BRICKWORKS

Clay Bricks and Pavers from Austral Bricks

Golden Grove, South Australia

Environmental Product Declaration
In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021

Programme: The International EPD® System www.environdec.com
Programme operator: EPD International AB
Regional Programme: EPD Australasia www.epd-australasia.com
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Date of issue: 2024-11-26 | Valid until 2029-11-26
Geographical scope: Australia

EPD of brick products from Golden Grove manufacturing facility, based on average results. An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.epd-australasia.com

EPD® THE INTERNATIONAL EPD® SYSTEM
EPD® AUSTRALASIA ENVIRONMENTAL PRODUCT DECLARATION

ECO PLATFORM EPD VERIFIED

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Disclaimer
EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

Program Information and Verification

An Environmental Product Declaration (EPD) is a standardised way of quantifying the potential environmental impacts of a product or system. EPDs are produced according to a consistent set of rules – Product Category Rules (PCR) – that define the requirements within a given product category. These rules are a key part of ISO 14025 as they enable transparency and comparability between EPDs.

This EPD is a "cradle-to-gate plus modules C1-C4, D" declaration covering production and end-of-life life cycle stages.

Brickworks Ltd, as the EPD owner, has the sole ownership, liability, and responsibility for the EPD.

Declaration Owner	Address: 738-780 Wallgrove Road, Horsley Park, NSW, 2175 Web: www.brickworks.com.au Phone: 13 27 43 Email: info@brickworks.com.au
EPD Program Operator and Regional Program	EPD International AB Box 210 60, SE-100 31 Stockholm, Sweden, E-mail: info@environdec.com EPD Australasia Limited Address: 315a Hardy Street Nelson 7010, New Zealand Web: www.epd-australasia.com Email: info@epd-australasia.com Phone: +61 2 8005 8206 (AU)
LCA/EPD Produced by:	Rob Rouwette, ERM Energetics Address: Lvl 7, 5 Blue St, North Sydney, NSW 2060 Australia Phone: 02 9929 3911 Email: rob.rouwette@energetics.com.au
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CEN standard EN 15804 serves as the Core Product Category Rules (PCR)

PCR	PCR 2019:14 Construction Products, Version 1.3.4, 2024-04-30 (valid until 2025-06-20)
PCR review was conducted by:	The Technical Committee of the International EPD® System. See www.environdec.com for a list of members. Most recent review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Independent verification of the declaration and data, according to ISO 14025:	■ EPD verification by individual verifier
Third party verifier: Approved by EPD Australasia Ltd	Sazal Kundu, Edge Impact Address: Level 5, 39 East Esplanade, Manly NSW 2095, Australia Web: https://www.edgeimpact.global/ Phone: +61 2 9438 0100 Email: sazal.kundu@edgeimpact.global
Procedure for follow-up of data during EPD validity involves third party verifier	☐ Yes ■ No

About Us

Brickworks is one of Australia's largest and most diverse building material manufacturers.

Brickworks has been transformed from originally a NSW state-based operation to an International organisation with manufacturing operations in New South Wales, Victoria, Tasmania, South Australia, Queensland and North America.

Austral Bricks is the subsidiary of Brickworks that manufactures and sells Australian made and imported clay bricks and pavers. Austral Bricks holds multiple ABN's in each state, and multiple brands including Daniel Robertson, Bowral Bricks and Nubrik.

Clay brick products are mainly used in residential and commercial construction. By adding oxides and coloured sands to the mix of raw materials, products with contemporary colours, textures and appeal can be produced in Australia. Brickworks manufactures brick products in seven brick plants, located in New South Wales (3), Queensland (1), Tasmania (1), South Australia (1) and Victoria (1) (see Figure 2).

This EPD covers all brick products produced at our Golden Grove, South Australia location which manufactures products underneath our Austral Bricks brand.

