Life Cycle Assessment
& Environmental Product Declaration

Adbri Lime Products EPD

Programme: The International EPD ® System, www.environdec.com
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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.environdec.com.

In accordance with ISO 14025:2016, EN15804+A2:2019

AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

ECO PLATFORM EPD VERIFIED

ADBRI
Building Australia since 1882

Adelaide Brighton Cement Ltd

COCKBURN CEMENT

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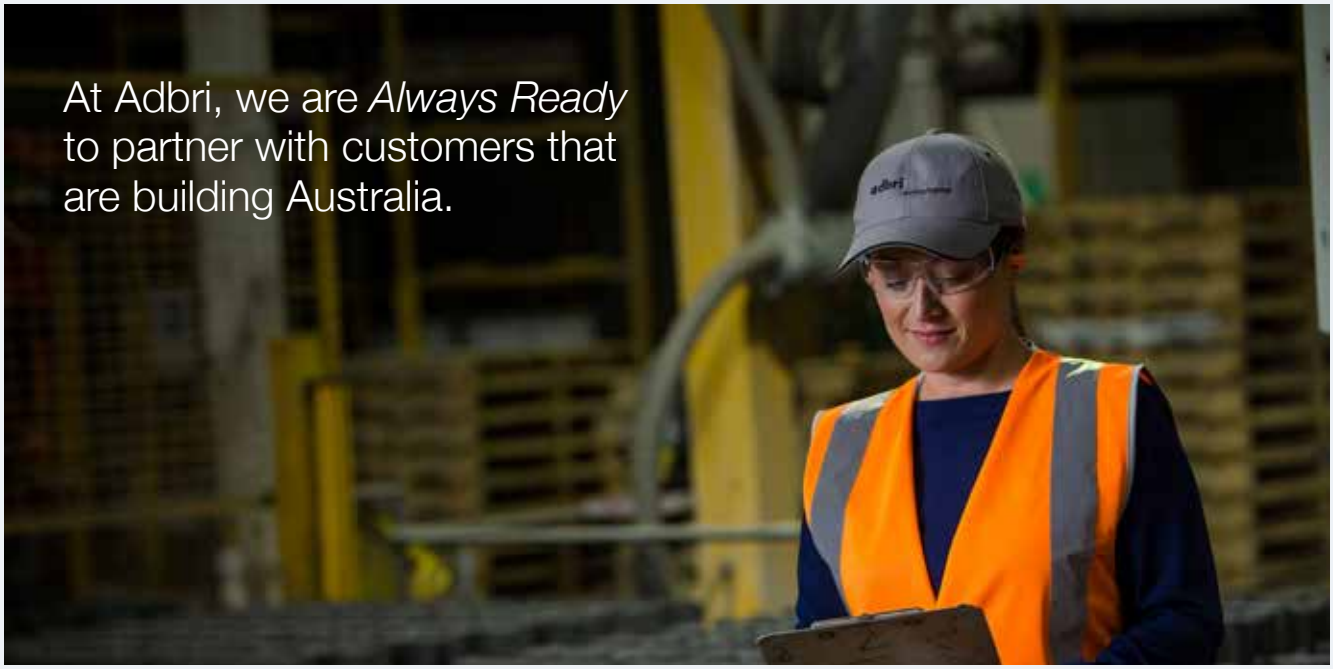
Adbri is *Building a Better Australia* with its locally manufactured cement, lime, concrete, aggregates, industrial minerals and concrete products.

About Adbri

We believe in doing business responsibly; keeping our people and communities safe; meeting the needs of our customers; and creating long-term value for our shareholders.

We contribute to a sustainable future.
Since our origins in 1882, we have focused on building long-term partnerships that add value. We are a proud Australian company with an extensive local manufacturing presence which allows us to be agile in meeting customer needs.



A proud Australian manufacturer and supplier

As one of Australia's most experienced construction materials companies, we have helped build the foundations of our communities.

Today our 1500+ strong team located across 200 locations, continue to work closely with our customers, partners and communities to develop solutions that enhance the quality of lives of Australians, underpinned by our national footprint, secure supply chain and technical expertise.

Technical expertise you can rely on.

We are committed to supplying innovative and quality products, supported by our leading technical advice. Our in-house technical experts are highly experienced in developing and managing quality control and assurance systems for our industry.

Adbri operates a centralised laboratory complex in Birkenhead (South Australia) that provides leading capability in the Australian heavy construction materials industry.

We were the first Australasian laboratory to commission a robotic quality control cement testing facility which improves testing accuracy and efficiencies.

Our customers are also supported by a national team of in-field technical specialists who work closely with our laboratory-based experts. All our laboratories have achieved ISO 9001 endorsement for Quality Management Systems and our centralised Birkenhead laboratory is also NATA accredited to ISO/IEC 17025 for a range of cementitious, lime, concrete and aggregate test methods.

OUR LIME BRANDS

With a range of respected and fully owned brands within the Adbri portfolio, complemented by seven joint venture companies, we have the technical capability, product range, scale, and geographic footprint to deliver on our purpose of *Building a Better Australia*.

Adelaide Brighton Cement Ltd

COCKBURN CEMENT

This EPD is a specific EPD for lime products. It covers lime products manufactured and distributed by our Adelaide Brighton Cement and Cockburn Cement brands.


AURIZON

Sustainability at Adbri

Contributing to a safe, healthy and sustainable future for Australians, our communities and the environment is a fundamental part of Adbri's culture.

Contributing to a safe, healthy and sustainable future for Australians, our communities and the environment is a fundamental part of Adbri's culture.

Our sustainability approach is built on strong relationships with our people, customers, suppliers, partners, shareholders and the communities in which we operate, coupled with continuous improvement across our value chains.

Cement, lime, concrete, aggregates, and masonry are essential materials to the global economy. Our products will play a critical role in the transition to a lower carbon environment, supplying key industries including construction, infrastructure, energy, mining, and agriculture.

Our goal at Adbri is to be net zero emissions by 2050.

