ASIAN DEVELOPMENT BANK

Technical Note

Project Number: 56120-001
October 2024

REG: Mainstreaming Nature-Positive Investments for Green, Resilient and Inclusive Recovery

Sustainable Construction Materials Market Analysis - Vietnam

ABBREVIATIONS

BFS	-	blast furnace slag
DMCs	-	developing member countries
EPD	-	environmental product declaration
GCCA	-	Global Cement and Concrete Association
GHG	-	greenhouse gases
GNR	-	getting the numbers right" (sustainability monitoring system for the global cement industry)
HMA	-	hot mix asphalt
ISO		international standards organization
LEED	-	Leadership in Energy and Environmental Design
MOC	-	Ministry of Construction
MOT	-	Ministry of Transport
MOIT	-	Ministry of Industry and Trade
NPI	-	nature positive investments
PC	-	Portland cement
PCB	-	Portland cement blend
PFA	-	pulverized fuel ash
RAP	-	recycled asphalt planings
SCM	-	supplementary cementitious material
SGBC	-	Singapore Green Building Council
TCVN	-	Vietnam standard (Tiêu chuẩn Việt Nam)
VGBC	-	Vietnam Green Building Council
VIBM	-	Vietnam Institute of Building Materials
VNCA	-	Vietnam Cement Association
VSA	-	Vietnam Steel Association
WMA	-	warm mix asphalt

CONTENTS

I. INTRODUCTION

1. The regional knowledge and support technical assistance (TA) “Mainstreaming Nature-Positive Investments for Green, Resilient and Inclusive Recovery” seeks to put in place the enabling conditions to increase and accelerate nature-positive investments (NPI). The TA aims to strengthen ADB's business processes, metrics and governance for NPIs and provide developing member countries (DMCs) with the required institutional capacity to integrate nature into national strategic planning, development and investment decision-making processes. The TA supports knowledge generation and sharing to provide an evidence-based model for enabling technical solutions for NPI. The TA includes multiple activities, including Sustainable Construction Materials Market Analysis, which is the subject of this Technical Note.

2. Construction materials such as concrete contribute up to 8% of global emissions while 90% of biodiversity loss is estimated to be caused by resource extraction and processing. This technical note on “Sustainable Construction Materials Market Analysis” presents the methods used and findings of identified opportunities to improve resource efficiency for the following critical construction materials – asphalt, cement, concrete and steel.

3. A number of countries were selected as strategic pilots for this initiative – Vietnam, Philippines, India, Georgia, Fiji. This report covers the findings in Vietnam. Given that this was the first of the pilot countries covered, the Technical Note also includes feedback regarding the methodology applied and lessons learnt which may be of use when carrying out market analysis in other countries.

Box 1: Terms of reference for the study are as follows:

a). Carry out national market analysis using established survey for identified opportunities to improve resource efficiency for the following critical construction materials – asphalt, cement, concrete and steel.
b). Document data collection methodology for the country; provide feedback on the survey framework
c). Recommendation on next steps in particular around existence or opportunities of / implementation of national green certification system and EPD or equivalent.
d). Draft a technical note reporting on availability and provisional costings of identified opportunities, against technical standards

II. METHODOLOGY

4. **Preparation**. At an internal ADB inception team meeting the scope of work and methodology were discussed. The main topic was how to maintain focus and maximize the benefit of the limited study time and budget. Accordingly it was tentatively agreed to narrow the focus where possible by

(i) study reinforcing steel bars rather than steel in general, since it is the most common steel product in civil works construction,
(ii) study cement as a prerequisite since it is the main contributor to CO_2 emissions from concrete, and to study concrete time permitting,
(iii) to keep an open mind on whether to study asphalt (i.e. asphalt concrete) or bitumen, since both the bitumen production and the asphalt concreting both have major contributions to CO_2 emissions.
(iv) to try to select one good opportunity for each of the studied materials, rather than trying to study all possible opportunities
(v) It was emphasized by ADB task manager that the key output of the study should be a table showing the conventional product and its greener alternative together with details of supply capacity, pricing, technical standard, and availability of certification.

5. **Kick off.** A kick off meeting was held with the TA counterpart agencies which are Ministry of Construction (MOC), Department of Building Materials, and the Vietnam Institute for Building Materials (VIBM) which is an agency under MOC. MOC agreed to act as counterpart and to help make introductions to the cement association, and other entities where required.

6. **Desk study.** Literature search initially included the following:

Roadmaps
- road maps on sustainable materials use existing in the country, if any, and
- best practice international models of roadmaps for sustainable materials use.

Environmental Product Declarations or certificates
- search the EPD library to see if there are any local suppliers holding EPDs
- search Singapore Green Buildings Council directory to see if there are any local suppliers holding certificates
- search Vietnam Green Buildings Council directory to see if there are any local suppliers holding certificates
- search Vietnam Institute of Building Materials website for news of firms receiving their green cement certification

Research papers
- studies on use of greener materials or techniques in the country
- CO_2 emissions data for conventional products or greener alternatives

Regulatory framework
- Government resolutions
- Technical standards

7. A completed questionnaire in Appendix 1 for comparison between the study countries contains information obtained from the desk study regarding the regulatory and standards framework.

8. **Identification of potential opportunities.** The identification of potential opportunities to improve resource efficiency is potentially challenging since it requires both understanding of the market as well as the technical details of the product. Examples of possible methods to identify opportunities are shown in Box 2.

Box 2: How to identify "opportunities to improve resource efficiency"?

a) where a greener alternative is widely used internationally but less so in the country

b) where suppliers have already chosen to obtain product environmental certification, possibly in response to demands from their customers (e.g. export customers, or private sector)

c) where greener alternatives exist on the market and are being used by the private sector on green buildings projects (such as LEED certified buildings) but not yet on government budget projects

d) where both normal and greener alternatives exist on the market but due to pricing the greener alternatives still have limited market share.

e) where substantially greener alternatives exist but there seems to be a barrier to their wider application e.g. design standards, cost norms, industry practice, regulatory framework

9. **Meetings with sector agencies.** Meetings were held with the following agencies to explain the study, to propose potential opportunities, and to request data or to respond to questionnaires. Meetings were held with:

a) Ministry of Construction (MOC), Department of Building Materials
b) Vietnam Institute for Building Materials (VIBM)
c) Vietnam Cement Association (VNCA)
d) Cement Information and Database Center (CIDC)

10. MOC and VIBM responsibilities are limited to cement and concrete, whilst reinforcing steel falls under the responsibility of the Ministry of Industry and Trade (MOIT) and asphalt under the Ministry of Transport (MOT). Meetings were requested with MOT, and with the Vietnam Steel Association (VSA) but are still pending.

11. Data on pricing was obtained from the monthly publications by Departments of Construction in each province, which are used for cost estimating, and which show the price list of a number of cement manufacturers, and reinforcing steel manufacturers. Around 100 items of price data for cement and rebar were selected from Hanoi, Ho Chi Minh City, and central Vietnam. Expert advice was mainly received through questioning engineers working in design or construction, and in particular materials engineers responsible for testing and approving materials during construction.

III. IDENTIFIED POTENTIAL OPPORTUNITIES FOR IMPROVED RESOURCE EFFICIENCY

12. Based on the desk study, meetings with sector agencies, and consultation with materials specialists and designer, the following potential opportunities were identified and market analysis undertaken.

Table 1: Opportunities selected for market analysis

Material	Conventional product	Greener alternatives	Basis for the opportunity
Cement	Portland cement (PC)	a) Portland cement blend (PCB) b) Blast furnace slag cements (PCB_{BFS})	Conventional product and greener alternatives coexist on the market and PCB has a larger market share due to its lower cost. However, there may be potential to further reduce PC usage and to further increase PCB blend percentages, and to increase blast furnace slag usage.
Reinforcing steel	Virgin steel	Steel produced from scrap	Both products coexist on the market with similar price, although they have very different CO_2 footprints
Asphalt	Hot mix asphalt	a) Warm mix asphalt b) Asphalt using recycled asphalt planings c) Polymer modified bitumen	These methods are widely used internationally to reduce CO_2 emissions (a and b) and to increase resilience of pavement layers and extend their lifespan (c)
Concrete	Concrete using Portland cement blend (PCB)	a) Carbon Mineralization Concrete (CMC) b) Blast furnace slag concretes (PCB_{BFS})	One supplier is already operating a readymix plant in Bien Hoa using licensed CarbonCure technology. The same supplier is also offering low carbon concretes based on replacing PCB with PCB_{BFS}

13. A number of possible opportunities were considered but not taken forwards, with reasons as follows:

Table 2: Opportunities not selected

Material	Conventional product	Greener alternatives	Reasons
Concrete	Natural aggregate	Recycled aggregate	Decision 1266[1] has a target to use aggregates from recycled and waste materials to replace up to 60% of natural materials in concrete for the period 2031 – 2050, but this is a medium-long term target and use of recycled aggregate in concrete does not yet seem to be applied. Unlike some countries which have limited hard rock resources, Vietnam has rich resources with distribution by inland waterway and road. As an emerging economy constructing new infrastructure, it lacks sources of uniform high

[1] Decision No. 1266/QD-TTg dated August 18, 2020 on Approving the Strategy for development of Vietnam's building materials for the 2021-2030 period, with orientations toward 2050

			quality demolition waste.[2] Green building systems allocate points for use of recycled aggregate from construction waste, but this is not yet applied in the market, only the reuse of coarse aggregate by washing rejected batches is occasionally applied.
Reinforcing steel	Basic oxygen blast furnace, electric arc furnace	• Increased use of hydrogen as fuel • Use of green electricity for electric arc furnaces (renewable electricity) • Carbon capture and underground storage	These strategies appear in Vietnam Steel Associations presentation on decarbonization but are for period 2030 – 2050 and products are not yet available on the market. Although it is noted that: a) The permitting direct power purchase agreements could rapidly permit sale of green electricity[3] b) Vietnam's hydrogen energy development strategy until 2030 with a vision to 2050 was issued February 7, 2024 and major production plants are commencing[4]
Asphalt	Hot mix asphalt	Cold mix asphalt Carboncor	The product has positive aspects since a) it is a cold mix so has reduced energy requirement for placing, and b) it uses a waste product as an alternative to bitumen. However, it is not selected as an opportunity since a) it has inferior strength and durability compared to hot mix asphalt so is only suitable for temporary pothole repair, or for paving of low traffic roads, and b) it seems to be based on coal tar with potential health or environmental risks.[5]

[2] Examination of their LEED scorecards of recent buildings receiving gold or platinum ratings shows that they invariably receive very low scores for materials and resources.

[3] On July 3, 2024, the Government of Vietnam issued a decree permitting direct power purchase agreements (DPPAs) for renewable energy between private project developers and private energy consumers. It also permits entirely privately developed, owned, and operated transmission lines. This provision could allow the development of large-scale solar or wind farms at remote sites to supply industrial consumers directly.

[4] "Vietnam's hydrogen economy takes shape with national strategy, projects", S&P Global, 15 March 2024 link

[5] Carboncor website gives very limited product technical details but states "Our unique environmentally conscious asphalt contains no harmful substances or emissions" link. On the other hand a distributor website in Vietnam states it "is a mixture made from coal tar, stone and special emulsion" link, and coal tar has potential risks to worker health.

IV. MARKET ANALYSIS FOR THE POTENTIAL OPPORTUNITIES

A. Description of the cement market

14. An overview of the cement market is as follows:

Production and exports. In 2022, Vietnam was the world's largest exporter of cement[6] and the third-largest cement producer in the world. It exported 31 million tons of cement, with value $1.8 billion to countries including China, the Philippines, Bangladesh, the US, and Guatemala.[7]

Growth. Steady growth in cement production in the last decade, with annual production increasing from 56 million tons /year in 2010 to 118 million ton/ year in 2022, but has since declined due to reduced export to China.

Imports. Imports are negligible, only 1.3% of the value of its cement exports.

Capacity and utilization. Currently, there are over 60 cement factories with a total capacity of approximately 117 million tons per year. But consumption in 2023 was only 87.8 million tons, of which domestic consumption 56.6 million tons and exports 31.2 million tons. The average utilization rate of Vietnam cement industry declined from 58% in 2022 to 55% in 2023 due to weak demand and launch of 2 new facilities.

Range of cement products: There are 15 cement standards, some of the key standards are as follows:

Table 3: Key cement types

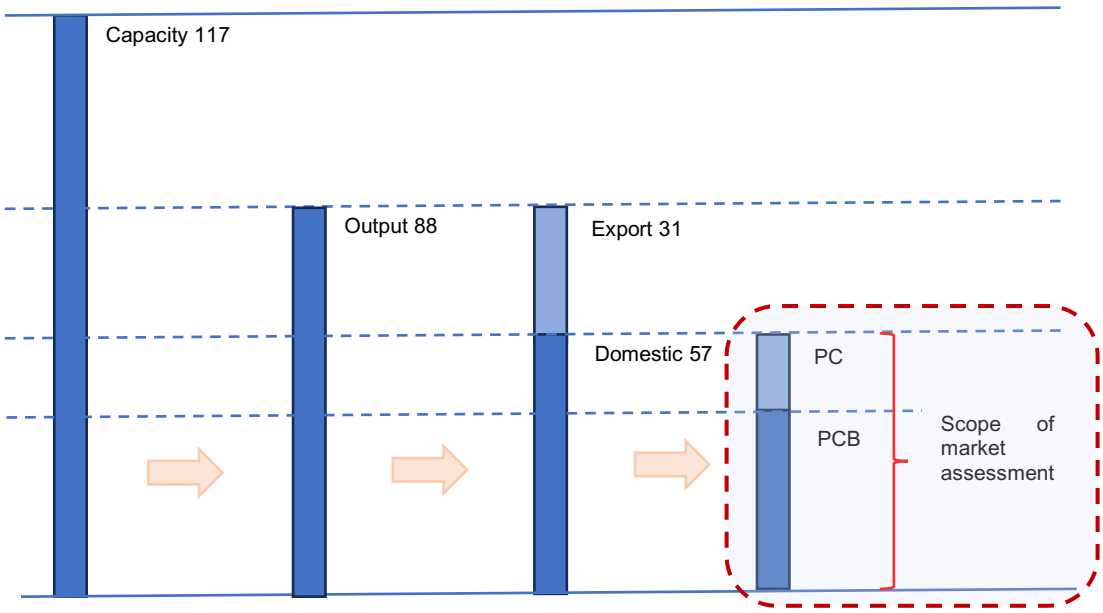
Name	Standard	Example nomenclature	Permitted blend %
Portland Cement	TCVN 2682 : 2020	PC30, PC40, PC50	Ground limestone up to 5%
Portland Blended Cement	TCVN 6260 : 2009	PCB30, PCB40, PCB50	Up to 40% of which full additives are not more than 20% Or up to 50%, by use of blast furnace slag of 10% or more.
Portland Blast Furnace Slag Cement	TCVN 4316 : 2007	Type I: PCB_{BFS}I 40, Type II: PCB_{BFS}II 40	Type I: slag content is from 40 % to 60% Type II: slag content is from 60 % to 70%
Sulfate Resistant Portland Cement	TCVN 6067 : 2004	PC_{SR}40	
Sulfate Resistant Blended Portland Cement	TCVN 7711 : 2007	PCB_{MSR}40, PCB_{HSR}40 (moderate sulfate Resistant and high sulfate resistant)	
Low Heat Blended Portland Cement	TCVN 7712 : 2007	PCB_{LH}40	

[6] These statistics include both cement and clinker.

[7] "Toward Cleaner and More Sustainable Cement Production in Vietnam via Carbon Capture and Storage" Sustainability 2024, 16, 942. link

15. As illustrated in Figure 1, the focus of the market assessment is on the domestic consumption of PC and PCB of around 57 million tons/ year, which represents less than half of industry capacity. As such it excludes production of clinker and cements for export.

Figure 1: Cement market capacity and usage



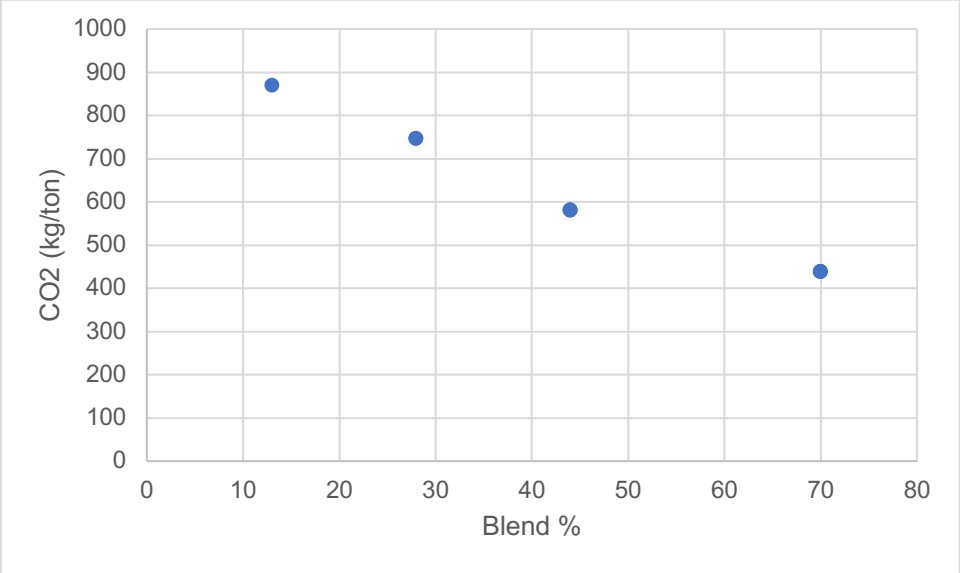
B. Cement market baseline data

16. Substantial effort was expended trying to obtain baseline statistics on a) breakdown of cement consumption by type (PC/ PCB / PCB_{bfs} etc.), b) average CO_2 emissions by cement type, and c) average blend % by cement type. However, such data is either not collected by sector agencies or the industry association, or they are unable to disclose it, and most firms seem unwilling to disclose it.

17. Eventually reference or indicative data was received by a) verbal estimate from the cement association, b) EPDs published by 3 companies[8] for their full product ranges, and c) information published in sustainability or ESG reports by a few companies. The data set is shown in Table 4. The relationship between blend % and CO_2 emissions for a leading manufacturer are shown in Figure 2.

[8] The certificate for Long Son is not stricltly an EPD as it does not give breakdown of emissions over the lifecycle. However, it shows total CO2 emissions and is 3rd party verified so is referred to as an EPD in this report since it provides the required level of information for this study.

Figure 2: Cement blend % and CO_2 emissions



18. Relationship between cement grade and CO_2 emissions are shown in Figure 3 (based on limited dataset of EPDs of 2 firms as in Table 4). For example, it can be seen that PCB40 includes 7 products with blend % ranging from 13 to 44%, and CO_2 / ton ranging from 870 to 527kg.