Owner of the EPD: Brickworks Limited
Contact: info@brickworks.com.au

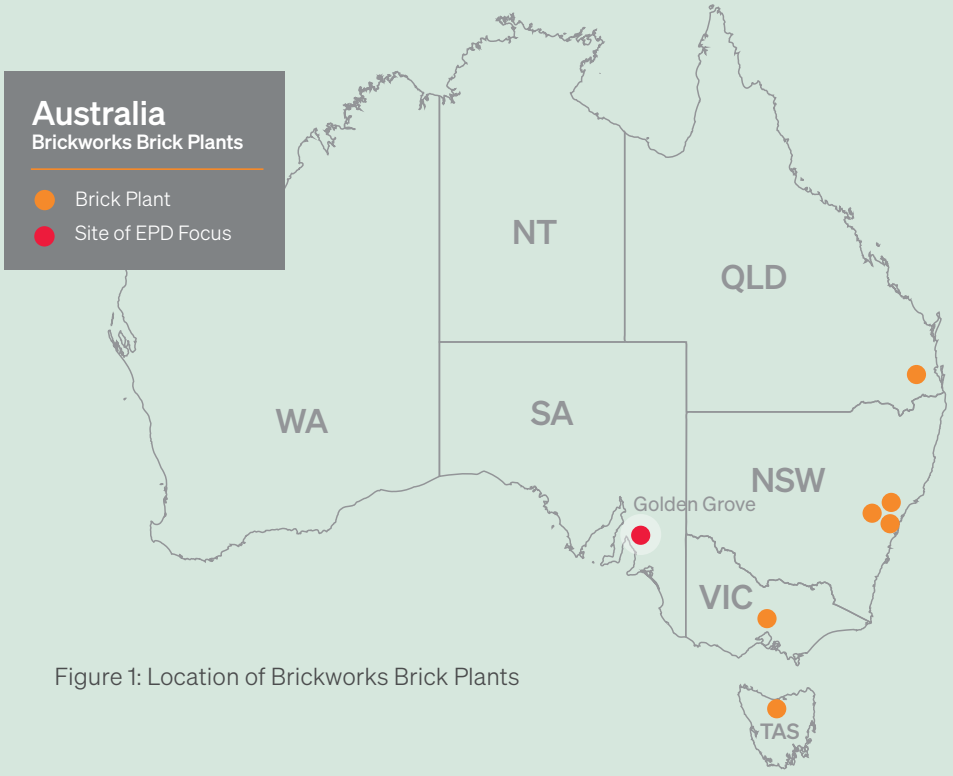


Figure 1: Location of Brickworks Brick Plants

Our Products

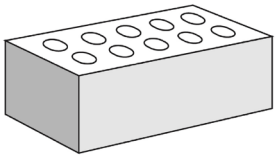
The manufacturing process for bricks and pavers is identical and for the purpose of this document, pavers may be referred to as bricks. The life cycle starts with mining clay and shale and mechanically processing it prior to shaping and firing the bricks in kilns fuelled predominantly by natural gas.

Clay bricks are used in construction; typically walling systems, planter boxes, etc. Clay pavers are used in paving and landscaping applications.

This EPD covers all brick and paver products produced across Golden Grove including the Austral Bricks brand.

Figure 2 - Typical brick and paver product sizing and available ranges (Source: Brickworks)

Bricks

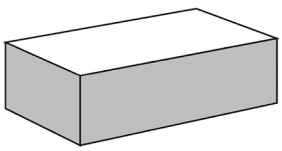


230L x 110W x 76H mm 10 Hole

Available Ranges:
Austral Bricks: Everyday Life, Symmetry, Urban One, Archetype, Archetype Warm, Festival, Fringe, Lumia, Russell Collection

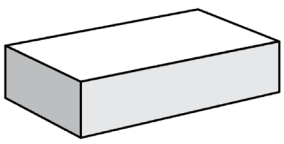
100 YEAR
PRODUCT WARRANTY

Pavers



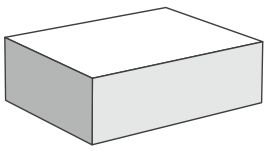
230L x 76W x 65H mm

Available Range:
Austral Bricks: Picollo Pavers



230L x 114W x 50H mm

Available Ranges:
Austral Bricks: Earth 50, Laneway, Heritage Pavers



230L x 114W x 65H mm

Available Ranges:
Austral Bricks: Earth 65

Content Declaration

Bricks may have unique characteristics such as shape, colour and dimensions, but in essence all brick products are made from clay. Minor additives are used to influence appearance (e.g. colour, glazing).

According to EN 15804, the declaration of material content of the product shall list, as a minimum, substances contained in the product that are listed in the "Candidate List of Substances of Very High Concern (SVHC) for authorisation" when their content exceeds 0.1% of the weight of the product. SVHC are listed by European Chemicals Agency and includes the Candidate List of SVHC (ECHA 2024). Clay bricks do not contain any substances included on the Candidate List of SVHC (exceeding 0.1% in mass).

Table 1: Product content declaration for bricks produced at Golden Grove

Ingredient	Weight (kg/t of bricks)	Post-consumer recycled material, weight % of product	Biogenic material, weight % of product	Biogenic material (kgC/t of bricks)
CLAY	>989	0%	0%	0
ADDITIVES	<11	0%	0.364%	1.53
TOTAL	**1000**	**0%**	**0.364%**	**1.53**

Our products may contain recycled content, however, in line with reporting requirements outlined in the PCR, the above table indicates 0% post-consumer recycled material where we cannot guarantee whether the origin of recycled material is pre-consumer or post-consumer.

Packaging materials

Table 2: Product content declaration for brick packaging

Packaging	Weight (kg/t of bricks)	Weight-% (versus the product)	Biogenic material (kg C/product or declared unit)
POLYPROPYLENE (PP) STRAPS	0.01	0.0011%	0
LDPE PACKAGING FILM	0.46	0.046%	0
TIMBER PALLETS	22.6	2.26%	10.25
TOTAL	**23.1**	**2.31%**	**10.25**


EDS

Technical Compliance

Brickworks brick products are manufactured to Australian Standard AS/NZS 4455 and AS 3700.

Product quality testing is performed in accordance with AS/NZS 4456.

Further details on product use and design for different applications can be found on Brickworks' website and more specifically our bricks product page and product information page[1].

Brick products are classified under:

- UN CPC 37350 - Non-refractory ceramic building bricks, flooring blocks, support or filler tiles, roofing tiles, chimney-pots, cowls, chimney liners, architectural ornaments and other ceramic construction goods
- ANZSIC 2021 - Clay Brick Manufacturing

Declared Unit

Bricks and pavers are available in various shapes and sizes that are specifically designed for different styles and applications. The declared unit that covers all the permutations within the scope of the products included in this EPD is:

1 tonne (1,000 kg) of brick products including brick and pavers.