We operate two emissions-intensive and hard-to-abate processes – the integrated manufacture of clinker and lime production. Our key decarbonisation challenge is associated with unavoidable process emissions that are chemically liberated from the high-temperature processing of limestone, which accounts for approximately 60% of Adbri's Scope 1 and Scope 2 greenhouse gas emissions.

In 2022 we released our Net Zero Emissions Roadmap which sets out the steps we will take to achieve our goal of net zero emissions by 2050, based on the three key actions of reducing emissions, creating new lower carbon products, and collaborating with key partners.

Refuse Derived Fuel

At our Birkenhead cement plant for clinker manufacture, Adbri pioneered in the use of refuse derived fuel (RDF) in Australia since 2003. Since then, we've used over 1.3 million tonnes of RDF which has significantly reduced the Group's greenhouse gas (GHG) emissions.

RDF is produced by a third party who processes industrial waste products to produce an alternative fuel source. As well as reducing demand for fossil fuels, it diverts waste from landfill.

Our Environmental Product Declarations

Adbri is committed to a sustainable future and this includes providing transparency about our products' environmental credentials via an Environmental Product Declaration (EPD).

Underpinning our EPDs is a Life Cycle Assessment (LCA) which identifies the environmental footprint throughout the life cycle of a product and is compliant with the ISO standards 14040 and 14044.

Having an EPD allows Adbri to understand the roles and contributions of different materials to the total environmental impacts, thus, meeting market demand for science-based, transparent, and verified environmental product information. Adbri has engaged start2see for the production of this EPD.

This report presents the methodology, data, results, and interpretation of the LCA. The LCA has been through several iterations of internal review to refine the life cycle data and assumptions.

2 General guidance

EPDs are independently verified documents that include information about the environmental impact of products throughout their life cycle:

EPDs require the completion of a Life Cycle Inventory (LCI), LCA and verification to best practice international and Australian standards.

- LCI is the collection of data on the inputs, processes and outputs within a defined system boundary.
- LCA is the modelling of LCI in accordance with ISO 14040, 14044 and 14025 standards.
- EN 15804+A2:2019: Sustainability of construction works – Environmental Product Declarations – core rules for the product category of construction products.
- General Programme Instructions (GPI) for the International EPD System V3.01 – containing instructions regarding methodology and the content that must be included in EPDs registered under the International EPD System.
- Third party verification of the output of the LCA in the format of an EPD.
- Product Category Rules (PCR) 2019:14, v1.11 – construction products.
- Complementary Product Category Rules (c-PCR-001) to PCR 2019:14 Cement and Building Lime (EN 16908), Version 2022-05-18

EPDs are not always comparable

When comparing EPDs it is important to recognise:

- EPDs within the same product category from different programmes may not be comparable.
- EPDs of construction products may not be comparable if they do not comply with EN 15804 or if they are produced using different PCRs.
- Understanding the detail is important in comparisons. Expert analysis is required to ensure data is truly comparable to avoid unintended distortions.
- 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.

Benefits of using this EPD

Results derived from this EPD can be used as a component for customers, for the purpose of compiling their own LCA calculation and modelling for EPDs. The 37 environmental impact indicators align with EN15804 +A2 and are used to support lower carbon lime initiatives, and to establish the global warming potential of materials used for material selection or decision making.

General information

Programme Information

Programme Operator	EPD Australasia
Address	EPD Australasia Limited 315a Hardy Street Nelson 7010 New Zealand
Phone	(+61) 02 8005 8206
Website	www.epd-australasia.com
E-mail	info@epd-australasia.com
CEN standard	EN 15804 serves as the Core Product Category Rules (PCR)
The Product Category Rules (PCR) for construction products and construction services PCR 2019	2014, version 1.11 (Environdec 2021) c-PCR-001: Cement and building lime products The c-PCR-001 references EN 16908:2017+A1:2022 Cement and building lime - Environmental product declarations - Product category rules complementary to EN 15804 EN 15804:2012+A2:2019 General Programme Instructions for the International EPD System, version 3.01 (Environdec 2019) ISO 14025:2006 ISO 14040:2006 ISO 14044:2006
PCR review was conducted by	*The Technical Committee of the International EPD® System.* *Chair: Claudia A. Peña. Contact via info@environdec.com*
Independent third-party verification	Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification
Third-party verifier (approved by EPD Australasia)	*Angela Schindler* *Tufinger Strasse 12, 88682 Salem, Germany* *Angela@schindler-umwelt.de*
Procedure for follow-up	Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☒ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025.

Company Information

Owner of the EPD	Adbri Limited Level 1 157 Grenfell Street Adelaide SA 5001 +61 8 8248 9999
Description of the organisation	Adbri is a leading Australian construction and building materials company that manufactures and distributes cement, lime, concrete, aggregates, masonry products and industrial minerals. With its origins dating back to 1882, Adbri is a vertically integrated business with operations spanning Australia. The Group employs more than 1,500 people and serves customers in the residential and non-residential construction, engineering construction, infrastructure, alumina production and mining markets through its portfolio of respected brands.
Name and location of production sites	This EPD covers a total of seven products manufactured at four sites. Even though there are two main product types (Quicklime, and Hydrated lime), these are branded differently as per the manufacturing facility, and have unique characteristics in terms of the purposes of this LCA. Included sites and products are as follows: — Adelaide Brighton Angaston plant: — Quicklime — Hydrated lime — Cockburn Dongara plant: — Quicklime — Cockburn Munster plant: — Quicklime —Premium Quicklime fine — Cockburn Kwinana plant: — Hydrated lime — Premium Hydrated Lime

Product Information

Adbri has developed a Life Cycle Assessment (LCA) and Environmental Product Disclosure (EPD) for their lime products manufactured over two states of Australia. The following products are included in this EPD:

Quicklime products

Adelaide Brighton Quicklime (Angaston)

Adelaide Brighton Quicklime (calcium oxide; CaO) is produced by the calcination of quarried limestone in a rotary kiln at elevated temperatures at Angaston, South Australia. The limestone is mixed with water and milled to produce a slurry before it is fed into the kiln, where nearly half of its mass is volatilised as carbon dioxide. It is low in impurities and possesses a high degree of reactivity making it suitable for use in chemical processes. Quicklime is a granular product, off-white in colour, and highly reactive with water generating considerable heat during the hydration process.

