Environmental Product Declaration

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

Clinker and Cement Products of INSEE Cement (Thailand)

from

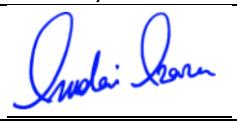
Siam City Cement Public Company Limited (Thailand)

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-04957
Publication date:	2023-04-07
Valid until:	2028-03-31
Geographical scope:	Thailand

General information

Programme:	The International EPD® System, www.environdec.com
EPD owner:	Siam City Cement Public Company Limited (Thailand)
Address:	99 Moo 9 and 219 Moo 5, Mitraparb Road Km. 129-131Tambon Tabkwang, Amphor Kangkoy, Saraburi Province 18260, Thailand
Website:	www.siamcitycement.com
Products:	Clinker and Cement products portfolio

Third-party verification

Name and organization of verifier:	**Hudai Kara, PhD** - Managing Director **Metsims Sustainability Consulting** www.metsims.com
Date and location:	**Oxford, United Kingdom, 2023.04.01**
Signature:	
This declaration is based on the European standard - EN 15804:2012+A2:2019 Independent verification of the declaration and data, according to EN ISO 14025 ☐ Internal ☒ External	
Reference standards:	ISO 14025:2006, ISO 14020:2000, EN 15804:2012+A2:2019, PCR 2019:14 Construction-products and services, version 1.11

LCA Information

Title:	Life Cycle Assessment of Clinker and Cement production of Siam City Cement Public Company Limited (Thailand): 1,000 kg average Clinker and Cement
Date of Issue:	Feb 2023
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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.

I Product related information

1.1 Company information

The company was first established on May 16, 1969 as Siam City Cement Company Limited with the initial registered capital of 100 million baht and began cement production after the completion of its cement plant in 1972.
In order to reduce the consumption of fuel which represented a major cost of cement production, in 1989 the company became the first cement producer in Southeast Asia to introduce a waste heat recovery system which converted heat captured from the cement kiln to produce electricity. Then in 1993, the company was officially renamed "Siam City Cement Public Company Limited" to reflect the nature of its being a fully listed company in Thailand's stock exchange.

In 2014, the Company became the first cement manufacturer in Thailand to be awarded the Carbon Footprint for Product (CFP) and Carbon Footprint Reduction labels from the Thailand Greenhouse Gas Organization (TGO). Moreover, the Company also received the Green Industry Level 5 (Green Network) Award for all of its plants, which is the highest award provided by the Ministry of Industry. This makes SCCC the first Company in the Thai cement industry awarded with Green Industry Level 5 certification for all of its cement manufacturing facilities.

In September 2015, we have taken steps to expand into more overseas markets. A joint venture was created to build a cement plant in the Kingdom of Cambodia under the name of Chip Mong INSEE Cement Corporation. SCCC held a 40 percent stake in this joint venture, with the remaining 60 percent held by Chip Mong Group Company Limited and three of the family members. Chip Mong INSEE Cement Corporation was officially established in December 2015. This cement plant, which was the most modern plant in the Kingdom of Cambodia, has the dry process cement kiln with an annual production capacity of 1.5 million tons.

At the end of 2015, SCCC was awarded 6 awards in Thailand and ASEAN energy awards in 3 categories, namely Special Submission, Off-Grid-Thermal, and Tropical Building. Such awards are our prides to encourage organizations of both state and private sectors to be aware of the importance on the efficient use of energy as well as to elevate Thai energy standard level to comparatively equal to that of international standard, as well.

In addition, the Company increased its registered capital to 2,980 million baht from the resolution of Annual General Meeting of Shareholders No. 24 on 31 March 2017. In 2018, the Company continued to develop and expand the products of its subsidiaries to serve the market demand such as expansion of the INSEE Superblock's wall-panel solution business, and in expansion of INSEE Ecocycle's industrial cleaning services and Municipal Solid Waste/Refused Derive Fuel management (MSW/RDF).

Currently, the Company has determined to grow the business portfolio and to expand its revenue base, and thus has expanded its businesses and established local and foreign subsidiary and joint venture companies in Southeast Asia and South Asia. As the Company has been producing and marketing high-quality and innovative cement products domestically and in Asia, the subsidiary and associated companies were also hard at work to develop products and services related to the Company's core business encompassing operations involving many types of construction products and fiber-cement decorative materials for architectural works both domestically and abroad. Also, well advanced were peripheral businesses such as waste management, industrial cleaning services and international seaborne trade.

1.2 Manufacturing process

The most important component of cement according to TIS.2594-2556 (Thai Industrial Standard) & ASTM C1157/C1157M Type GU. Our clinker produced from raw materials such as limestone, Shale, and clay etc. which are crushed, homogenized with the Lateral Reclaimer and/or Bridge Reclaimer which makes it consistent quality and throughout the entire pile, and fed into a rotary kiln. The raw materials are sintered at a temperature of 1450°C to form new compounds.

The clinker consists mainly of oxides of calcium, silicon, aluminums, and iron. In a second phase Calcium sulfate and possibly additional cementitious or inert materials are added to the clinker. All constituents are ground leading to a fine and homogenous powder with a daily production capacity of 39,500 tons of clinker.

The production of cement is subject to INSEE Cement (Thailand), which address all relevant environmental effects like the excavation of natural raw materials, the rehabilitation of quarries, the recovery of energy and material from wastes and the emission of noise, dust, and hazardous substances (NOx, SO2, heavy metals, etc.)

