 0.95 cm ($^3/_8$ in.) mortar joints between units. Joint mortar shall be compliant with ASTM C270, [2] Type N masonry cement mortar
- units installed with 0.32 cm ($^1/_8$ in.) setting bed mortar compliant with ANSI A118.4 [11]
- installation scrap rate of 5% of thin brick and 5% of mortar
- no other substrate, adhesive, or backing materials in the installation.

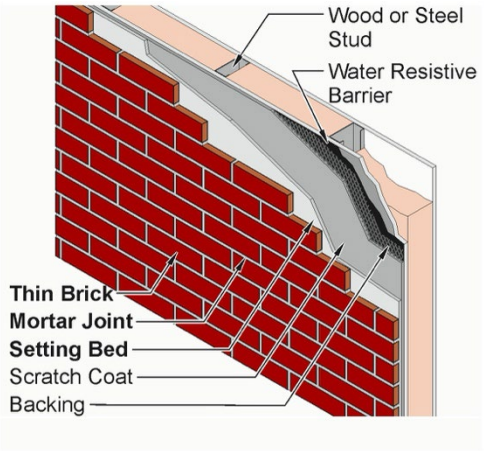


Figure 3
Example thin brick veneer installation

Installations of thin brick typically involve a one-time cleaning of the brick to remove excess mortar and restore a clean appearance. However, the impacts from such cleaning were found to fall below the criteria for inclusion (see Section 7.1.8) during the underlying LCA and thus may be considered zero. Where primary data are not available, the default values given in Table 9 for installation of thin brick shall be used for EPDs declaring Module A5.

Table 9
Vertical installation scenario of thin brick veneer (Module A5)

Metric	Details	Value	Unit
ancillary materials, by material	• mortar • water	(product-specific)	kg
net freshwater consumption by source	N/A – manual cleaning during construction	—	m^3
energy consumption	—	0.03	kWh
product loss per functional unit	5% brick and mortar default scrap	(product-specific)	kg
waste materials at construction site before waste processing	—	(product-specific)	kg
mass of pkg waste (specify by type)	—	(product-specific)	kg
biogenic carbon in package (specify by type)	—	(product-specific)	kg CO_2
VOC emissions	—	0	µg/m^3

[11] American National Standards Institute. 1899 L Street NW, 11th floor, Washington, DC 20036. <ansi.org>

7.1.7.3.3.2 Vertical installations – Clay brick and structural clay tile

For vertical installation of clay brick and structural clay tile products, as grouped in Table 1, the following scenario shall be used when creating an EPD for a product using the functional unit of 1 m^2 of vertically installed clay masonry. Figure 4 depicts a visual example of an installation where items included in the scenario are listed in bold text. The installation scenario for these products shall include:

- brick oriented so the exposed face is the stretcher face (i.e. side defined by length and height) as shown in Figure 4
- construction is a single layer, or wythe, with no specialty features
- brick or structural clay tile placed using 0.95 cm ($^3/_8$ in.) mortar joints between units. Joint mortar shall be compliant with ASTM C270, [2] Type N masonry cement. Other materials required for installation such as veneer ties.
- installation scrap rate of 5% of both brick or tile, and 5% of mortar
- no other underlying materials or substrate in the installation.

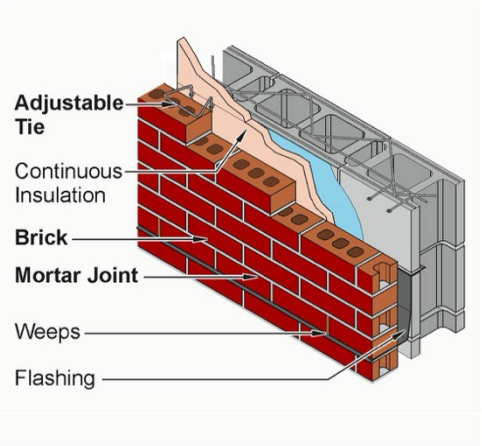


Figure 4
Example clay brick installation

Installations of clay brick and structural clay tile typically involve a one-time cleaning of the masonry to remove excess mortar and restore a clean appearance. However, the impacts from such cleaning were found to fall below the criteria for inclusion (see Section 7.1.8) during the underlying LCA and thus may be considered zero.

Where primary data are not available, the default values given in given in Table 10 for installation of clay brick and structural clay tile shall be used for EPDs declaring Module A5.

Table 10
Vertical installation of clay brick and structural clay tile scenario (A5)

Metric	Details	Value	Unit
ancillary materials, by material	• mortar • water • other (e.g. veneer ties) [a]	(product-specific)	kg
net freshwater consumption by source	N/A – manual cleaning during construction	—	m^3
energy consumption	mixing mortar	0.03	kWh
product loss per functional unit	5% brick and mortar default scrap	(product-specific)	kg
waste materials at construction site before waste processing	—	(product-specific)	kg
mass of package waste (specify by type)	—	(product-specific)	kg
biogenic carbon in pkg (specify by type)	—	(product-specific)	kg CO_2
VOC emissions	—	0	µg/m^3

[a] Veneer ties as required by code were modeled and found to be below the cutoff threshold in the industry-average LCA.

7.1.7.3.3.3 Horizontal installation – Clay brick pavers

For the installation of clay brick pavers, the following scenario shall be used when creating an EPD for a product using the functional unit of 1 m^2 of horizontally installed pavers. Figure 5 depicts a visual example of a clay brick paver installation where items included in the scenario are listed in bold text. The installation scenario for clay brick pavers shall include:

- clay brick pavers installed using 0.32 cm ($^1/_8$ in.) sand joints between units
- installation scrap rate of 5% of both pavers and sand. Waste sand is typically repurposed on-site and shall be assumed to be assigned no burden under the cut-off method
- no other ancillary materials. Materials used to form the setting bed and base materials for the pavers, as well as those used for an edge restraint shall be excluded from the scope of the EPD.

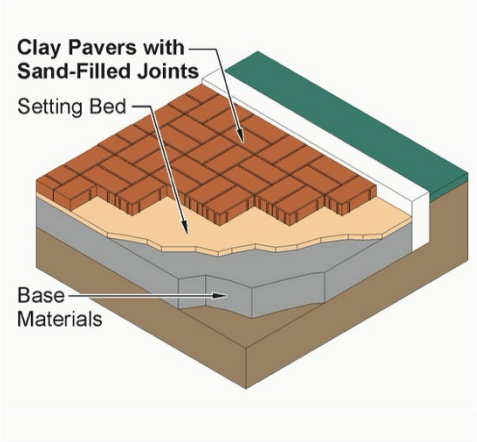


Figure 5
Example horizontal clay brick paver installation

Where primary data are not available, the default values given in given in Table 11 for installation of clay brick pavers shall be used for EPDs declaring Module A5.

Table 11
Horizontal Installation Scenario for Clay Brick Pavers using Sand (A5)

Metric	Details	Value	Unit
ancillary materials, by material	• sand • other	(product-specific)	kg
net freshwater consumption by source	N/A – manual cleaning during construction	—	m^3
energy consumption	—	—	kWh
product loss per functional unit	5% paver and sand default scrap	(product-specific)	kg
waste materials at construction site before waste processing	—	(product-specific)	kg
mass of package waste (specify by type)	—	(product-specific)	kg
biogenic carbon in pkg (specify by type)	—	(product-specific)	kg CO_2
VOC emissions	—	0	µg/m^3

Note 1. Setting bed material requirements for clay brick pavers depend on a variety of non-product related factors and can vary greatly by installation method and intended use. For these reasons, they are excluded from consideration in the functional unit for clay brick pavers.