Adelaide Brighton Quicklime is only available in sealed pneumatic bulk tankers.

Cockburn Quicklime (Dongara)

Cockburn Quicklime (Dongara) (calcium oxide; CaO) is produced by the calcination of limestone sand in a rotary kiln at Dongara, Western Australia. The calcining process results in volatilising nearly half of the stone's weight as carbon dioxide. It is low in impurities and possesses a high degree of reactivity making it suitable for use in chemical processes. It is highly reactive with water, generating heat in the hydration process. It is manufactured as a granular product and is off-white in colour.

Cockburn Quicklime (Dongara) is available in sealed pneumatic bulk tankers.

Cockburn Quicklime (Munster)

Cockburn Quicklime (Munster) (calcium oxide; CaO) is produced by the calcination of selectively dredged shell sand in a rotary kiln at Munster, Western Australia. It is a flash calcined lime with a high degree of reactivity making it suitable for use in chemical processes. The calcining process results in volatilising nearly half of the stone's weight as carbon dioxide. It is manufactured as a granular product and is off-white in colour.

Cockburn Quicklime (Munster) is available in sealed pneumatic bulk tankers.

When quicklime exits the kiln and is cooled through the cooling circuit there is a fines product that is swept away from the main quicklime product, the fines separated in this part of the process is what Adbri calls Premium Quicklime Fines (PQF). The product is only cooled utilising ambient air being drawn through cyclones. The cooled, heavy quicklime product drops out of the cyclone into the transport system. The fines that are drawn into the air stream come out the top of the cyclone to a bag filter. The bag filter then separates the air from the PQF product. The PQF product is then transported to the PQF silo until it is full.

Once the PQF silo is full the process then redirects the PQF back into the quicklime transport system where it is combined with the heavy quicklime product separated before and sent to the final product silo.

Hydrated lime products

Adelaide Brighton hydrated lime (Angaston)

Adelaide Brighton hydrated lime (Angaston) (calcium hydroxide; $Ca(OH)_2$ is produced by treating quicklime with just enough water to satisfy its chemical affinity at Angaston, South Australia. It is then ground and air classified to produce a fine white powder. Hydrated lime is an important material for use in the construction industry, chemical processing, and water treatment.

Hydrated lime is available in sealed pneumatic bulk tankers, bulk bags, and 20 kg multi-walled paper bags. Paper bags are palletised and stretch wrapped. This LCA only covers bulk products.

Cockburn hydrated lime (Kwinana)

Cockburn produces hydrated lime (calcium hydroxide; $Ca(OH)_2$ in Kwinana, Western Australia. The manufacturing process is similar to hydrated lime production in Angaston.

Hydrated lime is available in sealed pneumatic bulk tankers, nominal 1 tonne bulk bags, and 20 kg multi-walled paper bags. Paper bags are palletised and stretch wrapped. This LCA only covers bulk products. Premium hydrated lime is the same material milled to a finer particle size.

Coburn Quicklime (Munster)

Cockburn Quicklime (Munster) (calcium oxide; CaO) is produced by the calcination of selectively dredged shell sand in a rotary kiln at Munster, Western Australia. It is a flash calcined lime with a high degree of reactivity making it suitable for use in chemical processes. The calcining process results in volatilising nearly half of the stone's weight as carbon dioxide.

Cockburn Quicklime (Munster) is available in sealed pneumatic bulk tankers from Munster, Western Australia. It is manufactured as a granular product and is off-white in colour.

Uses and functional characteristics

The product codes for building lime products are UN CPC 374 (Plaster, lime and cement) and ANZSIC 20310 (Cement and Lime manufacturing).

— Quicklime (Calcium oxide; CaO) can be used for different applications such as soil stabilisation, neutralisation of acidic mine tailings, chemicals manufacturing, paper bleaching, water treatment and impurities removal in metallurgic industries.

  Adbri's quicklime products comply with Australian Standard AS 1672.1 (Limes and limestones, Part 1: Limes for Building).

— Hydrated lime (Calcium hydroxide; $Ca(OH)_2$ is an important material for use in the chemical processing industry, building industry and in water treatment processes.

Some examples of its many applications are:

— Flocculation processes in water treatment
— As an ingredient of materials such as glass, concrete, rubber, etc.
— For dehydration of petroleum, organic solvents, etc.
— Absorption, hydrolysation and neutralisation processes
— As a key constituent of cementitious mortars compliant with AS 3700

Adbri's Industrial / Hydrated Lime products comply with Australian Standard AS 1672.1 (Limes and limestones, Part 1: Limes for Building).

Content declaration

Table 1 | Lime product comparison

Components (kg / tonne)	Cockburn Quicklime (Dongara)	Cockburn Quicklime / Cockburn PQF (Munster)	Adelaide Brighton Quicklime (Angaston)	Cockburn Hydrated Lime / Cockburn Premium Hydrated Lime (Kwinana)	Adelaide Brighton Hydrated Lime (Angaston)
Lime (CaO)	1,000	1, 000	1, 000	78-80%	78-80%
Water	-	-	-	20-22%	20-22%
Total	1, 000	1, 000	1, 000	1, 000	1, 000

PQF = Premium Quicklime Fines

The products included in this EPD do not contain any substances that are listed in the "Candidate List of Substances of Very High Concern (SVHC) for authorisation" as defined by European REACH regulation (ECHA 2023) in concentrations >0.1% (m/m).

