Environmental Product Declaration

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

Hydrated lime – Sector EPD

from

European Lime Association (EuLA), Brussels

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

General information

Programme information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
E-mail:	info@environdec.com

Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product Category Rules (PCR): PCR 2019:14 - Construction Products (EN 15804:2012 + A2:2019), Version 1.3.2 Complementary Product Category Rules: c-PCR-001 - Cement and building limes (EN 16908:2017 + A1:2022), UN CPC code: 3742
PCR review was conducted by: The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com. Chair of the PCR review: Paola Borla. The review panel may be contacted via info@environdec.com.
Life Cycle Assessment (LCA)
LCA accountability: EuLA: info@eula.eu
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☒ EPD verification by individual verifier Third-party verifier: Prof. Adriana Del Borghi, University of Genoa Approved by: The International EPD® System
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 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.

Company information

Owner of the EPD: European Lime Association (EuLA), Rue des Deux Eglises 26,
1000 Brussels, Belgium

Contact: EULA : info@eula.eu

Description of the organisation: The European producers of quicklime and hydrated limed established their own representation at EU level through EuLA, a member of the Industrial Minerals Association Europe (IMA-Europe). EuLA is a non-profit organisation, which ensures member companies cooperation on scientific and legislative issues of common interests remated to quicklime, hydrated lime and dolime. As a member of IMA-Europe, the EuLA members benefit from a wide representation and strong voice at EU level and synergy on issues common to the industrial minerals sector as a whole. EuLA membership comprises 27 member organisations of which17 are companies and 10 national associations.

Name and location of production site(s): [...]
16 companies and 10 national associations located in the European Union plus UK and Norway:

1. WKO – Fachverband der Stein und keramischen Industrie
2. FEDIEX
3. Ognyanovo
4. InterCal
5. Czech Lime Association
6. Faxe Kalk
7. Nordkalk Estonia
8. Nordkalk Finland
9. UP'Chaux – Union des producteurs de chaux
10. KALK – Bundesverband der Deutschen Kalkindustrie
11. Yioi Th. Tsarouha
12. Carmeuse Hungary
13. Clogrennane Lime
14. CAMA
15. Dolomite Franchi
16. Franzefoss Minerals
17. Polish Lime Association
18. Calcidrata
19. Lhoist Iberica Lusical
20. Carmeuse Romania
21. CELCO
22. Carmeuse Slovakia
23. Intercal
24. ANCADE (Asociación Nacional de fabricantes de Cales y Derivados)
25. Swedish Lime Association – Svenska Kalkföreningen
26. Mineral Product Association (MPA)

(for more details: EuLA | IMA Europe (ima-europe.eu),
Regional coverage EU + UK + EFTA, Market coverage: > 85% of the hydrated lime produced from quicklime with a free CaO content ranging from 89,5% to 97,5%, placed on the EU + UK + EFTA market.

Product information

Product name:
Hydrated lime

Product identification:
Hydrated lime produced from a quicklime with a free CaO content (according to EN 459-2) ranging from 89,5% to 97,5%.

Product description:
Hydrated lime ($Ca(OH)_2$) is a versatile commodity that is produced by the hydration of high quality quicklime (CaO). The latter is produced by the calcination of high purity limestone ($CaCO_3$). In the production process the blocks of limestone from the quarry are blasted, crushed and sorted by size in screening plants. The high quality limestone, with a defined particle size, is calcined in a lime burning plant at a temperature of 900-1200°C, at which temperature it is decarbonised in either vertical shaft or horizontal rotary kilns fired by natural gas, oil, coal, coke or other fuels. During that process, carbonate is converted into oxide (CaO) and CO_2 is released. The thus obtained quicklime is then hydrated, i.e. combined with water, in a hydrating plant. The quantity of water added is more than the amount required for the hydration reaction. The excess water is added to moderate the temperature generated by the heat of reaction by conversion to steam. The end product is hydrated lime or slaked lime ($Ca(OH)_2$) in the form of a very fine powder, suitable for a variety of applications.