The Clinker and Cement is currently manufactured in the plants listed here below

Plant	Address
Plant 1	99 Moo 9, Mitraparb Road Km. 129-131Tambon Tabkwang, Amphor Kangkoy, Saraburi Province 18260
Plant 2	219 Moo 5, Mitraparb Road Km. 129-131Tambon Tabkwang, Amphor Kangkoy, Saraburi Province 18260
Plant 3	99 Moo 9, Mitraparb Road Km. 129-131Tambon Tabkwang, Amphor Kangkoy, Saraburi Province 18260

Currently, we operate only at Plant 2 and 3, while Plant 1 temporarily stopped operation for both production lines, with Production line No.2 stopping operation in 2008, Production line No.1 stopped operation in 2020 and Plant 4 has no plan to operate soon.

1.3 Standards and Certifications

To become one of the leading cement producers in the world and achieve with customer confidence in product and service, Siam City Cement Public Company Limited has intended to operate our business based on systematic principles and standardization. In this regard, our company has applied many standards and management systems covering all our product life-cycle and supply chain. The significant standards and certifications that we presently maintain and continuously develop are shown as follows:

International Organization for Standardization: ISO

- ISO 9001:2015 Quality Management System (QMS)
- ISO 14001:2015 Environmental Management System (EMS)
- ISO 45001:2018 Occupational Health and Safety Management System (OHSMS)
- ISO/IEC 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories

Other standards and certifications

- Global Cement and Concrete Association (GCCA) Charters
- Green Industrial Standard by the Department of Industrial Works, Thailand
- Environment, Social, and Governance (ESG) Standard, The Stock Exchange of Thailand
- Corporate Social Responsibility Standard by the Department of Industrial Works, Thailand
- Green Label Standard by Thailand Environment Institute
- Carbon Footprint for Organization by Thailand Greenhouse Gas Management Organization
- Carbon Footprint for Product by Thailand Greenhouse Gas Management Organization

1.4 Technical description of the products

No	Trade name	Significant characteristic & Recommended use	Product Standard
Cement Bag Segment			
1	**INSEE Petch** 	INSEE Petch is a high-performance Portland cement with a high strength, to optimize the concrete design in ready-mixed and precast and to improve the business performance. INSEE Petch offers a reliable workability behaviour during transport, which improves the concrete quality at jobsite. INSEE Petch can be used in ready-mixed concrete as well as in precast elements, such as piles, pipes, culverts, blocks, and concrete panels.	**TIS 15-2562** **ASTM C150**
2	**INSEE Petch Plus** 	INSEE Petch Plus is fully compliant with the Thai and international Quality standard TIS 2594-2556 for Hydraulic cement and ASTM C1157. INSEE Petch Plus is easier to mix and to pour, with faster working progress and higher productivity, offering significant savings to small CPM (blocks, pipes, poles etc), site mix concreting at jobsite and mini RMX plants.	**TIS 2594-2556** **ASTM C1157 type GU**
3	**INSEE Dang** 	INSEE Dang is mixed cement, manufactured from Portland cement clinker finely ground with other inert materials, which produces a mortar of high plasticity. INSEE Dang is suitable for masonry and plastering works where minimal mortar shrinkage and smooth finishing are required. The INSEE dang is also suitable for ordinary concrete works such as general housing works, concrete pavement, concrete tiles, piers, drainpipes, septic tanks, water tanks, etc	**TIS 80-2550**
4	**INSEE Poon Keaw** 	INSEE Poon Keaw is suitable for general bricklaying and plastering works which does not require high specific strength such as concrete column casting, small slab concrete, concrete pavement, concrete tiles, drain pipes and etc. Its specification conforms to the Thai Industrial Standard for Mixed Cement TIS 80-2550	**TIS 80-2550**
5	**INSEE Super** 	INSEE Super is new formula (40 kg.) concentrated mixed cement that ensures more solid and workable. The new INSEE Super tested and evaluated by professional contractors that appears in the same quality as the general 50 kg. mixed cement with more efficient work. INSEE Super Concentrated Mixed Cement. INSEE Super is high quality concentrated mixed cement which produced to conform to the Thai Industrial Standard of mixed cement: TIS 80-2550. INSEE Super is suitable for general bricklaying and plastering work such as small concrete pile, concrete fence, concrete pavement, concrete tile, drain, pipes etc.	**TIS 80-2550**
6	**INSEE Tong** 	INSEE Tong comprises ultra-fine cement powder and an inter-grinding admixture XD65. As the INSEE Tong contains the XD65. it promotes the INSEE Tong property to be perfect for plastering work as it improves workability, ball bearing effect, adhesion, water retention and air void distribution while reduces cracking, formation of mold, shrinkage, skin irritation and material wasted while working. INSEE Tong is premium cement, which specially formulated for plastering and bricklaying works. It conforms to the ASTM C91 Type N and TIS 2595-2556 Type 50 (masonry cement) standards. The INSEE Tong is perfect for plastering works, both interior and exterior. It can also be used for small repairing works and bricklaying works where high compressive strength is not essential. With the special admixture pre-added, masons do not need to add any extra admixture during the mixing process thus, supervision time and material cost can be reduced.	**TIS 2595-2556 Type 50** **ASTM C91 Type N**