- **Figure 3: CO_2 emissions by cement type / grade**

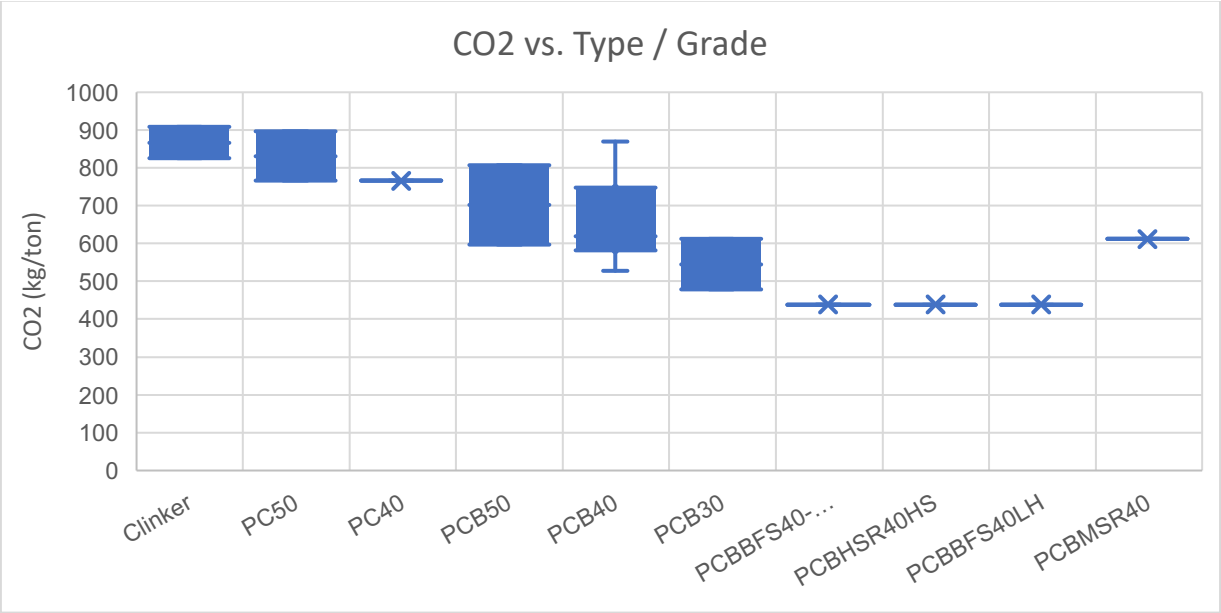


Table 4: Dataset of cement baseline data

Company	Type	Bag / bulk	% blend	CO_2 (kg/ton)	Product Name
Reference					
Insee Vietnam	Clinker	Bulk		910	Clinker
Long Son	Clinker	Bulk		825	Clinker

Baseline (PC and low blend PCB)					
Long Son	PC50	Bulk		766	PC50
Long Son	PC40	Bulk		766	PC40
Insee Vietnam	PCB40	Bag	13	870	Insee Power Cast
Insee Vietnam	PCB40	Bulk	28	747	Insee Easy Flow
Insee Vietnam	PCB40	Bulk	28	747	Insee Quick Cast
Quang Ninh cem.	PC50	Bulk		897	PC50
Quang Ninh cem.	PCB50	Bulk		807	PCB50
Greener alternatives (high blend PCB)					
Insee Vietnam	PCB40	Bag	44	582	Insee Power S
Insee Vietnam	PCB40	Bag	44	582	Eco Da Dung
Insee Vietnam	PCB40	Bag	44	582	Insee Power Fast
Long Son	PCB50	Bulk		597	PCB50
Long Son	PCB40	Bulk		527	PCB40
Long Son	PCB30	Bulk		479	PCB30
Quang Ninh cem.	PCB40	Bulk		656	PCB40
Quang Ninh cem.	PCB30	Bulk		612	PCB30
Greener alternatives (slag cements PCB_{BFS})					
Insee Vietnam	PCB_{BFS}40-Type II	Bulk	70	439	Insee Stable Soil
Insee Vietnam	PCB_{BFS}40-Type II	Bulk	70	439	Insee Compact Rock
Insee Vietnam	PCB_{HSR}40HS	Bulk	70	439	Insee Extra Durable
Insee Vietnam	PCB_{BFS}40LH	Bulk	70	439	Insee Mass Pour
Quang Ninh cem.	PCB_{MSR}40	Bulk		612[9]	

19. It was estimated by VNCA staff that PC comprises around one third of cement consumption. However, it was noted that in some cases this would be as an intermediate product, and cement substitutes would be added at the ready-mix plant, or by an intermediary.

C. International cement industry reference data

20. Reference data was provided by the Global Cement and Concrete Association (GCCA), as collected from member companies through their "Getting the Numbers Right (GNR)" reporting and monitoring system

21. The Cement CO_2 Protocol was originally created under the umbrella of the Cement Sustainability Initiative (CSI) of the World Business Council for Sustainable Development (WBCSD), by a number of leading cement companies in 2001, the CSI companies agreed on a methodology for calculating and reporting CO_2 emissions. While accounting for the specific needs of the cement industry, the protocol was closely aligned with the overarching Greenhouse Gas Protocol developed under a joint initiative of the WBCSD and the World Resources Institute (WRI). In 2019 management of the GNR reporting system and database was transferred to GCCA[10]. The protocol also forms the basis for preparation of EPDs.

[9] The EPD is of multiple cement products, based on worst case results, hence this high result might not be representative for the actual product

[10] The full methodology is given in "Stationary source emissions – Determination of Greenhouse Gas (GHG) emissions in energy-intensive industries — Part 3: Cement industry", EN-19694-3

22. Through the GNR database, all participating companies and interested stakeholders can access standard, web-based reports. The database's administrators also answer queries about specific issues within strict confidentiality guidelines. The database delivers uniform, accurate and verified data, and includes key emissions and performance drivers. It provides policymakers with current performance data to aid in analysis and decision-making. The database covers around 80% of the world's cement production, excluding China. Table 5 shows global and regional averages, as well as national averages for India, Philippines and Thailand.

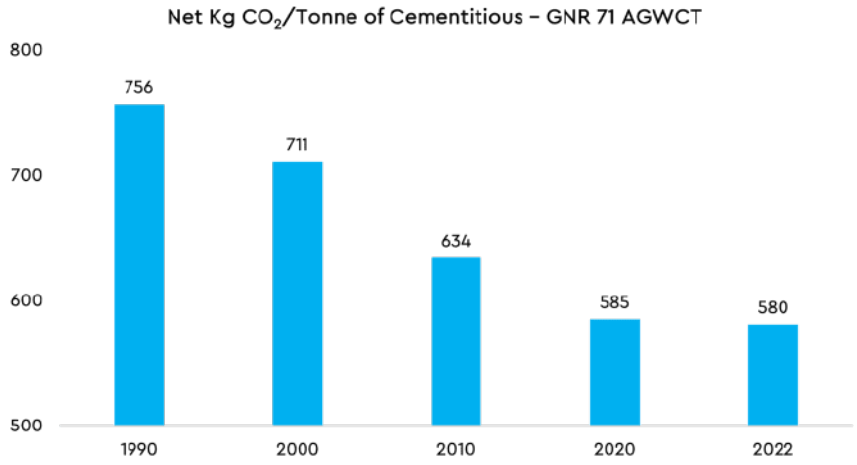
23. It is noted that the GCCA data shows global average CO_2 /ton cementitious material of 580kg, with values of 521kg for EU27, 539kg for India, 595kg for Philippines, and 640kg for Thailand. Average clinker percentage globally is 77%, with marginally lower averages for India, Philippines and Thailand. Data for Vietnam is not available as the cement association and its member countries have not yet joined GCCA[11].

Table 5: Global reference data for clinker and cement CO_2 emissions and clinker proportion

Region / country	Gross CO_2 emissions for clinker (kg CO_2 / t clinker)[12]	Clinker percentage (%)[13]	Net CO_2 emissions (kg CO_2 / t cementitious)[14]
EU27	789.96	0.77	521.49
World (ex. China)	822.41	0.77	584.63
India	820.74	0.75	538.98
Northeast Asia	828.91	0.82	681.53
Philippines	861.72	0.75	595.09
Thailand	832.70	0.76	640.10

Source: GCCA GNR Data for 2021

Figure 4: Global trend of reducing average CO_2 per tonne of cement



Source: GCCA GNR Data for 2022

[11] Insee Vietnam is a cement producer in Vietnam, which is owned by SCCG of Thailand which is a member of GCCA, hence data for the Vietnam cement plant(s) would be reported in GNR. But under GNR rules to respect confidentiality, if there are less than 3 companies in a country, country data is not published.
[12] Indicator 59cAGK - Gross CO_2 emissions - Weighted average | excluding CO_2 from on-site power generation
[13] Indicator 92AGW - Clinker to cementitious ratio - Weighted average
[14] Indicator 71AGWct - Net CO_2 emissions - Weighted average

D. Description of the steel market

24. An overview of the steel market is as follows:

Production and exports. In 2024, Vietnamese production of finished steel is expected to reach 30 million tons, based on crude steel production of around 20 million tons. Exports in 2023 were 11 million tons.[15] [16] Domestic consumption is around 22 million tons of finished steel, around half each for flat and long products [17]

Imports. Imports in 2023 were 13 million tons. Hot rolled coil, and galvanized products are main imports. Scrap steel of 4.2 million tons was also imported.

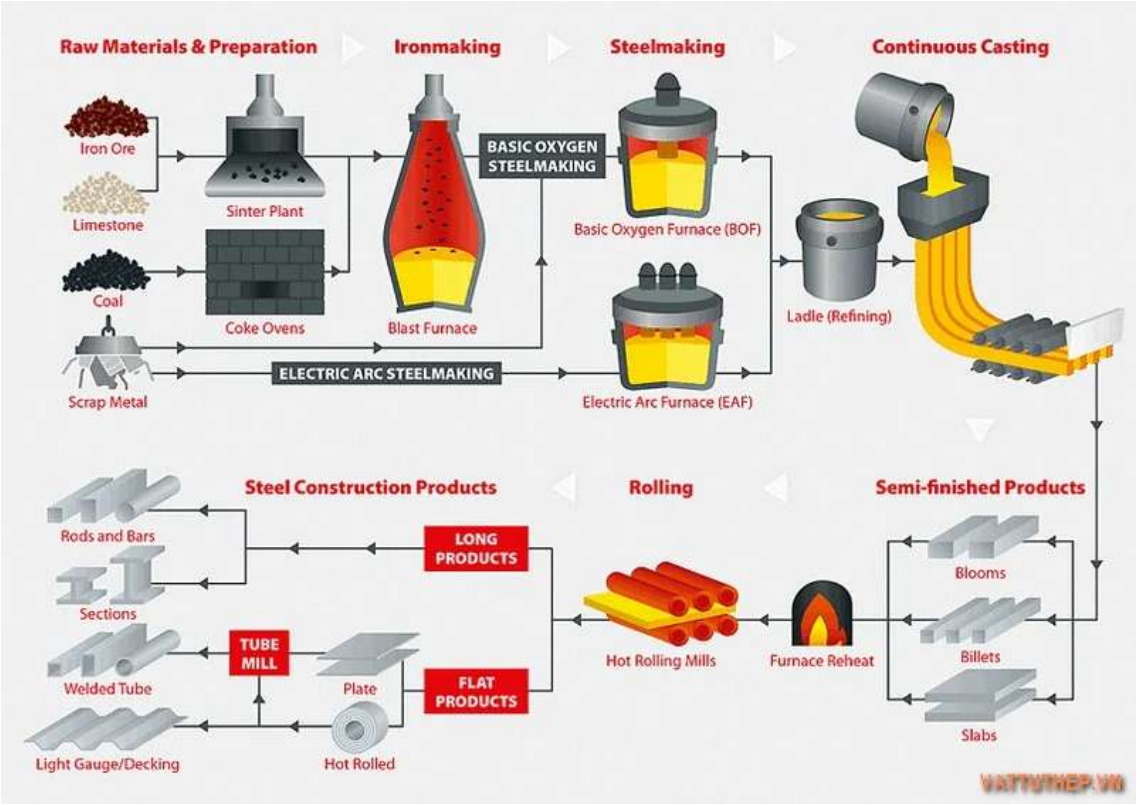
Capacity and utilization. According to VSA capacity is 23 million tons of crude steel (square and flat billets) and 38.6 million tons of finished steel products including construction steel, hot rolled, cold rolled, galvanized sheets and steel pipes. This suggests a utilization ratio of around 85%.

Range of steel products: There is a wide range of steel products, but this study focuses on the subset "construction steel" which has estimated domestic consumption of 8 million tons.

25. Comparison of the process for manufacturing reinforcing steel from iron ore, and from scrap, and the terminology used, is given in Figure 5.

[15] Vietnam news, 25 March 2024 link
[16] MRS Steel publication 22 May 2024 link
[17] Vietnam Steel Association "Overview of Vietnam iron and steel sector towards a decarbonization pathway" 14 April 2023, link

Figure 5: Workflow of steel production from iron ore and from scrap compared



26. As illustrated in Table 6[18], production capacity of main reinforcing steel producers is sufficient to meet demand. Over half of the capacity is by electric arc furnaces from scrap, one third is from virgin steel, and the remainder is from billet whose origin could be from either scrap or virgin steel.

Table 6: Construction steel (rebar) main producers and production method (unit thousand tons)

Company	Integrated iron and steel	From billet	Electric arc, from scrap	Grand Total
VAS (Viet My) Nghi Son			2,500	2,500
Pomina	1,100			1,100
Tung Ho			1,000	1,000
Thai Nguyen Tisco	1,000			1,000
Viet Duc		700		700
Mien Nam			550	550
Viet Nhat (Vina Kyoei)			500	500
Hoa Phat Hung Yen	400			400
Viet Y			350	350
Viet Uc		300		300
Viet Sing		250		250
Grand Total	**2,500**	**1,250**	**4,900**	**8,650**

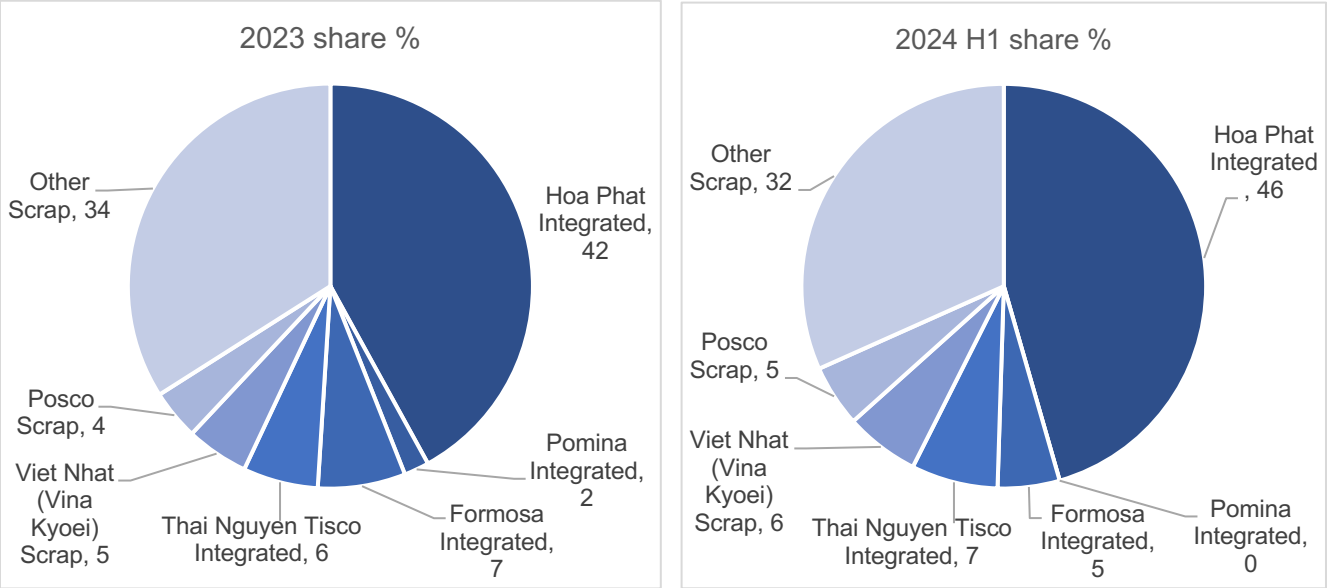
Possibly greener

Greener

[18] Source: company websites

27. Market share in 2023 and 2024 first half is shown in Figure 6[19] It can be seen that integrated steel makers hold the majority of the market share, which has increased in 2024, hence currently appear to have pricing advantage.

Figure 6: Market share of construction steel in 2023 and 2024



E. Steel market baseline data

28. There are two companies that have published EPDs for their rebar production in Vietnam. Results are shown in Table 7.

Table 7: CO_2 data of reinforcing steel from scrap in Vietnam (with virgin steel from China as comparison)

Company	Type	Production location	EPD date	CO_2 (kg/ton)
Baseline				
Jingye Steel Co. Ltd.	D500E, D500N 10-32mm, from iron ore	Shijiazhuang City, Hebei Province, China	10 Jun. 2024	2,160
Greener alternatives				
Tung Ho Steel Vietnam Corporation	CB300- CB500, 10-50mm, from scrap	Phu My, Ba Ria Vung Tau, Vietnam	16 Nov. 2023	1,010
VAS Group Nghi Son JSC	CB300- CB500, 10-40mm, from scrap	Nghi Son, Thanh Hoa, Vietnam	10 May 2024	739

Note: The rebar produced from iron ore by the Chinese manufacturer is listed since a) it is the only data in the EPD library for reinforcing steel produced from iron ore from either Vietnam or China, and b) it provides a comparison of the CO_2 savings achievable by use of scrap instead of iron ore.

[19] Source: VCBS report

F. Description of the asphalt market

29. An overview of the bitumen / asphalt market is as follows:

Production and imports. Imports of bitumen in 2023 were 1,000,000 tons from Singapore (32%), Middle East (24%), and Thailand, Taiwan, China (35%).[20] This is equivalent to around 10 million m3 of asphalt. Domestic production of bitumen is planned for the future, by one of the two existing refineries.

Market. Petrolimex Chemical Corporation is the largest importer with 30% market share, and imports 80% as hot thick bitumen maintained at 120 - 145°C, 13% as bitumen by drum, and 7% as medium curing (MC) or emulsion asphalt.

G. Asphalt market baseline data

30. Survey by internet search did not identify any firms providing greener asphalts by either use of warm mix, or use of recycled asphalt planings (RAP). Telephone survey was undertaken for 12 suppliers in Hanoi and its vicinity, all of whom confirmed that they only provide standard hot mix, and not warm mix or use of RAP.

31. There are a number of published papers in Vietnam on use of RAP, warm mix, or a combination of both. A pilot test of warm mix asphalt with RAP content up to 50% was undertaken in 2020[21]. The company involved in research is BMT group.[22] BMT group, with quarry and asphalt plant in Binh Duong province, and plants in Dong Nai, Long An, and Can Tho, has been stockpiling RAP and asphalt demolition waste for many years and has several million tons accumulated. It has used RAP on a pilot basis on private roads in industrial zones and factories, and has two plants that could use RAP, one up to 25% and one up to 50% mix, but it has not yet commenced commercial production pending demand for 50% RAP mixes.

32. A Vietnam standard allowing use of up to 25% RAP was circulated for comment in 2022, and issued in 2024[23]. A standard allowing up to 50% RAP is under preparation, hoped for approval within 2025. Preparation of a standard for warm mix asphalt does not seem to have commenced yet, so might not be available until around 2029 at the earliest.

33. Calculation of greenhouse gas reduction has been made by University of Transport Technology researchers as shown in Table 8[24]. It shows a baseline figure of 48kg CO_2 / ton of hot mix asphalt, and 16% reduction achievable for central batch mixing using warm mix with 20% RAP, which is an approach commonly found in international use.