A reference service life (RSL) is not declared, as the EPD does not cover the full life cycle.

[1] https://www.brickworks.com.au/products/#clay-bricks-and-pavers

Product Life Cycle
Overview

The EPD covers the cradle-to-gate with modules C1–C4 and module D (A1–A3, C and D) life cycle stages. Intermediate life cycle stages (Modules A4, A5 and B1-B7) have not been included as these are better defined at building or structure level.

Table 3: Scope of the EPD

Stages	Product stage			Construction stage		Use stage							End-of-life stage				Benefits beyond system boundary
	Raw Materials	Transport	Production	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential
Modules Declared	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	✓	✓	✓	ND	ND	ND	ND	ND	ND	ND	ND	ND	✓	✓	✓	✓	✓
Geography	AU	AU	AU										AU	AU	AU	AU	AU
Share of specific date		88%															
Variation products		<14%															
Variation sites		0%															

✓ = module is included in this study

ND = module is not declared. When a module is not accounted for, the stage is marked with “ND” (Not Declared). ND is used when we cannot define a typical scenario.

Product Stages (A1-A3)

Stage A1 – raw material extraction

The key raw material for clay bricks is obviously clay, which is extracted in quarries. Typically, various types of clay are mixed and additives and/or oxides are added to achieve desired product characteristics. Additives and oxides can consist of mineral elements, chemicals, char, etc. They are used to achieve product colours and glazing textures.

Stage A2 – transportation

Clay, additives and oxides are transported to our sites by truck. Clay is usually extracted in close proximity to the brick plant. Additives and oxides may be sourced locally or from overseas suppliers. Shipping to Australia is included where relevant. Internal transport occurs within the brick plants' core process and is included in stage A3 as it cannot always be separated from other core processes.

Stage A3 – manufacturing

Bricks are manufactured by mixing and milling the core ingredients so that they can be extruded in the required shape and dimension. Additives and oxides may be applied on the surface to achieve desired aesthetics. The bricks are dried before they are fired in tunnel kilns. Fired bricks are cooled in a controlled process before they are packaged and stored for transport to the customer.

End-of-life stage (C1-C4)

The end-of-life modules for bricks are based on generic scenarios. For bricks, we have used an Australian average end-of-life scenario representative for building & demolition materials. The scenario is based on the National Waste Report 2022 (NWR 2022). This scenario implies that 79.6% of the bricks are recycled and the remaining 20.4% of the bricks are sent to landfill. The scenarios included are currently in use and are representative for one of the most probable alternatives.

Details for the end-of-life scenario have been captured in table 4 hereafter.

Deconstruction / demolition (C1)

Module C1 covers demolition of the bricks at the end of their service life. Diesel consumption of demolition equipment is included.

Transport to waste processing (C2)

Module C2 comprises the transport from the demolition site to a recycling centre or landfill site. Transport is assumed to occur by truck over a one-way distance of 50km.

Waste processing (C3)

Module C3 encompasses the recycling process (i.e. crushing of concrete). Diesel consumption and electricity use of the crushing process is included.

The bricks collected for recycling reach end-of-waste status when they are crushed and stockpiled as "recycled crushed brick" aggregates. Crushed bricks are assumed to substitute primary (quarried) material without needing further processing (in module D).

Disposal (C4)

Module C4 represents disposal of bricks in a landfill site. A generic process for disposal of inert material in landfill is used to model the impacts.

Resource recovery stage (D)

Module D includes any benefits and loads from net flows leaving the product system (that have passed the end-of-waste state). For this EPD, any material collected for recycling and processed in Module C3, is considered to go through to Module D. We have assumed that recycled crushed brick aggregates (the output of module C3) replace virgin aggregates (crushed rocks) in module D. Per tonne of bricks, module D credits the avoided impacts for 798 kg of crushed aggregates[2]. See table 5 for further details on module D

[2] based on the National Waste Report 2022 (NWR 2022); table 37 building & demolition materials, Australian average