No	Trade name	Significant characteristic & Recommended use	Product Standard
Bulk Cement Segment			
7	**INSEE Petch** 	INSEE Petch is a high-performance Portland cement with a high strength, to optimize the concrete design in ready-mixed and precast and to improve the business performance. INSEE Petch offers a reliable workability behaviour during transport, which improves the concrete quality at jobsite. INSEE Petch can be used in ready-mixed concrete as well as in precast elements, such as piles, pipes, culverts, blocks, and concrete panels.	**TIS. 15-2562 Type I** **ASTM C150 Type I**
8	**INSEE Petch Easy Flow** 	INSEE Petch Easy Flow is an optimized cement specifically designed for Ready Mixed concrete customers who require long workability and stable strength for infrastructure and other construction projects. It also meets the needs of ready-mix companies looking to make concrete mixes with stable strength and flowability for use in curves, arches, and other architectural effects.	**TIS 2594-2556** **ASTM 1157 type GU**
9	**INSEE Petch Quick Cast** 	INSEE Petch Quick Cast offers a high early strength in concrete, the formwork can be removed early, and the concrete precast elements can be manipulated sooner: these speeds up the production cycle and saves investment costs.	**TIS 2594-2556** **ASTM 1157 type GU**
10	**INSEE Dum** 	INSEE Dum is a very high early strength Portland cement, that allows the early removal of the formwork at the optimized concrete mix design. With the optimal stiffening behaviour of INSEE Dum, the concrete surface can be finished earlier to further improve the productivity in a precast factory. The specific characteristics of INSEE Dum makes it very suitable for professional precast concrete, such as bridge segments, pre-stressed piles, beam & columns, and wall panel.	**TIS 15–2012 Type III** . **ASTM C150 Type III**

1.5 Declared unit

The declaration is established for the average product of these manufacturing plants. The average is based on the accounted production volume of each plant. As the applications of Clinker or Cement as an intermediate material are numerous, a unique functional unit cannot be defined and therefore this EPD is based on a declared unit = 1,000 kg of Clinker or Cement.

1.6 Description of underlying LCA – Based Information

The cement production process of Plants 1, 2, and 3 consists of 5 main steps: Raw Material Preparation, Raw Material Grinding, Clinker Burning, Cement Grinding, and Packaging and Transportation, details as shown in Figure 1-1

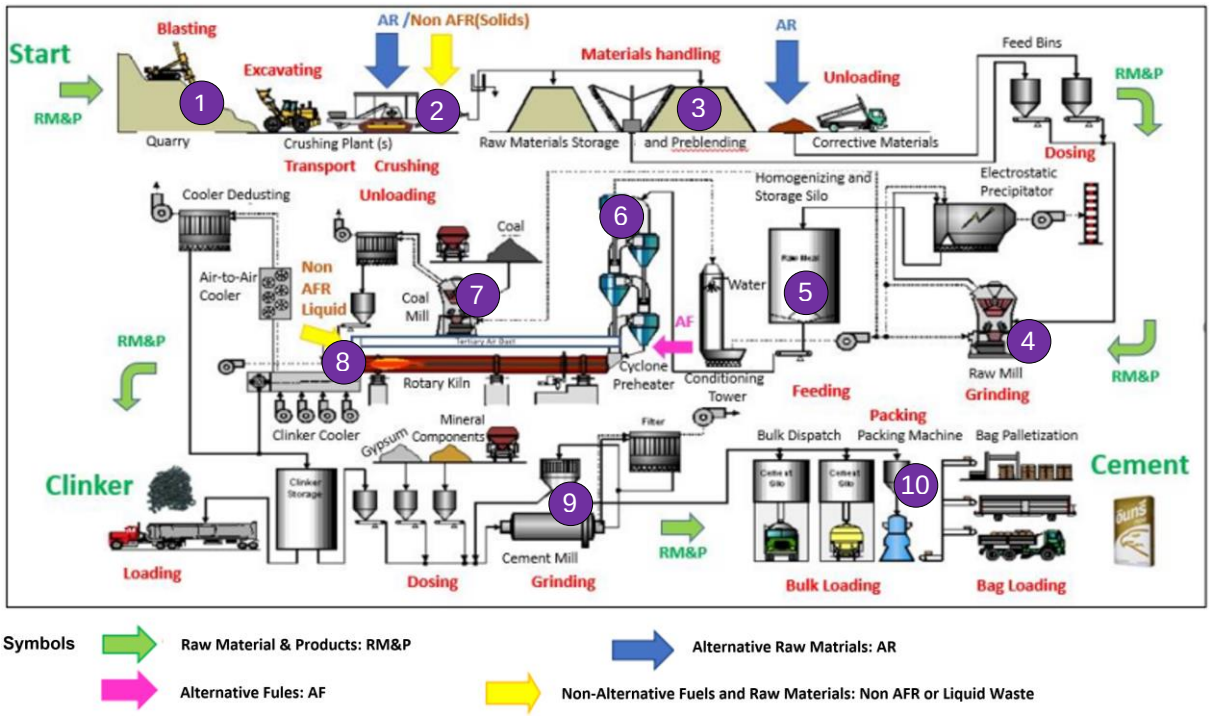

Figure 1-1 Boundary of the industry-average cement production processes at INSEE Cement (Thailand).