Note 2. Sand is used in the default functional unit for pavers. Impacts would vary for installations using a different type of joint material (e.g. mortar).

7.1.7.3.4 End-of-life Scenarios for Packaging (A5)

Per ISO 21930:2017 [1] Clause 7.1.7.3.4, with the following clarifications.

Per ISO 21930:2017 Clause 7.2.7, biogenic carbon emissions from product packaging materials shall be reported in information Module A5. If Module A5 is not declared in the EPD (e.g. cradle-to-gate), the biogenic emissions from the packaging shall be reported in a scenario table.

7.1.7.4 B1-B7, use stage

Per ISO 21930:2017 [1] Clause 7.1.7.4 with the following additions.

B1-B7 are optional for cradle-to-gate with options EPDs and are required for cradle-to-grave EPDs. A description of the reference scenarios shall be part of the EPD.

Impacts from clay masonry products during the use phase (Module B1) are non-existent and shall be reported as zero. Products claiming a benefit during the use phase (e.g. brick that uptakes carbon) may report a value other than zero, if evidence supporting the claim is documented and reported in the EPD.

Pavers require periodic cleaning, as described in Tables 12 and 13. Maintenance is not required on vertical installations and shall be reported as zero in Module B2.

Table 12
Pressurized washer maintenance of pavers (Module B2)

Scenario details			
maintenance scenario	maintenance of clay pavers using pressurized water requires a cleaning solution [a] (e.g. an appropriate masonry cleaner) to be prepared and sprayed on the target area as recommended		
Metric	**Details**	**Value**	**Unit**
maintenance cycle	cleaning (every 4 yr) – RSL	37.5	cycles
maintenance cycle	cleaning (every 4 yr) – ESL	18.75	cycles
net freshwater consumption, by source	total freshwater	0.009	m^3
ancillary materials, spec by type	• cleaning agent [a] • water [a]		kg kg
energy input, spec by activity	source (e.g. gas)	0.08	kWh
power output of equipment	power washer (average 13 hp, pressure not to exceed 800 psi)	9.7	kW

[a] For industry-average LCA, a cleaning solution of 1 part HCL (0.062 kg) to 4 parts water (0.217 kg) was used.

Table 13
Broom maintenance of pavers (Module B2)

Scenario details			
maintenance scenario	maintenance of clay pavers by sweeping requires no energy, water, or material inputs		
Metric	**Details**	**Value**	**Unit**
maintenance cycle	biennial cleaning – RSL	75	cycles
maintenance cycle	biennial cleaning – ESL	37.5	cycles

Installed clay masonry does not require repair or replacement and does not consume energy or water during the use phase. Clay masonry products used as part of exterior wall systems provide thermal mass that may positively affect the energy performance of the construction works. However, the LCA for this PCR does not account for the effects of clay masonry products on the operational energy used during the Use Phase of the construction works.

Therefore, impacts may be reported as zero for all declared Modules B3-B7.

7.1.7.5 C1-C4, end-of-life-stage

Per ISO 21930:2017 [1] Clause 7.1.7.5, with the following additions.

Modules C1-C4 are optional for cradle-to-gate with options EPDs and are required for cradle-to-grave EPDs. A description of the reference scenarios shall be part of the EPD.

The end-of-life stage of the construction product starts when it is replaced, dismantled or deconstructed from the construction works and does not provide any further functionality. Clay masonry products normally do not require repair or replacement over the life of a building due to the product's 150-yr RSL (see Section 7.1.4) and therefore typically reach end-of-life through the building demolition process (Module C1).

However, clay masonry products are sometimes salvaged for reclamation or recycling through a building deconstruction process. Deconstruction is defined by HUD as the process of carefully taking apart or removing valuable building components for reuse, which is typically done by labor using hand tools prior to building demolition. While a growing market exists for reclaimed or recycled brick, insufficient data currently exist to quantify this practice.

In this PCR, it is assumed that during the building demolition process, clay masonry products are removed from the structure as part of the demolition of the whole structure. Therefore, impacts from demolition are allocated to the whole structure. Given the mass of brick relative to the overall considerable mass of the structure, it is assumed that the impacts allocated to the brick alone are negligible and may be reported as zero.

If primary data are not available, transportation (Module C2) of brick to processing shall assume a 32-km distance based on the 2023 US EPA WARM model. [12]

[12] <EPA.gov/waste-reduction-model/versions-waste-reduction-model#v16>

Clay masonry products not reclaimed enter the waste stream and are sent to recycle (Module C3) or disposal to landfill (Module C4). The most recent release of US EPA *2018 Facts and Figures Fact Sheet*, Table 8 [13] shall be used to determine the percentages of the remaining (i.e. after reclaim) clay masonry product that are to be recycled and landfilled. The US EPA *Facts and Figures Fact Sheet* data considers reuse as shown in Table 14 to include both the salvage (reclamation) of clay masonry products for reuse in future construction and the recycling and grinding of clay masonry products for other uses.

End-of-life scenario data are presented in Table 14.

Table 14
End-of-life scenario for clay masonry products (Modules C1-C4)

Name		Value	Unit
assumptions for scenario development	Clay brick, clay brick pavers, and structural clay tiles are commonly collected separately in the demolition stage. demolition and collection requires no additional considerations from normal demolition; therefore, demolition impacts are de minimis. upon collection, 12% of the product (by mass) is reused in the form of bulk aggregate or other uses to offset virgin material in other product cycles, with the remaining 88% being landfilled.		
collection process (specified by type)	collected separately	100%	kg
	collected with mixed construction waste	0%	kg
recovery (specified by type)	reuse	12%	kg
	recycling	0%	kg
	landfill	88%	kg
	incineration	0%	kg
disposal (specified by type)	product or material for final deposition	(product-specific)	kg

7.1.7.6 Module D, benefits and loads beyond the system boundary

Per ISO 21930:2017 [1] Clause 7.1.7.6 with the following additions.

Where relevant, Module D information declares potential loads and benefits of secondary material, secondary fuel, or recovered energy leaving the product system based on scenarios.

Module D is optional. If provided, a description of the reference scenarios shall be documented in the EPD.

The calculation of benefits and loads associated with clay brick products outside the product system relies on the availability of data quantifying the rate of reclamation and reuse of the products at the end of the product lifecycle. Currently, insufficient national data exist to inform the inclusion of the reclamation and reuse of clay brick in this aspect of Module D in this PCR. However, a combination of reclamation and recycling of brick can occur.

Should suitable national data become available, or should the scope of an EPD be such that the data are known (e.g. project-specific local data) the following method shall be used to calculate Module D benefits:

[13] <EPA.gov/sites/default/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508>

1. reference flow (m^2) = quantity of brick (1 m^2) × brick reclaim rate (%)
2. Calculate the impacts from the production of the reference flow of new brick.
3. Module D is then determined by assigning the impacts from Step 2 as a credit representing the portion of brick in a future building that is no longer needed because of the reclaimed brick use.

Table 15 offers a default scenario that can be used in any case where brick enters the waste stream.

While clay brick products are capable of being recycled or reused as whole brick units (salvaged brick), they are commonly landfilled at this time. Per the US EPA, recycled brick is typically used as crushed aggregate to offset virgin sand and concrete materials in other product cycles, as per Table 15.

Table 15
Module D scenario for clay masonry products

Name	Value
Further assumptions for scenario development	12% of the product (by mass) is reused in the form of bulk aggregate to offset virgin sand or concrete material in other product cycles.