Figure 3: Flow diagram of the life cycle of brick products

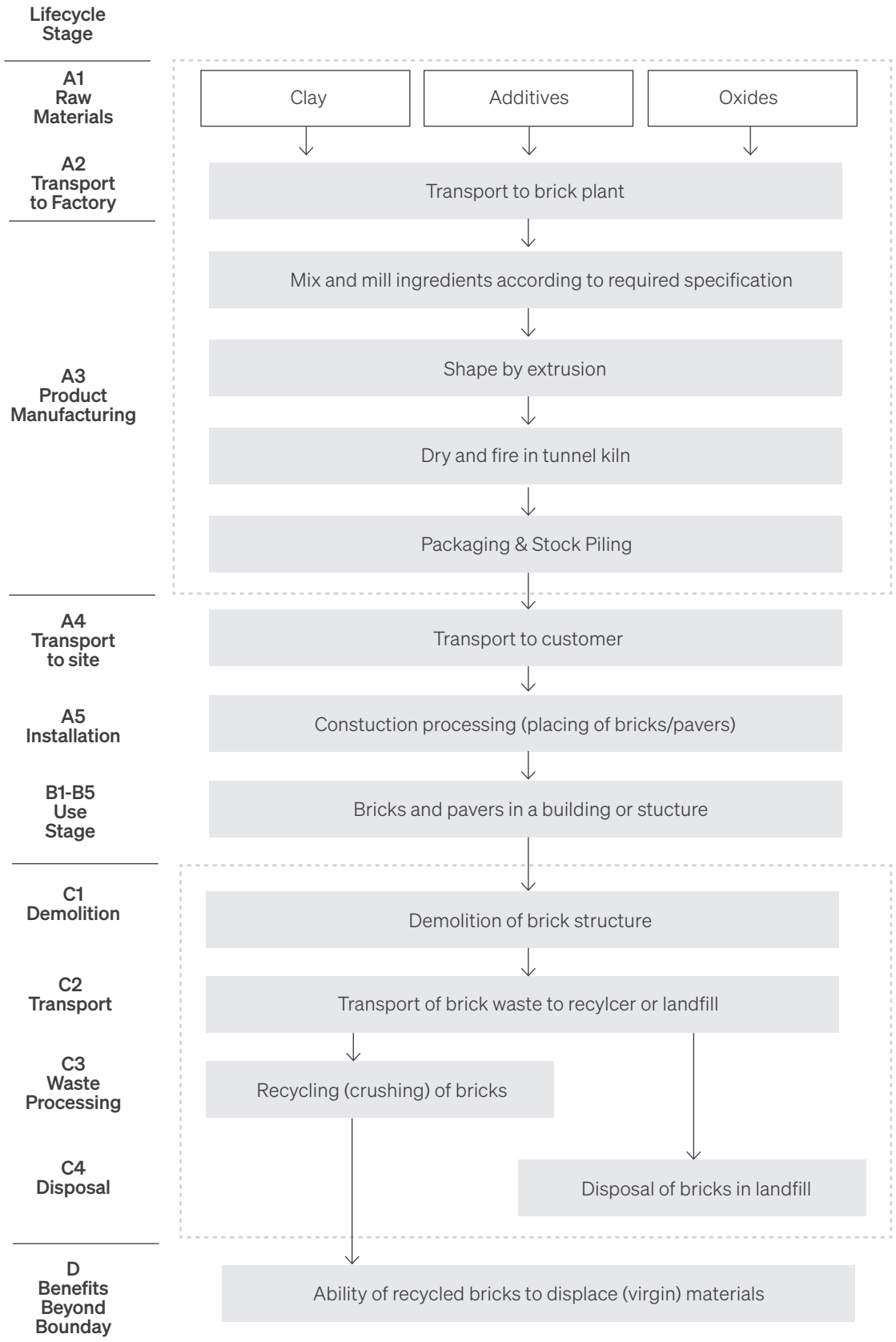


Table 4: End-of-life scenario of bricks, per tonne

Processes	Quantity	Unit
Collection process specified by type	1,000	kg collected separately
	0	kg collected with mixed construction waste
Transport from demolition site to recovery/ disposal sites	50	km transport (transport, truck, 16-28t, fleet average/AU U)
Recovery system specified by type	0	kg for re-use
	798	kg for recycling (recycling brick rubble and concrete, at plant/AU U)
	0	kg for energy recovery
Disposal to landfill	202	kg product or material for final deposition (disposal, concrete, 5% to inert material landfill/CH U/ AusSD U)
Assumptions for scenario development		61.7 MJ/tonne of diesel for the demolition process (C1)
		38 MJ/ tonne of diesel for the crushing process (C3) +
		4 MJ/ tonne of electricity for the crushing process (C3)

Table 5: Assumptions relating to Module D of brick products

Parameter	Unit / effect
$M_{MR\ out}$ = 79.8%	Amount of bricks exiting the system that will be recycled in a subsequent system
$M_{MR\ in}$ = 0%	Amount of recycled input material in the bricks
Y = 100%	the material yield, between point of end-of-waste (M-EoW) in modules A4-C4 and point of substitution (M-DoS) in module D (when the material has been upgraded).
$E_{MR\ after\ EoW\ out}$ = transport + recycling	Specific emissions and resources consumed per unit of analysis arising from material recovery processes of a subsequent system after the end-of-waste state.
$E_{VMSub\ out}$ = virgin materials	Specific emissions and resources consumed per unit of analysis arising from acquisition and pre-processing of the primary material, or average input material if primary material is not used, from the cradle to the point of functional equivalence where it would substitute secondary material that would be used in a subsequent system Virgin materials: Crushed rock (Gravel, crushed, at mine/CH U/AusSD U)
$Q_{R\ out}$	Quality of the outgoing recovered material
Q_{Sub}	Quality of the substituted material
$Q_{R\ out}$ / Q_{Sub} = 1	Quality ratio between outgoing recovered material and the substituted material is assumed to be 1 (equal quality)

Life Cycle Assessment
Methodology

LCA methodology

A background LCA for Brickworks bricks and paver products was conducted by ERM/Energetics and serves as the foundation for this EPD. The methodology for the LCA is detailed below.

Primary and Background Data

Brickworks supplied primary data for the FY22 (1 July 2021 – 30 June 2022) period. Primary data include production volumes at each Austral Bricks plant, product compositions for all brick products, type and quantity of clay, additives and oxides used at site level, energy, water consumption and waste data at site level. Austral Bricks also provided information regarding its upstream value chain (raw materials and supply chain logistics data). Data sets used for calculations have been reviewed and where relevant updated within the last 10 years for generic data and within the last 5 years for producer-specific data.