Table 8: CO_2 reduction calculated for greener asphalts

	Mix proportions					CO_2 kg/ton	Reduct-ion (%)
	RAP %	Bitumen in RAP	New bitumen	Bitumen with zycotherm additive	Asphalt emul-sion		

[20] Argus media group, 19 July 2024 link
[21] Evaluation of energy saving and greenhouse gas emission reduction efficiency of warm recycled asphalt concrete technology, DD Van, YL Thi, LN Ngoc - Journal of Transport Science, 2020
[22] Video on seminar on new asphalt technologies, including the pilot construction link
[23] TCVN 13567 -4:2024 Hot Mix Asphalt Pavement Layer - Construction and Acceptance Part 4 : Hot Mix Recycled Asphalt in plant with RAP content less than 25%
[24] "Effective greenhouse gas emission reduction when applying some new technologies to replace traditional hot asphalt concrete technology", Environment magazine, 16 July 2023 link

Baseline (hot mix)							
Hot mix asphalt (HMA)	0	0	5			48.13	0
Greener alternatives							
Hot central plant recycling (HCPR)	20	0.8	4.2			41.75	13.3
Warm central plant recycling (WCPR)	20	0.8	0	4.2		40.58	15.7
Cold central plant recycling (CCPR)	91.8	3.7	0		3.2	28.69	40.4

34. Estimates by BMT group based on this CO_2 emissions baseline of 48.1kg/ton for HMA, are an estimated 20% reduction with 30% RAP, 27% reduction with 50% RAP, and 16% reduction for WMA with 20% RAP. Cost impact depends on the assumption for RAP cost – if RAP is assumed free of charge (not realistic in the long term) the HMA is 21% cheaper for 30% RAP, 31% cheaper for 50% RAP. For warm mix, the cost savings from energy savings relative to HMA are likely offset by additional cost of additives (waxes), giving no net cost change.

H. Description of the concrete market

35. An overview of the concrete market is as follows:

Production. Domestic consumption is an estimated 470 million tons of concrete in 2023[25]. Production modes are a) readymix production at commercial batching plants, b) readymix production at mobile batching plants (project basis), and c) production using mobile concrete mixers. This study focusses on readymix production at commercial batching plants since they have the largest operational scale, with regular production, and the most advanced application of sustainable concrete technology.

Market. Concrete consumption in 2021 was estimated as 55% for buildings, 25% for industrial, and 20% for infrastructure**.** [26] Readymix plants can only deliver within a maximum of around 2 hours travel, i.e. around 50 - 80km, and typically for much shorter distances for cost reasons. Production facilities can range from 25m3/hour to over 300m3/ hour capacity and having 1 – 8 silos of 40-200 tons each.

I. Concrete market baseline data

36. Advice from a specialist green buildings consultancy firm[27] led to introduction to what they considered the leading producer of concretes serving the needs of green building developers. The firm FiCO PanU is a joint venture between concrete producer Pan-United Group of Singapore, and cement producer FiCO of Vietnam. The company is not tied to any single cement producer and uses cements from producers including FiCO, Vicem Ha Tien, Insee. Those cement producers all operate GCCA's reporting spreadsheet for monitoring materials and energy usage and reporting CO2 emissions calculations, and share (non public) data with the concrete producer. The company has achieved annual production of up to 6 million m3 based on production capacity of 870m3/hour at 4 locations around Ho Chi Minh City.

37. The firm confirmed and supplemented a number of the study findings, namely that green building systems have rapidly become more demanding in their criteria and scoring systems and that the industry has not yet caught up, that clients focus mainly on the largest sources of credits i.e. energy consumption during operation, and location / transport access, and attention to material credits is frequently given only rather late in the design process. Reuse of coarse aggregate from construction demolition waste is not applied, however, occasionally partial credits have been obtained by instead of dumping rejected batches, they are returned to the plant and washed to recover and reuse the coarse aggregate. Reuse of aggregates from construction demolition waste is not favored for reasons of cost and complexity, and as multiple operations and transport would likely lead to increased CO2 emissions (increasing life cycle embodied carbon). Use of granite crusher dust is applied for over 60% replacement of river sand for fine aggregates in order to gain credits.

38. The firm considers concrete using PCB cement as the current baseline, with CO2 emissions of 227kg / m3 of M400 concrete (40MPa strength, which is a common mix for commercial building construction). It is developing and offering products with reduced CO2 emissions relative to that baseline. The firm gave the firm opinion that making reference to

[25] Estimation by author, based on 56.6 million tons cement consumption, and 12% cement content by weight.
[26] Estimate by market research firm, here
[27] GREENVIET is a Vietnamese green building consulting firm for LEED, LOTUS and Green Mark projects that has completed over 150 projects in Vietnam and across Southeast Asia, and claims it has over 50% of Vietnam's green building market

concretes using PC cement as a baseline is not appropriate since such approach is outdated and not representative of current practice, and would be "greenwashing".

39. The firm noted that specifications for use of PC cement in concrete are sometimes still be encountered on infrastructure projects, but this may be in order to inflate the cost estimate, and the requirement is subsequently relaxed during implementation. The exception is HCMC line 1 metro which specified use of Nghi Son PC cement and implemented it.

40. The greener products offered by the firm include:

a) PanU Carbon mineralization concrete (CMC)[28]. This offers a 17kg/m3 reduction in CO_2 emissions, and uses a licensed technology from CarbonCure of Canade to inject CO_2 into the mix, which immediately react chemically with the calcium oxide in the product's cement. Strength increases are achieved nano-calcium carbonate ($CaCO_3$) minerals that improve cement efficiency and the performance of the concrete. Price premium is 2 – 5% of concrete cost, 30,000VND/m3 for CMC concrete, 50,000VND/m3 for CMC Low carbon concrete, 60,000VND/m3 for CMC Very low carbon concrete, and 70,000VND/m3 for Ultra low carbon concrete. The license is non-exclusive, but the firm is the first mover and operates the system at one of its plants, with scope to extend to the remaining plants. The product complies with Vietnam standard TCVN9340 for ready mixed concretes, and specifically with ASTM C494-Type S. CO_2 source is from local industrial gas producers, who use recovery plants taking flue gas stream of partner refineries, ethanol plants, ammonia plants etc. to access, capture, purify and then distribute CO_2 to their customers. The method can be used with concretes of all grades, and thickness of product.
b) CMC Low, very low, ultra low carbon concrete. In addition to use of CMC, there is replacement of PC or PCB by blast furnace slag (BFS) at the batching plant to further reduced the embodied carbon for applications like mass concrete for foundations, bored piles and diaphragm walls, and high strength concrete. This can give reductions ranging from 50 kgCO_2/m3 to 200 kgCO_2/m3 of concrete. It is noted that to achieve the highest reductions, they must be for high strength concretes which have very high cement content in the baseline case.

41. Early adopters are private sector building developers, and developer Keppel Land is using CMC Very low carbon concrete on mass foundations, and CMC concrete on the superstructure of its Infiniti development[29,30]. For this project a self certified EPD was used, so the project was eligible for 50% of the points in GreenMark. If a new project such as a metro line needed an independently certified EPD, it could be obtained reasonably quickly using a certification agency from Singapore since the firm is already using GCCA software.

Table 9: CO_2 reduction for greener concretes

	Method	Cost / cost impact (VND/m3)	CO_2 kg/m3	CO_2 reduct-ion (%)
Baseline (PCB)				
FiCO PanU M400 concrete (PCB)	Baseline (PCB)	1,500,000	227	0
Greener alternatives				
FiCO PanU M400 CMC	CO_2 injection	+30,000	210	7.5%

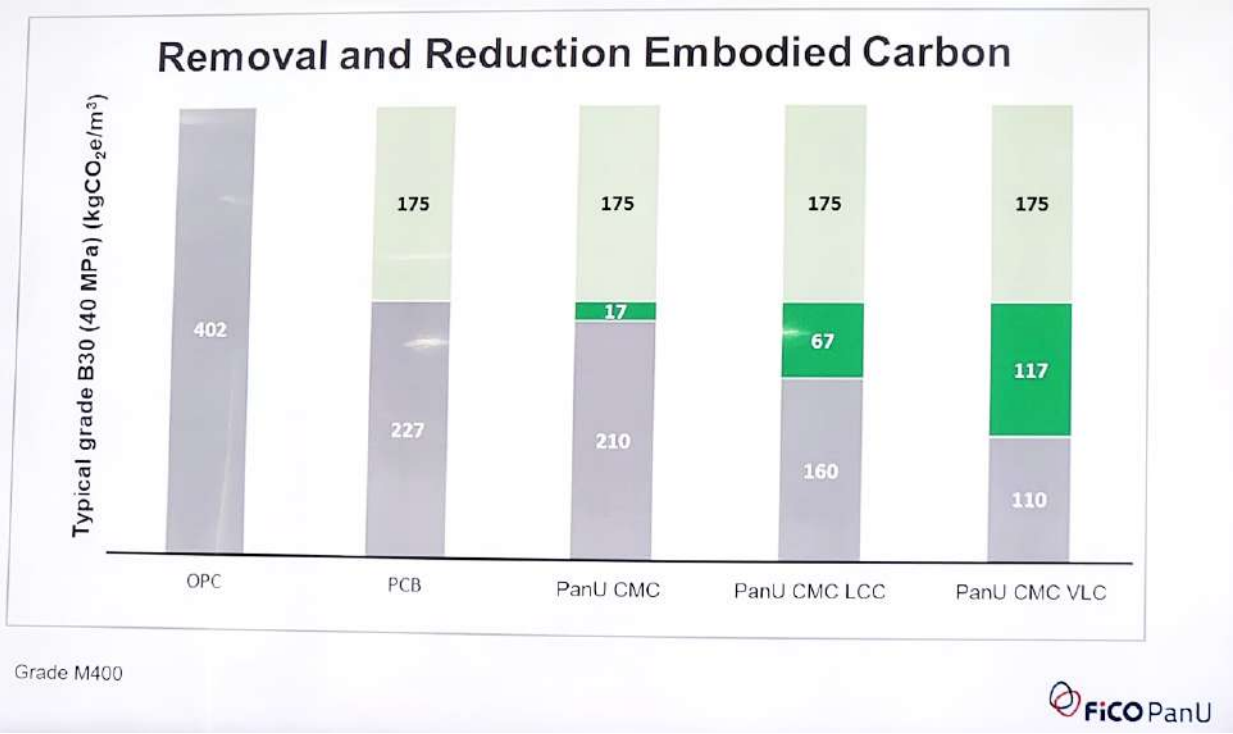
[28] Brand name

[29] News article is here

[30] The Infiniti, as part of the Riviera Point development, has received Green Mark Gold certification from the Building and Construction Authority of Singapore and the Green Property Award at the Vietnam Outstanding Property Awards 2023.

FiCO PanU M400 Green Low Carbon Concrete	CO_2 injection + PCB_{BFS} as partial replacement of PCB	+50,000	160	29.5%
FiCO PanU M400 Green Very Low Carbon Concrete	CO_2 injection + PCB_{BFS} as partial replacement of PCB	+60,000	110	51.5%

Figure 7: CO_2 reduction for greener concretes



J. Overall findings of the market analysis for potential opportunities

42. Findings of market analysis for the potential opportunities are summarized in Table 10.

Table 10: Summary of opportunities for improved resource efficiency

	Greener alternative	Speci-fication	Ecolabel/ Certi-fication	Annual consumption conventional material (tons or m3)	Unit cost of conventional material (VND million /ton or m3)	Annual availability of greener alternative (tons)	Unit cost of greener alternative (VND million /ton)	% of greener alternative domestic production	Names of possible suppliers	Notes
	Cement									
1	**Blended cements (PCB)**	TCVN 6260 : 2020	3 firms have EPD	19,000,000	1.15	80,000,000	0.79	100%	Around 50 firms[1]	1. Green alternative is already the default on the market. 2. Conventional product (PC) still exists as a) standards may require its use for high strength concretes 50MPa of higher, b) it minimizes transport costs to ready-mix plants if blending will occur there, and c) designers or contractors may select it for reliability. 3. 14m tons fly ash is produced per year in VN, but insufficient processing and management limits quality, thus limiting blend proportion that can be used. 4. The lower cost of PCB encourages its use.
									PC40	
			No		*1.15 (HN)*				*Bim Son Cement*	*PC40 bulk, no CO_2 data*
			No		*1.65 (HCM)*				*Vicem Ha Tien*	*PC40 bulk, no CO_2 data*
									PCB40 without EPDs	
			No				*0.79 (HN)*		*Bim Son Cement*	*PCB40, % blend not disclosed, no CO_2 data*
			No				*1.18(HCM)*		*Vicem Ha Tien*	*PCB40 XM Power Cement, % blend not disclosed, no CO_2 data*
									PCB40 with EPDs	
			Yes				*1.35 (Binh Dinh factory)* *1.75 (Vinh Long)*		*Long Son Cement*	*PCB40 bulk, % blend not disclosed, 527kgCO_2/ton*
			Yes				*1.70 (HCM)*		*Insee Vietnam*	*PCB40 Power-S, 44% blend, 582kgCO_2/ton*

[1] Since PCB is the default product on the market with so many suppliers, this table only shows data for selected firms having lowest prices published in April 2024 by Departments of Construction in various provinces. Prices vary by location, are ex. VAT, and delivery conditions vary, so prices are only indicative.

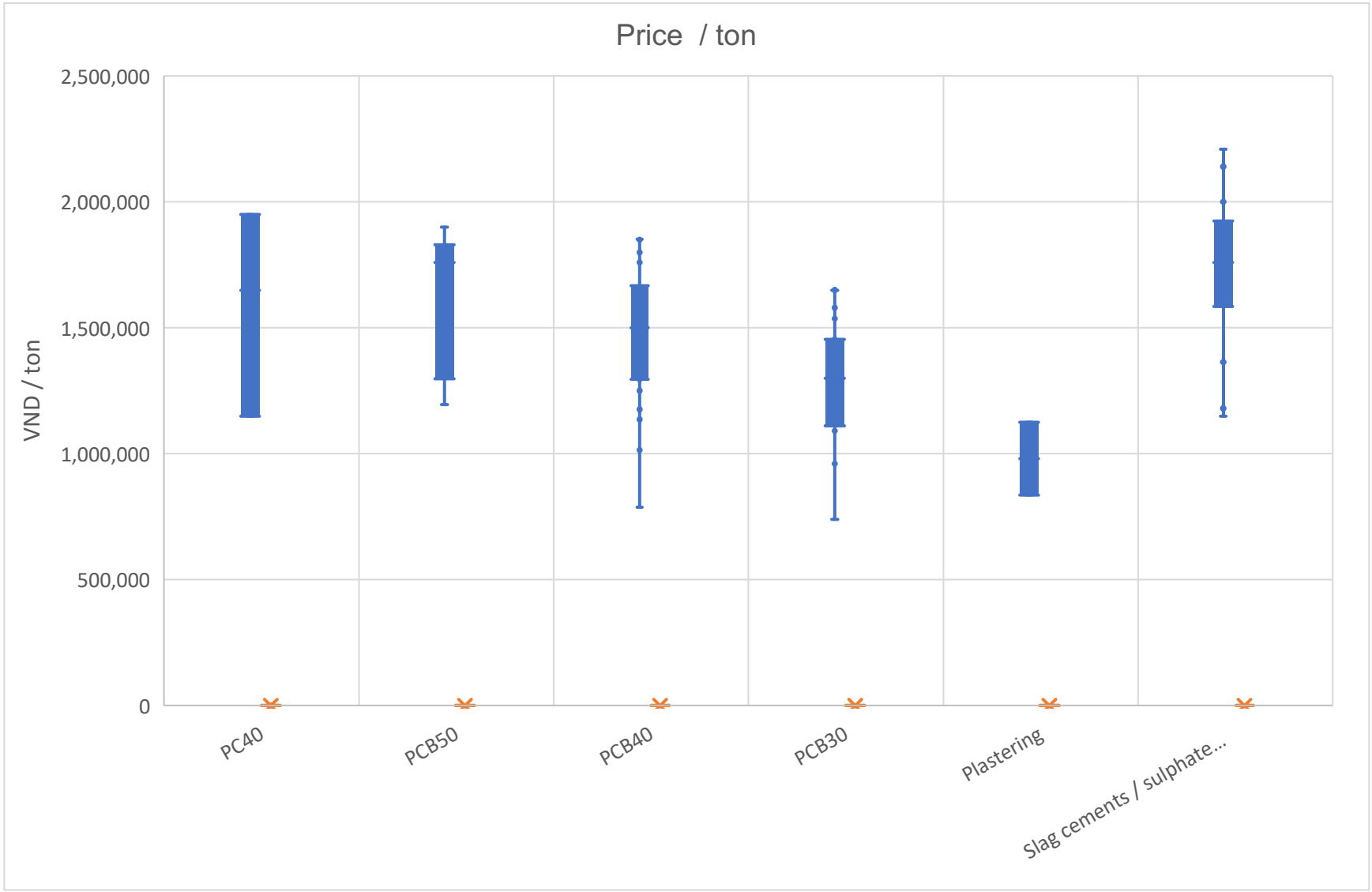
	Greener alternative	Speci-fication	Ecolabel/ Certi-fication	Annual consumption conventional material (tons or m3)	Unit cost of conventional material (VND million /ton or m3)	Annual availability of greener alternative (tons)	Unit cost of greener alternative (VND million /ton)	% of greener alternative domestic production	Names of possible suppliers	Notes
			Yes				*1.01 (Quang Ninh factory)*		*Quang Ninh Construction and Cement*	*PCB40 bulk, 21% blend, 656kgCO_2/ton*
2	**Blast furnace slag cements (PCB_{BFS})**	TCVN 4316 : 2007	1 firm has EPD	19,000,000	1.65	4,000,000 (limited by slag availability)	1.32	100%	Many cement firms produce PCB_{BFS} cements	1. Availability of slag is finite and supply is fully utilized. 2. Estimated 2.32m tons of slag is produced per year in VN, sufficient for around 5m tons of slag cement. Some is also imported. 3. Profitable uses of PCB_{BFS} are in deep soil mixing for strengthening of soft soils, and in sulphate resistant cements. 4. The current market price of slag (in the south) is only around 10% below that of clinker, hence it is a premium product.
									PCB40	
			No		*1.65 (HCM)*				*Vicem Ha Tien*	*PC40 bulk, no CO_2 data*
									PCB_{BFS}	
			No				*1.76 (HCM)*		*FICO-YTL*	*PCB_{BFS}50HS bulk, no CO_2 data*
			Yes				*1.32 (HCM)*		*Insee Vietnam*	*PCB_{BFS}40LH bulk, 70% blend, 439kgCO_2/ton*
	Reinforcing Steel									
3	**Rebar produced from scrap**	TCVN 1651-2: 2018	2 firms have EPD	4,000,000	14.10	6,500,000	14.10	100%	*[Summary data]*	1. Steel from scrap offers 50 – 70% reduction in CO2 emissions compared to virgin steel from a coal (coke) fired blast furnace. 2. Pricing of the two products is dependent on international prices of iron ore and of scrap respectively, hence market share between virgin steel and steel from scrap varies. 3. Scrap imports in 2023 were 4.2m tons, reference price is around VND 9 - 10,000,000 /ton. 4. 2024 domestic consumption of construction steel is estimated at 8m tons (source VCBS).
									Virgin steel	
					14.24 (HN) *16.10 (HCM)*				*Hoa Phat Steel*	
					17.30 (HCM)				*Pomina Steel*	
					14.95 (HN)				*Thai Nguyen Iron & Steel*	
									Steel from scrap	
							14.29 (HN)		*Viet Duc (Vietnam Germany Steel Pipe JSC)*	
							14.11 (HN) *15.05 (HCM)*		*Viet Nhat (Vina Kyoei Steel))*	

	Greener alternative	Speci-fication	Ecolabel/ Certi-fication	Annual consumption conventional material (tons or m3)	Unit cost of conventional material (VND million /ton or m3)	Annual availability of greener alternative (tons)	Unit cost of greener alternative (VND million /ton)	% of greener alternative domestic production	Names of possible suppliers	Notes
							14.24 (HN)		*Viet Y (Vietnam Italy Steel)*	5. There is substantial price volatility and variability depending on international market prices, and production / actual delivery location. 6. Suppliers apply different pricing methods, either at the plant / at distribution centers in the province / delivered to site. This makes comparison different.
			Yes				*14.10 (HN)*		*Viet My (VAS) Nghi Son*	
							14.60 (HCM)		*Mien Nam (Southern Steel Co.)*	
							14.19 (HN)		*Viet Uc (Vinausteel Co. Ltd.)*	
			Yes				*16.90 (HCM)*		*Tung Ho Steel Vietnam*	
							14.29 (HN)		*Viet Sing (NatSteelVina)*	
	Asphalt									
4	**Warm mix asphalt**	TCVN 7493: 2005	0	10,000,000	1.10	0	1.10	0	BMT Construction Investment JSC – Dong Nai branch (did pilot)	1. Warm mix not yet available on the market, only in research / pilot. RAP stockpile exists and VN standard was approved 2024 (for 25% RAP). VN standard for 50% RAP is under approval. 2. VN annual bitumen imports are 1,000,000 tons, assume 4% bitumen content, density 2,400kg/m3, this is equivalent to 10 million m3 HMA as baseline. 3. Warm mix has reduced energy, but additional cost of waxes, so there is no net change in cost. 4. Range of prices shown depends on whether RAP is assumed free or charge or not. 5. Supplier prefers to wait for approval of VN standard for 50% RAP, hopefully within 2025 6. Standard for warm mix not yet started, so maybe available in 2029 7. CO2 emissions baseline is 48.1kg/ton for HMA, with estimated 20% reduction with 30% RAP, 27% reduction with 50% RAP, and 16% reduction for WMA with 20% RAP.
5	**Hot mix asphalt + RAP**	TCVN 13567-4: 2024	0	10,000,000	1.10	500,000 (target)	0.90 – 1.10 (30% RAP) 0.80-1.10 (50% RAP)	0	BMT Construction Investment JSC – Dong Nai branch (did pilot)	
5	**Warm mix asphalt + RAP**	TCVN 13567-4: 2024	0	10,000,000	1.10	0	0.90 – 1.10 (30% RAP) 0.80-1.10 (50% RAP)	0	BMT Construction Investment JSC – Dong Nai branch (did pilot)	
	Concrete									
7	**Carbon Minerali-zation**	TCVN 9340,	Self certified EPD	6,000,000 (by firm)	1.50	1,000,000 (expandable)	1.53 (+2%)	100%	FiCO PanU, HCMC	1. CMC can be applied to all concrete types, offering 17kgCO_2/m3 reduction.