Module D is optional. If provided, a description of the reference scenarios shall be documented in the EPD.

For a project-specific EPD, in cases where the building has a lifespan of more than 75 yr, this method can also be used.

Where both the reclamation and recycling are characterized in an EPD, the reclamation shall be calculated first.

Where Module D is reported, the EPD shall include the following statement:

> *"Benefits and loads calculated in Module D occur outside of the product system and thus are not additive to product system LCIA impacts."*

7.1.8 Criteria for the inclusion and exclusion of inputs and outputs

Per ISO 21930:2017 [1] Clause 7.1.8, with the following clarification.

The procedure used shall be documented in the EPD as required in Section 9.3.

7.1.9 Selection of data and data quality requirements

Per ISO 21930:2017 [1] Clause 7.1.9, with the following additions and clarifications.

7.1.9.1 Foreground data

7.1.9.1.1 Time period

Facility-specific datasets (Module A3) shall include 12 consecutive months of data beginning within 3 yr of the publication date of the EPD. Any exceptions to this scenario shall be justified in the LCA report and noted in the EPD.

For transparency, the time period for collection of foreground data should be reported in EPDs as specified in Table 18.

If the market-based method for Scope 2 accounting is used to quantify potential GHG emission reductions associated with electricity consumption and reported as additional environmental information (see Section 8.3), documentation shall meet the Scope 2 Quality Criteria in the GHG Protocol *Scope 2 Guidance*. [14]

7.1.9.1.2 Documents on file

Foreground data shall be based on utility and energy bills, sales records, product designs, and similar records, all of which provided to the reviewer, if requested. Any exceptions shall be justified in the LCA report and noted in the EPD.

7.1.9.1.3 Geography

Foreground data for a facility-specific EPD shall be specific to the facility. Company averages are not allowed. Foreground data for industry-average EPDs shall be specific to the participating facilities and products that meet the applicable specification(s).

7.1.9.1.4 Data gaps in foreground data

Data gaps for foreground data shall be limited only to those items for which a predetermined parameter has been provided in this PCR. Any exceptions to this scenario shall be justified in the LCA report and noted in the EPD.

7.1.9.2 Background data

7.1.9.2.1 Prioritization of data for upstream processes

Use of upstream data associated with production of commodities and raw materials shall follow this hierarchy. Deviations from this hierarchy shall be identified in the background document and justification provided.

1. Valid facility-specific and product-specific EPDs with impact categories modeled according to TRACI v2.2 [5] for the specific inputs associated with the EPD.
2. Either of the following:
    - valid industry-average EPDs with impact categories modeled according to TRACI v2.2
    - freely available public datasets as prescribed in this PCR including critically reviewed LCA studies that are conformant with ISO 14040/14044 [1] that have been published to the USLCI.
3. Publicly available, critically reviewed LCA studies that are conformant with ISO 14040/14044 that have not been published to the USLCI.
4. Either of the following:
    - commercial (proprietary) inventory data, when process or flow impacts are estimated to be greater than 1% total
    - declared data gap, in cases where no data exist or when process or flow impacts are estimated to be less than 1% total. Except where specifically allowed by this PCR, proxy data shall not be used.

[14] <ghgprotocol.org/scope-2-guidance>

7.1.9.2.2 Uniformity in use of life cycle inventories

Manufacturers who develop manufacturer-average EPDs, facility-specific EPDs, or public datasets that could be used as upstream data for clay masonry products are strongly encouraged to use the public datasets prescribed in Annex A for common upstream energy and materials to improve the consistency and comparability of EPDs developed under this PCR.

7.1.9.2.3 Geography and regionalization

The upstream data specified in Annex A are specific to North America, unless otherwise stated. Baseline US inventories for electricity in Annex A shall be regionalized at the balancing authority level. Baseline Canadian inventories for electricity shall be regionalized at the provincial level.

7.1.9.2.4 Electricity use from the grid

Electrical energy data shall use NERC regions, [15] or similar data to represent electrical energy production for the US and Canada. Preference shall be given to datasets that include transmission and distribution losses. For regions other than the US and Canada, country or region-specific processes shall be used for the manufacturing stage provided they are representative. The sources for electricity and the calculation procedure shall be documented.

7.1.9.2.5 Renewable energy usage and renewable energy credits

This PCR shall follow the most recent version of the ACLCA *Guidance for Quantifying Renewable Electricity Instruments in Environmental Product Declarations*. [3]

7.1.9.2.6 Data gaps in background data

Data gap identification shall be performed in accordance with the ACLCA *Guidance for Assessing Data Quality of Background Life Cycle Inventory (LCI) Datasets* [3] for background dataset selection. Gaps that occur in background data that are not otherwise excluded under Section 7.1.8, shall be described in the EPD and the following statement provided:

> *"Data for [list of materials] was not available at the time of EPD preparation and may have significant effects on total impacts."*

7.1.9.2.7 Updating prescribed inventory data

LCA practitioners and other users of this PCR are encouraged to notify NSF directly of changes to available background datasets relevant to this PCR. This includes the release of newly available data, the expiration of previously available data, or significant updates to existing data. In such instances, NSF will evaluate the information and convene the PCR data subcommittee to consider if an update to the PCR is necessary. Any resulting revisions based on this review shall be summarized in the revision log for this PCR and shall include the date of revision. The PCR's date of expiry shall not be affected.

7.1.9.3 Data quality assessment

Per ISO 21930:2017 [1] Clause 7.1.9.3, with the following additions.

[15] North American Electric Reliability Corporation. 3353 Peachtree Road NE, Suite 600 North Tower, Atlanta, GA 30326. <nerc.com>

The DQA is required for primary/foreground data as well as for all background and generic data including any data used for Module D. The DQA shall include an evaluation of the temporal, geographical, technological representativeness, accuracy, precision, and completeness of the datasets used.

7.1.10 Units

Per ISO 21930:2017 [1] Clause 7.1.10, with the following additions.

All EPD values shall be reported using SI (metric) units. Optionally, EPDs may provide both SI units and US imperial units using the following conversion factors from NIST. [16]

Table 16
Conversion factors to be used if reporting in Imperial units

Convert from:	To:	Multiply by:
square meter (m^2)	square foot (ft^2)	1.076391E+01
kilogram (kg)	pound (lb)	2.204622
megajoule (MJ)	British Thermal Unit (BTU)	9.478170E+02
degrees Celsius (°C)	degrees Fahrenheit (°F)	(°C * 9/5) +32
cubic meter (m^3)	cubic foot (ft^3)	3.531466E+01
meter (m)	foot (ft)	3.281
thermal transmittance (m^2·°K/W)	thermal transmittance (ft^2·°F·h/BTU)	5.6783
metric tonne (t)	ton (tn)	1.102

Source: NIST.
Special Publication 811 <nist.gov/pml/special-publication-811>, SI Units – Temperature <nist.gov/pml/wmd/metric/temp.cfm>, and Approximate Conversions from US Customary Measures to Metric <nist.gov/pml/wmd/metric/common-conversion-b.cfm>.

7.2 Inventory analysis

7.2.1 Data collection

Per ISO 21930:2017 [1] Clause 7.2.1 (which references ISO 14044:2006 [1] Clause 4.3.2), with additional guidance from Section 7.1.9, and the following clarification.

An EPD describing a specific product shall be calculated using specific (i.e. primary) data. Primary data shall, at a minimum, be collected for the processes over which the manufacturer has influence.