Table 2 | Life cycle of building products: stages and modules included in this EPD

Information module			Mod	Geo	Data	Var-P	Var-S
A1-3. Manufacturing stage	**A1**	Raw material supply	X	AU	100%	Not relevant	Not relevant
	A2	Transport	X	AU			
	A3	Manufacturing	X	AU			
A4-5. Construction stage	**A4**	Transport	ND				
	A5	Construction-installation process	ND				
B1-7. Use stage	**B1**	Use	ND				
	B2	Maintenance	ND				
	B3	Repair	ND				
	B4	Replacement	ND				
	B5	Refurbishment	ND				
	B6	Operational energy use	ND				
	B7	Operational water use	ND				
C1-4. End of life stage	**C1**	Deconstruction and demolition	ND				
	C2	Transport	ND				
	C3	Waste Processing	ND				
	C4	Disposal	ND				
D. Recyclability potentials	**D**	Reuse, recovery, recycling potential	ND				

— Mod = Module

— X = 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.

— Geo = geography (Geographical representation per module reported by the country code(s)).

— Data = The share of the GWP-GHG indicator results in A1-A3 coming from product-specific LCI data.

— Var-P = Variation - products (If the EPD is based on multiple products, the difference in GWP-GHG indicator results in A1-A3 between the reported average and the results for the underlying products shall be reported in percent. If the variation is less than +/- 10%, "<10%" may bereported.)

— Var-S = Variation - sites (If the EPD is based on multiple manufacturing sites, the difference in GWP-GHG indicator results in A1-A3 between the reported average and the results for the underlying sites shall be reported in percentage. If the variation is less than +/- 10%,"<10%" may be reported. If the results are for one manufacturing site "not relevant" shall be declared).

5 LCA information

Declared unit

The declared unit is 1000kg (1 tonne) of bulk lime products (quicklime, hydrated lime).

Databases and LCA software used

The software used was SimaPro® LCA software (v9.4.0.2). The background life cycle inventory data are mostly sourced from AusLCI (v1.36).

Life cycle inventory data

Adbri has collected and supplied the primary data for our limestone extraction sites and quicklime manufacturing plants in Dongara, Munster, and Angaston, as well as our hydrated lime production facilities in Angaston and Kwinana, based on the FY22 reporting period (1 July 2021 – 30 June 2022). Background data (e.g. for other raw materials, energy and transport processes) have predominantly been sourced from AusLCI and the AusLCI shadow database (v1.36) (AusLCI 2021), as well as ecoinvent v3. Background data used are either less than 10 years old or have been reviewed within this period.

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

Electricity used in production processes has been modelled using the AusLCI electricity data for South Australia and Western Australia. The greenhouse gas emissions (GWP-GHG) intensity of the electricity used in the model has been adjusted to align with the National Greenhouse Accounts (NGA 2022). The resulting GWP-GHG comes to 0.33 kg CO_2e/kWh (SA) and 0.55 kg CO_2e/kWh (WA) respectively.

Description of system boundaries and excluded life cycle stages

The scope of this EPD is cradle-to-gate (modules A1-A3). Downstream modules covering the construction process (modules A4-A5), use stages (B1-B7) and end-of-life modules (C1-C4 and D) have not been modelled as these are best modelled at the use level given the range of different applications (e.g. asphalt, steel and agriculture) of lime and hydrated lime. All modules included in this EPD are marked as X in the table below and those excluded are marked as 'Module not declared' (ND). The system boundary for this EPD is depicted in Figure 1.

Upstream processes

A1 raw material extraction

Limestone raw material is extracted from quarries (Angaston), lime sand dunes (Dongara) and offshore lime sand deposits (Munster).

A2 Transport to lime kilns

Limestone raw materials are transported to Adbri's lime kiln sites via trucks (Angaston, Dongara) or pipeline (Munster).

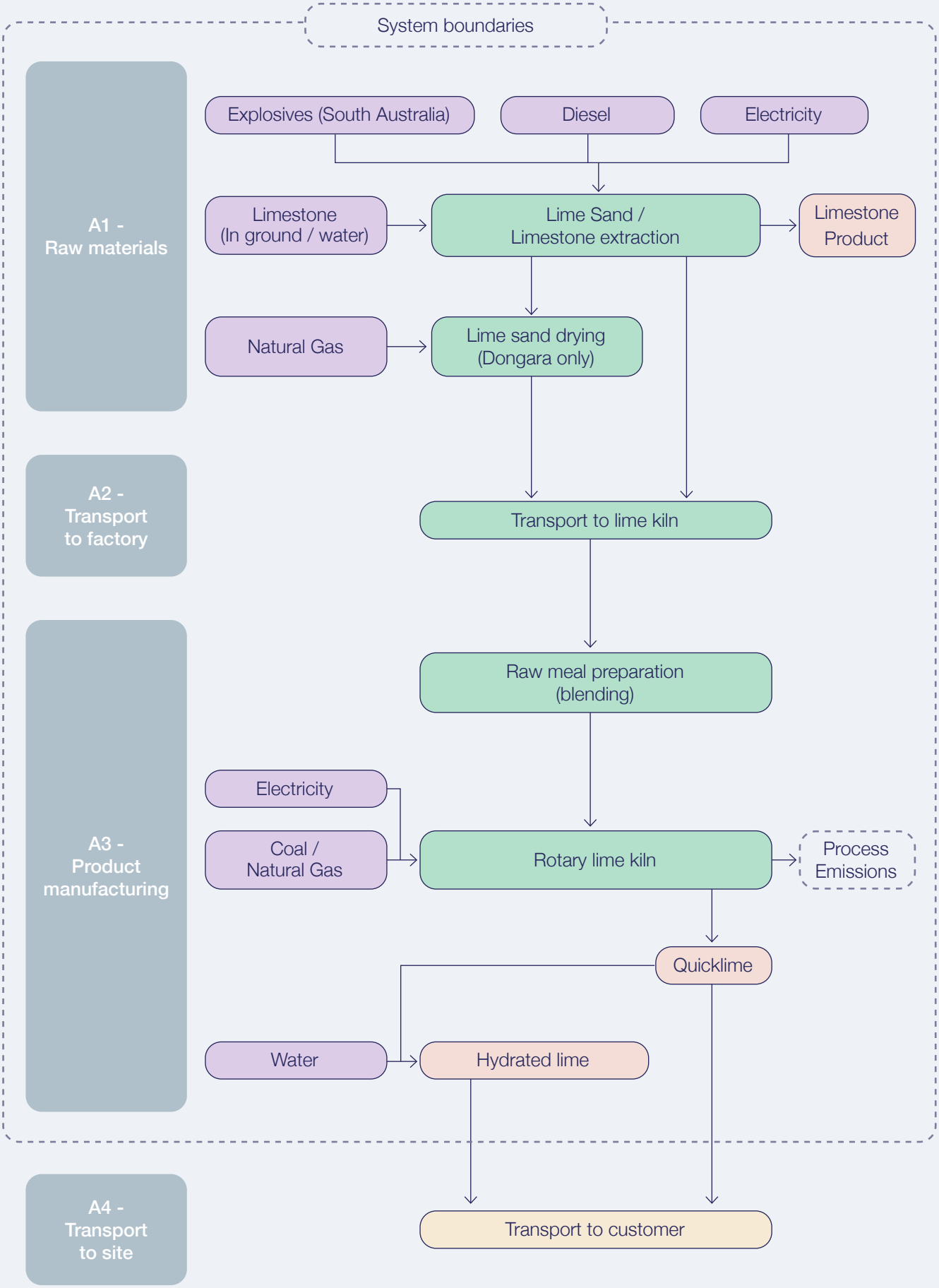
A3 Quicklime and hydrated lime production