	Greener alternative	Speci-fication	Ecolabel/ Certi-fication	Annual consumption conventional material (tons or m3)	Unit cost of conventional material (VND million /ton or m3)	Annual availability of greener alternative (tons)	Unit cost of greener alternative (VND million /ton)	% of greener alternative domestic production	Names of possible suppliers	Notes
	Concrete (CMC)	ASTM C494-Type S								2. System is currently installed at one location, but could be expanded to the firm's 3 other locations subject to demand. 3. System is licensed from CarbonCure of Canada on a non-exclusive basis
8	**CMC + Low Carbon Concrete (LCC)**	TCVN 9340	Self certified EPD	6,000,000 (by firm)	1.50	1,000,000 (limited by slag availability)	1.55 (+3.3%)	100%	FiCO PanU, HCMC	1. Applies CMC with further CO2 reduction of 50kg CO_2/m3 by partial replacement of PCB by PCB_{BFS}. 2. Potential use for mass concrete for foundations, bored piles and diaphragm walls, and high strength concrete

43. Given the wide variation in cement prices by cement type, and proximity to sources of input materials, price distribution by quartile is presented in Table 10a for around 100 price data points collected during the study.

Table 10a: Price distribution for Cements



V. CERTIFICATION

A. Introduction

44. The terms of reference include to study and give recommendation regarding the existence or opportunities of / implementation of national green certification system and Environmental Product Declaration (EPD) or equivalent. This section firstly introduces sustainable building certification systems of relevance to Vietnam, and then the product certifications which are often associated with those building certification systems.

B. Sustainable buildings certifications

45. Sustainable buildings certifications are used to assess and recognize buildings which meet certain sustainability requirements or standards. Green Building Councils, which are members of the World Green Building Council (WorldGBC) global network, develop and administer many of the world's building certifications.

46. In the Vietnam context, the most relevant schemes that have been considered in this study are as follows:

- LEED – US based scheme, the most popular in Vietnam having 187 buildings certified

Platinum	18
Gold	106
Silver	38
Certified	25
Total	**187**

- Lotus – Vietnamese system, currently having 50 new construction buildings certified.
- Green mark – Singapore system, currently having 23 new construction buildings certified in Vietnam.

47. The scoring systems are similar across the schemes, with highest weighting given to energy efficiency during use, to location and transportation, and to indoor environmental quality etc. In contrast, the weighting given to materials and resources used is construction is relatively low, typically around 13% of the score.

48. As an example, the scoring for material and resources in the Green mark system includes points for use of waste products e.g.

- Use of PFA, BFS in cement (CEM II – V standards)
- Use of crushed concrete aggregates >20% in concrete

49. The schemes continue to evolve and issue new versions.

- The 2021 Green mark version has a whole life carbon section with 15 points for a) having a whole life carbon analysis, and b) achievement of 30% reduction from benchmark CO_2 values per m2 of floor area etc. As shown in Table 9, the excel file for carbon assessment requires input of the weights of cement constituents including Portland cement, PFA, GGBFS. Users may either use the default emissions value for each material, or may enter a specific value. If choosing the latter, EPD evidence is required.
- LEED v4.1 also awards points for a) having at least 20 products from at least 5 different manufacturers each having an EPD type III[1], and b) having at least 5 products from at least

[1] Highest points are given for a product specific EPD, externally reviewed, compliant with both ISO 14025 and either EN 15804 or ISO 21930

three different manufacturers that have a compliant embodied carbon optimization report or action plan separate from the Life cycle analysis or EPD[2].

Table 11: Green mark whole life carbon example calculation, allowing either default (global values) or user defined data entry with documentation[3]

Cement					
Component	**Country of origin**	**Emission factor ($kgCO_2$ eq/kg material)**	**Value Used**	**User defined Emission factor ($kgCO_2$ eq/kg material)**	**Quantity**
Ordinary Portland Cement (OPC)	Vietnam	0.92	Global		
Ground-Granulated Blast-Furnace Slag (GGBS)	Vietnam				
GGBFS Nghi Son	Vietnam	0.08	Global		
Limestones	Vietnam	0.10	Global		
Limestones Fines	Vietnam	0.09	Global		
Fly Ash	Vietnam	0.06	Global		

50. Examination of scoresheets of some of the most recent LEED gold and platinum buildings in Vietnam showed that they tend to score poorly for the section of materials and resources used. This may be because LEED and Green mark now place emphasis on whole life carbon calculation, use of materials having EPDs, and use of recycled aggregates, but that these methods are not yet in common use.

C. Product certification

51. The drivers behind the development of product certification of sustainable building materials in Vietnam appear to be a) ability of a building developer to earn points for sustainable buildings certification through use of materials having product certification, and b) requirements for import certification particularly for the EU carbon border tax whose transitional phase commenced on May 17, 2023.

52. Two types of certificate were examined

1) ISO 14024 Type I Certificates issued by Green Building Councils or other entities
2) ISO 14025 Type III Certificates issued by Environmental Product Declaration program operators

53. **Type I Certificates** As shown in Table 12, the SGBC system is favored by Vietnamese cement manufacturers, with 5 firms and 23 products have cement certificates from SGBC, with 2 firms and 11 products certified by VGBC, and 2 firms and 2 products by VIBM. The products certified by VGBC are all certified by SGBC as well.

[2] The LEED points system relating to EPDs is complex, it may be found in full at link

[3] The file requires selection of material input components from a pull-down list. Emissions factor for the selected product is automatically displayed. Alternatively the use may manually enter user defined emissions factor but supporting documentation (an EPD) is then required. The user also enters the quantities (weights) of the material input components.

- **Table 12: No. of cements having product certificates from SGBC, VGBC, and VIBM**

System / Company	PC	PCB	PCB 30	PCB 40	PCB 50	$PCB_{BFS}40$ HS	PCB_{BFS} 50	Grand Total
SGBC		**9**		**9**	**2**	**2**	**1**	**23**
Fico Tay Ninh Cement Joint Stock Company (Fico-YTL)		3		3		2		8
Ha Long Cement company Ltd.				2	1			3
Siam City Cement (Vietnam) Ltd		6		1			1	8
Thang Long Cement JSC				1				1
VICEM Ha Tien Cement JSC				2	1			3
VGBC	**2**	**1**		**6**	**2**			**11**
Fico Tay Ninh Cement Joint Stock Company (Fico-YTL)				1				1
VICEM Ha Tien Cement JSC	2	1		5	2			10
VIBM			**1**	**1**				**2**
Nghi Son Cement				1				1
VICEM But Son			1					1
Grand Total	**2**	**10**	**1**	**16**	**4**	**2**	**1**	**36**

54. SGBC website states that its Certification Scheme is accepted by regional green building rating tools include of Malaysia, and Vietnam and that "The SGBP complies with many of the requirements in ISO 14024 Environmental labels and declarations — Type I environmental labelling". Building products are assessed on their environmental properties and performance for Energy Efficiency, Water Efficiency, Resource Efficiency, Health & Environmental Protection and Other Green Features. Buildings are rated with a tick from 1 to 4. Having 4 ticks indicates a leader position. The criteria are not published, and do not include CO_2 emission data as the following email response.

> *"As part of our efforts to ensure that the criteria are kept up to date with the technological advances in the industry and to stay relevant to market needs, we continuously review, make improvements and adjustments to the criteria. Therefore, in order to prevent outdated criteria from being circulated, we do not share the criteria publicly. Criteria will be viewable on the portal to the applicant after SGBC accepts the application for products/services certification."*
>
> *"We do not evaluate cement products based on their carbon emissions yet"*

55. **Type III Certificates.** At the start of the materials survey, examination of the EPD library hosted by EPD International at https://www.environdec.com revealed that in reinforcing steel, cement, and asphalt categories in Vietnam there was only one firm with an EPD for reinforcing steel. By the end of the survey, this had increased to 4 EPDs (2 for reinforcing steel, and 2 for cements of which one has not yet appeared in the library). There is major difference in the level of information between Type I and Type III certificates as follows:

- Type I certificates do not show criteria or result
- Type I certificate by SGBC has 4 levels, but criteria are not public
- Type III EPDs are independently verified and show CO_2 emissions, and percentage of supplemental cementitious material.

56. **Other certificates.** Vietnam Institute of Building Materials (VIBM) introduced a "green cement certificate" whose criteria are public as in Table 13. Whilst there are multiple criteria, the

requirement for CO_2 emissions <650kg/ ton is perhaps the principal criteria. Two cements have been certified – one a PCB30, the other a PCB40. The certificate does not include any statement regarding compliance with an ISO standard, or the methodology applied for CO_2 calculation. It is noted that the CO_2 emissions criteria of 650kg/ ton exceeds the global average as shown in Table 5, as well as the averages for India, Thailand and Philippines.

Table 13: Criteria for VIBM Green cement certificate

Green cement criteria
1. Requirements for using alternative raw materials and fuels
Use alternative fuels Up to 15%
Or use industrial waste as an alternative material Minimum 39%
2. Energy consumption and emission levels
a) For clinker production stage
Heat energy consumption ≤ 800kcal/kg clinker
Power consumption ≤ 65 kWh/ton clinker
Emission levels in kiln flue gas SO_2 ≤ 200mg/Nm3, NO_2 ≤ 800 mg/Nm3, Dust ≤ 30 mg/Nm^3.
b) For cement grinding stage
Power consumption ≤ 40 kWh/ton of cement
Amount of CO_2 emitted during cement production ≤ 650kg/ton of cement

D. Conclusions regarding certification schemes

57. The following conclusions are made regarding sustainable building and building materials certification schemes:

1) The green buildings systems have a clear objective and substantially meet that objective. However, since materials and their embodied carbon only account for around 13% of the rating score, the building certification systems are not appropriate for use on infrastructure projects.
2) For civil engineering works, disclosure of CO_2 emissions, and cement composition is fundamental to be able to compare alternative design solutions or bids, hence use of EPD declarations seems essential.
3) Singapore and Vietnam Green Building Councils current product certification systems lack quantitative data for cements and would not contribute in the case of civil works (although one firm's steel is identified as being produced from recycled materials).
4) Fortunately, moves by LEED and Green mark to give credits for use of whole life carbon assessment and for submission of EPDs seems to be rapidly driving moves towards more widespread use of EPDs, for cement in particular.
5) The objective of the VIBM green cement certificate seems unclear since it does not declare that the certification complies with a particular ISO methodology, or a particular protocol for the CO_2 calculation. It seems to have limited benefit to differentiate between products since the CO_2 criteria is not particularly demanding, and there is just a single set of criteria without differentiation for clinker, PC, PCB or different cement strength grades. It is unclear whether VIBM would be eligible or interested to enter the market as an EPD program operator.
6) The Hong Kong model for EPDs for concrete (Figure 8 for an example) seems a useful reference, since it presents both the CO_2 emissions result, as well as the proportion of SCM in the mix and the strength / purpose[4]. Full details of the criteria and system for concrete are published in a useful guide[5].

[4] Issued by Hong Kong Construction Industry Council, which is an industry association (non-government entity)
[5] Guide to the Hong Kong concrete EPD system is here

7) Regarding a suitable approach for Vietnam for green materials certification, there are many cases to consider, such as for LEED buildings, for infrastructure construction in a major city, and for infrastructure construction outside a city. The Hong Kong example of EPDs for concrete is successful in a dense city environment where readymix is virtually always used. To obtain an EPD requires data analysis of input materials and energy etc. for a defined period of production, typically 1 year. For a cement plant that might be feasible, but for a readymix plant producing a very wide range of mixes it might not be so easy to separate out the data for each particular mix with sufficient rigor to withstand audit. Then, for custom concrete mixes e.g. for a metro project, the readymix firm might need to create EPDs just for those mixes which would take time. Use of cement EPDs avoids many of these issues, hence cement EPDs also seem to be a vital tool particularly for projects outside of the major cities. Use of EPDs for reinforcing steel is likely to be the way forward, although noting that provided the steel is certified as produced from scrap, major CO_2 reduction is automatically obtained so recourse to requiring an EPD might not be required during early years of adoption.

Figure 8: Example EPD for concrete, Hong Kong

C45 35%PFA Tremie,Max CC 500kg/m3, (Sai Tso Wan Plant)

Manufacturer:	Golik Concrete Limited
Factory Site Address:	3 Dai Shing Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong
Category:	Ready-mixed concrete
Origin:	HK
Carbon Rating:	PLATINUM CIC GREEN PRODUCT CERTIFICATION platinum
CFP Value:	267.070 kg CO_2e/m^3 product
Certificate No.:	CICGPC-L-23594(RMC)
Licence End Date:	2027-01-03

VI. LESSSONS LEARNT REGARDING THE STUDY METHODOLOGY

58. Key lessons learnt from the methodology applied for the study are as follows:

Challenges

1) Obtaining company level or product level data from industry associations was unsuccessful. The reason is that association rules require the association to maintain confidentiality of data and it can only be disclosed with permission of the data owner.
2) Obtaining unpublished company level or product level data from companies was unsuccessful. Many of the firms are stock market listed firms and stock market rules require specific disclosures because the selective release of information places individual shareholders at a disadvantage. Accordingly, staff are instructed not to provide any information beyond that shown in the published marketing, technical data, or investor relations reports.
3) Countries whose associations and firms are not members of the Global Cement and Concrete Association such as Vietnam are likely to have more limited information available, since they do not participate in GCCA's standardized data reporting system. This standardized data reporting system also forms the basis for preparation of EPDs.
4) Government agencies and industry associations provided occasional advice or opinion of value, but overall were of rather limited benefit to the study as it was time consuming to obtain a meeting appointment, typically only a single meeting would be arranged due to the heavy workloads of their staff, and they generally lacked data or were unable to disclose it.
5) Most firms are highly secretive regarding the "recipe" for their products in order to maintain competitive advantage. Only a small subset of firms has recognized and acted on market trends for information disclosure as required for clients constructing green buildings, or for export countries that require EPDs.

Successes

1) EPDs published in the EPD library were the most valuable data source, since they show both CO_2 emissions at a product level, as well as percentage blend for various cement products.
2) Company sustainability reports, or ESG reports were somewhat useful as they helped identify firms with a progressive approach. Although they typically only give data at a company level rather than a product level.
3) Government published material price data as part of the cost norm system was useful for providing a uniform price database.
4) Materials engineers undertaking construction supervision assignments, and engineers from contractors were found to be most useful respondents regarding actual practice, technical, regulatory, and practical issues, and for discussing potential opportunities for improved resource efficiency and possible constraints to their adoption.
5) Vietnamese sector roadmaps, or presentations made by industry associations to international forums provided useful overviews of roadmaps for GHG emissions reduction and the timeline of planned adoption of technologies and targets.
6) International references such as company brochures, global association roadmaps, and research publications were of particular use in identifying and understanding details of the potential opportunities that could be applied in the country context.

VII. CONCLUSIONS AND WAY FORWARD

59. Opportunities identified and an assessment of their relative potential are summarized as follows.

- Reinforcing steel is considered to have the highest potential as a candidate for improved resource efficiency since a standard product (steel produced from iron ore) and a substantially greener alternative (steel produced from scrap) are both available on the market with roughly equal market shares and currently competing on price based on the same technical specifications. Production capacity of the greener alternative is sufficient to meet market demand and replace the standard product. The potential CO_2 emissions reduction of the greener alternative is 50 to 70%.
- Asphalt is considered to currently have lowest potential for improved resource efficiency, since greener products (warm asphalt, and use of recycled asphalt planings) are not yet available on the market due to their higher cost / time requirements and absence of demand. The potential CO_2 emissions reduction of the greener alternative is estimated at 16% if applying 20% RAP content.[6]
- Cement is considered to have intermediate potential as a candidate for improved resource efficiency. Vietnam currently has extensive supply of PFA and BFS from its coal fired power stations and steel making industry, although in future this will decline as part of decarbonization efforts. Over the past decades greener alternatives of blended cements (PCB) have already displaced standard products (PC) to gain a dominant market share based on their lower price. There remains continued improved resource efficiency improvement through optimization of cement usage, and if selection of solutions is based on CO_2 emissions as well as price.
- Concrete is considered to have relatively good potential as a candidate for improved resource efficiency since there is a product available on the market (CMC) offering reduced CO_2 emissions (7.5%) for a small price premium, and a product available on the market offering reduced CO_2 emissions (30% or more) based on partial replacement of PCB with PCB_{BFS} for a small price premium. This latter opportunity does however have limitation based on the finite supply of blast furnace slag, which is already in high demand.

60. As next steps, issues proposed for study and verification are as follows:

Reinforcing steel.

- Verification by sector agencies[7] that there are no particular technical issues with production and quality control of reinforcing steel made from scrap that could limit its wider usage, or else make proposals to remedy any issues identified.
- Verification by sector agencies that promotion of the greener alternative and reducing usage of the standard product would not result in unacceptable negative economic impacts on producers of the standard product, or if there are, propose a transitional timeline to mitigate their impact.