7.2.2 Calculation procedures

Per ISO 21930:2017 [1] Clause 7.2.2 (which references ISO 14044 [1]).

7.2.3 Allocation

Per ISO 21930:2017 [1] Clause 7.2.3, with the following addition:

[16] National Institute of Standards and Technology, US Department of Commerce. 100 Bureau Drive, Gaithersburg, MD 20899-8930. <nist.gov>

Allocation shall be based on the mass of clay masonry products produced at the manufacturing site. Allocation during transport shall be based on the mass of products transported.

7.2.4 Principles for allocation for both allocation situations

Per ISO 21930:2017 [1] Clause 7.2.4.

7.2.5 Allocation for co-products

Per ISO 21930:2017 [1] Clause 7.2.5, with the following addition.

Co-product allocation shall follow the step-based process described in ISO 21930 Clause 7.2.5.2. System expansion shall not be used to avoid allocation and is not allowed under this PCR.

7.2.6 Allocation across the system boundary

Per ISO 21930:2017 [1] Clause 7.2.6.

7.2.7 Accounting of biogenic carbon uptake and emissions during the life cycle

Per ISO 21930:2017 [1] Clause 7.2.7, with the following additions.

Clay masonry products are often shipped using wood pallets or other biobased materials. For bio-based packaging materials, the quantity of biogenic carbon (expressed in kg CO_2) contained within the packaging for the declared or functional unit shall be reported in Module A3 and documented in information Module A5 as technical scenario information.

The uptake and emissions of biogenic carbon from clay masonry products is not typically relevant and thus shall be considered zero, unless otherwise justified.

7.2.8 Carbonation and calcination

Per ISO 21930:2017 [1] Clause 7.2.8, with the following clarification.

While mortar used in the installation of clay masonry products can result in carbonation, the carbonation effects should be excluded unless justification is provided in the EPD. Carbonation is also not typically relevant to clay masonry products and should be excluded from the calculation of GWP, unless justification is provided in the EPD.

7.2.9 Accounting of delayed emissions

Per ISO 21930:2017 [1] Clause 7.2.9, there is no consensus approach to reporting delayed emissions in the quantification of GWP, and therefore such calculations are not part of the quantification of GWP. If a manufacturer wishes to declare qualitative or quantitative information on delayed emissions within the EPD, it shall be reported under Section 9.6.

7.2.10 Inventory indicators describing resource use

Per ISO 21930:2017 [1] Clause 7.2.10. For additional guidance on inventory reporting, refer to the ACLCA *Guidance to Calculating Non-LCA Inventory Metrics in Accordance with ISO 21930:2017*. [3]

7.2.11 Greenhouse gas emissions from land use change

Land use change is not relevant to clay masonry products or the scope of this PCR and shall be reported as zero in all modules declared in the EPD. The LCA was conducted, and it was determined that, given the duration of operation of these facilities and the complexities in citing and evaluating such locations, such changes in land use are beyond the scope of this PCR.

7.2.12 Additional inventory indicators describing emissions and removal of carbon

Per ISO 21930:2017 [1] Clause 7.2.12, with additional guidance in Sections 7.2.7 and 7.2.8. For additional guidance on inventory reporting, refer to the ACLCA *Guidance to Calculating Non-LCA Inventory Metrics in Accordance with ISO 21930:2017.* [3]

7.2.13 Inventory indicator describing consumption of freshwater

Per ISO 21930:2017 [1] Clause 7.2.13. For additional guidance on inventory reporting, refer to the ACLCA *Guidance to Calculating Non-LCA Inventory Metrics in Accordance with ISO 21930:2017.* [3]

7.2.14 Environmental information describing waste categories and output flows

Per ISO 21930:2017 [1] Clause 7.2.14. For additional guidance on inventory reporting, refer to the ACLCA *Guidance to Calculating Non-LCA Inventory Metrics in Accordance with ISO 21930:2017*. [3]

7.3 Impact assessment indicators describing main environmental impacts derived from LCA

Per ISO 21930:2017 [1] Clause 7.3, with the following clarifications.

Table 17 presents the core environmental impact indicators that, at a minimum, shall be reported for each module declared in the EPD. The US EPA TRACI v2.2 [5] methodology shall be used for all factors except GWP. For GWP, the IPCC 2013 (AR5) [17] or current method for a 100-yr time horizon shall be reported. The characterization models used shall be reported in the EPD.

Table 17
Mandatory impact categories – North America (TRACI)

Impact category	Unit
acidification potential (AP)	kg SO_2 eq
eutrophication potential (EP)	kg N eq
global warming potential (GWP) – IPCC 2013 (AR5)	kg CO_2 eq
ozone depletion potential (ODP)	kg CFC-11 eq
smog formation potential (SFP)	kg O_3 eq

[17] Intergovernmental Panel on Climate Change, UN Environment Programme. C/o World Meteorological Organization, 7 bis Avenue de la Paix, CP 2300, CH-1211 Geneva 2, Switzerland. <ipcc.ch>

LCIA results reported in the EPD shall be preceded by the statement:

> *"LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks."*

For European market EPDs developed with this document as the core PCR, the characterization method included in the latest edition of EN 15804 [18] shall be used.

8 Additional environmental information

Per ISO 21930:2017 [1] Clause 8, with the following additional requirements.

Additional information shall only be related to environmental aspects. Information and instructions on product safety unrelated to the environmental performance of the building product shall not be part of a Type III environmental declaration (ISO 14025:2006 [1]).

8.1 General

Per ISO 21930:2017 [1] Clause 8.1.

8.2 Additional LCA related information not included in preset LCIA indicators

Per ISO 21930:2017 [1] Clause 8.2, with the following additions.

An EPD may also report additional environmental impact metrics not covered in Section 7.3. This reporting may include impact categories that are still under development or have high levels of uncertainty that preclude international acceptance pending further development. Examples include:

- abiotic depletion potential for non-fossil mineral resources ($ADP_{elements}$)
- land-use related impacts
- toxicological aspects.

When reporting such metrics, they must be accompanied by the following statement:

> *"These five 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."*

In addition to the metrics reported in Section 7.3, an EPD may also report GWP using the IPCC:2021 Sixth Assessment Report (AR6) [17] metric in this section of the EPD. Reporting shall be over a 100-yr span.

8.3 Additional environmental information not derived from or related to LCA

Per ISO 21930:2017 [1] Clause 8.3, with the following modifications.

Other characteristics or properties of clay masonry products that are important to the function of the clay masonry assembly may be reported here. Examples of such properties include but are not limited to acoustical

[18] European Standards s.r.o. Krimicka 134, 318 00 Pilsen, Czech Republic. <en-standard.eu>

or thermal properties, or fire rating. See Section 9.2 for required statements.

8.4 Mandatory additional environmental information

Per ISO 21930:2017 [1] Clause 8.4.

Regulated substances shall be reported in the EPD along with the product material content.

9 Content of an EPD

9.1 General

Per ISO 21930:2017 [1] Clause 9.1.

9.2 Declaration of general information

Per ISO 21930:2017 [1] Clause 9.2, with the following clarification and additions.

The manufacturer is responsible for the provision of all information in the following sections. An EPD developed under this PCR shall include the following information.