Quicklime is produced by feeding the limestone raw material through a rotating kiln. At high temperature, limestone (calcium carbonate) converts to lime (calcium oxide). Hydrated lime (calcium hydroxide) is manufactured by mixing a controlled amount of water with the quicklime.

The premium quicklime and hydrated lime products consist of finer particle fractions of these materials.

Process Flow

Figure 1 | Lime process flow



Cut-off rules and exclusion of small amounts

It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold percentage of the total, but with the exception that where the input/output has a "significant" impact it should be included. According to the PCR 2019:14 v1.11, life cycle inventory data, shall according to EN 15804+ A2, include a minimum of 95% of total inflows (mass and energy) per module. Inflows not included in the LCA include:

— The contribution of capital goods (production equipment and infrastructure) is excluded, as these processes are non-attributable and they contribute less than 10% to GWP-GHG.

— Personnel-related impacts, such as transportation to and from work, are also not accounted for in the LCI. The impacts of employees are also excluded from inventory impacts on the basis that if they were not employed for this production or service function, they would be employed for another. It is very hard to decide what proportion of the impacts from their whole lives should count towards their employment. For this project, the impacts of employees are excluded.

— Ancillary materials used in the quarries and manufacturing plants including, but not limited to, greases, lubricating oils, engine oils, conveyor belts and other minor ancillary materials used during quarrying, or lime production. (The exceptions are greases and lubricants consumed in Angaston and Dongara, which have been included in the analysis as data were readily available.)

— Packaging of raw materials (explosives, grinding aids, greases and lubricants) has been excluded as their cumulative contribution is well below the cut-off limit.

— Water used in lime production is mostly evaporated or becomes part of the product (hydrated lime). There is no wastewater going to treatment, other than minor flows (e.g. water use at site offices) that end up in the municipal sewer system. The latter have been excluded as these flows are immaterial.

Allocation

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

— Production of limestone (raw material): In Angaston, limestone is extracted from the local Penrice quarry (owned by Adbri). The quarry produces limestone for Adbri's lime kiln in Angaston and cement kiln in Birkenhead, limestone for use as mineral addition in cement manufacturing, scalps and Brightonlite lime. Energy use and other environmental flows at the quarry have been allocated to the products on a mass basis, which results in an equal intensity per tonne of material.

— Use of secondary grinding media in Angaston. The steel grinding media used in Angaston are sourced from other local mills. We have assumed the end-of-waste state lies at the gate of the supplying mills and transport of the grinding media to Angaston is attributed to Adbri's product system.

— Production of hydrated lime products in Kwinana: Kwinana produces Hydrated lime (HLKW), Industrial Hydrated Lime (IHLKW) and Premium Hydrated Lime (PHLKW). We are not able to distinguish between these products, although we know that the premium grade product is milled to a finer particle size. Ultimately, we used estimates to distinguish (the different electricity intensity for milling) the various products.

— Landfill: There is limited production waste (e.g. lime kiln dust and off-spec product) going to landfill at the participating lime plants. Allocation of waste to landfill follows physical causality rules.

Key Assumptions

The key choices and assumptions in the LCA are:

— Greenhouse gas emissions of key energy sources (electricity, natural gas, diesel) have been aligned with NGA 2022.

— At a given extraction site, all (non-calcinated) limestone co-products receive the same impacts, regardless of quality and end-user. Although the amount of processing (e.g. crushing and milling) may vary between co-products, a further distinction is not possible as the process details are not available.

— Adbri produces standard hydrated lime, industrial hydrated lime and premium hydrated lime in Kwinana.

— We have distinguished energy use (electricity for milling) between the standard and premium products based on estimates.

— The composition of hydrated lime is based on the stoichiometric ratio of lime (78-80%) and water (20-22%) in hydrated lime.

6 Environmental indicators

The potential environmental impacts, use of resources and waste categories included in this EPD using the SimaPro v9.4.0.1 tool and are listed in Table 3. All tables from this point will contain the abbreviations only.

The LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds and safety margins or risks. The impact assessment results are presented in the next sections.