Hydrated lime can be used in many applications in the construction sector like:

- Mortars, renders and plasters

  Functionality: the hydrated lime is mixed with water, sand and eventually cementitious binder and additives. Once put in place, the blends harden both when the calcium hydroxide reacts with the atmospheric carbon dioxide, thus generating calcium carbonate, and the cementitious binder hardens to increase the compressive strength. Carbon dioxide is chemically fixed.

- Paints

  Hydrated lime is used in lime-based paints.

- Soil stabilisation

  Functionality: hydrated lime enables the cation exchange and crowding of additional cations onto the surfaces of particles of clay, which are negatively charged, take place, resulting in a different behaviour where clay particles become attracted to one other, causing flocculation. These effects induce at short term soil modifications, making it feasible to compact them easily on building sites, and even more in function of the quantity of lime added, long term properties can be realized due to pozzolanic reactions between solubilized elements of clay particles, moisture and lime.

- Use in grouts for tunnel construction

  Functionality : hydrated lime is used as a component in cementitious grout mixtures used in tunnelling. It enables adjusting the injection flow and the setting characteristics of the fluid grout and helping with the hardening of the injected grout mixture.

UN CPC code: 37420 Quicklime, slaked lime and hydraulic lime

Geographical scope: European Union plus UK and Norway

LCA information

Functional unit / declared unit:
Declared unit used in the LCA study is 1 metric tonne (1000 kg) of product.

Time representativeness:
Reference year for the EuLA LCI study for hydrated lime is 2021.

Database(s) and LCA software used:
For life cycle modelling of the hydrated lime, the GaBi ts Software System for Life Cycle Engineering (version 10.7.1.28 (2023)) developed by Sphera is used. The GaBi database contains consistent and

documented datasets, which are documented in the online GaBi documentation: https://lcadatabase.sphera.com/dataset-documentation. To ensure comparability of the results from the LCA, only the latest data from the GaBi database were used.

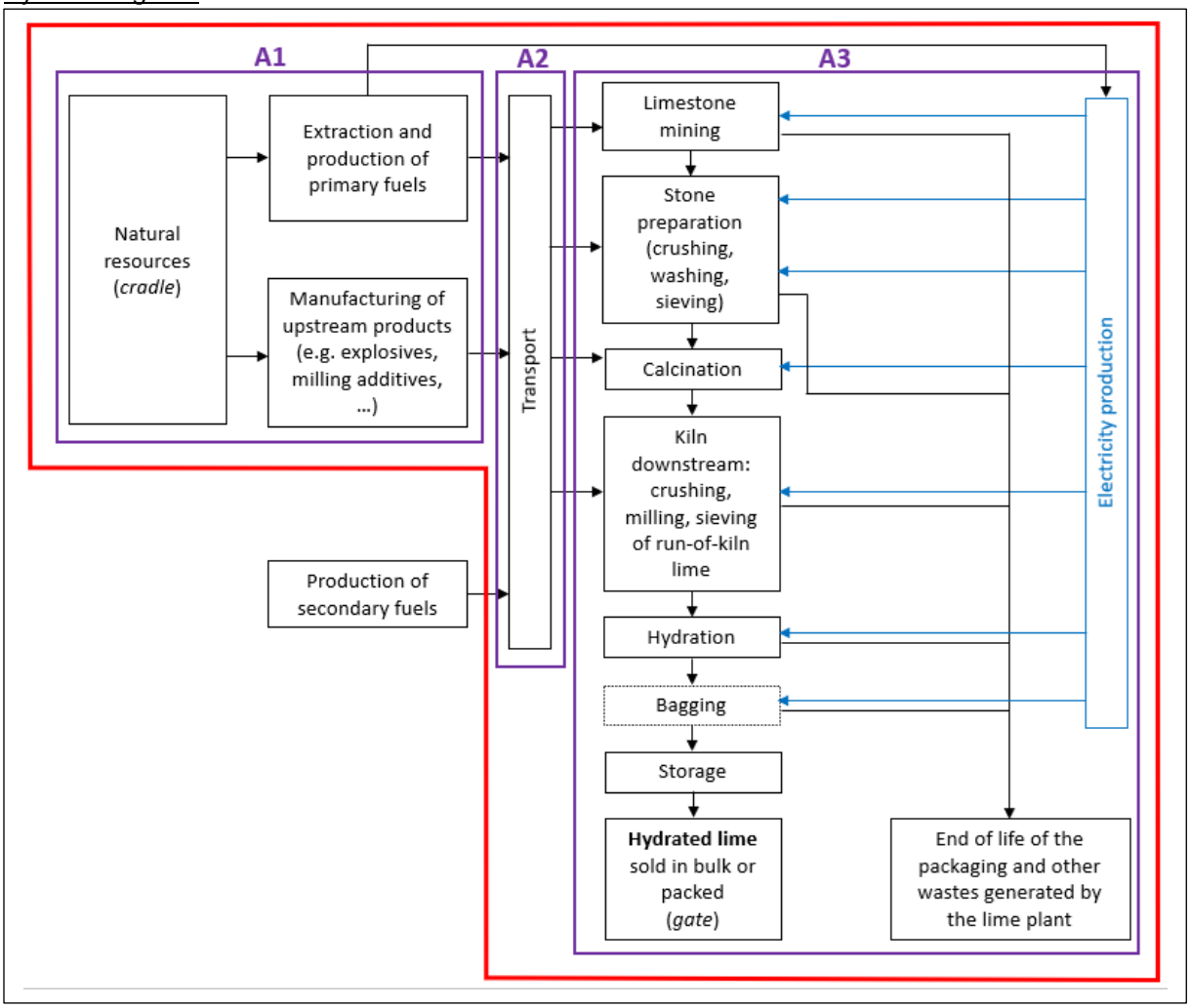
Description of system boundaries:
Cradle to gate with modules A1–A3