9.2.1 Owner and verification information

- Table 18 of general product and verification information shall be presented on the inside cover of the EPD

Table 18
Demonstration of verification

Product name	
Manufacturer name and address	
Program operator	
General program instructions and version number	
Declaration number	
Reference PCR and version number	
EPD type and scope	
Defined functional or declared unit	
Product's intended application and use	
Markets of applicability	
Date of issue	
Period of validity	
Year of reported manufacturer primary data	
LCA software and version number	
LCI database and version number	
LCIA methodology and version number	
Overall data quality assessment score	
The sub-category PCR review was conducted by:	
This declaration was independently verified in accordance with ISO 14025: 2006. ISO 21930:2017 serves as the core PCR. Sub-category PCR: **Clay Masonry Products** Product Category Rule ☐ Internal ☐ External	Industrial Ecology Consultants, Thomas P. Gloria, PhD, t.gloria@industrial-ecology.com
This life cycle assessment was conducted in accordance with ISO 14044:2006/AMD 1:2007/AMD 2:2020 and the reference PCR by:	
This life cycle assessment was independently verified in accordance with ISO 14044:2006/AMD 1:2007/AMD 2:2020 and the reference PCR by:	
Explanatory material can be obtained from the following:	

9.2.2 Required statements

- The statement:

  "EPDs are only comparable if they comply with ISO 21930, this sub-category PCR, include all relevant information modules and are based on equivalent scenarios with respect to the construction works context."

- The statement:

  "Environmental declarations from different programs may not be comparable. Comparison of the environmental performance of products using EPD information shall be based on the product's use and impacts at the building or construction works level, and therefore EPDs may not be used for comparability purposes when not considering the whole building life cycle. EPD comparability is only possible when all stages of the life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background datasets may lead to differences in the results upstream or downstream of the life cycle stages declared."

- If the EPD is based on a declared unit, include the statement:

  "The environmental impact results of products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the product impact the precise function at the construction level. The environmental impact shall be converted to a functional unit basis before any comparison is attempted."

- If the EPD is based on a functional unit, the statement:

  "This EPD defines the functional unit for clay brick, clay brick pavers, and structural clay tile products as 1 m^2 of product installed as per Table 2 of the PCR. Depending upon the application, other characteristics of clay masonry products should be considered when making comparisons. Fire rating, thermal properties, impact resistance, and acoustic performance may be important in characterizing the performance of clay masonry assemblies."

- The statement:

  "*Once installed, clay brick, clay brick pavers, and structural clay tile products last the life of a building, and they can be salvaged, reclaimed, or recycled for future construction after a building is demolished. The RSL for clay masonry established by this PCR is 150 years, but masonry products can and do last longer. While the impacts presented in this EPD are calculated for an ESL of 75 years, the cradle-to-grave impacts reported in this EPD would be identical for buildings with an ESL up to 150 years."*

- The statement:

  "The EPD owner has sole ownership, responsibility, and liability for the content of this EPD."

9.2.3 Product specifications

- Identification of the product name, unit size designation, and ASTM specification according to Table 1. A depiction of the item shall be included.
- A description of the main product components or materials that make up the product shall be given both in mass and percent of total. Mass may be reported by material using a range to protect proprietary product information. A single bill of materials may be presented for all brick in the EPD if the material contents of the products vary by less than 5% by mass.

- For each product evaluated in the EPD, the product-specification data shown in the applicable Table below shall be reported. EPDs shall contain a table for each category of products represented in the EPD (i.e. tables shall not be combined). Specification data shall be provided for every product in the EPD, even those grouped within a category. Products shall be sorted by ASTM specification. Refer to Section 9.5.1 for guidance on the calculation and reporting of mortar mass and both brick/paver and mortar conversion factors.
- Description of the main product packaging materials, if applicable, shall be given in mass per functional or declared unit. Where multiple products are represented, the packaging may be given for a representative product by category.
- Regulated hazardous materials or substances shall be identified, listed by CAS number, and identify the standard or regulation in the relevant market. When such materials are reported, the following note may be added immediately after the required information:

  "While regulated materials are sometimes included in the raw materials used, there is not a direct relationship between what is added during manufacturing and what is contained in the fired product. During firing, these materials are commonly incorporated into the glassy matrix of the brick and become functionally inert. The degree of conversion depends on the nature of the raw materials and degree of firing."

Table 19
Specification of clay brick and structural clay tile

Unit size designation	ASTM Specification [a]	Dimensions (in.) (W × H × L)	Dimensions (cm) (W × H × L)	Void space [b] (%)	Mass of masonry unit (kg/unit)	No. of units/m^2 (0.95 cm joint) [c]	Brick conversion factor	Mortar mass (kg/m^2)	Mortar conversion factor
e.g. Modular	*C216, C652*	*3.625 × 2.25 × 7.625*	*9.2 × 5.7 × 19.4*	*25%*	*1.52*	*73.81*	*1.00*	*32.77*	*1.000*

[a] See Table 1.
[b] For brick with frogs, the frog area should be reported as percent void space.
[c] 0.95 cm joint = $^3/_8$ in. joint.

Table 20
Specification of thin brick

Unit size designation	ASTM Specification [a]	Dimensions (in.) (W × H × L)	Dimensions (cm) (W × H × L)	Mass of thin brick (kg/unit)	No. of units/m^2 (0.95 cm joint) [b]	Thin brick conversion factor	Mortar conversion factor
e.g. Modular thin brick	*C1088*	*0.5 × 2.25 × 7.6*	*1.3 × 5.7 × 19.4*	*0.28*	*73.8*	*1.01*	*0.99*

[a] See Table 1.
[b] 0.95 cm joint = $^3/_8$ in. joint.

Table 21
Specification of clay brick pavers

Paver designation	ASTM Specification [a]	Dimensions (in.) (W × H × L)	Dimensions (cm) (W × H × L)	Mass of paver (kg/unit)	No. of units/m² (0.32 cm joint) [b]	Paver conversion factor
e.g. Standard paver	*C902*	*4.02 × 2.25 × 8*	*10.2 × 5.7 × 20.3*	*2.35*	*46.24*	*1.01*

[a] See Table 1.

[b] 0.32 cm joint = 1/8 in. joint.

9.3 Declaration of the methodological framework

Per ISO 21930:2017 [1] Clause 9.3, with the following additions and clarifications. The EPD shall specify the following:

- declared or functional unit. For EPD using a functional unit, report only the functional unit(s) that apply:
    - **declared unit**: 1 mt of clay masonry product
    - **functional unit (brick)**: 1 m^2 vertically installed brick using 0.95 cm ($^3/_8$ in.) mortar joints for the estimated life of the building
    - **functional unit (paver)**: 1 m^2 of horizontally installed brick paver using 3.2 mm ($^1/_8$ in.) sand joints for the estimated life of the installed surface.
- the RSL of the product
- the scope of the EPD with respect to life-cycles stages covered (e.g. cradle-to-gate) as described in Section 5.2.2
- life cycle stages covered and not covered, using Table 22. The table shall indicate by module whether that module is declared or not declared in the EPD. Modules A1-A3 are required for all EPD types.

Table 22
Description of EPD system boundary

Production stage			Construction stage		Use stage							End of life stage				Benefits and loads beyond the system boundary
Raw material extraction	Transport	Manufacturing	Transportation to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operation energy use	Operation water use	De-construction	Transport	Waste processing	Disposal	Reuse/recycle
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X														O

Note. X = module declared, O = optional declaration

- the type of EPD with regards to data specificity as indicated in Section 5.3:
  - industry-average, manufacturer-average, or facility-specific
  - product-specific or product-average
- for industry-average EPDs, include the date and source of industry data survey including a list of all companies who participated in the EPD data.

9.4 Declaration of technical information and scenarios

Per ISO 21930:2017 [1] Clause 9.4, with the following clarifications.