Asphalt

- Verification with sector agencies[8] to determine whether adoption of the proposed greener alternatives forms part of their decarbonization strategy in the short term.

[6] Whilst currently assessed as having low potential in Vietnam, for reference in the UK design standard allow up to 10% RAP in surface course, 50% in binder course. 90% of available reclaimed asphalt is recycled in hot mix, warm mix or cold recycled, of which 80% in hot or warm mix and warm mix, and 5-15% is cold recycled, the remainder is used for other applications. “Comprehensive review of asphalt recycling with a view to increasing recycled content in the medium-term”, January 2020, Atkins link

[7] MOIT Science and Technology Department, VSA

[8] MOT Science and Technology and Environmental Department

Cement and concrete

- Verification by sector agencies[9] that current design regulations, cost norms, and contract forms do not hinder optimal resource efficiency, or else make proposals to remedy any issues identified.
- Consideration by sector agencies on risk allocation with regard to selection of optimum cement and concrete solutions, whether prescriptive approach by regulators or clients who thereby retain risk, or by motivating contractors to select optimum solutions by giving them freedom to select conforming solutions and hence bear increased risk.

61. Regarding the issues for verification mentioned above, the following additional information is noted:

Reinforcing steel - quality. One respondent noted concern regarding increased risk of cracking of reinforcing steel made from scrap during the 180-degree bend test. Marketing material by manufacturers of the standard product may serve to propagate such concerns, as it highlights the low levels of Cu, Nickel, Cr of <0.03%[10] of their product. On the other hand, oxygen injection during processing of steel scrap also has the effect of removing impurities, and these issues are not insurmountable since in the UK 100% of reinforcing steel is now produced from scrap[11].

Reinforcing steel – economic impact. Introduction of CO_2 cap and trade mechanism from 2027 will begin to penalize producers of steel from iron ore. Perhaps in recognition of this, at the 2023 General Meeting of Shareholders, Chairman of the Board of Directors of Hoa Phat Group, said that "in the coming time the group will focusing on developing high-quality steel , leaving the playing field for enterprises producing basic construction steel."[12]

Reinforcing steel – market price of input material. If Vietnam and other countries simultaneously choose to promote use of scrap for steel, this will have an impact on market pricing domestic supply is insufficient and purchasers compete at auction to purchase cargoes from the US, Korea, Japan etc. based on the quality of the material.

Asphalt – supply of reliable input materials. Whilst road planing is frequently used in Hanoi to avoid the need to reset the elevations of drainage and sidewalks, variability of the existing pavement materials, and limited working space hinder reuse of the RAP. In future when expressways or national highways require periodic maintenance, these may provide better sources of consistent RAP and adequate working area.

Asphalt – equipment and materials constraints. It is understood that batching plants can typically accommodate up to 25-40% RAP without substantial modification, but use of higher proportions would require a separate pre-heating line for the RAP.

Cement and concrete – optimal resource efficiency. Understanding of current resource efficiency can be best understood by examining project case studies, and the practical factors that impact selection by clients and contractors of a range of cements and concretes for their project. A case study is examined in Appendix 1, for a typical

[9] MOC Building Materials Department, VNCA, VCA

[10] Hoa Phat steel website "Thanks to the closed steelmaking process and modern technology lines of G7 countries, Hoa Phat has transformed iron ore into many product lines with standard quality and clean impurities. Hoa Phat's finished steel has a very low amount of impurities (Cu, Ni, Cr), only <0.03%, lower than the standards of countries around the world. Moreover, the steelmaking process from ore thoroughly removes other harmful impurities such as S, P, so the product is cleaner, purer and of better quality. Therefore, the product quality is more stable, the life of the project is longer. With extremely low impurities, steel made from ore has high bending strength, toughness and elongation. Therefore, steel made from ore has superior physical and mechanical properties and can be rolled into products with higher diameters and grades. In Vietnam, only Hoa Phat Steel can roll products up to D55 high grade." link

[11] Sustainableconcrete.org.uk link

[12] Report and transcript of Hoa Phat 2023 AGM, 30 March 2023 link

transport sector project. which may help the reader understand the practical factors, and that efficiency improvement is likely to be incremental, seeking opportunities on a project-by-project base.

62. It is emphasized that whilst this study was initiated to explore opportunities for improved resource efficiency with a view to potential use of procurement mechanisms to encourage their adoption, discussion with stakeholders will be required to determine the most appropriate mechanism to adopt in order to promote each opportunity. Mechanisms to promote improved resource efficiency will likely include options of:

a). regulation e.g. mandating a specified RAP content in asphalt, or
b). price preference in procurement, or
c). as a result of the cap-and-trade mechanism commencing in 2027 in Vietnam

Caution will be required to ensure that price preferences are not duplicated, e.g. by applying a cap-and-trade mechanism to the industry overall, and at the same time applying a preference system in procurement.

63. In order to promote use of greener alternatives in government procurement, it will be necessary to ensure that the system of cost norms recognizes their existence, includes them in work activity cost calculations, and that price data is collected and published monthy/ quarterly by provincial Departments of Construction. This is necessary so that cost estimates at feasibility study and detailed design stage include adequate budget for use of greener alternatives. Published price information should also be enhanced by a) identifying whether the rebar is a product of virgin steel or scrap, and b) identifying the blend percentage, and CO2 emissions of cements whenever it is available.

APPENDIX 1 - QUESTIONNAIRE FOR COMPARISON BETWEEN THE STUDY COUNTRIES

1.0 Regulatory Framework and Environmental Standards		
1.1	Are there national strategic goals to promote sustainable development and circular economy, including resource efficiency in the construction sector?	Yes. 2022 NDC seek 43.5% reduction in GHG by 2030, plus 2022 "Climate change action plan in the construction sector for the 2022 – 2030 period with vision towards 2050 to fulfill Vietnam's commitments in COP26" gives additional details. Strategic goals regarding sourcing of cement, steel, concrete are not part of such plans since Vietnam is a major producer and exporter. Regarding bitumen, domestic production is expected to commence in future at existing oil refineries. Strategic goals regarding manufacture of cement and steel are reduction of GHG through introduction of CO_2 cap and trade system from 2027/28 Strategic goals regarding recycling are covered in the Building Materials Development Strategy 2030, vision 2050 1266/QD-TTg (MOC). Regarding concrete, this has objectives: • 2021-2030 Efficient and economical use of mineral resources, fuel and energy; Use industrial, agricultural, construction, traffic waste,... and artificial, recycled aggregates and low clinker content cement to produce concrete. • 2031-2050 - Use aggregates from recycled and waste materials to replace up to 60% of natural materials; Develop mineral and chemical additives to be included as mandatory ingredients in concrete production to improve the quality of concrete products.
	If YES, please give details of strategic goals related to:	
	a) Sourcing	
	b) Manufacture	
	c) Recycling	
1.2	Do the laws and regulations of country set a specific target for achieving resource efficiency in the use of critical construction raw materials – asphalt, cement, concrete and steel?	Yes, Law on Economic and Efficient Use of Energy was enacted in 2010 requiring use of energy management systems (i.e. ISO 50001:2018) to help firms identify existing issues and potential energy-saving opportunities. a) Yes, Building materials development strategy 2050 - Decision 1266/QD-TTG, 2020 has targets by 2030 of 65% clinker content in cement, 650kg CO_2/ton cement. c) Yes, Building materials development strategy 2050 - Decision 1266/QD-TTG, 2020 has target by 2050 to use aggregates from recycled and waste materials to replace up to 60% of natural materials in concrete.
	If YES, please give details of the relevant regulatory framework.	
	a) Energy Efficiency/Embodied Carbon	
	b) Water use	
	c) Mining of raw materials	
1.3	Please provide information on any government economic policies or financial incentives, such as tax breaks, subsidies, grants, or other support mechanisms for construction materials .	Yes. Environmental protection tax law in 2010 imposed taxes on fossil fuels including gasoline, aviation fuel, diesel, kerosene, fuel oil, lubricants, and grease, and on coals. In the event of mixed fuels comprised of both biofuel and fossil-fuel-based fuels, the EPT only applies to the fossil-fuel-based portion. The rates were increased in 2015 and are around $0.50 per tCO2e on coal, $77.60 per tCO2e on gasoline, and $32.90 per tCO2e on diesel. Vietnam imposes a low (0.33 percent) average tariff on import of environmental goods
1.4	Does your country have construction and demolition (C&D) waste law/rule/regulations that mandate minimum use of C&D waste in construction and building projects?	Yes, Building materials development strategy 2050 - Decision 1266/QD-TTG, 2020 has target by 2050 to use aggregates from recycled and waste materials to replace up to 60% of natural materials.
	If YES, please give details of the targets for construction sector.	
	a) Landfill	
	b) Recycling	

1.5	Do regulations for cement and concrete permit incorporation of Supplementary Cementitious Materials (SCMs) such as Ground Granulated Blast Furnace Slags (GGBS), Pulverized Fly Ash (PFA), limestone, calcinated clay, natural pozzolana, etc.?	Yes. • Portland Cement – Specifications TCVN 2682 : 2020 e.g. PC40, permits up to 5% limestone. • Portland Blended Cement – Specifications TCVN 6260 : 2009 The total amount of mineral additives (excluding gypsum) in mixed Portland cement, calculated by cement volume, is not more than 40%, of which full additives are not more than 20%. e.g. PCB40 2020 updated 5.4 The total amount of mineral additives (excluding gypsum) in mixed Portland cement, calculated by cement volume, is allowed to be up to 50%, provided that the manufacturer must use blast furnace slag at the right ratio. ratio greater than 10% or more. • Portland Blast Furnace Slag Cement TCVN 4316 : 2007 Type I: slag content is from 40 % to 60% - signed PCB_{BFS}I , Type II: slag content is from 60 % to 70% - signed PCB_{BFS}II e.g. PCB_{BFS}I 40 • Sulfate Resistant Portland Cement TCVN 6067 : 2004 e.g. PC_{SR}40 • Sulfate Resistant Blended Portland Cement TCVN 7711 : 2007 e.g. PCB_{MSR}40, PCB_{HSR}40 (moderate sulfate Resistant and high sulfate resistant) • Low Heat Blended Portland Cement TCVN 7712 : 2007 e.g. PCB_{LH}40
	If YES, please give details of national standards for Blended cement.	
1.6	Do regulations allow for the use of natural fiber composites in Reinforced Cement Concrete (RCC)?	No, not for civil engineering use.
	If YES, please give details.	
1.7	Do regulations allow for alternate binding materials, such as rubber tires, plastic, and other similar materials, as substitutes for asphalt in the construction of asphalt concrete roads or other related applications?	Polymer modified bitumens using crumb rubber, or polymers such as SBS are permitted under Vietnamese standards (22 BC 319 - 04, TCVN 11193:2021), although its use is mainly limited to asphalt paving on structures/ viaduct which use thin surfacing layers, or at particular heavily trafficked locations.
	Please elaborate on any specific guidelines or provisions that permit or regulate the use of these materials.	
1.8	Does your country have national standards permitting the use of Recycled, co-products or waste materials (RCWMs) such as Reclaimed asphalt pavement, Construction and Demolition (C&D) wastes, Recycled concrete aggregate, Blast furnace slag, Steel furnace slag, Foundry sand, etc. to replace coarse and fine aggregates?	Yes, many directives from the Prime Minister to promote reuse of fly ash and GGBFS for uses including cement production, amongst others. The directives led to the establishment of standards for material properties and grades, and use in various products. Technical standards: TCVN 6882:2001 Mineral additives for cement, applied to fly ash and bottom ash; TCVN 7570: 2006 Aggregates for concrete and mortar, applied to bottom ash; TCVN 4315:2007 Granulated blast furnace slag used for cement production; TCVN 8262:2009 Fly ash – Chemical analysis method; TCVN 8256:2009 Plasterboard – Technical requirements; TCVN 8257:2009 Plasterboard – Test method; TCVN 8825:2011 Mineral additives for roller compacted concrete, applicable to fly ash and bottom ash; TCVN 8654:2011 Plaster – Chemical analysis method; TCVN 9807:2013 gypsum used for cement production; TCVN 10302:2014 Fly ash active additive for concrete, mortar and cement; TCVN 10379:2014 Soil reinforcement with inorganic binders, chemicals or synthetic reinforcement, used in road construction - Construction and acceptance (with regulations on using fly ash as inorganic binder)
	If YES, please give details of relevant national standards.	
	Please provide any specific quality guidelines or quality standards that govern their use.	

		; TCVN 11586:2016 Finely ground blast furnace slag for concrete and construction mortar; TCVN 11833:2017 Phosphorus gypsum as an additive for cement production; TCVN 11860:2017 Thermal power ash and slag - Method for determining free lime content; TCVN 12249:2018 Ash and slag from coal-fired thermal power plants as backfilling material – General requirements; TCVN 12660:2019 Ash and slag from coal-fired thermal power plants for road base – Technical requirements, construction and acceptance; TCVN 12261:2019 Coal combustion products – Terms and definitions; Decision No. 375/QD-DHXD dated March 28, 2019 of the Principal of the University of Civil Engineering on promulgation of Facility Standards TCCS 01:2019/DHXD Technical design, construction and acceptance of level ground treatment CFG pile; Decision No. 376/QD-DHXD dated March 28, 2019 of the Principal of the University of Civil Engineering on promulgating basic standards 02:2019/DHXD Technical instructions - component selection and brick quality control concrete uses crushed stone waste and fly ash. For Asphalt, use of up to 25% RAP is permitted under TCVN 13567-4:2024.
1.9	Does your country have a national standard on the use of bamboo as a structural material in building construction and adequate testing facility for testing bamboo as per standards?	No, not for civil engineering use.
	If YES, please provide details of national standards on bamboo.	
2. Availability and Cost of Sustainable Materials		
Blended Cement		
2.1	Can you provide a broad estimate (with information source) of the market share and cost comparison of blended cement or blend Portland cement with Supplementary Cementitious Materials (SCMs) such as Ground Granulated Blast Furnace Slags (GGBS), Pulverized Fly Ash (PFA), lime stone, calcinated clay, natural pozzolana, etc. with that of Portland Cement?	Statistics are not published or disclosed, but it is estimated that PC comprises one third of domestic sales, the remainder being PCB. However, of the PC sales, some of it may still be subject to blending by intermediaries or at the batching plant. Price is proportionate to the clinker percentage, hence a PCB40 may be 10 - 30% cheaper than a PC40, and a PC30 may be 5-10% cheaper than a PC40. PCB cements may contain from 5 - 40% PFA or other replacements, and PCB_{BFS} cements up to 70% replacement, so there is a wide range in prices depending on the usage whether for structural or non-structural use. Source of price data is monthly or quarterly price data published by provincial departments of construction showing prices of the range of products from a range of manufacturers.
	Please provide company details where available.	

SCMs	Market share	Cost Comparison	Company Details	
Pulverized Fly Ash		150 – 300k (in south)		The market survey was carried out for cements, not for their component parts. Furthermore, most firms strictly do not disclose composition details of their cements, merely that they comply with the relevant standard, which for PCB may be within a range of 5 - 70% of SCM of various types. Only 2 firms have EPDs showing blend proportions and CO_2 emissions for each product (please see the separate table).
Blast Furnace Slag		660k (at factory, Hai Duong)		

			1,000 – 1,100k (in the south)		Some details of supply of SCMs are as follows 14m – 22m tons fly ash (range of estimates) is produced per year in VN (sources here and here) 2.32m – 4.8m tons of blast furnace slag (range of estimates dependent on number of blast furnaces in operation), is produced per year in VN (source here). One blast furnace operator (Hoa Phat, Hai Duong plant) said that half their sales are to cement firms, half to readymix firms. Profitable uses of blast furnace slag cement PCBBFS are in deep soil mixing for strengthening of soft soils, and in sulphate resistant cements. Availability of slag is finite and with high demand the current market price (in the south) is only around 10% below that of clinker, hence this limits increased adoption in cement / concrete. On the other hand, PFA supply is around 4 times higher, but lack of processing and quality control at source really limits usability in cement production.
	Calcinated clay				
	Natural pozzolana				
	Others, if any				
Recycled Materials					
2.2	Can you provide a broad estimate (with information source) of market share of Recycled, co-products or waste materials (RCWMs) and their cost comparison vis-à-vis virgin coarse or fine aggregates?				There is not a market for recycled coarse and fine aggregates as input material for concrete or asphalt. Until now, occasionally in response to client request, rejected concrete batches have been washed to extract the coarse aggregate for reuse, and by this method can obtain 50% of the available credits in Greenmark scoring system.
	RCWMs	Market Share	Cost Comparison	Company Details	
	Reclaimed asphalt pavement				
	Recycled concrete aggregates				
	Blast furnace slag				
	Foundry sand				
	Other materials, if any				Use granite fines for fine aggregate replacement >50% (quarry dust is used to replace river sand in the mix). However, it is debatable whether or not this is “recycled” – on one hand crusher dust might otherwise be a waste product, but on the other hand it is a virgin aggregate.
2.3	Please provide information on availability and costing of options for resource efficient asphalt such as:				There is not a market supply of WMA and RAP since there is not yet demand. Research has been carried out by various universities in Vietnam including a pilot in Dong Nai province for a 300m length in conjunction with a large asphalt supplier named BMT in 2021.
	Warm Mix Asphalt (WMA)				
	Permeable Pavements				Permeable pavement is not applied.
2.4	Please provide information on availability and costing of options for resource efficiency in manufacture such as:				By end of 2022 waste heat recovery systems had been installed in 39 cement production lines in the country, with capacity of around 260 MW.
	Waste Heat Recovery				
3. Innovation & Market Development Opportunities					
3.1	Could you provide specific examples of recent technological innovations or advancements in country that have improved the resource efficiency of				Cement: Firms continue efforts made over the past 20 years to reduce clinker percentage through increased use of SCMs, and to increase energy efficiency through use of alternative fuels, and installation of waste heat recycling. Steel: February 7, 2024, Vietnam issued a national hydrogen

	key construction materials like asphalt, cement, concrete, and steel?	development strategy, aiming to achieve a hydrogen production capacity of 100,000–500,000 tons per year by 2030. This is critical in order to decarbonize raw steel production. Previous efficiency improvement had been primarily by investment in larger and more modern plants. Bitumen: Around 2014 problems of rutting and pavement failure reached extreme levels, and new standards were introduced permitting use of polymer modified bitumens (currently TCVN 11193: 2021 and TCVN 13567-2: 2022), and use of Hamburg wheel tracking testing (currently TCVN 13899:2023). The latter led to better control of mixes and greatly improved asphalt reliability and durability, so polymer modification was only applied for limited application uses. Concrete: One firm has licensed use of CarbonCure technology and is applying it at one batching plant, for 2 high rise building projects. It injects CO_2 into the ready mix where it converts to a mineral, improving compressive strength. This allows optimization of mix designs, reducing cement content and lowering the carbon footprint of the concrete. The firm is ready to provide the technology at the remainder of its batching plants subject to demand.
3.2	Can you describe any national programs, policies, or incentives that promote research and development in new construction materials and technologies, particularly those enhancing resource efficiency? How effective have these programs been in driving innovation and adoption in the construction sector?	Both cement and steel industries are highly competitive, and firms make substantial investment in research and efficiency improvements in order to remain competitive in the domestic and export markets. Many plants have full or partial foreign investment, or have strategic partnerships with international plant suppliers. Firms tend to be highly secretive about their intellectual property. The most effective government support might be considered the efforts to promote reuse of waste products,
3.3	What are the predominant challenges or obstacles encountered in adopting new technologies for construction material efficiency in your country, such as cost, technical expertise, or industry resistance? What strategies or measures are being implemented by government and businesses to address these challenges?	Cyclical domestic and export demand and overcapacity in the cement and steel industries leads to temporary or permanent shutdowns and financial losses for the less efficient producers. Thus such firms lack cashflow and reserves to finance to replace or upgrade their facilities. The government approach has been to refuse investment licenses for new plants unless they are of sufficient scale and apply efficient processes.
3.4	How is the construction industry in country fostering collaborations with technology companies, startups, and academic research institutions to innovate in the field of resource-efficient materials, technologies and methods? Are there any notable partnerships or collaborative projects that have yielded significant advancements?	Foreign invested cement firms hold around one third of the market, and other private sector firms (many are stock market listed) often have strategic partnerships with international firms for materials and equipment supply and consulting. Likewise the steel sector has substantial foreign involvement by leading international firms (e.g. Formosa (Taiwan), Posco (Korea), Tung Ho (Taiwan), Viet Nhat (Japan) etc.). Academic research institutes have contributed to the research and standards development listed in response 1.8
4. Supply Chain Management Practices		
4.1	In what ways is digital technology, such as real-time tracking systems or predictive analytics, being utilized in supply chain to improve the efficiency, accuracy, and	For cement manufacture the major input materials are normally sourced locally so advanced supply chain management is not applicable. For steel manufacturers some firms rely on local input materials whilst others use imported ore and fuel.