Using terminology from EN 15804, the Gradle to Gate life cycle is broken down into three life cycle stages:

- *A1 - Raw material excavation & Raw Material Preparation - Stage 1, 2,3*
  - Raw Material Grinding – Stage 4,5
- *A3 - Clinker Burning & Clinker production - Stage 6,7,8*
- *A3 - Cement production & Storage of cement for dispatch - Stage 9,10*

The Upstream Processes (A1) include:

- The raw materials used in the production process are limestone and shale, which are available in the production concession area. The raw materials are dry and have low moisture content which is adopted by drilling and blasting rock out of a lump the size 1000-1,400 mm, then transported by 35 and 80 tons to enter crushing which is separately between the limestone and shale. The size of the device is approximately 35 mm, and then transported by conveyor belt to keep the pile with a stacker. The limestone is kept outdoors, and the shale is kept in the building to prevent rainwater. For industrial waste (both mineral and non-mineral), the project will be used as an Alternative Raw Material (AR) to the specified criteria and the materials were fed consistently to take the time to use the Lateral Reclaimer and/or Bridge Reclaimer which makes it consistent quality and throughout the entire pile.
- Iron ore and gypsum were transported and stored in the project area before they were conveyed to raw material silos and sent to the mixer with other raw materials according to the requirement.
- The raw material from the storage building will be transported into the Feed Hopper, and then forwarded to Raw Mill. The raw materials grinding will extract hot air from the burning process to unused heated material at the pre-heater tower which has a temperature of approximately 325 ºC to moisture out of the material during the grinding in the Raw mill. The raw material powder is stored in Blending Silo and enters a process to clinker.

The Core Processes (A3) include:

- The grinding material is conveyed out of the Blending Silo to the upper part of the reheating tower (Pre-Heater Tower), in which each set consists of cyclone 5 sets in consecutive order from upstairs to downstairs. The grinding material is moved from the top of the cyclone counter to the hot air from the kiln which has a temperature of about 1,000 ºC to the cyclone ground floor. Then the raw material is heated

up to about 880-900 ºC and flows into the Pre-Calciner, Then the fuel is used to burn the decomposition of calcium carbonate (CaCO3) into calcium oxide (CaO).

- The material that is burning was sent to the kiln where burning lime used coal-fired as the main fuel and renewable fuels. The temperature in the cement kiln to about 1450 ºC. The raw materials are burned and transformed into Clinker and will be forwarded to the Clinker Cooler by using cool air from external to cool clinker and making the temperature down to 80-90 ºC before being transported to the storage in the clinker silo.
- The hot air from the combustion in the kiln and Pre-Calciner runs counter to the new raw material being fed through the cyclone of the Pre-Heater Tower to make the new raw material. At the same time, the raw materials composed of limestones will be trapped in a kind of acids caused by combustion such as oxides of sulfur and others back into the burning kiln and sealed in the clinker. The last temperature of the hot air out of the Pre-Heater tower is about 320 ºC and will be taken to the Pre-Heater Boiler for power generation from the waste heat recovery and some sent to Raw Mill to remove moisture from the material. The hot air will be sent to the Gas Conditioning Tower (GCT) to reduce the temperature to about 150 ºC before passing into the dust collector and venting into the atmosphere.
- The hot air generated from Clinker Cooler will be taken advantage of. The first section with a high temperature of about 1000 ºC will be used as secondary air to make the main fuel combustion at the Main Burner and the second part of the hot air, with temperatures about 800 ºC is applied to the tertiary air to make the fuel combustion at the Pre-Calciner. Then left hot air with a temperature about 350 ºC will be sent to the AQC-boiler for generating electricity from waste heat recovery. The hot air will be passed into the dust collector and vent into the atmosphere.

The Core Processes (A3) include:

- The clinker products will be transported from the storage tank to the cement mill and will be mixed with the other additives (Dosing) such as limestone, fly ash from coal-fired power plants, gypsum and grinding aids, etc. The determined proportion of additives and the products are different types of cement processes. The cement product is sent to be stored in the Cement Mill.

Π Environmental performance-related information & estimations and methodology

2.1 Main product components

Clinker INSEE Cement (Thailand) is ground to a fine powder and used as the binder in many cement products. A little gypsum is sometimes added. Clinker, when stored in dry conditions, can be kept for several months without appreciable loss of quality.

TABLE 1.1 : Technical Specification of Clinker and INSEE Petch Cement

	Unit	Clinker	Remark
SiO_2	%	21.41	20 - 23
Al_2O_3	%	5.16	4 - 7
Fe_2O_3	%	3.38	3 - 5
CaO	%	66.29	64 - 68
MgO	%	1.57	< 3.0
Na_2O eq	%	0.56	< 0.5
SO_3	%	0.82	< 1.5
LSF	&	97.16	> 93
C_3S Bogue	%	63.51	> 57
C_3A Bogue	%	7.96	< 9
FCaO	%	1.20	< 1.5

	Unit	INSEE Petch	Remark
SO_3	%	2.88	< 3.5
LOI		2.81	< 3.0
IR	%	0.38	< 0.75
Free CaO	%	1.41	< 2.0
Na_2O eq	%	0.47	< 0.6
C_3S Bogue	%	67.1	> 56
C_3A Bogue	%	7.45	< 9.0
C_4AF Bogue	%	9.16	9-11
Air Content	%	9.6	< 11
Blaine	cm^2/g	3,522	> 3,300
Initial setting time	min	112	> 80
Final setting time	min	196	< 300
LOI	%	1.41	< 2.0
3D Strength	Psi	3,761	> 3,000
7D Strength	Psi	4,458	> 4,000

INSEE Cement (Thailand) according to TIS 2594-2556 and ASTM C1157 are produced by grinding and mixing the constituents defined in the standard.
Reduce the clinker factor by using different materials such as Limestone, Fly ash (coal thermal power plant), steel Slag and Alternative raw materials, Alternative fuels such are part of the energy mix. Proper adjustment and maintenance of the system is also considered to be the best way of increasing energy efficiency.