Background data have predominantly been sourced from AusLCI (v1.42), the AusLCI shadow database (based on ecoinvent v2) and ecoinvent v3.9.1:

- Clay extraction data are based on primary data from Brickworks, where they extract the clay from Brickworks owned quarries, or AusLCI data where the clay is supplied by external parties. The effect of clay extraction on the LCA results is minimal.\
- Life cycle inventory (LCI) data for additives and oxides are based on proxy data from the AusLCI (shadow) database. Brickworks uses a large variety of additives and oxides, and high-quality LCI data are often not available for the specific materials used.
- LCI data for frit have been sourced from ecoinvent v3.9.1.

The majority of environmental impacts are caused by the energy consumption in the brick production process. Combustion of natural gas (or wood waste in Longford) and electricity consumption are the largest contributors to the footprint of bricks. As a result, the share of specific data in this LCA is relatively high.

Methodological choices have been applied in line with EN 15804 and any deviations have been recorded.

Allocation

The materials, products, and processes in the life cycle of brick products that require allocation are:

- Production of various brick products: Brickworks manufactures a range of brick products. Energy use for brick production has been allocated to the products based on their share in the total mass of production. This is considered to be the most appropriate allocation, since kiln energy is mainly driven by the mass throughput.
- Landfill: landfill is a multi-input process. Physical causality has been used to allocate emissions in landfill.

Cut-off Criteria

Where possible (i.e. for which data are available), all inputs and outputs to a process have been included. The cut-off criteria applied are 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of a process.

The materials and processes that have been excluded are:

- Greases and lubricants, other minor ancillary materials used during brick production.
- Packaging of additives and oxides are also well below the cut-off: Additives make up 0.15% - 2.2% of the mass of the bricks. Packaging of additives (IBCs) is estimated to make up less than 0.01% of total mass inputs and can be reused.
- Oxides make up less than 1% of the mass of the bricks. Packaging of oxides (20 kg lined paper bags) is estimated to make up less than 0.01% of total mass inputs.

The total (cumulative) of neglected input flows for the cradle-to-gate stages is well below 5% of energy usage and mass (the exact percentage has not been determined).

The contribution of capital goods (production equipment and infrastructure) and personnel is excluded, as these processes are non-attributable, reasonable data for capital goods are not readily available, and they contribute less than 10% to GWP-GHG.

Overhead energy use (e.g. for offices) at manufacturing sites could not be distinguished from process energy use and is therefore included in the LCA. This represents a conservative approach.

Calculation of averages

The environmental impacts are representative for all brick and paver products manufactured in Golden Grove. The environmental profile presented in this EPD is calculated as the weighted average across all products made at the site.

Key assumptions

The following key assumptions have been made:

- The average brick composition is determined at site level.
- Production waste tonnage is measured at site level and attributed evenly to products by mass.
- For additives and oxides, the mode of transport to sites was not always provided. Energetics has included transport modes for these raw materials based on assumptions. These assumptions have no material impact on the LCA results.
- Brickworks uses various oxides to colour the bricks. Brickworks has confirmed that all of their oxides are ferrous oxides. Brickworks has indicated iron ore is the best fit to model ferrous oxides. If other data sets are used, or if other minerals are used, then this could have an impact on the results.

Electricity

- Electricity in core processes has been modelled using adjusted AusLCI data to represent the estimated residual electricity grid mix in Australian states. This is done by removing renewables from the Australian Energy Statistics 2024 data (Table O.6). The GWP-GHG of the electricity is 0.835 kg CO_2e/ kWh. The proxy residual grid mix is made up of natural gas (94.1%), and oil products (5.9%).
- Electricity consumption – and therefore the selection of the electricity grid mix – can have a material impact on the carbon footprint of bricks. Therefore, to facilitate comparisons with other reporting frameworks and EPDs, we present a separate GWP-GHG (IPCC AR5) indicator based on a location-based electricity accounting approach.
- Electricity used in upstream and downstream processes is typically modelled following a location-based approach.

LCA Indicators

An LCA serves as the foundation for this EPD. An LCA analyses the production systems of a product. It provides comprehensive evaluations of all upstream and downstream material and energy inputs and outputs.

The results are provided in a form which covers a range of environmental impact categories using characterisation factors (CFs) based on the "EF 3.1 reference package to be used in in the context of EN 15804.

Table 6: Environmental indicators legend (EN 15804+A2)

Core indicators	Acronym	Unit
Climate change – total	GWP-total	kg CO_2 equivalent
Climate change – fossil	GWP-fossil	kg CO_2 equivalent
Climate change – biogenic	GWP-biogenic	kg CO_2 equivalent
Climate change – land use and land use change	GWP-luluc	kg CO_2 equivalent
Ozone layer depletion	ODP	kg CFC-11 equivalent
Acidification	AP	mol H^+ equivalent
Eutrophication aquatic freshwater	EP-freshwater	kg P equivalent
Eutrophication aquatic marine	EP-marine	kg N equivalent
Eutrophication terrestrial	EP-terrestrial	mol N equivalent
Photochemical ozone formation	POCP	kg NMVOC equivalent
Abiotic depletion potential – minerals and metals[2]	ADP minerals & metals	kg Sb equivalent
Abiotic depletion potential – fossil fuels[2]	ADP fossil	MJ, net calorific value
Water use[2]	WDP	m^3 world equivalent deprived