Modules A1-A3 are required under this PCR. All other information modules are optional. If any of the information modules beyond the factory gate are included, technical information describing the declared information modules shall be provided in the EPD. The information describes the basis for the technical scenarios used to assess the performance of a product within the construction works. See Sections 7.1.7.3 through 7.1.7.6 for scenario tables and default values for each declared module to be reported. Additional information may be listed if necessary to describe the scenario. Irrelevant or non-applicable rows may be omitted.

> *Note*. Installation of products under this PCR may involve either vertical or horizontal installation methods as described in Section 7.1.7.3.3. For EPDs that include both vertically and horizontally installed products, a separate scenario table for each method of installation shall be provided.

9.5 Declaration of environmental indicators derived from LCA

9.5.1 LCA Results from the LCIA

Per ISO 21930:2017 [1] Clause 9.5.1 and Section 7.3 of this PCR, with the following additions.

Cradle-to-gate EPDs shall report LCIA results based on the declared unit for clay masonry products in the impact categories defined in Section 7.3.

For all other EPDs that include the use phase, a baseline product shall be defined for each general category of product covered by the EPD (e.g. clay brick and structural clay tile, thin brick, or paver). For example, if an EPD contained clay brick, structural clay tile, and paver products, a single product from each category would be selected to serve as the baseline for all other products reported within that category. LCIA results shall be reported in the EPD per applicable functional unit for *each baseline product only* using Tables 23 through 25 as shown below.

> *Note 1*. Impacts for Modules A1-A3 may be reported separately or combined into a single A1-A3 value as shown in the tables.
>
> *Note 2*. No activity is expected in Modules B1 and B3-B7 for clay masonry products and therefore may be reported as zero for EPDs with a cradle-to-grave scope. For clay brick, structural clay tile, and thin brick, no activity is expected for Module B2 and therefore may be reported as zero for EPDs with a cradle-to-grave scope.

LCIA results tables shall be preceded by the following statement:

> *"LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks."*

Table 23

LCIA results table – Clay brick and structural clay tile

Impact category	Production	Construction			Use							End-of-life				Benefits & Loads Beyond System Boundary
	A1-A3	A4	A5 – Installation		B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
			Brick wastage	Mortar												
GWP (kg CO_2 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
ODP (kg CFC-11 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
AP (kg SO_2 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
EP (kg N eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
SF (kg O_3 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
ADPF (MJ)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					

Table 24
LCIA results table – Thin brick

Impact category	Production	Construction			Use							End-of-life				Benefits & Loads Beyond System Boundary
	A1-A3	A4	A5 – Installation		B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
			Brick wastage	Mortar												
GWP (kg CO_2 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
ODP (kg CFC-11 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
AP (kg SO_2 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
EP (kg N eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
SF (kg O_3 eq)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
ADPF (MJ)					0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					

Table 25

LCIA results table – Clay pavers

Impact category	Production	Construction			Use							End-of-life				Benefits & Loads Beyond System Boundary
	A1-A3	A4	A5 – Installation		B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
			Brick wastage	Mortar												
GWP (kg CO_2 eq)					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
ODP (kg CFC-11 eq)					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
AP (kg SO_2 eq)					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
EP (kg N eq)					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
SF (kg O_3 eq)					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
ADPF (MJ)					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					

In each table, results for Module A5 for the baseline product shall be broken out and reported in the indicated columns. This is to allow the end user to better understand the contributions of both the clay masonry product and the mortar (or sand) to the overall reported impacts.

Immediately after the presentation of results in the EPD, the following statements shall be presented:

> *"Results in the above table for Modules A1-A3 and A4 reflect the manufacture and transportation to the job site of the clay masonry product only. Beginning with Module A5 installation, the remaining columns reflect the impacts of the masonry product within the construction works, and thus consider the presence of mortar, etc."*
>
> *"Results in the preceding table reflect the life cycle impacts associated with the baseline product only. Impacts for other products in the EPD can be determined using a conversion factor. To determine the results for another product simply multiply the impacts in the above table by the appropriate conversion factor as follows:*
>
> - *Where applicable, multiply the results from the mortar column (under Module A5) by the mortar conversion factor.*
> - *Multiply all non-mortar column results by the applicable clay masonry product conversion factor for that product."*

9.5.1.1 Clay brick and structural clay tile conversion factors

A conversion factor is a product-specific value that can be used to scale the results reported for the category baseline to those that reflect the environmental performance for that product. A conversion factor shall be calculated for every product in the EPD, except for the product(s) that serve as the baseline(s). For clay brick and structural clay tile products, conversion factors shall be calculated for both the brick and the mortar used, per functional unit. Calculated values shall be reported in Table 19 for each individual clay masonry product evaluated in the EPD.

The brick conversion factor for clay brick and structural clay tile shall be calculated as follows (dimensions in cm):

$$PM = [10{,}000/(H + 0.95\ \text{cm})(L + 0.95\ \text{cm})] \times mass$$

$$\text{brick conversion factor} = PM_{(product)}/PM_{(baseline)}$$

where:

PM = product mass per functional unit (kg/m^2)
H = height of product (cm)
L = length of product (cm)
$mass$ = mass of product (kg)

Additionally, the mortar conversion factor for each clay brick and structural clay tile can be calculated using the dimensions of the product. The mortar conversion factor for clay brick and structural clay tile products shall be calculated as follows:

$$\text{mortar mass} = 10{,}000 \times [1 - (H \times L)/(H + 0.95\ \text{cm})(L + 0.95\ \text{cm})] \times W \times \text{density (kg/m}^3) \times 1\ \text{m}^3/(1{,}000{,}000\ \text{cm}^3_{(mortar)})$$

$$\text{mortar conversion factor} = \text{mortar mass}_{(product)}/\text{mortar mass}_{(baseline)}$$

where:

H = height of product (cm)
L = length of product (cm)
W = width of product (cm)
$density_{(mortar)}$ = mortar mass/volume (kg/m^3) (default value of 1,944.4 kg/m^3 may be used)

9.5.1.2 Thin brick conversion factors

For thin brick products, conversion factors shall be calculated for both the thin brick and the mortar used, per functional unit. Calculated values shall be reported in Table 20 for each individual thin brick product evaluated in the EPD.

The brick conversion factor for thin brick shall be calculated as follows (dimensions in cm):

$$PM = [10{,}000/(H + 0.95\ cm)(L + 0.95\ cm)] \times mass$$

$$\text{brick conversion factor} = PM_{(product)}/PM_{(baseline)}$$

where:

PM = product mass per functional unit (kg/m^2)
H = height of product (cm)
L = length of product (cm)
$mass$ = mass of product (kg)

Additionally, the mortar conversion factor for each thin brick product shall be calculated using the dimensions of the specific product. The mortar conversion factor for thin brick shall be calculated as follows:

$$\text{mortar mass} = (10{,}000 \times [1 - (H \times L)/(H + 0.95\ cm)(L + 0.95\ cm)] \times W + 3{,}175\ cm) \times \text{density (kg/m}^3) \times 1\ m^3/(1{,}000{,}000\ cm^3)$$

$$\text{mortar conversion factor} = \text{mortar mass}_{(product)}/\text{mortar mass}_{(baseline)}$$

where:

H = height of product (cm)
L = length of product (cm)
W = width of product (cm)
$density_{(mortar)}$ = mortar mass/volume (kg/m^3) (default value of 1,944.4 kg/m^3 may be used)

Note. For the thin brick, the mortar mass calculation must account for the bedding mortar. A value of 3,175 is added to the volume to account for the 0.32 cm ($^1/_8$ in.) × 1 m^2 layer of mortar on the bed side of the thin brick.