The EPD is of this type because the following three conditions are valid according to the PCR:

1. the product or material is physically integrated with other products during installation so they cannot be physically separated from them at end of life, and
2. the product or material is no longer identifiable at end of life as a result of physical or chemical transformation, and
3. the product or material does not contain biogenic carbon.

During the use phase of the hydrated lime, carbonation occurs. Although this process is outside the system boundaries defined above for the modules A1 – A3, EN 16908:2017+A2 specifies that EPD covering solely the modules A1-A3 may optionally include information on carbonation of building limes that occur during the use phase.

System diagram:



Remark: infrastructure and capitals goods are included in the system boundaries.

Key assumptions

Since an extended collection data was performed among lime plants so as to gather all primary data that are relevant for modelling the manufacturing processes, solely few assumptions had to be made. The key one relates to the modelling of the electricity consumed by the plants.

According to the data collection, it was found that the electricity was consisting of:

- 84% of electricity from the grid,
- 14% of green electricity,
- 2% of electricity produced on site, mostly from photovoltaic panels.

In most cases the lime companies were unable to specify if the generation of green electricity was already accounted in the national electricity production statistics or not.

Therefore a number of assumptions were made for the development of the EPD:

- Electricity from the grid: all inputs and outputs related to the production of the electricity consumed in the different process steps were modelled through a specific electricity mix for the EU(27) + UK + Norway that combines:
  - the Life Cycle Inventories (LCIs) of the national electricity produced in the different countries. These LCIs were taken from the GaBi database, version 10.7.1.28, 2023,
  - the weighting factors representing the contribution of the national productions of quciklime (with the qualities specified in the EPD) to the total production of quicklime (with the qualities specified in the EPD).
- Green electricity production
  Since a double accounting of the green electricity could not be excluded from the submitted information, it was conservatively assumed that green electricity was already included in the national statistics for electricity production and thus considered in the EPD as electricity from the grid.
- On site electricity production
  In few cases electricity is produced on site, independently from the grid. Most of this electricity is generated by photovoltaic panels. Data from the GaBi database, version 10.7.1.28, 2023 were taken to model the production of this type of electricity.

Based on these assumptions, following electricity mix was finally taken into account in the baseline scenario:

- Electricity from the grid weighted by factors representing the percentages of national lime production in the total production - as explained above: 98%,
- Electricity from photovoltaic panels: 2%.