TABLE 1.2 : Composition of INSEE Cement (Thailand)

No	Product name	Standards	% Recycled Content (e.g. Slag , Fly ash, Limestone, AR)	%OPC
Cement Bag Segment				
1	INSEE Petch	TIS 15-2562 ASTM C150	9	91
2	INSEE Petch Plus	TIS 2594-2556 ASTM C1157 type GU	21	79
3	INSEE Dang	TIS 80-2550	59	41
4	INSEE Poon Keaw	TIS 80-2550	59	41
5	INSEE Super	TIS 80-2550	54	46
6	INSEE Tong	TIS 2595-2556 Type 50 ASTM C91 Type N	51	49
Cement Bulk Segment				
7	INSEE Petch	TIS 15-2562 Type I ASTM C150 Type I	9	91
8	INSEE Petch Easy Flow	TIS 2594-2556 ASTM 1157 type GU	13	87
9	INSEE Petch Quick Cast	TIS 2594-2556 ASTM 1157 type GU	26	74
10	INSEE Dum	TIS 15–2012 Type III ASTM C150 Type III	7	93

2.2 Estimations and methodology

Based on data 2021 from all INSEE Clinker & Cement plants in Thailand follow methodology – GCCA's Industry EPD Tool for Cement and Concrete (V3.1), International version.

This LCA was modelled with the program EPD Tool v3.1 from GCCA (Global Cement and Concrete Association) with the scope of A1-A3, cradle-to-gate.

2.3 Result - Potential environmental impacts derived from LCA

This EPD is established for the modules A1, A2 and A3 (X = included in LCA, MND = Module Not Declared)

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
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

TABLE 1.3 : Life-Cycle Stages and Modules

This section presents the aggregated results per indicator and per life cycle stage, as per PCR 2019:14 Construction products (EN 15804:A2) and complementary PCR c-PCR-001 Cement and building limes (EN

16908), including i) core environmental impact indicators (13 indicators), ii) additional environmental impact indicators (6 indicators), iii) parameters describing resource use (10 indicators), iv) other environmental information describing waste categories (3 indicators), and environmental information describing output flows (4 indicators)

2.3.1 **Clinker product:** Impact per 1000 kg average **Clinker INSEE Cement (Thailand)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	908.2 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	908.1 *	kg CO_2 eq.
Global Warming Potential, biogenic	5.296E-2 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	5.554E-2	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	5.866E-6	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.9376	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.1366	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	8.492E-3	kg N eq.
Eutrophication potential, Accumulated Exceedance	2.046	mol N eq.
Formation potential of tropospheric ozone	0.4278	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	8.221E-5	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3741	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	16.27	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 882.3 kg CO2–eq. The net GWP-fos is 882.2 kg CO2-eq. The net GWP-bio is 3.956E-2 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	908.2 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.288E-5	Disease incidence
Potential Human exposure efficiency relative to U235	2545	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	54.56	CTUe
Potential Comparative Toxic Unit for humans - cancer	3.591E-3	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	2.819E-5	CTUh
Potential soil quality index	1602	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 882.3 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	117.1	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of renewable primary energy resources	117.1	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3741	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of non-renewable primary energy resources	3741	MJ, net calorific value
Use of secondary materials	20.39	kg
Use of renewable secondary fuels	8.636	MJ, net calorific value
Use of non-renewable secondary fuels	307.6	MJ, net calorific value
Net use of fresh water	0.4578	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	0.1700	kg
Materials for recycling	0.1800	kg
Materials for energy recovery	0.5200	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	525.0	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	1.340E-2	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	25.96	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	0	kg CO_2

2.3.2 **Cement product:** Impact per 1000 kg average **INSEE Petch (Bag)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	848.5 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	853.3 *	kg CO_2 eq.
Global Warming Potential, biogenic	-4.877 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	0.1057	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	8.22E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	1.027	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.1327	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	8.55E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	2.178	mol N eq.
Formation potential of tropospheric ozone	0.483	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	1.28E-04	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3803	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	24.64	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 825.0 kg CO2–eq. The net GWP-fos is 829.8 kg CO2-eq. The net GWP-bio is -4.889 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	853.5 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.27E-05	Disease incidence
Potential Human exposure efficiency relative to U235	3303	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	64.26	CTUe
Potential Comparative Toxic Unit for humans - cancer	3.26E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	3.01E-05	CTUh
Potential soil quality index	3311	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 829.9 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	228.6	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	45.93	MJ, net calorific value
Total use of renewable primary energy resources	274.6	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3797	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	6.295	MJ, net calorific value
Total use of non-renewable primary energy resources	3803	MJ, net calorific value
Use of secondary materials	19.94	kg
Use of renewable secondary fuels	7.836	MJ, net calorific value
Use of non-renewable secondary fuels	279.1	MJ, net calorific value
Net use of fresh water	0.6798	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.854	kg
Materials for recycling	0.1733	kg
Materials for energy recovery	0.4818	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	476.4	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	1.22E-02	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	23.55	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	-4.953	kg CO_2

2.3.3 **Cement product:** Impact per 1000 kg average **INSEE Petch Plus (Bag)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	744.4 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	749.0 *	kg CO_2 eq.
Global Warming Potential, biogenic	-4.701 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	9.90E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	7.54E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.921	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.1171	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	7.58E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	1.968	mol N eq.
Formation potential of tropospheric ozone	0.4395	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	1.21E-04	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3389	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	23.09	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 723.8 kg CO2–eq. The net GWP-fos is 728.4 kg CO2-eq. The net GWP-bio is -4.711 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	749.2 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.13E-05	Disease incidence
Potential Human exposure efficiency relative to U235	3034	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	57.45	CTUe
Potential Comparative Toxic Unit for humans - cancer	2.84E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	2.68E-05	CTUh
Potential soil quality index	3074	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 728.6 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	213.5	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	44.25	MJ, net calorific value
Total use of renewable primary energy resources	257.8	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3383	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	5.712	MJ, net calorific value
Total use of non-renewable primary energy resources	3389	MJ, net calorific value
Use of secondary materials	21.25	kg
Use of renewable secondary fuels	6.837	MJ, net calorific value