9.5.1.3 Clay brick paver conversion factors

For clay brick paver products, a single conversion factor shall be calculated for the clay brick paver used, per functional unit. Though sand fills the joints between clay brick pavers similar to mortar for vertical applications, sand was found to have negligible impacts to the LCA and it is excluded from the functional unit. Calculated values shall be reported in Table 21 for each individual clay brick paver product evaluated in the EPD.

The clay brick paver conversion factor shall be calculated as follows:

$PM = 10{,}000/(W + 0.32\ \text{cm})(L + 0.32\ \text{cm})] \times mass$

clay brick paver conversion factor = $PM_{(product)}/PM_{(baseline)}$

where:

PM = product mass per functional unit (kg/m^2)
L = length of product (cm)
W = width of product (cm)
mass = mass of product (kg)

9.5.2 LCA Results from the LCI

Per ISO 21930:2017 [1] Clause 9.5.2, and Sections 7.2.10, and 7.2.12 through 7.2.14 of this PCR for each information module.

LCI shall be reported for each baseline product defined in Section 9.5.1.

9.6 Declaration of additional environmental information

Per ISO 21930:2017 [1] Clause 9.6, with additional guidance from Sections 8.2 and 8.3 of this PCR.

10 Project report

Per ISO 21930:2017 [1] Clause 10, with the following addition.

EPDs for clay masonry products that are developed using a verified software tool do not need an individual project report for each EPD. Instead, the underlying project report for the software tool may serve as the project report for the EPD.

11 Verification and validity of an EPD

Per ISO 21930:2017 [1] Clause 11, with the following additions.

EPD calculations completed by software systems are permitted provided the software has been verified in a process similar to that of the verification of an EPD. The process used to verify the software calculations should be publicly accessible and referenced from the EPD. When a product-specific EPD is aligned with an industry-average EPD, the following additional item is required.

In order to evaluate the consistency of results between product-specific EPDs and industry-average EPDs the same LCA background data set and characterization model shall be used to create the EPD; EPDs shall be recalculated when any of the following conditions apply:

- an EPD shall be recalculated when changes to manufacturing practices are reasonably expected to result in a significant change (greater than 5%) to the EPD results
- an EPD shall be recalculated when its period of validity is complete or when updates to the PCR result in significant changes (greater than 5%) to the EPD results

- significant changes are an increase or decrease of GWP 100, AP, EP or POCP by greater than 5% of previously reported result.

12 References

12.1 ISO standards

ISO 14021/AMD1, *Environmental Labels and Declarations – Self-declared Environmental Claims (Type II Environmental Labeling)* [1]

ISO 14067:2018, *Greenhouse Gases – Carbon Footprint of Products – Requirements and Guidelines for Quantification* [1]

ISO 14050:2009, *Environmental Management – Vocabulary* [1]

ISO 14071, *Environmental management – Life cycle assessment – Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006* [1]

ISO 15686-7:2017, *Buildings and constructed assets – Service life planning, Parts -1, -2, -7 and -8* [1]

12.2 Other references

ACLCA, *Assessing Data Quality of Background Life Cycle Inventory (LCI) Datasets* (2022) [3]

ACLCA, *Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017* (2019) [3]

EN 15804:2012+A1:2013, *Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products*, January 2012 [18]

FTC, *Green Guides* [19]

Greenhouse Gas Protocol, *Product Life Cycle Accounting and Reporting Standard* [20]

Intergovernmental Panel on Climate Change (IPCC) [17]

US EPA, *Municipal Solid Waste, 2018 Fact and Figures Fact Sheet* (2020) [13]

US EPA, *Waste Reduction Model, version 16* (2023) [21]

[19] Federal Trade Commission. 600 Pennsylvania Avenue, NW, Washington, DC 20580. <ftc.gov>

[20] World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). <ghgprotocol.org>

[21] <EPA.gov/waste-reduction-model>

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Annex A

Default data sources (Version 1, July 2025)

A.1 Materials

Category	Material/Process	Dataset name	Geography	Year	Reference
materials	clay and shale	• A dataset was generated to evaluate the amount of diesel used to mine clay and shale using primary data. The value stated here is averaged from similar mining processes. • 0.765 L of diesel per st of wet material mined • also include 1 st of *"Inputs from Nature – Clay"*	US	2023	primary data
	ash, furnace bottom ash	• ash, from combustion of straw (GLO) • market for ash, from combustion of straw • cut-off, U	GLO	2021	Ecoinvent 3
	grog (externally sourced fired, crushed materials)	• rock crushing (RoW) • rock crushing • cut-off, U	ROW	2021	Ecoinvent 3
additives	pigments, primary	• manganese dioxide (GLO) • market for manganese dioxide • cut-off, U	GLO	2021	Ecoinvent 3
		• chromite ore concentrate (RoW) • chromite ore concentrate production • cut-off, U	GLO	2023	Ecoinvent 3
	body additives (e.g. barium carbonate)	• barium carbonate (GLO) • market for barium carbonate • cut-off, U	GLO	2021	Ecoinvent 3
	sand	• sand (RoW) • market for sand • cut-off, U	ROW	2021	Ecoinvent 3
support materials	hydrated lime	• lime, hydrated, packed (RoW) • market for lime, hydrated, packed • cut-off, U	ROW	2021	Ecoinvent 3

Category	Material/Process	Dataset name	Geography	Year	Reference
support materials	limestone	limestone, at mine/US	US	2015	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/49e563d8-0cea-3f97-96b8-15787be48b91>
	sodium bicarbonate	• sodium bicarbonate (RoW) • market for sodium bicarbonate • cut-off, U	ROW	2021	Ecoinvent 3
	white mineral oil	white mineral oil, at plant/RNA	NA	2011	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/874dc726-50f1-300b-958f-9335fd1c53cd>
packaging	straps, plastic	polypropylene resin, at plant/ RNA	NA	2013	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/2e8facf6-46aa-4ddb-95de-a4e2a00eb2bb>
	straps, steel	steel, stainless 304, flat rolled coil/kg/RNA	NA	2014	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/49f5324b-fc33-36e9-b5af-3c80d73492bd>
	strips/dividers, paper	paper, freesheet, uncoated, average production, at mill/kg/RNA	NA	2014	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/732a5578-1750-3738-b0f2-607106574358>
	strips/dividers, wood	pulpwood, hardwood, average, at forest road, NE-NC/ m3/RNA	NA	2010	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/bada054f-b912-3251-96c1-19e64cde8930>

Category	Material/Process	Dataset name	Geography	Year	Reference
packaging	wooden pallets	pulpwood, hardwood, average, at forest road, NE-NC/ m3/RNA	NA	2010	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/bada054f-b912-3251-96c1-19e64cde8930>

Note. GLO = global, NA = North America, RoW = rest of world

A.2 Resources/energy

Category	Material/Process	Dataset name	Geography	Year	Reference
water	water, from public utility	• tap water (RoW) • market for tap water • cut-off, U	ROW	2021	Ecoinvent 3
	water, from natural source (e.g. groundwater well)	water (well water) (input from nature)	—	—	Ecoinvent 3
electricity	public utility – US	Most recent USLCI dataset for US regional eGRIDs are from 2010. To make these datasets more accurate, the energy mix composition should be updated using EPA data. [a] Select the USLCI dataset for your region, then update the energy mix using the 2023 data above.	US, regional	2023	<lcacommons.gov>
	public utility – outside of US	Ecoinvent 3 regional electrical grids	varies	varies	Ecoinvent 3