Table 3 | EN 15804+A2 impact categories included in this assessment

Impact category	Indicator	Unit	Model
Climate change – total[a]	Global Warming Potential total (GWP-total)	kg CO_2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013 as implemented by JRC
Climate change - fossil	Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013 as implemented by JRC
Climate change - biogenic	Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013 as implemented by JRC
Climate change - land use and land use change[b]	Global Warming Potential land use and land use change (GWP-luluc)	kg CO_2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013 as implemented by JRC
Ozone Depletion	Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11 eq.	Steady-state ODPs, WMO 2014
Acidification	Acidification potential, Accumulated Exceedance (AP)	mol H^+ eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008
Eutrophication aquatic freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication aquatic marine	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-marine)	kg N eq.	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication terrestrial	Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	mol N eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al. 2008
Photochemical ozone formation	Formation potential of tropospheric ozone (POCP);	kg NMVOC eq.	LOTOS-EUROS ,Van Zelm et al., 2008, as applied in ReCiPe
Depletion of abiotic resources - minerals and metals[2]	Abiotic depletion potential for non-fossil resources (ADP minerals & metals)	kg Sb eq.	CML 2002, Guinée et al., 2002, and van Oers et al. 2002.
Depletion of abiotic resources - fossil fuels[2]	Abiotic depletionpotential for fossil resources (ADP-fossil)	MJ, net calorific value	CML 2002, Guinée et al., 2002, and van Oers et al. 2002.
Water use[2]	Water (user) deprivation potential, deprivationweighted water consumption (WDP)	m^3 world eq. deprived	Available WAter REmaining (AWARE) Boulay et al., 2016

Table 4 | Additional EN 15804+A2 environmental impact indicators

Impact category	Indicator	Unit	Model
Particulate matter emissions	Potential incidence of disease due to PM emissions (PM)	Disease incidence	SETAC-UNEP, Fantke et al. 2016
Ionising radiation, human health[1]	Potential Human exposure efficiency relative to U235 (IRP)	kBq U235 eq.	Human health effect model as developed by Dreicer et al. 1995 update by Frischknecht et al., 2000
Ecotoxicity (freshwater)[2]	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	CTUe	Usetox version 2 until the modified USEtox model is available from EC-JRC
Human toxicity, cancer effects[2]	Potential Comparative Toxic Unit for humans (HTP-c)	CTUh	Usetox version 2 until the modified USEtox model is available from EC-JRC
Human toxicity, noncancer effects[2]	Potential Comparative Toxic Unit for humans (HTP-nc)	CTUh	Usetox version 2 until the modified USEtox model is available from EC-JRC
Land use related impacts / soil quality[2]	Potential Soil quality index (SQP)	dimensionless	Soil quality index based on LANCA
Climate change - Carbon footprint	Global Warming Potential (GWP-GHG)	kg CO_2e	IPCC 2013 baseline model with 100 year time horizon*

Disclaimer 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 from some construction materials is also not measured by this indicator.

Disclaimer 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.

** The GWP-GHG indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product as defined by IPCC AR 5 (IPCC 2013). This indicator is determined using the IPCC AR5 Global Warming Potentials (GWP) with a 100-year time horizon.*

Table 5 | Legend of Indicators

Impact category	Abbreviation	Measurement unit
RESOURCE USE CATEGORIES		
Use of renewable primary energy excluding non-renewable primary energy resources used as raw materials	PERE	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	PERM	MJ, net calorific value
Total use of renewable primary energy resources	PERT	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ, net calorific value
Use of non- renewable primary energy resources used as raw materials	PENRM	MJ, net calorific value
Total use of non- renewable primary energy resources	PENRT	MJ, net calorific value
Use of secondary material	SM	kg
Use of renewable secondary fuels	RSF	MJ, net calorific value
Use of non-renewable secondary fuels	NRSF	MJ, net calorific value
Use of net fresh water	FW	m^3
WASTE CATEGORIES		
Hazardous waste disposed	HWD	kg
Non-hazardous waste disposed	NHWD	kg
Radioactive waste disposed/stored	RWD	kg
OUTPUT FLOWS		
Components for reuse	CRU	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ per energy carrier

Table 6 | EN 15804+A1 impact categories included in the assessment

Impact category	Parameter	Unit	Model
Global Warming	Global warming potential, GWP,	kg CO_2 eq	Global Warming Potential for a 100-year time horizon as in IPCC 2007
Ozone Depletion	Depletion potential of the stratospheric ozone layer, ODP,	kg CFC 11 eq	Ozone Depletion Potentials for steady-state, WMO 2003
Acidification for soil and water	Acidification potential of soil and water, AP,	kg SO_2 eq	Acidification Potentials for average Europe total as in Huijbregts, 1999
Eutrophication	Eutrophication potential, EP,	kg $(PO_4)^{3-}$ eq	Eutrophication Potential as in Heijungs et al. 1992
Photochemical ozone creation	Formation potential of tropospheric ozone, POCP,	kg Ethene eq	Photochemical Ozone Creation Potentials for oxygenated volatile organic compounds, Jenkin & Hayman, 1999; Derwent et al. 1998
Depletion of abiotic resources-elements	Abiotic depletion potential (ADPE) for non fossil resources	kg Sb eq	Abiotic Resource Depletion Potentials for ultimate ultimate reserves as in Oers et al. 2002
Depletion of abiotic resources-fossil fuels	Abiotic depletion potential (ADPF) for fossil resources	MJ, net calorific value	Abiotic Resource Depletion Potentials for fossil fuels as in Oers et al. 2002

Environmental performance

Modules product stage (A1-A3) results per tonne of lime

The results for the lime products have been established based on the life cycle impact assessment method stipulated by EN 15804:2012+A2:2019.