Indicator	A1-A3 (Total)	Unit
Use of non-renewable secondary fuels	243.5	MJ, net calorific value
Net use of fresh water	0.6357	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.835	kg
Materials for recycling	0.1525	kg
Materials for energy recovery	0.4217	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	415.6	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	1.06E-02	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	20.55	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	-4.772	kg CO_2

2.3.4 **Cement product:** Impact per 1000 kg average **INSEE Dang (Bag)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	397.0 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	401.7 *	kg CO_2 eq.
Global Warming Potential, biogenic	-4.718 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	7.74E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	5.60E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.5824	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	6.46E-02	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	4.32E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	1.298	mol N eq.
Formation potential of tropospheric ozone	0.3005	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	9.09E-05	kg Sb eq.
Abiotic depletion potential for fossil resources potential	1967	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	16.95	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 386.4 kg CO2–eq. The net GWP-fos is 391.1 kg CO2-eq. The net GWP-bio is -4.723 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	401.8 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	6.72E-06	Disease incidence
Potential Human exposure efficiency relative to U235	2183	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	41.37	CTUe
Potential Comparative Toxic Unit for humans - cancer	1.47E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	1.62E-05	CTUh
Potential soil quality index	2497	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 391.2 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	167.4	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	44.22	MJ, net calorific value
Total use of renewable primary energy resources	211.6	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	1961	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	5.081	MJ, net calorific value
Total use of non-renewable primary energy resources	1967	MJ, net calorific value
Use of secondary materials	17.15	kg
Use of renewable secondary fuels	3.523	MJ, net calorific value
Use of non-renewable secondary fuels	125.5	MJ, net calorific value
Net use of fresh water	0.4611	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.769	kg
Materials for recycling	8.34E-02	kg
Materials for energy recovery	0.2222	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	214.2	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	5.47E-03	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	10.59	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	-4.769	kg CO_2

2.3.5 **Cement product:** Impact per 1000 kg average **INSEE Poon Keaw (Bag)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	397.1 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	401.7 *	kg CO_2 eq.
Global Warming Potential, biogenic	-4.746 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	7.77E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	5.61E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.5828	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	6.46E-02	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	4.32E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	1.298	mol N eq.
Formation potential of tropospheric ozone	0.3008	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	9.10E-05	kg Sb eq.
Abiotic depletion potential for fossil resources potential	1968	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	17.01	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 386.5 kg CO2–eq. The net GWP-fos is 391.1 kg CO2-eq. The net GWP-bio is -4.752 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	401.9 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	6.72E-06	Disease incidence
Potential Human exposure efficiency relative to U235	2187	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	41.42	CTUe
Potential Comparative Toxic Unit for humans - cancer	1.47E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	1.62E-05	CTUh
Potential soil quality index	2506	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 391.3 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	167.8	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	44.49	MJ, net calorific value
Total use of renewable primary energy resources	212.3	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	1962	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	5.717	MJ, net calorific value
Total use of non-renewable primary energy resources	1968	MJ, net calorific value
Use of secondary materials	17.15	kg
Use of renewable secondary fuels	3.523	MJ, net calorific value
Use of non-renewable secondary fuels	125.5	MJ, net calorific value
Net use of fresh water	0.4625	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.769	kg
Materials for recycling	8.34E-02	kg
Materials for energy recovery	0.2222	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	214.2	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	5.47E-03	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	10.59	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	-4.797	kg CO_2

2.3.6 **Cement product:** Impact per 1000 kg average **INSEE Super (Bag)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	442.6 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	448.2 *	kg CO_2 eq.
Global Warming Potential, biogenic	-5.687 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	8.78E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	5.90E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.6345	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	7.18E-02	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	4.82E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	1.402	mol N eq.
Formation potential of tropospheric ozone	0.3249	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	9.97E-05	kg Sb eq.
Abiotic depletion potential for fossil resources potential	2184	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	19.19	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 430.7 kg CO2–eq. The net GWP-fos is 436.4 kg CO2-eq. The net GWP-bio is -5.693 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	448.4 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	7.44E-06	Disease incidence
Potential Human exposure efficiency relative to U235	2417	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	44.87	CTUe
Potential Comparative Toxic Unit for humans - cancer	1.65E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	1.81E-05	CTUh
Potential soil quality index	2870	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 436.5 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	186.4	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	53.28	MJ, net calorific value
Total use of renewable primary energy resources	239.7	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	2164	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	19.72	MJ, net calorific value
Total use of non-renewable primary energy resources	2184	MJ, net calorific value
Use of secondary materials	13.48	kg
Use of renewable secondary fuels	3.955	MJ, net calorific value
Use of non-renewable secondary fuels	140.9	MJ, net calorific value
Net use of fresh water	0.52	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.778	kg
Materials for recycling	9.24E-02	kg
Materials for energy recovery	0.2482	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	240.5	kg CO_2 eq.