Table 6: Environmental indicators legend (EN 15804+A2) - continued

Additional indicators	Acronym	Unit
Global Warming Potential – Greenhouse gases	GWP-GHG	kg CO_2 equivalent
Particulate matter emissions	PM	disease incidence
Ionising radiation, human health[1]	IRP	kBq U235 equivalent
Ecotoxicity (freshwater)[2]	ETP-fw	CTUe
Human toxicity, cancer effects[2]	HTP-c	CTUh
Human toxicity, non-cancer effects[2]	HTP-nc	CTUh
Land use related impacts / soil quality[2]	SQP	- (dimensionless)
Additional GHG indicator	**Acronym**	**Unit**
Carbon footprint in line with IPCC AR5	GWP-GHG (IPCC AR5)	kg CO_2 equivalent
Carbon footprint in line with IPCC AR5 – location-based electricity	GWP-GHG (IPCC AR5) (location-based electricity)	kg CO_2 equivalent

1 This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and some construction materials, is also not measured by this indicator.

2 The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

Note regarding various GWP indicators:

GWP-total is calculated using the European Union's Joint Research Centre's characterisation factors (CFs) based on the "EF 3.1 package" for CFs to be used in the EU's Product Environmental Footprint (PEF) framework. CFs listed by JRC are based on the IPCC AR6 method (IPCC 2021) and include indirect radiative forcing, which results in higher numerical Global Warming Potential (GWP) values than the CFs in the internationally accepted (IPCC 2013). The GWP-GHG indicator is identical to GWP-total except that the CFs for biogenic CO2 are set to zero. The GWP-GHG indicator in PCR 2019:14 v1.3.4 (based on EF 3.1) differs from the GWP-GHG in earlier PCR 2019:14 versions (if based on EF 3.0). The "GWP-GHG (IPCC AR5)" indicator is determined using the IPCC AR5 GWPs with a 100-year time horizon (IPCC 2013). This indicator is aligned with Australia's greenhouse gas reporting frameworks, using a market-based electricity accounting approach. The "GWP-GHG (IPCC AR5) (location-based electricity)" indicator is aligned with Australia's greenhouse gas reporting frameworks, using a location-based electricity accounting approach.

Table 7: Legend for parameters describing resource use, waste and output flows

Parameter	Acronym	Unit
Parameters describing resource use		
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ_{NCV}
Use of renewable primary energy resources used as raw materials	PERM	MJ_{NCV}
Total use of renewable primary energy resources	PERT	MJ_{NCV}
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ_{NCV}
Use of non-renewable primary energy resources used as raw materials	PENRM	MJ_{NCV}
Total use of non-renewable primary energy resources	PENRT	MJ_{NCV}
Use of secondary material	SM	kg
Use of renewable secondary fuels	RSF	MJ_{NCV}
Use of non-renewable secondary fuels	NRSF	MJ_{NCV}
Use of net fresh water	FW	m^3
Waste categories		
Hazardous waste disposed	HWD	kg
Non-Hazardous waste disposed	NHWD	kg
Radioactive waste disposed	RWD	kg
Output flows		
Components for re-use	CRU	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ

Table 8: Legend for EN 15804+A1 indicators

Indicator	Acronym	Unit
Global warming potential	GWP	kg CO_2 equivalent
Ozone layer depletion potential	ODP	kg CFC-11 equivalent
Acidification potential	AP	kg SO_2 equivalent
Eutrophication potential	EP	kg PO_4^{3-} equivalent
Photochemical oxidation (Photochemical ozone creation) potential	POCP	kg ethylene equivalent
Abiotic depletion potential - elements	ADPE	kg Sb equivalent
Abiotic depletion potential – fossil fuels	ADPF	MJ_{NCV}

Life Cycle Assessment
Results

The results in the following tables are provided by life cycle module, per declared unit (one tonne of bricks).

The results have been calculated with SimaPro software v9.5.0.0.

Water flows have been disaggregated using the 36 ALCAS water catchments for which characterisation factors are available for both Pfister WSI and the AWARE method.

To separate the use of primary energy into energy used as raw material and energy used as energy carrier, Option B from Annex 3 of PCR 2019:14 has been applied. In option B, the energy used as raw material is declared as an input to the module where it enters the product system (often in module A1) and as an output from the product system if it exits the product system as useful energy (often from modules A5 or C3).

(Note: As module A5 is not declared, balancing has occurred in modules A1-A3.) Energy content that is wasted (e.g. in landfill), remains as part of the indicator for energy used for raw materials, and is not reported as an input of energy used for energy carriers.

Please consider the following mandatory statements when interpreting the results:

- The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.
- The use of the results of modules A1-A3 (A1-A5 for services) without considering the results of module C is discouraged.