As noted, the EN 15804+A2 standard applies a slightly different impact assessment model for global warming, compared to the standard GWPs from the IPCC's AR5 100-year time horizon, which exclude indirect radiative forcing. Therefore, we separately present the carbon footprint according to the GWPs used within the Australian National Greenhouse and Energy Reporting (NGER) framework as GWP-GHG. Finally, we also include the results in line with EN 15804:2012+A1:2013,

Quicklime

Table 7 | EN 15804+A2 Indicators (A1-A3), Quicklime, per tonne

Environmental impact category	Unit	Quicklime, Angaston	Quicklime, Dongara	Quicklime, Munster	Premium Quicklime Fine (PQF), Munster
EN 15804+A2 Core indicators					
GWP-total	kg CO_2-eq.	1400	1150	1240	1240
GWP-fossil	kg CO_2-eq.	1.40E+03	1.15E+03	1.25E+03	1.25E+03
GWP-biogenic	kg CO_2-eq.	2.82E-01	5.53E-01	4.37E-01	4.37E-01
GWP-luluc	kg CO_2-eq.	3.10E-05	4.10E-06	2.11E-05	2.11E-05
ODP	kg CFC11-eq.	2.07E-06	4.52E-07	3.42E-06	3.42E-06
AP	mol H^+ eq.	1.78E+00	1.54E+00	3.73E+00	3.73E+00
EP-freshwater	kg P eq.	7.84E-05	1.32E-04	5.38E-04	5.38E-04
EP-marine	kg N eq.	7.29E-01	5.41E-01	8.85E-01	8.85E-01
EP-terrestrial	mol N eq.	7.97E+00	5.90E+00	9.57E+00	9.57E+00
POCP	kg NMVOC eq.	1.92E+00	1.43E+00	2.38E+00	2.38E+00
ADP minerals & metals	kg Sb eq.	3.42E-08	5.47E-09	3.26E-08	3.26E-08
ADP fossil	MJ (NCV)	1.23E+04	8.59E+03	7.32E+03	7.32E+03
WDP	m^3 world eq. deprived	1.88E+03	1.11E+03	9.77E+02	9.77E+02
EN 15804+A2 Additional indicators					
PM	Disease incidence	2.27E-05	2.04E-05	6.05E-05	6.05E-05
IRP	kBq U235 eq.	5.44E-04	8.97E-05	5.54E-04	5.54E-04
ETP-fw	CTUe	1.15E+02	2.25E+02	4.49E+02	4.49E+02
HTP-c	CTUh	7.99E-09	1.36E-08	5.93E-08	5.93E-08
HTP-nc	CTUh	1.04E-06	1.22E-06	4.06E-06	4.06E-06
SQP	-	3.09E+03	1.00E+04	5.30E+02	5.30E+02
Carbon footprint					
GWP-GHG	kg CO_2-eq.	1400	1140	1240	1240

Table 8 | EN 15804+A2 Indicators (A1-A3), Quicklime, per tonne

Parameter	Unit	Quicklime, Angaston	Quicklime, Dongara	Quicklime, Munster	Premium Quicklime Fine (PQF), Munster
PERE	MJNCV	1.99E+02	1.07E+02	5.96E+01	5.96E+01
PERM	MJNCV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJNCV	1.99E+02	1.07E+02	5.96E+01	5.96E+01
PENRE	MJNCV	1.23E+04	8.59E+03	7.32E+03	7.32E+03
PENRM	MJNCV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJNCV	1.23E+04	8.59E+03	7.32E+03	7.32E+03
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJNCV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJNCV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	2.55E+00	5.19E-01	1.13E+01	1.14E+01
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	3.51E-01	4.04E-01	1.26E+00	1.26E+00
RWD	kg	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
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	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

Table 9 | EN 15804+A1 indicators (A1-A3), Quicklime, per tonne

Indicator	Unit	Quicklime, Angaston	Quicklime, Dongara	Quicklime, Munster	Premium Quicklime Fine (PQF), Munster
GWP	kg CO_2 eq	1.39E+03	1.14E+03	1.24E+03	1.24E+03
ODP	kg CFC11 eq	1.63E-06	3.58E-07	2.70E-06	2.70E-06
AP	kg SO_2 eq	9.59E-01	6.98E-01	1.16E+00	1.16E+00
EP	kg PO_4^{3}- eq	2.46E-01	1.83E-01	3.00E-01	3.00E-01
POCP	kg C_2H_4 eq	6.80E-02	3.88E-02	3.63E-02	3.63E-02
ADPE	kg Sb eq	4.28E-08	1.41E-08	3.67E-08	3.67E-08
ADPF	MJNCV	1.23E+04	8.59E+03	7.31E+03	7.31E+03

Hydrated Lime

Table 10 | EN 15804+A2 Indicators (A1-A3), Hydrated Lime, per tonne

Environmental impact category	Unit	Hydrated Lime, Angaston	Hydrated Lime, Kwinana	Premium Hydrated Lime, Kwinana
EN 15804+A2 Core indicators				
GWP-total	kg CO_2-eq.	1110	1060	1070
GWP-fossil	kg CO_2-eq.	1.11E+03	1.06E+03	1.07E+03
GWP-biogenic	kg CO_2-eq.	2.72E-01	2.14E-01	2.47E-01
GWP-luluc	kg CO_2-eq.	3.33E-05	1.93E-01	1.93E-01
ODP	kg CFC11-eq.	1.90E-06	8.76E-06	8.77E-06
AP	mol H^+ eq.	1.47E+00	3.59E+00	3.63E+00
EP-freshwater	kg P eq.	7.67E-05	5.36E-04	5.43E-04
EP-marine	kg N eq.	5.85E-01	9.26E-01	9.34E-01
EP-terrestrial	mol N eq.	6.39E+00	1.00E+01	1.01E+01
POCP	kg NMVOC eq.	1.54E+00	2.48E+00	2.50E+00
ADP minerals & metals	kg Sb eq.	3.41E-08	1.11E-05	1.11E-05
ADP fossil	MJ (NCV)	1.01E+04	6.82E+03	6.91E+03
WDP	m^3 world eq. deprived	1.55E+03	8.59E+02	8.61E+02
EN 15804+A2 Additional indicators				
PM	Disease incidence	1.93E-05	6.24E-05	6.30E-05
IRP	kBq U235 eq.	5.48E-04	2.47E-02	2.47E-02
ETP-fw	CTUe	1.04E+02	8.62E+02	8.67E+02
HTP-c	CTUh	6.66E-09	6.15E-08	6.22E-08
HTP-nc	CTUh	8.53E-07	3.69E-06	3.74E-06
SQP	-	2.53E+03	6.44E+02	6.64E+02
Carbon footprint				
GWP-GHG	kg CO_2-eq.	1110	1060	1060