Indicator	A1-A3 (Total)	Unit
Emissions from combustion of secondary fuels from renewable sources used in production processes	6.14E-03	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	11.89	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	-5.746	kg CO_2

2.3.7 **Cement product:** Impact per 1000 kg average **INSEE Tong (Bag)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	470.4 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	476.0 *	kg CO_2 eq.
Global Warming Potential, biogenic	-5.637 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	9.06E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	6.31E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.6713	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	7.64E-02	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	5.10E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	1.471	mol N eq.
Formation potential of tropospheric ozone	0.3395	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	1.04E-04	kg Sb eq.
Abiotic depletion potential for fossil resources potential	2302	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	20.44	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 457.8 kg CO2–eq. The net GWP-fos is 463.3 kg CO2-eq. The net GWP-bio is -5.643 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	476.1 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	7.78E-06	Disease incidence
Potential Human exposure efficiency relative to U235	2482	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	46.1	CTUe
Potential Comparative Toxic Unit for humans - cancer	1.75E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	1.90E-05	CTUh
Potential soil quality index	2930	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 463.5 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	194.9	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	52.82	MJ, net calorific value
Total use of renewable primary energy resources	247.8	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	2295	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	6.797	MJ, net calorific value
Total use of non-renewable primary energy resources	2302	MJ, net calorific value
Use of secondary materials	9.922	kg
Use of renewable secondary fuels	4.201	MJ, net calorific value
Use of non-renewable secondary fuels	149.6	MJ, net calorific value
Net use of fresh water	0.5577	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.783	kg
Materials for recycling	9.76E-02	kg
Materials for energy recovery	0.263	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	255.4	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	6.52E-03	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	12.63	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	-5.696	kg CO_2

2.3.8 **Cement product**: Impact per 1000 kg average **INSEE Petch (Bulk)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	846.7 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	846.5 *	kg CO_2 eq.
Global Warming Potential, biogenic	6.067E-2 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	6.67E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	7.49E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.9771	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	1.30E-01	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	8.13E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	2.081	mol N eq.
Formation potential of tropospheric ozone	0.4544	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	9.96E-05	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3705	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	18.44	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 823.1 kg CO2–eq. The net GWP-fos is 823.0 kg CO2-eq. The net GWP-bio is 4.850E-2 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	846.7 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.21E-05	Disease incidence
Potential Human exposure efficiency relative to U235	2726	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	56.32	CTUe
Potential Comparative Toxic Unit for humans - cancer	3.26E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	2.69E-05	CTUh
Potential soil quality index	1758	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 823.1 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	155.9	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of renewable primary energy resources	155.9	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3705	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of non-renewable primary energy resources	3705	MJ, net calorific value
Use of secondary materials	19.93	kg

Indicator	A1-A3 (Total)	Unit
Use of renewable secondary fuels	7.836	MJ, net calorific value
Use of non-renewable secondary fuels	279.1	MJ, net calorific value
Net use of fresh water	0.5186	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.684	kg
Materials for recycling	1.73E-01	kg
Materials for energy recovery	0.4818	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	476.4	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	1.22E-02	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	23.55	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	0	kg CO_2

2.3.9 **Cement product:** Impact per 1000 kg average **INSEE Petch Easy Flow (Bulk)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	808.9 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	808.8 *	kg CO_2 eq.
Global Warming Potential, biogenic	6.073E-2 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	6.52E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	7.23E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.9411	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	1.25E-01	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	7.78E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	2.012	mol N eq.
Formation potential of tropospheric ozone	0.4415	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	1.01E-04	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3571	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	18.05	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 786.4 kg CO2–eq. The net GWP-fos is 786.3 kg CO2-eq. The net GWP-bio is 4.913E-2 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	808.9 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.17E-05	Disease incidence
Potential Human exposure efficiency relative to U235	2732	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	55.09	CTUe
Potential Comparative Toxic Unit for humans - cancer	3.11E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	2.58E-05	CTUh
Potential soil quality index	1688	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 786.4 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	149.2	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of renewable primary energy resources	149.2	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3571	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of non-renewable primary energy resources	3571	MJ, net calorific value
Use of secondary materials	23.16	kg
Use of renewable secondary fuels	7.472	MJ, net calorific value
Use of non-renewable secondary fuels	266.1	MJ, net calorific value
Net use of fresh water	0.5068	m³

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.677	kg
Materials for recycling	1.66E-01	kg
Materials for energy recovery	0.4599	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	454.2	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	1.16E-02	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	22.46	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	0	kg CO_2

2.3.10 Cement product: Impact per 1000 kg average **INSEE Petch Quick Cast (Bulk)**

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	700.8 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	700.6 *	kg CO_2 eq.
Global Warming Potential, biogenic	5.407E-2 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	5.96E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	6.90E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	0.8471	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	1.09E-01	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	6.79E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	1.82	mol N eq.
Formation potential of tropospheric ozone	0.4031	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	9.11E-05	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3139	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	16.96	m³ world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 681.5 kg CO2–eq. The net GWP-fos is 681.4 kg CO2-eq. The net GWP-bio is 4.411E-2 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	700.8 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.02E-05	Disease incidence
Potential Human exposure efficiency relative to U235	2438	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	50.27	CTUe
Potential Comparative Toxic Unit for humans - cancer	2.67E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	2.25E-05	CTUh
Potential soil quality index	1544	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 681.5 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	141.6	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of renewable primary energy resources	141.6	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3139	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of non-renewable primary energy resources	3139	MJ, net calorific value
Use of secondary materials	17.56	kg
Use of renewable secondary fuels	6.418	MJ, net calorific value
Use of non-renewable secondary fuels	228.6	MJ, net calorific value
Net use of fresh water	0.4772	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.656	kg
Materials for recycling	1.44E-01	kg
Materials for energy recovery	0.3965	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	390.2	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	9.96E-03	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	19.29	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	0	kg CO_2