Table 9: Environmental impact (EN15804+A2) indicators covering modules A1-A3, C1-C4 and D for average brick production, per tonne

Environmental Indicator	Unit	Module A1-A3	Module C1	Module C2	Module C3	Module C4	Module D
			Core Indicators				
GWP-total	kg CO_2-eq.	2.54E+02	5.30E+00	6.40E+00	3.28E+00	1.47E+00	-7.04E+00
GWP-fossil	kg CO_2-eq.	2.52E+02	5.30E+00	6.40E+00	3.27E+00	1.47E+00	-7.02E+00
GWP-BIOGENIC	kg CO_2-eq.	2.04E+00	3.51E-04	3.96E-04	3.12E-03	1.03E-04	-1.38E-02
GWP-luluc	kg CO_2-eq.	3.28E-03	2.54E-06	3.02E-06	1.52E-06	7.09E-07	-1.08E-06
ODP	kg CFC11-eq.	3.05E-06	8.47E-07	1.01E-06	4.14E-07	2.37E-07	-2.40E-07
AP	mol H+ eq.	7.23E-01	5.82E-02	5.62E-02	9.01E-03	5.98E-03	-2.57E-02
EP-freshwater	kg P eq.	1.03E-03	7.05E-07	3.85E-07	2.43E-06	1.71E-07	-5.06E-06
EP-marine	kg N eq.	2.64E-01	2.53E-02	1.77E-02	1.60E-03	1.54E-03	-4.30E-03
EP-terrestrial	mol N eq.	2.79E+00	2.78E-01	1.94E-01	1.75E-02	1.69E-02	-4.66E-02
POCP	kg NMVOC eq.	7.19E-01	7.42E-02	4.73E-02	4.68E-03	4.24E-03	-1.22E-02
ADP minerals & metals[2]	kg Sb eq.	5.68E-05	6.25E-09	7.43E-09	8.13E-07	1.74E-09	-1.03E-06
ADP fossil[2]	MJ (NCV)	4.06E+03	7.39E+01	8.79E+01	4.67E+01	2.07E+01	-1.01E+02
WDP[2]	m^3 world eq. deprived	4.24E+01	4.67E-01	5.56E-01	4.79E-01	1.31E-01	-4.69E+01
			Additional Indicators				
GWP-GHG	kg CO_2-eq.	2.52E+02	5.30E+00	6.40E+00	3.28E+00	1.47E+00	-7.04E+00
PM	Disease incidence	1.01E-05	1.54E-06	3.16E-07	6.00E-08	1.53E-06	-2.15E-07
IRP[1]	kBq U235 eq.	5.70E-02	1.08E-04	1.28E-04	6.60E-04	3.02E-05	-6.39E-04
ETP-fw[2]	CTUe	1.94E+03	1.64E+01	1.94E+01	8.06E+00	4.55E+00	-4.82E+00
HTP-c[2]	CTUh	1.65E-08	2.05E-10	2.75E-11	6.86E-11	1.01E-11	-3.06E-10
HTP-nc[2]	CTUh	2.71E-06	1.09E-09	5.24E-10	4.47E-10	1.28E-10	-1.93E-09
SQP[2]	-	1.15E+03	3.55E-01	3.95E-01	1.10E+01	1.13E+01	-1.44E+02
			Carbon footprint				
GWP-GHG (IPCC AR5)	**kg CO_2 eq**	**253**	**5.30**	**6.40**	**3.28**	**1.47**	**-7.04**
GWP-GHG (IPCC AR5) (location-based electricity)	**kg CO_2 eq**	**218**	**5.30**	**6.40**	**3.28**	**1.47**	**-7.04**

[1] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and some construction materials, is also not measured by this indicator.

[2] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

Table 10: Parameters covering modules A1-A3, C1-C4 and D, per tonne

Environmental Indicator	Unit	Module A1-A3	Module C1	Module C2	Module C3	Module C4	Module D
PERE	MJ_{NCV}	1.52E+02	1.14E-01	1.26E-01	8.08E-01	3.42E-02	-5.74E+00
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.52E+02	1.14E-01	1.26E-01	8.08E-01	3.42E-02	-5.74E+00
PENRE	MJ_{NCV}	4.06E+03	7.39E+01	8.79E+01	4.67E+01	2.07E+01	-1.01E+02
PENRM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ_{NCV}	4.06E+03	7.39E+01	8.79E+01	4.67E+01	2.07E+01	-1.01E+02
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	3.26E+00	1.07E-02	1.27E-02	1.66E-02	3.00E-03	-1.10E+00
HWD	kg	1.25E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	6.13E-02	3.39E-04	3.73E-04	2.28E-03	2.02E+02	-1.69E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.56E+00	0.00E+00	0.00E+00	7.98E+02	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 11: Environmental impact (EN 15804+A1) indicators covering modules A1-A3, C1-C4 and D, per tonne*

Environmental Indicator	Unit	Module A1-A3	Module C1	Module C2	Module C3	Module C4	Module D
GWP	kg CO_2 eq	2.52E+02	5.28E+00	6.39E+00	3.27E+00	1.46E+00	-7.00E+00
ODP	kg CFC11 eq	2.43E-06	6.69E-07	7.97E-07	3.27E-07	1.87E-07	-1.90E-07
AP	kg SO2 eq	4.72E-01	4.14E-02	3.12E-02	5.69E-03	3.96E-03	-8.08E-03
EP	kg PO_4^{3-} eq	1.10E-01	8.50E-03	5.97E-03	5.58E-04	5.22E-04	-1.49E-03
POCP	kg C_2H_4 eq	4.31E-02	4.06E-03	2.01E-03	3.18E-04	2.25E-04	-5.57E-04
ADPE	kg Sb eq	5.74E-05	6.33E-09	7.52E-09	8.13E-07	1.76E-09	-1.04E-06
ADPF	MJ_{NCV}	4.05E+03	7.39E+01	8.79E+01	4.67E+01	2.07E+01	-1.01E+02

* Note: the indicators and characterisation methods are from EN 15804:2012+A1:2013, but other LCA rules (system boundaries, allocation, etc.) are according to EN 15804:2012+A2:2019; i.e., the results of the "+A1 indicators" shall not be claimed to be compliant with EN 15804:2012+A1:2013.