Table 11 | EN 15804+A2 Indicators (A1-A3), Hydrated Lime, per tonne

Parameter	Unit	Hydrated Lime, Angaston	Hydrated Lime, Kwinana	Premium Hydrated Lime, Kwinana
PERE	MJNCV	2.64E+02	8.75E+01	9.34E+01
PERM	MJNCV	0.00E+00	0.00E+00	0.00E+00
PERT	MJNCV	2.64E+02	8.75E+01	9.34E+01
PENRE	MJNCV	1.01E+04	6.82E+03	6.91E+03
PENRM	MJNCV	0.00E+00	0.00E+00	0.00E+00
PENRT	MJNCV	1.01E+04	6.82E+03	6.91E+03
SM	kg	0.00E+00	0.00E+00	0.00E+00
RSF	MJNCV	0.00E+00	0.00E+00	0.00E+00
NRSF	MJNCV	0.00E+00	0.00E+00	0.00E+00
FW	m^3	2.85E+00	1.50E+01	1.51E+01
HWD	kg	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	2.88E-01	1.08E+00	1.10E+00
RWD	kg	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00

Table 12 | EN 15804+A1 indicators (A1-A3), Hydrated Lime, per tonne

Parameter	Unit	Hydrated Lime, Angaston	Hydrated Lime, Kwinana	Premium Hydrated Lime, Kwinana
GWP	kg CO_2 eq	1.11E+03	1.06E+03	1.06E+03
ODP	kg CFC11 eq	1.50E-06	6.94E-06	6.94E-06
AP	kg SO^2 eq	7.73E-01	1.27E+00	1.28E+00
EP	kg PO_4^{3-} eq	1.97E-01	3.14E-01	3.17E-01
POCP	kg C_2H_4 eq	5.75E-02	6.56E-02	6.59E-02
ADPE	kg Sb eq	4.09E-08	1.12E-05	1.12E-05
ADPF	MJNCV	1.01E+04	6.81E+03	6.90E+03

Interpretation of results

The key drivers for environmental impacts within the cradle-to-gate life cycle of quicklime products are:

- The extraction of limestone (module A1) makes up between 0-4% of the cradle-to-gate greenhouse gas emissions.
- Transport of raw materials (module A2) hardly contributes to the cradle-to-gate environmental impacts, mainly due to the short distance between extraction sites and lime kilns.
- The manufacturing process (module A3) of quicklime is responsible for approximately 96-99% of the cradle-to-gate greenhouse gas emissions.
  - Calcination emissions make up 48-59% of the carbon footprint,
  - Emissions from combustion of kiln fuel (natural gas, coal) makes up 33-49% of the carbon footprint,
  - Other processes (electricity use, diesel for equipment, overhead) combined contribute 2-4% to the carbon footprint.

Differences between quicklime products are mainly related to differences in processing efficiency and raw material composition (which affects calcination emissions).

The key drivers for environmental impacts within the cradle-to-gate life cycle of hydrated lime products are:

- The production of quicklime dominates the environmental profile of hydrated lime, since it is an energy intensive process, while producing hydrated lime only involves mixing quicklime with water. The share of cradle-to-gate quicklime production in the carbon footprint of hydrated lime is 94-98%.
- Electricity use by the hydrator contributes 2-3% to the carbon footprint of hydrated lime, while diesel use in Kwinana contributes 3% to the hydrated lime produced there.

Differences between hydrated lime products are mainly related to differences in quicklime production, with minor differences due to processing.

References

Adbri	Safety Data Sheets and Product Description documents (https://www.adbri.com.au/our-products/all-products/), 2023
AEPDP 2018	Australasian EPD Programme, Instructions of the Australasian EPD programme v3.0 - a regional annex to the general programme instructions of The International EPD® System, Version 3.0, 18 September 2018
AS 1672.1	AS 1672.1:1997, Limes and limestones, Part 1: Limes for building, Standards Australia, Sydney, 5 September 1997
AusLCI 2021	Australian Life Cycle Inventory database v1.36, published by the Australian Life Cycle Assessment Society (ALCAS) http://www.auslci.com.au/
ECHA 2023	European Chemicals Association, Candidate List of substances of very high concern for Authorisation, published in accordance with Article 59(10) of the REACH Regulation, Helsinki Accessed on 12 January 2023 from: https://echa.europa.eu/candidate-list-table
EN 15804+A1	EN 15804:2012+A1:2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products, European Committee for Standardization (CEN), Brussels, September 2013
EN 15804+A2	EN 15804:2012+A2:2019, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products, European Committee for Standardization (CEN), Brussels, October 2019
EN 16908 EN	16908:2017+A1:2022 Cement and building lime - Environmental product declarations - Product category rules complementary to EN 15804, European Committee for Standardization (CEN), Brussels, February 2022
Environdec 2019	International EPD System, General Programme Instructions for the International EPD System, Version 3.01, 18 September 2019
ISO 14025	ISO14025:2006, Environmental labels and declarations - Type III environmental declarations - Principles and procedures. International Organization for Standardization, Geneva, Switzerland, 2006
ISO 14040	ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework. International Organization for Standardization, Geneva, Switzerland, 2006
ISO 14044	ISO14044:2006, Environmental management - Life cycle assessment - Requirements and guidelines. International Organization for Standardization, Geneva, Switzerland, 2006
NGA 2022	Commonwealth of Australia - Department of Climate Change, Energy, the Environment and Water, Australian National Greenhouse Accounts Factors 2022, November 2022
PCR2019:14 (version 1.11)	Product category rules for Construction products (EN 15804:A2), registration number 2019:14, published on 5 February 2021

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