In order to check the impact of the assumption made for green electricity (sensitivity analysis)), the latter was assumed to consist of equal proportions of electricity from nuclear, electricity from wind, electricity from solar and electricity from biomass. Given the very low contribution of electricity in the environmental impacts of hydrated lime (e.g. less than 2,5% for GWP-GHG), it was found that the type of green electricity does not affect materially the majority of the environmental indicators.

Cut-off criteria

The processes not taken into account in the inventory (cut-off criteria) represent less than 0,01% of the mass inputs and less than 0,5% of the energy inputs.

More information:

LCA practitioner: EESAC SAS, www.eesac.eu

Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results):

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Geography	EU(27), UK, NOR			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Specific data used	> 90% for A1 – A3			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	Not relevant			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	> 35% for A1 – A3			-	-	-	-	-	-	-	-	-	-	-	-	-	-

ND: Not Declared

Content information

The product properties are listed in the following table

Name	Purity	Particle size	Form of delivery
Hydrated lime	Hydrated lime produced from a quicklime with 89,5% ≤ Free CaO ≤ 97,5%	Powder	Bulk or packed (bags / big-bags)

Results of the environmental performance indicators

General remark: the following declared impact results are relative expressions, which do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Mandatory impact category indicators according to EN 15804

Results per functional or declared unit (per 1 metric tonne product)		
Indicator	**Unit**	**A1-A3**
GWP-fossil	kg CO_2 eq.	8,92E+02
GWP-biogenic	kg CO_2 eq.	1,47E+01
GWP-luluc	kg CO_2 eq.	4,79E-02
GWP-total	kg CO_2 eq.	8,92E+02
ODP	kg CFC 11 eq.	6,35E-10
AP	mol H^+ eq.	5,67E-01
EP-freshwater	kg P eq.	2,25E-04
EP-marine	kg N eq.	2,11E-01
EP-terrestrial	mol N eq.	2,31E+00
POCP	kg NMVOC eq.	7,65E-01
ADP-minerals&metals*	kg Sb eq.	2,57E-05
ADP-fossil*	MJ, net calorific value	3,73E+03
WDP*	m^3	1,35E+01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption	

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

Additional information related to the electricity

Electricity data and quality	Data for the electricity mix as described above using GaBi database version 10.7.1.28
GWP-GHG indicator of the electricity	0,357 kg CO_2 eq./kWh

Additional information related to the carbonation of the hydrated lime during the use phase

When used in various products or applications, hydrated lime may carbonate during the use phase. Since this phase is out of the boundaries of the system considered in this EPD, the approximate minimum amounts of CO_2 that are sequestrated over a period of 100 years are provided hereafter for informative purposes only. They are based on an extended bibliographical review (s. references):

- Hydrated lime used in the production of mixed air-lime mortars : -1.13 E+02 kg CO_2 eq. /t $_{\text{hydrated lime}}$
- Hydrated lime used in the production of pure air-lime mortars : -5,22 E+02 kg CO_2 eq. /t $_{\text{hydrated lime}}$
- Hydrated lime used in soil stabilisation : -2,10 E+02 kg CO_2 eq. /t $_{\text{hydrated lime}}$

Additional mandatory and voluntary impact category indicators

Results per functional or declared unit (per 1 metric tonne product)		
Indicator	**Unit**	**A1-A3**
GWP-GHG[1]	kg CO_2 eq.	8,92E+02
PM	Disease incidence	4,82E-06
IRP[2]	kBq U235 eq.	1,04E+01
ETP-fw[3]	CTUe	8,16E+02
HTP-c*	CTUh	3,15E-08
HTP-nc*	CTUh	1,75E-06
SQP*	-	3,32E+02
Acronyms	PM = Particulate Matter emissions; IRP = Ionizing radiation, human health; ETP-fw = Ecotoxicity (freshwater); HTP-c = Human toxicity , cancer effects; HTP-nc = Human toxicity non-cancer effects; SQP = Land use related impacts / soil quality	

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

[1] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO2 is set to zero.