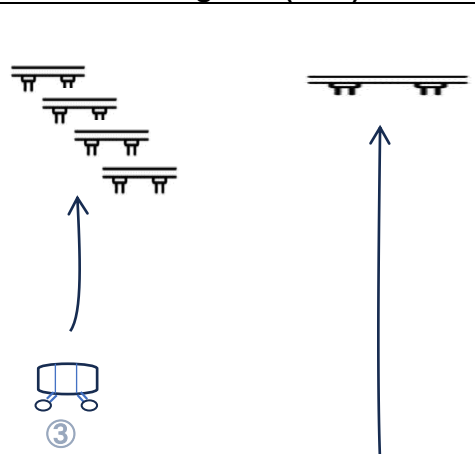
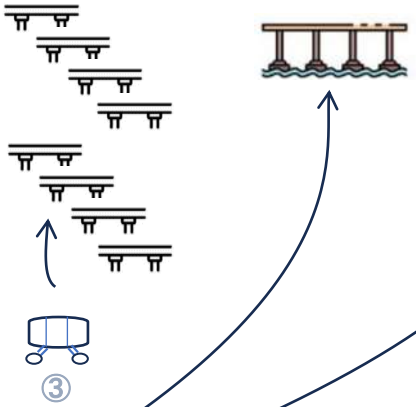
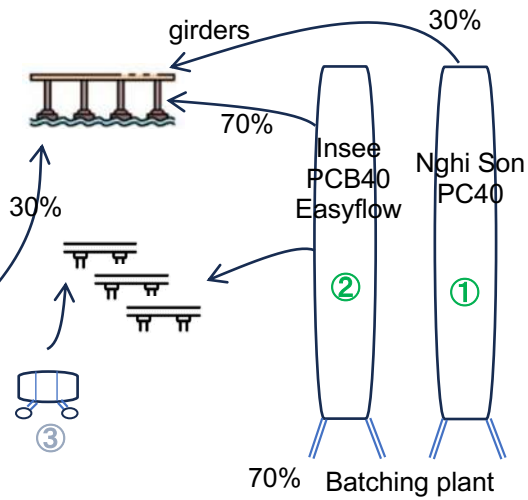
	transparency of material distribution? Can you provide examples of successful implementations that led to tangible improvement in resource efficiency?	Many firms are located on coastal sites with port facilities permitting access by large vessels for both import of input materials and export of products.
4.2	How are sustainable sourcing practices for construction materials integrated into supply chain management? What measures are in place to verify the sustainability of sourced materials from upstream supply chain partners, and what challenges have been encountered in implementing these practices?	No information is available.
4.3	Can companies provide specifications demonstrating increased resource efficiency? What standards and accreditations are most widely used? Please list.	A small number of firms publish annual sustainability of ESG reports setting out their targets, achievements, and methods applied. Certification systems used by firms include the Singapore Green Buildings Council, the Vietnam Green Buildings Council, and VIBMs green cement certificate. Please refer to the main text section on certification.
5. Questions for Contractors/ Industry Associations		
5.1	In the context of economic situation in country, what are the major specific economic challenges and opportunities faced by market players in adopting resource-efficient materials and practices in construction projects?	Both cement and steel industries face challenges of excess capacity, and the steel sector faces challenges of increasing imports of HRC steel. Hence financial situation in both sectors is described as critical. Current primary concern of firms in the market is promotion of domestic consumption and of export demand. Many cement production lines have suspended operations. Hence moves towards net zero during a period of a critical market situation would likely lead to closure of less efficient production facilities.
5.2	Could you provide an in-depth analysis of the current availability of key construction materials such as asphalt, cement, concrete, and steel in your country, and whether this supply is sufficient to meet the existing and projected demands for infrastructure development? Please elaborate on factors such as domestic production capacities, reliance on imports, and any known constraints or challenges in sourcing these materials.	Cement: Vietnam was the No.1 exporter of clinker and cement in the world in 2022, and has capacity of 120m tons, far in excess of domestic demand of around 88m tons. Steel: Vietnam is the 12th largest steel producer in the world, has consumption around 20m tons, production around 26m tons, and is a major exporter and importer. Production capacity of raw steel is around 23m tons, and of finished steel around 39m tons. Increased import of hot rolled coil (HRC) is currently putting pressure on domestic firms. Bitumen: Is imported generally from refiners in Singapore, but in future may be produced at one of the existing Vietnamese refineries.
5.3	Could you provide an overview of the national standards and regulations in your country related to the production of cement and concrete, particularly focusing on the incorporation of Supplementary Cementitious Materials (SCMs) such as Ground Granulated Blast Furnace Slags (GGBS), Pulverized Fly Ash (PFA), limestone, calcined clay, natural pozzolana, etc.?	Vietnamese cement standards are aligned with EU and US standards and cover a range of cements using SCMs.

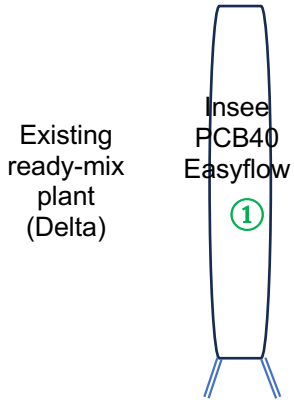
5.3.1	Please elaborate on how these standards accommodate or regulate the substitution of clinker with SCMs, both in cement production and in the production of concrete at batching plants at construction sites.	Similar to EU / US standards, the standards are product type standards showing permitted ranges of SCMs in each cement type.
5.4	In the context of country's construction industry, could you discuss the presence and scope of national standards or regulations that permit the use of Recycled, Co-products, or Waste Materials (RCWMs) like Reclaimed Asphalt Pavement, Construction and Demolition (C&D) wastes, Recycled Concrete Aggregate, Blast Furnace Slag, Steel Furnace Slag, Foundry Sand, etc., as substitutes for traditional coarse and fine aggregates in construction projects?	Cement standards specifically permit use of PFA, blast furnace slag in cements. There is a standard for recycled coarse aggregate in concrete TCVN 11969:2018 It states that according to quality, recycled coarse aggregate is divided into two types: type I and type II. Type I is recommended for concrete up to grade M35, type II is recommended for concrete up to grade M20. It may contain a proportion of brick, although content is limited by density requirements of >2300kg/m3 and >1800kg/m3 TCVN 13567: 2022 permits use of blast furnace slag as mineral powder in asphalt. But it does not specifically permit use of recycled aggregates.
5.4.1	Please elaborate on the extent to which these materials are integrated into construction practices, any specific guidelines or quality standards that govern their use, and the impact these practices have on the sustainability and efficiency of construction projects.	Recycled aggregate is often used as a filling material, foundation or surface concrete in site preparation or road works that do not require high quality such as rural roads. In pavement applications, recycled aggregates tend to be used primarily in unbonded form, more often in base/subbase layers and less often in bonded layers. In Hanoi since 2019 there have been 2 construction waste crushing stations, but only carrying out crushing, with no recycling method yet. (source here page 127)
5.5	Could you provide an overview of how your country's national standards address the use of alternate binding materials, such as rubber tires, plastic, and other similar materials, as substitutes for asphalt in the construction of asphalt concrete roads or other related applications? Please elaborate on any specific guidelines or provisions that permit or regulate the use of these materials.	Polymer modified bitumens using crumb rubber, or polymers such as SBS are permitted under Vietnamese standards (22 BC 319 - 04, TCVN 11193:2021), although its use is mainly limited to asphalt paving on structures/ viaduct which use thin surfacing layers.
5.6	Could you discuss how your country encourages and incentivizes companies in the building and construction sector to adopt system standards and accreditations such as ISO 14001/OSHAS 18001, UGBC LEED, BREEAM, or align with guidelines and formal initiatives like ISO 26000, GRI, the United Nations Global Compact, and the World Business Council for Sustainable Development? Please elaborate on any specific guidelines or provisions that permit or regulate the use of these materials.	Government regulations on construction quality management exist so holding ISO9001 certification is not mandatory in government procurement. Green building standards are adopted in the private sector market, with LEED being the dominant system in use, but not in the state sector.

5.7	What are current approaches, programme and models for imparting skill development training to construction sector employee on improving sustainability and circularity, including resource efficiency in infrastructure projects, especially SMEs engaged as subcontractors?	Vietnam has a number of specialist universities for construction, transport sector, water sector, as well as colleges. Ministries of construction, and transport have their own newspapers and websites sharing news and articles for transport, construction.
5.8	What roles do construction materials association (global/regional) or collectives of construction companies play in facilitating the exchange of information on good practices, specifically aimed at enhancing resource efficiency in the use of construction materials? If so, could you describe functions and activities of such associations, including how they promote knowledge sharing, the adoption of efficient practices, and any collaborative projects or initiatives they have spearheaded?	Universities in Vietnam have undertaken research on latest techniques applied in other countries and their application in the Vietnamese context. Industry associations, their websites, and sector newspapers disseminate translations of articles on innovations from other countries, and application of new techniques in Vietnam e.g. ximang.vn website for the cement sector.
5.9	Could elaborate on any recent advancements, challenges, or notable projects, if any, related to the use of RCWMs as coarse or fine aggregates as substitute for virgin aggregates in country?	Government has regulations on recycling and collecting CDW for reuse, recycling to environmental protection through Circular No. 08/2017/TT-BXD in 2017. But given ready availability and reliability natural aggregate is used in virtually all cases for concrete and asphalt and CDW is used for less demanding uses such as site filling, haul roads, capping layers. Green building schemes offer points for reuse of construction demolition waste in concrete, but a green buildings consultant and the leading readymix firm advised that recycled aggregate is not used since in the Vietnam context it is not yet practical, and in the Vietnam context would actually increase CO_2 emissions relative to virgin aggregate due to transport, crushing and processing. Until now, occasionally in response to client request, rejected concrete batches have been washed to extract the coarse aggregate for reuse, and by this method can obtain 50% of the available credits in Greenmark green building scoring.
5.10	Could you elaborate on any recent updates, innovations, or notable projects, if any, that have incorporated alternative materials as substitute for steel in reinforced concrete structure? Please discuss the impact these changes have had on construction practices and building resource efficiency in your country?	No. Not for civil engineering works, only for niche uses such as glass fiber reinforced precast concrete panels e.g. for Vietcombank building façade panels.

APPENDIX 2 - CASE STUDY OF CEMENT USAGE IN PROJECTS

Case Study – 15km road construction in Mekong Delta in 3 contracts with many bridges

Package 4A (5km)	Package 4B (5km)	Package 4C (5km)
		



①	**Bulk**: Nghi Son PC40	CO_2 850 kg/ton (est.) 5% blend
②	**Bulk**: Insee PCB40 Easyflow	CO_2 747kg/ton – 28% blend
③	**Bag**: Insee PCB40 Da dung power S	CO_2 582kg/ton – 44% blend

Summary

1) Specification only permitted use of PC. Contractors had to propose use of PCB and it was approved after some time and wasted use of PC in bored piles.
2) Subsequently PC was only used for bridge girders.
3) Insee Da Dung power S is not supplied in bulk, and access for ready-mix trucks is poor so mobile mixers were used for small bridges
4) Overall a reasonably low CO_2 approach was used except for some wastage due to error in the specifications
5) Cement shipment from Nghi Son (1,500km) is by ocean going vessel, then silo barge (200km) from Hiep Phuoc. From Insee (Ha Tien) is 150km by silo barge on inland waterways

Attachment 3 Environmental Product Declarations

1) **Insee Vietnam (Cements)**
2) **Long Son Group (Cements)**
3) **Quang Ninh cement and construction / Lam Thach (Cements)**
4) **Tung Ho (Steel)**
5) **VAS Nghi Son (Steel)**

1) **Insee Vietnam (Cements)**

Environmental Product Declaration

In accordance with ISO 14025 and EN 15804:2012+A2:2019 for :

Clinker & Cement INSEE Vietnam

SIAM CITY CEMENT (VIET NAM) Ltd

Programme operator:	EPD International AB - Stockholm, Sweden
Registration number of EPD(s):	**S-P-03647**
Publication date:	2021-07-19
Valid until:	2026-07-18
Geographical scope:	**Vietnam**

GENERAL INFORMATION

Programme:	The International EPD® System, www.environdec.com	
EPD owner	**SiamCityCement (Vietnam) Ltd**	Address: 12th Floor, E-town Central, 11 Doan Van Bo Street, Ward 13, District 4, HCMC, Vietnam o *Phone: +84 28 73 017 018* o *Hotline: 1800 1718* o *Fax: +84 28 73 036 038* Website: www.insee.com.vn
Products	Clinker & Cement products portfolio	
Verification		
Name and organization of verifier	**Hudai Kara, PhD** - Managing Director **Metsims Sustainability Consulting** UK Head Office: 4 Clear Water Place, Oxford OX2 7NL, U.K. T : 0800 772 0185 - M :07557 351 476 **www.metsims.com**	
Data and location	**Oxford, United Kingdom, 2021.07.19**	
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, GCCA_Protokol V3_1_final_1103,*	
LCA Information		
Title	Life Cycle Assessment of Clinker & Cement production of INSEE Vietnam: 1000 kg average Clinker & Cement	
Date of Issue:	May 2021	
Preparer:	**Dung Thanh *Nguyen*** - *Sustainable Construction Manager* *Ecocycle and Sustainable Development Department* *Mobile: +84 90 8 674 558, Email: dungb.nguyen@siamcitycement.com* **Siam City Cement (Vietnam) Ltd** 12th Floor, E-town Central, 11 Doan Van Bo Street, Ward 13, District 4, HCMC, Vietnam	

This document serves as the report of Environmental Product Declarations (EPD) of construction products and intended to be used by consultants, architects, engineers, designers and procurers and for B2B, B2C. INSEE VN provides full information for customers to apply green building standards.

I. Product related information:

1. About the Company:

Being established in 1994, INSEE in Vietnam - earlier known as Holcim (Vietnam), has become over the years the leading cement producer and waste management solution provider in the South of Vietnam. We are proud that our products have been used in so many of the iconic buildings and infrastructure as well as housing and commercial developments in the South of Vietnam and how we have contributed to the economy, environment and society.

INSEE looks forward to contributing to Vietnam's national growth with the ambition to continuously provide innovative solutions to our customers while improving living condition for the community, protecting the environment, investments in people and enhancing sustainable construction. INSEE is committed to sustainability across our value chain that will pave the way to brighter futures.

"Build for Life", INSEE Vietnam believes that the world would be a better place if everything we build together can improve quality of life.

Manufacturing process

The most important component of cement according to TCVN 6260:2009 type PCB40, ASTM 1157 & EN 197-1. Is clinker produced from raw materials such as limestone and clay which are crushed, homogenized and fed into a rotary kiln. The raw materials are sintered at a temperature of 1450°C to form new compounds.

Clinker consists mainly of oxides of calcium, silicon, aluminums and iron. In a second phase calcium sulfates 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 5,000 tons of clinker.

The production of cement is subject to INSEE VN and Vietnam legislation, 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 & Cement is currently manufactured in the plants listed here below

	Plant	Address
1.	Hon Chong Cement plant	Binh An commune, Kien Luong District, Kien Giang Province
2.	Cat Lai Cement Terminal	Km 7, Nguyen Thi Dinh Street, Thanh My Loi Ward, Dist. 2, Ho Chi Minh City
3.	Thi Vai Cement Terminal	Phu My 1 Industrial Zone, Tan Thanh District, Ba Ria – Vung Tau Province
4.	Hiep Phuoc Cement Terminal	Hiep Phuoc Industrial Park, Nha Be District, Ho Chi Minh City

5.	Nhon Trach Terminal	Ong Keo Industrial Park, Phuoc Khanh commune, Nhon Trach District, Dong Nai Province

2. The company's progress:

INSEE VN has been successfully certified with scope applied to Development, Manufacturing and Distribution of Cement, Clinker; and Providing waste management services.