2.3.11 Cement product: Impact per 1000 kg average INSEE Dum (Bulk)

Core environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, total	873.5 *	kg CO_2 eq.
Global Warming Potential, fossil fuels	873.4 *	kg CO_2 eq.
Global Warming Potential, biogenic	6.399E-2 *	kg CO_2 eq.
Global Warming Potential, land use and land use change	7.04E-02	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	7.87E-06	kg CFC 11 eq.
Acidification potential, Accumulated Exceedance	1.016	mol H+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	1.35E-01	kg P eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	8.41E-03	kg N eq.
Eutrophication potential, Accumulated Exceedance	2.155	mol N eq.
Formation potential of tropospheric ozone	0.4724	kg NMVOC eq.
Abiotic depletion potential for non- fossil resources	1.06E-04	kg Sb eq.
Abiotic depletion potential for fossil resources potential	3846	MJ, net calorific value
Water (user) deprivation potential, deprivation-weighted water consumption	20.03	m^3 world eq. deprived

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 849.2 kg CO2–eq. The net GWP-fos is 849.1 kg CO2-eq. The net GWP-bio is 5.147E-2 kg CO2-eq.*

Additional environmental impact indicators

Indicator	A1-A3 (Total)	Unit
Global Warming Potential, GHG	873.5 **	kg CO_2 eq.
Potential incidence of disease due to PM emissions	1.25E-05	Disease incidence
Potential Human exposure efficiency relative to U235	2859	kBq U235 eq.
Potential Comparative Toxic Unit for ecosystems	58.27	CTUe
Potential Comparative Toxic Unit for humans - cancer	3.35E-03	CTUh
Potential Comparative Toxic Unit for humans - non-cancer	2.78E-05	CTUh
Potential soil quality index	1832	dimensionless

*** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 849.2 kg CO2–eq.*

Parameters describing resource use

Indicator	A1-A3 (Total)	Unit
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	164.7	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of renewable primary energy resources	164.7	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3846	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
Total use of non-renewable primary energy resources	3846	MJ, net calorific value
Use of secondary materials	19.05	kg
Use of renewable secondary fuels	8.065	MJ, net calorific value
Use of non-renewable secondary fuels	287.2	MJ, net calorific value
Net use of fresh water	0.5643	m^3

Other environmental information describing waste categories

Indicator	A1-A3 (Total)	Unit
Hazardous waste disposed	0	kg
Non-hazardous waste disposed	0	kg
Radioactive waste disposed	ND	kg

Environmental information describing output flows

Indicator	A1-A3 (Total)	Unit
Components for re-use	1.689	kg
Materials for recycling	1.78E-01	kg
Materials for energy recovery	0.4956	kg
Exported energy	0	MJ per energy carrier

Extra indicators

Indicator	A1-A3 (Total)	Unit
Emissions from calcination and removals from carbonation	490.3	kg CO_2 eq.
Emissions from combustion of secondary fuels from renewable sources used in production processes	1.25E-02	kg CO_2 eq.
Emissions from combustion of secondary fuels from non-renewable sources used in production processes	24.24	kg CO_2 eq.
Removals and emissions associated with biogenic carbon content of the bio-based product	0	kg CO_2
Removals and emissions associated with biogenic carbon content of the bio-based packaging	0	kg CO_2

2.4 Other environmental information

Climate Change Protection - INSEE Cement (Thailand) is fully aware of the climate change problem and therefore has set a target to reduce carbon dioxide emission and to manage the crucial factors in the bid to reduce carbon dioxide emission, such as, the determination to use more alternative raw materials and fuels, by using discarded materials and industrial wastes as alternative raw materials and fuels; the determination to increase the efficiency in energy consumption, as well as to develop products that are more friendly to the environment by reducing the clinker factor in the cement products while improving the workability characteristics.

INSEE Cement (Thailand) being aware of its responsibility as a cement manufacturer towards the environment. Thus, all the activities that could have a significant impact on the environment are kept under control.

2.5 Differences versus previous versions

This is the first EPD version – No previous versions

2.6 References

- **EN 15804:2012+A2:2019** Sustainability of construction works – Environmental product declarations - Core rules for the product category of construction products
- **PCR 2019:14** Construction products and services, the construction product PCR based on EN 15804:A2
- **c-PCR-001** Cement and building limes (EN 16908)
- **ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework.**
- **ISO 14044: 2006 Environmental management – Life cycle assessment – Requirements and guidelines.**
- **ISO 14025: 2006 Environmental labels and declarations – Type III environmental declarations - Principles and procedures.**
- **Industry EPD Tool for Cement and Concrete** (https://concrete-epd-tool.org/)
    - User Guide (v3.1, International version, 10 November 2021)
    - LCA Model (v3.1, International version, 10 November 2021)
    - LCA Database (v3.1, 10 November 2021)
- **Global Cement and Concrete Association (GCCA) – The Cement CO2 and Energy Protocol, V3 CO2 and Energy Accounting and Reporting Standard for the Cement Industry.**
- **Global ASTM Standards** (https://www.astm.org/)
    - **ASTM C1157** Standard Performance Specification for Hydraulic Cement
    - **ASTM C91** Standard Specification for Masonry Cement
    - **ASTM C150** Standard Specification for Portland Cement

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