Variation (A1-A3) per impact category

- At each site Brickworks produces a large number of product variations, which means grouping of products is required to present the results in a meaningful manner. Therefore, the results are presented for an average brick product at site level. The average consists of the weighted average composition. Products with high quantities of oxides and additives are likely to sit above the average results, whereas bricks with low quantities of oxides and additives are likely to sit below the average. The variation for each indicator is provided in the table hereafter.
- No grouping of products across multiple sites is undertaken.

Table 12: Maximum variation per impact category

Impact category	Unit	Variation ranges from the average brick produced
GWP-total	kg CO2 eq	-9% / +14%
ODP	kg CFC11 eq	-14% / +19%
AP	mol H+ eq	-22% / +33%
EP-freshwater	kg P eq	-94% / +38%
EP-marine	kg N eq	-19% / +24%
EP-terrestrial	mol N eq	-15% / +23%
POCP	kg NMVOC eq	-15% / +22%
ADP m&m6	kg Sb eq	-98% / +127%
ADP fossil6	MJ	-7% / +12%
WDP6	m3 depriv.	-49% / +27%
GWP-GHG	kg CO2 eq	-9% / +14%

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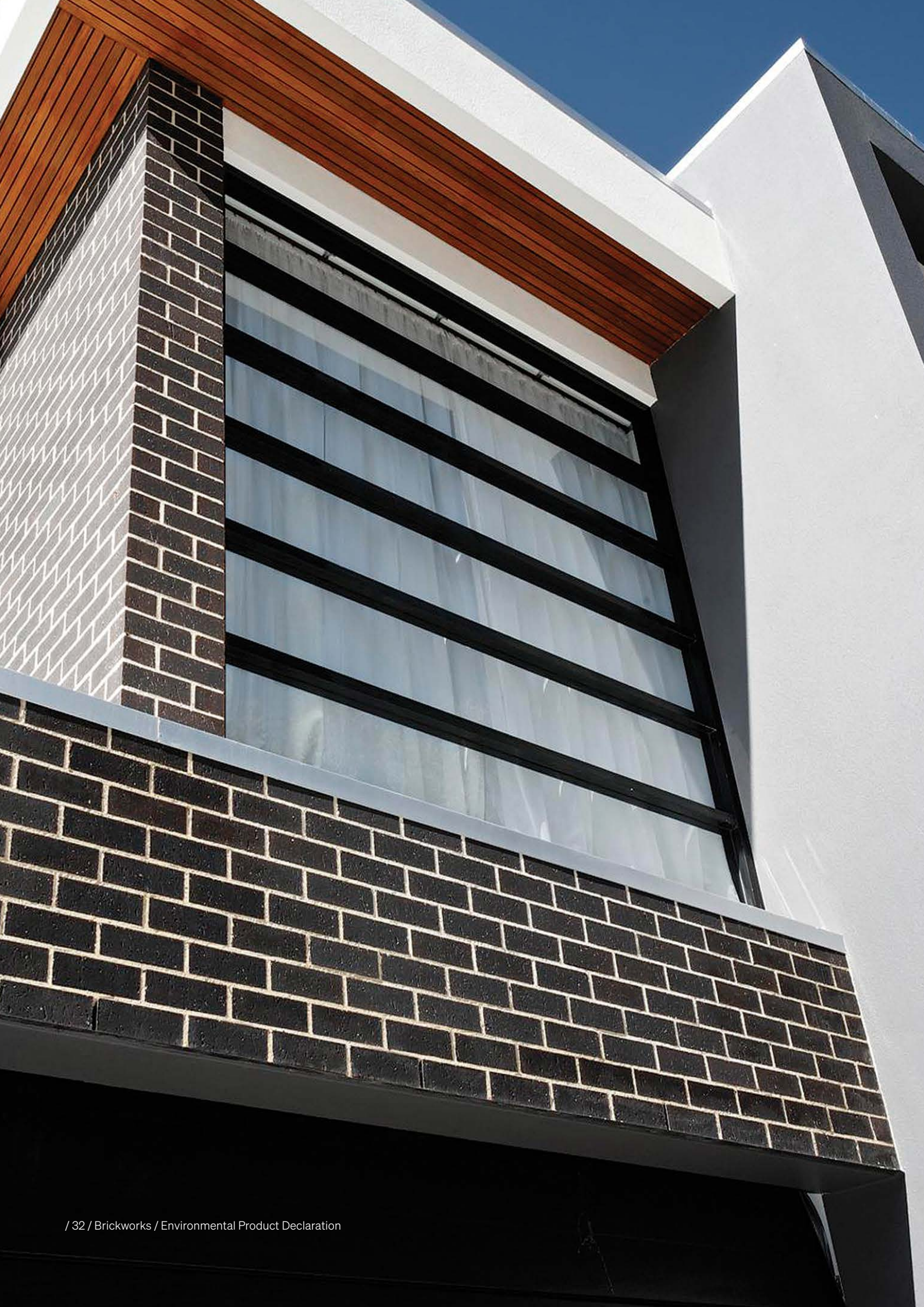

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