In order to respect the principles of sustainable development, INSEE Vietnam implements, maintains and continuously improves the integrated management system, in accordance with the applicable documentation:

* Quality Management System (QMS) since February 2003 according to ISO 9001:2018.
* Environmental Management System (EMS) since June 2006 according to ISO 14001:2018.
* Energy Management System (EnMS) since December 2018 according to ISO 50001:2018.
* Health and Safety Management System (SMS) ISO 45001:2018 certified in September 2019.
* Follow methodology - Cement CO2 and Energy Protocol, Version 3.1-Cement Sustainability Initiative (CSI) and European Cement Research Academy (ECRA).
* Products on Green Database of Vietnam Green Building Council since March 2014 up to this day. (http://greendatabase.vgbc.vn/en/structure)
* Certificated Green Label of Singapore Green Building Council since Aug 2017 up to this day. (https://web.sgbc.online/public/product/2/23/products)

Organization Team:

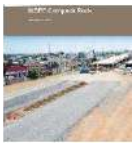
- Representative expert for Sustainable Construction
- Representative expert for Environment
- Quality Assurance and Testing Center 3 (Quatest 3) Vietnam

3. Technical description of the products:

No	Trade name	Significant characteristic & Recommended use	Product Standard
Cement Bag Segment			
01	INSEE Power-S (IPSC) 	INSEE Power-S Multi-purpose Cement for long-lasting concrete foundation. Conventional concrete often has visible holes, factors such as water (groundwater, alum water, high chlorine) and air will gradually core into the structure, affect to the steel, which causes rust and reduces life expectancy.	TCVN 6260:2009 type PCB40, CEM V/A (SR EN 197-1:2011)

	ECO Da Dung (EDDC) 	The new Eco Đa Dụng makes mortar construction faster, concrete pumping easier and increases labor productivity. As a result, the motar is smooth, adhesive and easy for plastering, bringing great benefits to the masonry works. High early strength of concrete from Eco Đa Dụng allows to remove the formwork early as well as reuse the formwork quickly, reducing labor costs, thus saving time of operation and cost incurred. Concrete usually has air holes which are latent detects. Eco Đa Dụng would fill the voids, limiting the penetration of these elements such as air, groundwater, alum-infected water, thus enhancing the durablitity of concrete.	TCVN 6260: 2009 type PCB 40. CEM V/A
	INSEE Power Fast (IPFC) 	High early strength of concrete from INSEE Power Fast allows to remove the formwork early as well as reuse the formwork quickly, reducing labor costs, thus saving time of operation and cost incurred. Concrete usually has air holes which are latent detects. INSEE Power Fast would fill the voids, limiting the penetration of these elements such as air, groundwater, alum-infected water, thus enhancing the durablitity of concrete.	TCVN 6260: 2009 type PCB 40 CEM V/A
02	INSEE Wall Pro (IWPC) 	INSEE Wall Pro is developed to be specialized for the tropical weather, offering top three value propositions: - Anti shrinkage cracks - Smoothness, high workability - Same ratio, same mortar volume Contains Super Flex active ingredients that are hydrated, strengthen moisture retention and slow down surface evaporation, so improve maximum of the phenomenon of shrinkage cracks.	TCVN 9202: 2012 MC 25 CEM II/B-M
03	Lavilla Extra CC40	Lavilla XTra Cement which is suitable for both all civil works and large projects.	TCVN 9501: 2013 type CC40, CEM V/A

	(LEC) 	Lavilla Xtra Cement produces high strength concrete to ensure the main quality of the work such as foundation, beam and floor beams, pillars, thus enhancing the prestige and quality of construction works.	(SR EN 197-1:2011)
04	INSEE Power Cast 	INSEE Power Cast is an super high early strength cement specifically designed for precast concrete, especially for spun pile, the formwork can be removed early and the concrete precast elements can be manipulated sooner : this speeds up the production cycle & saves investment cost Total of equivalent alkali content (Na_2O+0.658 K_2O) < 0.6% to avoid alkali aggregate reaction	TCVN 6260:2009 type PCB40, ASTM 1157 type HE
Bulk Cement Segment			
06	INSEE Easy Flow (IEFC) 	INSEE 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.	TCVN 6260:2009 type PCB40, ASTM 1157 type GU, CEM II/A-S (SR EN 197-1:2011)
07	INSEE Quick Cast (IQCC) 	As INSEE Quick Cast offers a high early strength in concrete, the formwork can be removed early and the concrete precast elements can be manipulated sooner: this speeds up the production cycle and saves investment costs.	TCVN 6260:2009, ASTM C1157/C1157M-17 type HE, CEM II/A-S (SR EN 197-1:2011)
INSEE Slag Cement			
08	INSEE Mass Pour (IMPC)	The low heat of hydration of INSEE Mass Pour significantly reduces the risk of thermal cracking in massive concrete elements. This is especially important in structures such as large foundations for	TCVN 7712:2013 type PCB_{BFS}40-LH,

		high-rise buildings, tower pile caps for bridges, tunnels, dams and large quays.	ASTM C1157/C1157M-17 type LH, CEM III/B (SR EN 197-1:2011)
09	INSEE Extra Durable (IEDC) 	INSEE Extra Durable is a special cement designed for concrete with high durability requirements and for chemically aggressive environments (seawater, sulphates, acids, chlorides,). Infrastructure package project to prevent fast degradation of concrete structure linked to chloride corrosion of steel reinforcement and sulphate attack of concrete.	TCVN 7711: 2013 type PCB_{HSR}4HS, ASTM C1157/C1157M-17 type HS, CEM III/B (SR EN 197-1:2011)
10	INSEE Stable Soil (ISSC) 	It is well suited for Cement Deep Mixing applications as well as ***Jet-grouting*** and any other type of soil mixing, which are used for the construction of ports and container quays, infrastructure like tunnels and bridges, or airports and Highrise buildings in phase of ground improvement. This high-quality stabilization increases the admissible load on the treated layer, can reduce the number or size of the required columns which reduces the costs of the total jobsite.	TCVN 4316:2007 PCB_{BFS}40-Type II , CEM III/ B (SR EN 197-1:2011)
11	INSEE Compact Rock (ICRC) 	It is well suited for and/cement mat and cement treated base layer for roads, industrial platforms, ports, etc.. The aggregate/cement mix, using INSEE Compact Rock, has a longer initial setting time, which allows more time for transport, leveling and compaction and assures a better quality of the compacted layer.	TCVN 4316:2007 PCB_{BFS}40-Type II, CEM III/B (SR EN 197-1:2011)

4. 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 = 1000kg of Clinker or Cement. SI units shall be used.

Preferred power and energy units are: kW (MW) for power, kWh (MWh) for electric energy, MJ for fuels

5. Description of underlying LCA – Based Information

System boundaries for Clinker & Cement - *Fig. 1.1*

The main process for Clinker & Cement production of INSEE VN are highlighted as follows:

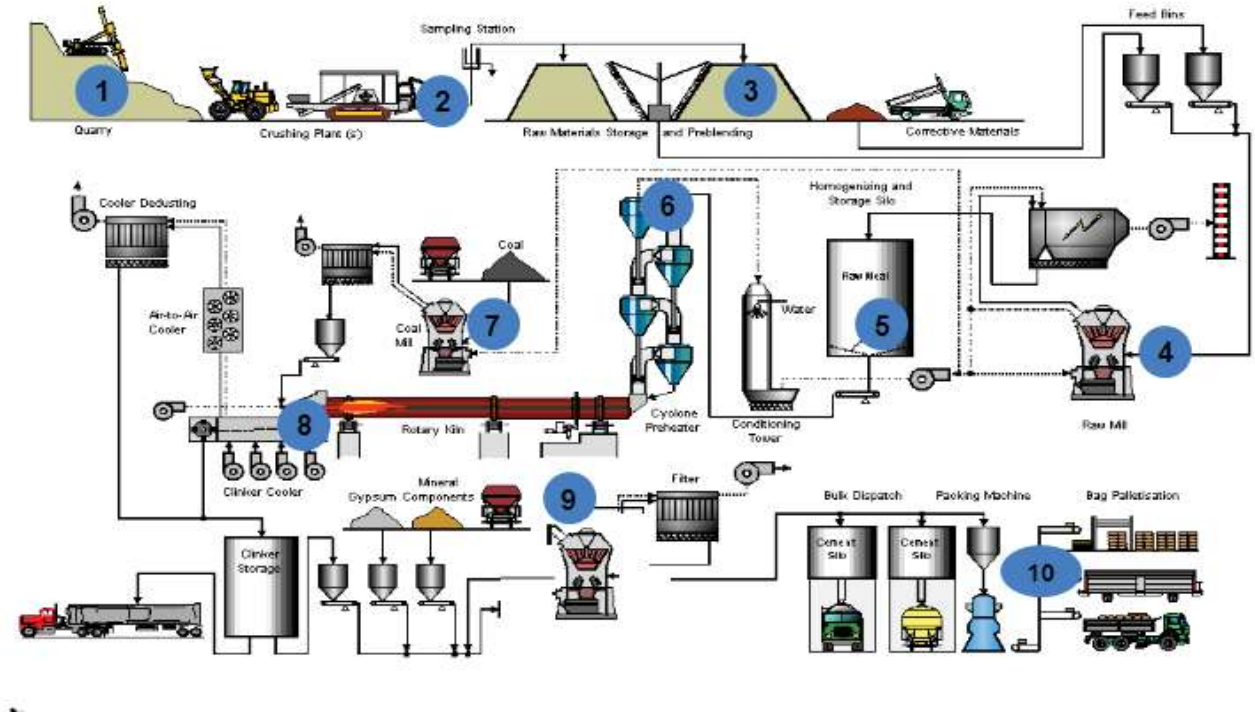


Fig. 1.1 – Boundary of the industry-average cement production processes at INSEE VietNam.

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

- A1 - Raw material excavation & preparation - Stage 1, 2,3
  - Production of raw mix – Stage 4,5
- A2 - Burning of clinker & clinker production - Stage 6,7,8
- A3 - Cement production & storage of cement for dispatch - Stage 9,10

The Upstream Processes (A1) include:

- Exploiting raw materials: Limestone is exploited from three mines of Cay Xoai, Bai Voi and Khoe La; The clay is mined from the Binh Tri clay mine
- The stage of crushing limestone from size <1000mm down to size <100mm
- Preliminary mixing stage: limestone after crushing and clay is mixed in certain proportions and controlled by PGNAA analyzer.
- Raw material grinding stage: the homogeneous mixture of limestone and clay combined with corrected materials such as red stone and sand is quantified and put into the raw material mill.
- Raw material coming out of the mill is put into storage silo and homogenized before being put into the clinker kiln

The Core Processes (A2) include:

- Clinker heating stage: Raw material is fed into the pre-heating tower to heat and decompose CaCO3 before going into the clinker kiln, the material is further heated in the rotary kiln until 1450^{o}C to form clinker
- Coal crushing stage: Coal is stored in the warehouse and transported by conveyor to the mill. After grinding, the fine coal is stored in the intermediate bin to feed into the clinker kiln. In addition, INSEE Cement Plant Viet Nam also uses a part of alternative fuel from the co-processing of waste. Co-processing technology (replacing coal with alternative waste fuel) is a sustainable waste treatment solution: over 1.2 million tonnes of waste have been safely co-processed so far by INSEE and zero ashes were sent to landfill.
- Clinker cooling stage: Clinker is cooled down from 1450^{o}C to <150^{o}C, then put into the silo. In addition, INSEE VN uses waste heat to operate the Waste Heat Recovery Power Plant allows reduction of electricity consumption by 25 per cent, generating 6.3 megawatt.

The Core Processes (A3) include:

- Cement grinding stage: clinker, gypsum and active mineral additives are quantified and put into two roller mills (vertical mill) to grind into cement. (Mineral additives: Slag (Blast furnace), Fly-ash (Thermal power plant) accounts for a high proportion in the cement production process)
- Cement after grinding is stored in silos, part of the cement is transferred to Hiep Phuoc, Thi Vai, Nhon Trạch terminal, a part is delivered to customers at the Hon Chong plant bagging plant in the form of 50kg bags or bulk cement.

The distribution processes (A4) include:

- Bag cement (with a maximum range of 200 square kilometers): Distributed over 90% to official distributors and retailer shops by vehicles: barge, inland waterway ship, truck, bleck truck & workers. The rest 10% is delivered directly to the project customer by truck.
- Bulk cement (with a maximum range of 400 square kilometers) : Delivered by cement tank truck to batching plants and precast concrete plant

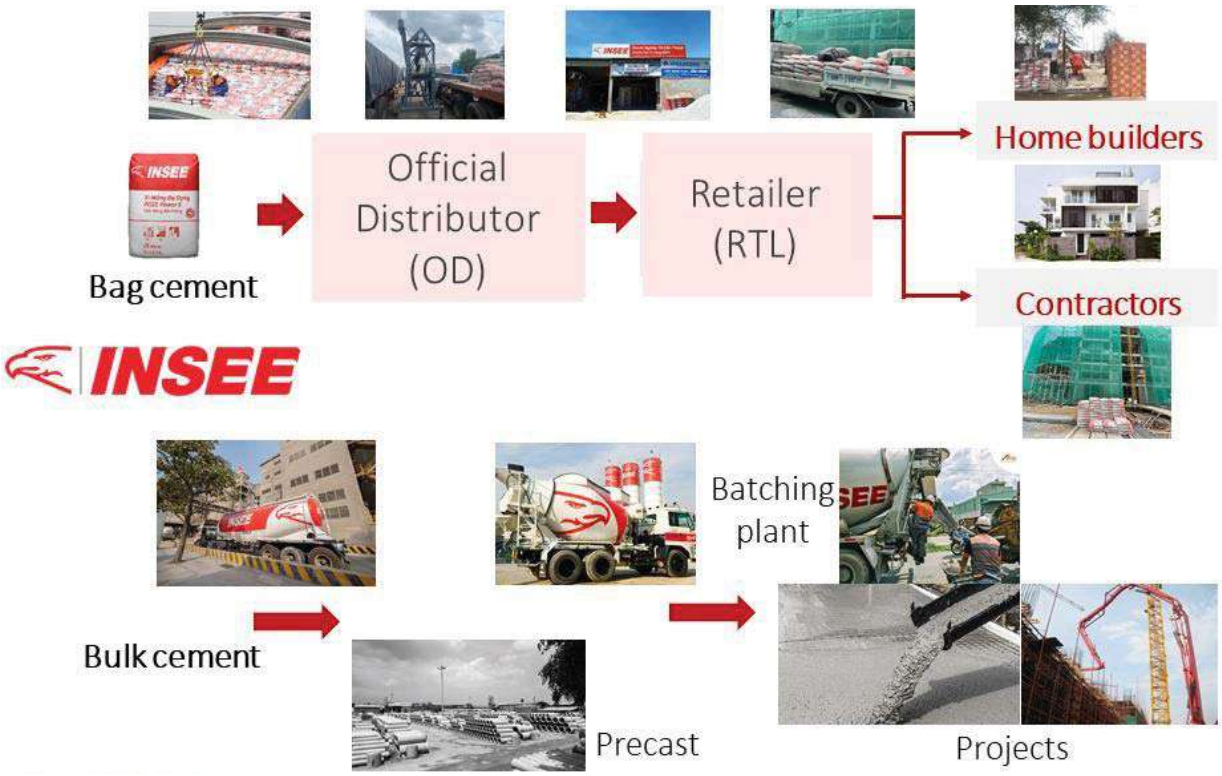


Fig. 1.2 – The distribution cement processes of INSEE Vietnam

II. Environmental performance-related information & estimations and methodology

2.1 Main product components

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

TABLE 1.1 : Composition and Technical Specification of Clinker INSEE VN

	Unit	Clinker 2020	Remark
SiO_2	%	21.79	
Al_2O_3	%	5.19	
Fe_2O_3	%	3.44	
CaO	%	66.43	
MgO	%	1.68	
SO_3	%	0.33	
Cl	%	0.02	
LOI		0.48	
IR	%	n/a	
Free CaO	%	1.19	
Cr (IV)	ppm	n/a	

K_2O	%	0.56	
Na_2O	%	0.18	
Na_2O eq	%	0.55	
LSF		95.8	
SM		2.53	
AM		1.51	
C_3S_Bogue	%	60.3	
C_2S_Bogue	%	17.0	
C_3A_Bogue	%	7.9	
C_4AF_Bogue	%	10.5	
C_3S+C_2S	%	77.3	
CaO/SiO_2		3.05	
Specific gravity	g/cm^3	3.14	
Specific Surface	cm^2/g	2960	

Residue on 0.045 mm	%	17.1	
Soundness	mm	n/a	
Normal consistency	%	25.3	
Initial setting time	min	115	
Residue on seive 40 mm	%	n/a	
Residue on seive 25 mm	%	13.9	
Residue on seive 10 mm	%	n/a	R8mm = 55.9
3D Strength	Mpa	34.5	2D not available
7D Strength	Mpa	41.9	
28D Strength	Mpa	50.7	

INSEE VN Cement according to EN 197-1 (TCVN 6260:2009, ASTM C1157) is produced by grinding and mixing the constituents defined in the standard.

Reduce the clinker factor by using different materials such as Pozzolana, Limestone, Flyash (coal thermal power plant) and steel Slag, 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 and Technical Specification of Cement INSEE VN

No	Name	Standards (EN 197-1)	% Recycled Content (Slag , Flyash, Pozzolan, Limestone, Calcium sulfate usage at least)	% OPC
Bag Segment				
1	INSEE Da Dung Power-S INSEE Power Fast ECO Da Dung	CEM IV/B	44	56
2	INSEE Wall Pro	CEM II/B-M	60	40
3	Lavilla Extra CC40	CEM V/A	60	40
4	INSEE Power Cast	CEM II/A-S	13	87
Bulk Segment				
5	INSEE Easy Flow INSEE Quick Cast	CEM II/A-S	28	72
Slag Cement				
6	INSEE Mass Pour	CEM III/B	70	30
7	INSEE Extra Durable	CEM III/B	70	30
8	INSEE Stable Soil	CEM III/B	70	30
9	INSEE Compact Rock	CEM III/B	70	30

2.2 Estimations and methodology

Based on data 2020 from all INSEE Clinker & Cement plants in Vietnam follow methodology - Cement CO2 and Energy Protocol, Version 3.1, CO2 Emissions and Energy Inventory with was developed by the WBCSD Cement Sustainability Initiative (CSI) and European Cement Research Academy (ECRA).

This LCA was modelled with the program EPD Tool v3.0 / CML v4.7 from the Global Cement and Concrete Association (GCCA).

2.4 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 Stage		Use Stage							End of Life Stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction-Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-recovery
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

2.4.1 For Clinker product: *Impact categories considered, as per the PCR 1000 kg average* ***Clinker INSEE VN***

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	909.6	kg CO_2 eq.
2	Global Warming Potential fossil fuels	909.5	kg CO_2 eq.
3	Global Warming Potential biogenic	4.09E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	4.40E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	4.73E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	1.979	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3396	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1108	kg P eq.

9	Eutrophication potential, fraction of nutrients reaching marine end compartment	7.05E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	8.215	mol N eq.
11	Formation potential of tropospheric ozone	2.008	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.05E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	2882	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	24.96	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.38E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	3080	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	29.59	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	4.29E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	5.01E-06	CTUh
20	Potential soil quality index	984.5	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	84.41	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	84.41	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3076	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	3076	MJ, net calorific value
27	Use of secondary materials	33.37	kg
28	Use of renewable secondary fuels	91.93	MJ, net calorific value
29	Use of non-renewable secondary fuels	89.77	MJ, net calorific value
30	Net use of fresh water	0.7257	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	7.79E-03	kg
32	Non-hazardous waste disposed	129.3	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	525	kg CO_2 eq.

35	Emissions from combustion of waste from renewable sources used in production processes	0.3433	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	10.05	kg CO_2 eq.

2.4.2 For Cement product: *Impact categories considered, as per the PCR 1000 kg average* ***INSEE Power S, Eco Da Dung, Insee Power Fast***

a. Produced at Hon Chong Plant

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	582	kg CO_2 eq.
2	Global Warming Potential fossil fuels	581.9	kg CO_2 eq.
3	Global Warming Potential biogenic	6.01E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	5.95E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	5.71E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	1.698	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3154	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1029	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	6.71E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	5.536	mol N eq.
11	Formation potential of tropospheric ozone	1.398	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.07E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	2489	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	23.5	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	9.98E-06	Disease incidence
16	Potential Human exposure efficiency relative to U235	4187	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	31.64	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	2.41E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	6.29E-06	CTUh
20	Potential soil quality index	954.1	dimensionless
	Parameters describing resource use		

21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	132.5	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	132.5	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	2626	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	75.52	MJ, net calorific value
26	Total use of non-renewable primary energy resources	2701	MJ, net calorific value
27	Use of secondary materials	143.2	kg
28	Use of renewable secondary fuels	51.74	MJ, net calorific value
29	Use of non-renewable secondary fuels	50.53	MJ, net calorific value
30	Net use of fresh water	0.6903	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.22E-02	kg
32	Non-hazardous waste disposed	202	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	295.3	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	0.1932	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	5.655	kg CO_2 eq.

b. Produced at Thi Vai Terminal

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	606	kg CO_2 eq.
2	Global Warming Potential fossil fuels	605.8	kg CO_2 eq.
3	Global Warming Potential biogenic	7.91E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	7.04E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	8.47E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	2.123	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3479	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1135	kg P eq.