[2] Disclaimer : this impact category deals mainly with 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 construction materials is also not measured by this indicator.

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

Resource use indicators

Results per functional or declared unit (per 1 metric tonne product)		
Indicator	**Unit**	**A1-A3**
PERE	MJ, net calorific value	3,30E+02
PERM	MJ, net calorific value	0,00E+00
PERT	MJ, net calorific value	3,30E+02
PENRE	MJ, net calorific value	3,45E+03
PENRM	MJ, net calorific value	2,79E+02
PENRT	MJ, net calorific value	3,73E+03
SM	kg	0,00E+00
RSF	MJ, net calorific value	1,25E+02
NRSF	MJ, net calorific value	0,00E+00
FW	m^3	1,22E+00
Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water	

Waste indicators

Results per functional or declared unit (per 1 metric tonne product)		
Indicator	**Unit**	**A1-A3**
Hazardous waste disposed	kg	6,73E-02
Non-hazardous waste disposed	kg	1,46E+01
Radioactive waste disposed	kg	6,82E-02

Output flow indicators

Results per functional or declared unit (per 1 metric tonne product)		
Indicator	**Unit**	**A1-A3**
Components for re-use	kg	0
Material for recycling	kg	4,74E-01
Materials for energy recovery	kg	5,88E-02
Exported energy, electricity	MJ	0,00E+00
Exported energy, thermal	MJ	0,00E+00

Information on biogenic carbon content

Results per functional or declared unit (per 1 metric tonne product)		
BIOGENIC CARBON CONTENT	**Unit**	**QUANTITY**
Biogenic carbon content in product	kg C	0
Biogenic carbon content in packaging	kg C	0

Note: 1 kg biogenic carbon is equivalent to 44/12 kg CO2

Information related to Sector EPD

The sector EPD covers the production of hydrated lime produced from a quicklime with a free CaO content ranging from 89,5% to 97,5%, produced by the members of EuLA and placed on the EU +UK + EFTA market.

EuLA members producing in the EU (27) + UK + Norway are:

1. WKO – Fachverband der Stein und keramischen Industrie
2. FEDIEX
3. Ognyanovo
4. InterCal
5. Czech Lime Association
6. Faxe Kalk
7. Nordkalk Estonia
8. Nordkalk Finland
9. UP'Chaux – Union des producteurs de chaux
10. KALK – Bundesverband der Deutschen Kalkindustrie
11. Yioi Th. Tsarouha
12. Carmeuse Hungary
13. Clogrennane Lime
14. CAMA
15. Dolomite Franchi
16. Franzefoss Minerals
17. Polish Lime Association
18. Calcidrata
19. Lhoist Iberica Lusical
20. Carmeuse Romania
21. CELCO
22. Carmeuse Slovakia

23. Intercal
24. ANCADE (Asociación Nacional de fabricantes de Cales y Derivados)
25. Swedish Lime Association – Svenska Kalkföreningen
26. Mineral Product Association (MPA)

The market coverage is more than 85% of the hydrated lime produced from quicklime with the specification mentioned above that is placed on the EU + UK + EFTA market.

The data providers/ production sites have been chosen by EuLA's LCA/EPD task force as representative for the year 2021, the declared product and the respective hydrated lime production. The average calculation was done according to the weighted production share of the data providing plants.

References

General Programme Instructions of the International EPD® System. Version 4.0.
PCR 2019:14. Version 1.3.2

Complementary Product Category Rules: PCR 2019:14 c-PCR-001 – Cement and building limes (EN 16908) (2022-05-18)

GaBi ts dataset documentation for the software system and databases, LBP, University of Stuttgart and Sphera, Leinfelden-Echterdingen,(http://documentation.gabi-software.com/).

Grosso M., Biganzoli L., Campo F. P., Pantini S., Tua C. 2020. Literature review on the assessment of the carbonation potential of lime in different markets and beyond. Report prepared by Assessment on Waste and Resources (AWARE) Research Group at Politecnico di Milano (PoliMI), for the European Lime Association (EuLA). Pp. 333.

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