Category	Material/Process	Dataset name	Geography	Year	Reference
electricity	on-site solar/PV	• electricity, low voltage (RoW) • electricity production, photovoltaic, 3 kWp flat-roof installation, multi-Si • cut-off, U	ROW	2021	Ecoinvent 3
primary fuels	diesel, conventional and low-sulfur AND Light fuel oil	diesel, combusted in industrial equipment/US	US	2013	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/d6ad7035-5498-3237-8abd-50e93b1eef89>
	gasoline	gasoline, combusted in equipment/US	US	2008	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/d3e13675-1455-375f-a557-bb8234de75ff>
	propane	liquefied petroleum gas, combusted in industrial boiler/US	US	2008	<lcacommons.gov>
	natural gas	natural gas, combusted in industrial boiler/US	US	2008	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/f347daea-82be-4e62-8872-a0dc0ca24ca3>
	hard coal	bituminous coal, combusted in industrial boiler/US	US	2008	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/26465530-69ff-3c68-834f-c67ccb6ee1b2>

Note. RoW = rest of world, US = United States

[a] <EPA.gov/egrid>

A.3 Other data

Category	Material/ Process	Dataset name	Geography	Year	Reference
transportation	truck transportation	transport, combination truck, average fuel mix/US	US	2008	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/dce702f1-03a1-3fe9-bb48-94a5217fd8cb>
	rail transport	transport, train, diesel powered/US	US	2008	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/7de9c230-fd0f-3478-be87-f80181132faa>
	waste transportation	transport, refuse truck, diesel powered/tkm/ RNA	NA	2011	<lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/dataset/PROCESS/16d56c2f-7a14-33c1-863d-baecbc1b5170>
installation	mortar	• cement mortar (RoW) • cement mortar production • cut-off, U	ROW	2018	Ecoinvent 3
	water for mortar	• tap water (RoW) • market for tap water • cut-off, U	ROW	2021	Ecoinvent 3
	sand for installation	• sand (RoW) • market for sand • cut-off, U	ROW	2021	Ecoinvent 3
	brick waste at installation	• waste brick (RoW) • treatment of waste brick, collection for final disposal • cut-off, U	ROW	2016	Ecoinvent 3

Category	Material/Process	Dataset name	Geography	Year	Reference
cleaning	cleaning agent	• hydrochloric acid, without water, in 30% solution state (RoW) • market for hydrochloric acid, without water, in 30% solution state • cut-off, U	ROW	2023	Ecoinvent 3
	sand	• sand (RoW) • market for sand • cut-off, U	ROW	2021	Ecoinvent 3
	water for cleaning	• tap water (RoW) • market for tap water • cut-off, U	ROW	2021	Ecoinvent 3
non-hazardous waste	non-hazardous waste to municipal solid waste	• municipal solid waste (RoW) • treatment of municipal solid waste, sanitary landfill • cut-off, U	ROW	2021	Ecoinvent 3
	brick waste at end-of-life	• waste brick (RoW) • treatment of waste brick, collection for final disposal • cut-off, U	ROW	2016	Ecoinvent 3
	wastewater	• wastewater, average (RoW) • treatment of wastewater, average, wastewater treatment • cut-off, U	ROW	2021	Ecoinvent 3
	wastewater	• wastewater, average (RoW) • treatment of wastewater, average, wastewater treatment • cut-off, U	ROW	2021	Ecoinvent 3
	plastic landfilling	• waste plastic, mixture (RoW) • treatment of waste plastic, mixture, sanitary landfill • cut-off, U	ROW	2023	Ecoinvent 3
	paper and wood landfilling	• waste paperboard (RoW) • treatment of waste paperboard, sanitary landfill • cut-off, U	ROW	2023	Ecoinvent 3
incineration	plastic incineration	• waste plastic, mixture (GLO) • treatment of waste plastic, mixture, municipal incineration • cut-off, U	ROW	2023	Ecoinvent 3
	paper and wood incineration	• waste paperboard (GLO) • treatment of waste paperboard, municipal incineration • cut-off, U	ROW	2023	Ecoinvent 3

Category	Material/Process	Dataset name	Geography	Year	Reference
hazardous waste	hazardous waste to incineration	• hazardous waste, for incineration (RoW) • treatment of hazardous waste, hazardous waste incineration • cut-off, U	ROW	2021	Ecoinvent 3
recovery	recovered brick	• gravel, round (RoW) • gravel and sand quarry operation • cut-off, U	ROW	2018	Ecoinvent 3

Note. GLO = global, NA = North America, RoW = rest of world, US = United States

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Annex B

Reference service life literature references

Physical observation of what are considered "historic" masonry buildings in the US provide evidence of brick having a service life of over 150 yr. The evidence of longer lasting brick structures is even more apparent in Europe and throughout the world.

Environdec EPDs for clay brick products [22]

- Several EPDs listed define the RSL as 150 yr.

"Maintenance of Brick Masonry," Technical Notes on Brick Construction #46, Brick Industry Association [10]

- This publication lists the estimated time to repair for brick walls as 100 to 150+ yr.

Hamid, Ahmad A. and Schuller, Michael. *Assessment and Retrofit of Masonry Structures*. Longmont: The Masonry Society, 2019 [23]

- This book lists a service life of 100 to 150 yr for clay brick walls.

"Building Envelope Design Guide: Masonry Wall Systems," National Institute of Building Sciences, 2011 [24]

- This publication lists a service life for brick veneer of 150+ yr.

"Home Equity Study of Life Expectancy of Home Components," National Association of Home Builders/Bank of America, February 2007 [25]

- This publication indicates that brick walls have an average life expectancy of more than 100 yr.

"Clay Brick End-of-life Cycle: General Guide," Brick Development Association (UK), 2023 [26]

- This publication lists a service life of over 150 yr.

"Created by Nature, Built to Last," Clay Brick Association (South Africa) [27]

- This publication gives examples of clay brick structures that are over 150 yr old; in several cases over 200 yr old.

[22] EPD International System. <environdec.com/library>

[23] The Masonry Society. 2629 Redwing Road, Suite 136, Fort Collins, CO 80526. <masonrysociety.org>

[24] National Institute of Building Sciences. 2121 K Street NW, Suite 800, Washington, DC 20037. <nibs.org>

[25] National Association of Home Builders. 1201 15th Street, Washington, DC 20005. <nahb.org>

[26] Brick Development Association. Commerce House, Festival Park, Stoke-on-Trent, ST1 5BE United Kingdom. <brick.org.uk>

[27] Clay Brick Association. 22, 15a Riley Road, Bedfordview, Germiston, 2008 South Africa. <www.claybrick.org>

"Exterior Walls, Volume 2 of the Rehab Guide," Partnership for Advancing Technology in Housing (PATH), 1999 [28]

- This publication states that "Brick and stone masonry are among the oldest, long-lasting, and most versatile materials. Throughout the US, many brick homes, centuries old, continue to perform well." And that "the service life of many bricks exceeds 100 yr."

"Brick Construction Lasts for Centuries," Ziegelindustrie International (Brick and Tile Industry International), Issue 03/2024 [29]

- This article references a German study that showed that German residential buildings over 70 yr old are largely made of masonry brick.

[28] Partnership for Advancing Technology in Housing, US Department of Housing and Urban Development. 451 7th Street SW, Washington, DC 20410. <huduser.gov>

[29] ZI 03/2024. <zi-online.info>

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