9	Eutrophication potential, fraction of nutrients reaching marine end compartment	7.27E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	5.332	mol N eq.
11	Formation potential of tropospheric ozone	1.354	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.39E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	3070	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	50.19	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.36E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	5466	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	59.57	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	1.13E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	2.23E-05	CTUh
20	Potential soil quality index	1165	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	144.7	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	144.7	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3248	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	75.52	MJ, net calorific value
26	Total use of non-renewable primary energy resources	3324	MJ, net calorific value
27	Use of secondary materials	177.4	kg
28	Use of renewable secondary fuels	62.16	MJ, net calorific value
29	Use of non-renewable secondary fuels	64.41	MJ, net calorific value
30	Net use of fresh water	1.267	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.20E-02	kg
32	Non-hazardous waste disposed	35.89	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	290.1	kg CO_2 eq.

35	Emissions from combustion of waste from renewable sources used in production processes	0.2321	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	6.169	kg CO_2 eq.

c. Produced at HIEP PHUOC Terminal

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	587.9	kg CO_2 eq.
2	Global Warming Potential fossil fuels	587.8	kg CO_2 eq.
3	Global Warming Potential biogenic	6.30E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	6.21E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	6.69E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	1.798	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.2978	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	9.71E-02	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	6.27E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	5.498	mol N eq.
11	Formation potential of tropospheric ozone	1.398	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.18E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	2629	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	30.83	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.07E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	4543	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	38.91	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	2.12E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	1.00E-05	CTUh
20	Potential soil quality index	1021	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	140.6	MJ, net calorific value

22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	140.6	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	2774	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	75.52	MJ, net calorific value
26	Total use of non-renewable primary energy resources	2849	MJ, net calorific value
27	Use of secondary materials	153.7	kg
28	Use of renewable secondary fuels	54.22	MJ, net calorific value
29	Use of non-renewable secondary fuels	53.81	MJ, net calorific value
30	Net use of fresh water	0.8316	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	4.85E-03	kg
32	Non-hazardous waste disposed	64.8	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	294.5	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	0.2025	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	5.782	kg CO_2 eq.

2.4.3 For Cement product: Impact categories considered, as per the PCR 1000 kg average INSEE Wall Pro produced at Hon Chong plant

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	505.3	kg CO_2 eq.
2	Global Warming Potential fossil fuels	505.2	kg CO_2 eq.
3	Global Warming Potential biogenic	6.06E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	5.83E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	5.78E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	1.522	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.2484	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	8.10E-02	kg P eq.

9	Eutrophication potential, fraction of nutrients reaching marine end compartment	5.36E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	4.902	mol N eq.
11	Formation potential of tropospheric ozone	1.246	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	9.74E-05	kg Sb eq.
13	Abiotic depletion for fossil resources potential	2204	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	40.56	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	8.78E-06	Disease incidence
16	Potential Human exposure efficiency relative to U235	4088	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	30.57	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	2.08E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	6.69E-06	CTUh
20	Potential soil quality index	1382	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	173	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	173	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	2319	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	75.52	MJ, net calorific value
26	Total use of non-renewable primary energy resources	2394	MJ, net calorific value
27	Use of secondary materials	100.1	kg
28	Use of renewable secondary fuels	44.5	MJ, net calorific value
29	Use of non-renewable secondary fuels	43.45	MJ, net calorific value
30	Net use of fresh water	1.184	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.16E-02	kg
32	Non-hazardous waste disposed	191.9	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	254.1	kg CO_2 eq.

35	Emissions from combustion of waste from renewable sources used in production processes	0.1662	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	4.865	kg CO_2 eq.

2.4.4 *For Cement product:* *Impact categories considered, as per the PCR 1000 kg average* ***Lavila Extra CC40 produced at Nhon Trach Terminal***

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	507.9	kg CO_2 eq.
2	Global Warming Potential fossil fuels	507.8	kg CO_2 eq.
3	Global Warming Potential biogenic	6.78E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	6.45E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	7.11E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	1.843	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3151	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1028	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	6.62E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	4.477	mol N eq.
11	Formation potential of tropospheric ozone	1.168	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.20E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	2705	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	37.84	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.11E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	4699	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	44.05	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	1.14E-06	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	3.59E-05	CTUh
20	Potential soil quality index	1019	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	142.9	MJ, net calorific value

22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	142.9	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	2859	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	75.52	MJ, net calorific value
26	Total use of non-renewable primary energy resources	2934	MJ, net calorific value
27	Use of secondary materials	381.3	kg
28	Use of renewable secondary fuels	141.3	MJ, net calorific value
29	Use of non-renewable secondary fuels	44.52	MJ, net calorific value
30	Net use of fresh water	0.974	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.76E-02	kg
32	Non-hazardous waste disposed	43.59	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	225.2	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	0.5278	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	3.796	kg CO_2 eq.

2.4.5 ***For Cement product:*** *Impact categories considered, as per the PCR 1000 kg average* ***INSEE Power Cast produced***

a. ***Produced at Hon Chong Plant***

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	870.3	kg CO_2 eq.
2	Global Warming Potential fossil fuels	870.1	kg CO_2 eq.
3	Global Warming Potential biogenic	6.01E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	6.97E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	6.79E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	2.258	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3901	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1272	kg P eq.

9	Eutrophication potential, fraction of nutrients reaching marine end compartment	8.28E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	8.084	mol N eq.
11	Formation potential of tropospheric ozone	1.997	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.38E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	3225	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	48.88	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.34E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	4879	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	37.07	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	3.84E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	7.56E-06	CTUh
20	Potential soil quality index	1309	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	169.9	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	169.9	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3472	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	3472	MJ, net calorific value
27	Use of secondary materials	29.85	kg
28	Use of renewable secondary fuels	82.26	MJ, net calorific value
29	Use of non-renewable secondary fuels	80.32	MJ, net calorific value
30	Net use of fresh water	1.435	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.48E-02	kg
32	Non-hazardous waste disposed	245	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	469.7	kg CO_2 eq.

35	Emissions from combustion of waste from renewable sources used in production processes	0.3072	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	8.994	kg CO_2 eq.

b. produced at Nhon Trach Terminal

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	966.8	kg CO_2 eq.
2	Global Warming Potential fossil fuels	966.6	kg CO_2 eq.
3	Global Warming Potential biogenic	0.1128	kg CO_2 eq.
4	Global Warming Potential land use and land use change	0.1104	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	1.26E-05	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	3.715	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.6545	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.2135	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	1.35E-02	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	7.783	mol N eq.
11	Formation potential of tropospheric ozone	1.902	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	2.41E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	5183	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	103.7	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	2.37E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	8380	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	113.3	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	2.09E-06	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	5.60E-05	CTUh
20	Potential soil quality index	2103	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	261.5	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	261.5	MJ, net calorific value

24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	5587	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	5587	MJ, net calorific value
27	Use of secondary materials	98.11	kg
28	Use of renewable secondary fuels	112.7	MJ, net calorific value
29	Use of non-renewable secondary fuels	121	MJ, net calorific value
30	Net use of fresh water	2.489	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.50E-02	kg
32	Non-hazardous waste disposed	3.155	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	451.5	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	0.112	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	12.76	kg CO_2 eq.

2.4.6 For Cement product: *Impact categories considered, as per the PCR 1000 kg average* ***INSEE Easy Flow Cement & INSEE Quick Cast***

a. Produced at Hon Chong Plant

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	747.3	kg CO_2 eq.
2	Global Warming Potential fossil fuels	747.2	kg CO_2 eq.
3	Global Warming Potential biogenic	6.79E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	7.51E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	7.63E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	2.133	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3569	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1164	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	7.62E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	7.057	mol N eq.

11	Formation potential of tropospheric ozone	1.78	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.40E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	3035	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	46.67	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.22E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	5378	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	38.23	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	3.16E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	7.83E-06	CTUh
20	Potential soil quality index	1184	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	166.4	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	166.4	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3281	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	3281	MJ, net calorific value
27	Use of secondary materials	133.6	kg
28	Use of renewable secondary fuels	67.63	MJ, net calorific value
29	Use of non-renewable secondary fuels	66.03	MJ, net calorific value
30	Net use of fresh water	1.368	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.35E-02	kg
32	Non-hazardous waste disposed	224.4	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	386.2	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	8.87E-02	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	9.344	kg CO_2 eq.

b. Produced at Thi Vai Terminal

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	782.8	kg CO_2 eq.
2	Global Warming Potential fossil fuels	782.6	kg CO_2 eq.
3	Global Warming Potential biogenic	9.26E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	8.64E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	1.04E-05	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	2.87	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.4823	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1573	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	9.99E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	6.54	mol N eq.
11	Formation potential of tropospheric ozone	1.632	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.82E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	3981	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	73.9	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.86E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	6657	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	82.95	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	6.74E-05	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	3.80E-05	CTUh
20	Potential soil quality index	1530	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	178.7	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	178.7	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	4291	MJ, net calorific value

25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	4291	MJ, net calorific value
27	Use of secondary materials	190.1	kg
28	Use of renewable secondary fuels	87.66	MJ, net calorific value
29	Use of non-renewable secondary fuels	92.74	MJ, net calorific value
30	Net use of fresh water	1.808	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.12E-02	kg
32	Non-hazardous waste disposed	22.02	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	375.4	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	9.17E-02	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	10.28	kg CO_2 eq.

c. *Produced at HIEP PHUOC Terminal*

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	743	kg CO_2 eq.
2	Global Warming Potential fossil fuels	742.8	kg CO_2 eq.
3	Global Warming Potential biogenic	6.42E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	7.08E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	7.50E-06	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	2.202	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.3722	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1214	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	7.80E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	6.819	mol N eq.
11	Formation potential of tropospheric ozone	1.709	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.39E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	3113	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	36.43	m^3 world eq. deprived
	Additional environmental impact indicators		

15	Potential incidence of disease due to PM emissions	1.31E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	5122	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	42.97	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	2.66E-04	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	1.31E-05	CTUh
20	Potential soil quality index	1202	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	162.3	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	162.3	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3359	MJ, net calorific value
25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	3359	MJ, net calorific value
27	Use of secondary materials	140.5	kg
28	Use of renewable secondary fuels	71.13	MJ, net calorific value
29	Use of non-renewable secondary fuels	70.83	MJ, net calorific value
30	Net use of fresh water	0.9787	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	8.82E-03	kg
32	Non-hazardous waste disposed	85.06	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	381.9	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	8.88E-02	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	9.473	kg CO_2 eq.

2.4.7 For Cement product: *Impact categories considered, as per the PCR 1000 kg average* ***INSEE Slag Cement : INSEE Mass Pour, INSEE Extra Durable, INSEE Stable Soil, INSEE Compact Rock produced at Thi Vai Terminal***

No	Core environmental impact indicators		
	Indicator	**A1-A3 (Total)**	**Unit**
1	Global Warming Potential total	438.7	kg CO_2 eq.
2	Global Warming Potential fossil fuels	438.6	kg CO_2 eq.
3	Global Warming Potential biogenic	8.22E-02	kg CO_2 eq.
4	Global Warming Potential land use and land use change	8.37E-02	kg CO_2 eq.
5	Depletion potential of the stratospheric ozone layer	1.22E-05	kg CFC 11 eq.
6	Acidification potential, Accumulated Exceedance	2.054	mol H+ eq.
7	Eutrophication potential, fraction of nutrients reaching freshwater end compartment	0.33	kg PO_4 eq.
8	Eutrophication potential, fraction of nutrients reaching freshwater end compartment*	0.1076	kg P eq.
9	Eutrophication potential, fraction of nutrients reaching marine end compartment	6.98E-03	kg N eq.
10	Eutrophication potential, Accumulated Exceedance	3.804	mol N eq.
11	Formation potential of tropospheric ozone	1.091	kg NMVOC eq.
12	Abiotic depletion potential for non- fossil resources	1.41E-04	kg Sb eq.
13	Abiotic depletion for fossil resources potential	3012	MJ, net calorific value
14	Water (user) deprivation potential, deprivation-weighted water consumption	48.2	m^3 world eq. deprived
	Additional environmental impact indicators		
15	Potential incidence of disease due to PM emissions	1.28E-05	Disease incidence
16	Potential Human exposure efficiency relative to U235	6723	kBq U235 eq.
17	Potential Comparative Toxic Unit for ecosystems	62.35	CTUe
18	Potential Comparative Toxic Unit for humans - cancer	1.15E-06	CTUh
19	Potential Comparative Toxic Unit for humans - non-cancer	2.59E-05	CTUh
20	Potential soil quality index	1070	dimensionless
	Parameters describing resource use		
21	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	165.8	MJ, net calorific value
22	Use of renewable primary energy resources used as raw materials	0	MJ, net calorific value
23	Total use of renewable primary energy resources	165.8	MJ, net calorific value
24	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	3272	MJ, net calorific value

25	Use of non-renewable primary energy resources used as raw materials	0	MJ, net calorific value
26	Total use of non-renewable primary energy resources	3272	MJ, net calorific value
27	Use of secondary materials	697.7	kg
28	Use of renewable secondary fuels	38.65	MJ, net calorific value
29	Use of non-renewable secondary fuels	41.5	MJ, net calorific value
30	Net use of fresh water	1.207	m^3
	Other environmental information describing waste categories		
31	Hazardous waste disposed	1.00E-02	kg
32	Non-hazardous waste disposed	2.067	kg
33	Radioactive waste disposed	0	kg
	Extra indicators		
34	Emissions from calcination and removals from carbonation	154.9	kg CO_2 eq.
35	Emissions from combustion of waste from renewable sources used in production processes	3.84E-02	kg CO_2 eq.
36	Emissions from combustion of waste from non-renewable sources used in production processes	4.377	kg CO_2 eq.

2.5 Interpretation

The following table provides an identification of the most significant contributors to a selection of the parameters presented above:

Parameter	Most significant contributor
Primary energy demand	Dominated by the use of non-renewable energy and the corresponding supply chains. The most significant process using energy is the kiln.
Water demand	Dominated by the use of surface water related to the generation of electricity. The water use on site is less than 1% of the total freshwater use.
Waste generation	Waste in terms of material waste is generated in upstream processes fuel supply.
Global warming potential	The kiln causes about 89% of the greenhouse gas emissions. The use of clinker in the cement is the main cause for overall global warming potential. Emissions in the kiln result from both decarbonation of limestone as well as the burning of fuel.
Acidification potential	Dominated by sulphur dioxide emissions from the kiln and emissions from electricity production.
Eutrophication potential	The kiln is the major source for emission of nitrous oxides. Lignite production is another significant contributor.

Ozone depletion potential	Dominated by emissions from electricity production.
Photochemical ozone creation potential	Dominated by nitrous oxide and sulphur dioxide emissions from the kiln as well as from fuel production for the burning of clinker. Emissions from electricity production as further significant contributor.
ADP elements	Highest contribution associated with the quarry of gypsum
ADP fossil	Fossil fuel consumption is dominated by the supply and use of fossil fuels (diesel). Second largest contribution through the supply chain of electricity. Considered electricity mix for INSEE Vietnam.
Dust: PM10-equivalents	Generated by emissions from electricity production. PM 10 is the fraction of particulates in air of very small size (<10μm)
Risk poll: PM2,5-equivalents	Generated by emissions from electricity production in Romania. PM 2,5 is the fraction of particulates in air of very small size (<2,5μm)

TABLE 1.4: Most significant contributors to life cycle parameters

Concluding, the use of energy is the most significant contributor to environmental impacts associated with cement. Energy is used as electricity and fuel, by far dominated by the kiln. Also contributing is the energy demand related to the excavation of raw materials. The contribution to global warming (carbon emissions) is dominated by the decarbonation of clinker – a process necessary to produce cement.

2.6 Other environmental information

INSEE Vietnam, being aware of its responsibility as cement manufacturer towards the environment, and in particular on the limited natural resources has implemented as part of its integrated management system, an environmental management system. Thus, all the activities that could have a significant impact on the environment are kept under control. Also, we ensure that the constituent materials used within our products are responsibly sourced and we apply the principles of Sustainable Development and of Environmental Stewardship as a standard business practice in our operations.

In this sense, we measure, monitor, assess and continuously improve our environmental performances. We prevent environmental pollution by implementing in our operations the best available technology and by maintaining and operating our installations in optimum ways. Protecting the environment by preserving non-renewable natural resources, increasing energy efficiency, reducing the environmental emissions, limiting the impact of materials transportation to and from our operations is part of our way in doing business. INSEE is promoting in Vietnam the reduction, recycling and recovering of waste and the optimization of water consumption in all processes.

More information regarding our environmental and responsibly sourcing objectives and activities are available on http://insee.com.vn/en/phat-trien-ben-vung/gioi-thieu-sd

Report standards

We refer to GRI standards in our annual SD report follow the Global reporting Initiative (GRI) Guideline - https://insee.com.vn/INSEE_SD_report.pdf

INSEE VN has joined to the program "Benchmarking and Announcing Sustainable Companies in Vietnam" that organized annually by The Vietnam Business Council for Sustainable Development (VBCSD) to rate the Sustainability performance for private sector in VN with the name of CSI (Corporate Sustainability Index) with this link : http://en.vbcsd.vn/csi.asp

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

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

The terms A1 – A3 refer to the specific modules in the EN 15804 standard, essentially this means that the information in this EPD is for the 'cradle to gate' part of the life cycle.

Global Cement and Concrete Association (GCCA) - The Cement CO_2 and Energy Protocol, V3 CO_2 and Energy Accounting and Reporting Standard for the Cement Industry

ISO 9001:2018 Quality Management Systems

ISO 14001:2018 Environmental Management System

ISO 50001:2018 Energy Management System (EnMS)

ISO 45001:2018 Health and Safety Management System (SMS)

SiamCityCement (Vietnam) Ltd

12th Floor, E-town Central, 11 Doan Van Bo Street, Ward 13, District 4, HCMC, Vietnam

Website: www.insee.com.vn

2) Long Son Group (Cements)

Verification Report

Verification Opinion

Verified as Satisfactory	
Based on the process and procedures conducted, the GHG statement contained in the GHG Inventory Report 2022 [10/06/2023] produced by Long Son Company Limited (Thanh Hoa Branch - Long Son Cement Plant).	• Is materially correct and is a fair representation of GHG data and information. • Has been prepared in accordance with ISO14064-1:2018 and its principles
Lead Verifier	**Do Thanh Ha**
Independent Reviewer	**Nguyen Dinh Minh Tam**
Signed on behalf of BSI	**Dr Le Duyen Anh - Managing Director Vietnam**
Issue Date	15/11/2023
BSI Vietnam Company Limited - 15 Floor APC Tower, 518B Dien Bien Phu Street, Ward 21, Binh Thanh District, Ho Chi Minh City, Vietnam. Telephone: +84 (28) 38 200 066. A member of the BSI Group of Companies.	
Note: BSI Vietnam is independent to and has no financial interest in Long Son Company Limited (Thanh Hoa Branch - Long Son Cement Plant). This 3rd party Verification Opinion has been prepared for Long Son Company Limited (Thanh Hoa Branch - Long Son Cement Plant) only for the purposes of verifying its statement relating to its GHG emissions more particularly described in the scope above. It was not prepared for any other purpose. In making this Statement, BSI Vietnam has assumed that all information provided to it by Reporting organization is true, accurate and complete. BSI Vietnam accepts no liability to any third party who places reliance on this statement.	

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Verification Engagement

Organization	LONG SON COMPANY LIMITED (THANH HOA BRANCH - LONG SON CEMENT PLANT) Dong Son Ward, Bim Son Town, Thanh Hoa Province, Vietnam
Responsible party	LONG SON COMPANY LIMITED (THANH HOA BRANCH - LONG SON CEMENT PLANT)
Verification Objectives	To express an opinion on whether the organizational GHG Statement which is historical in nature: • Is accurate, materially correct and is a fair representation of GHG data and information. • Has been prepared in accordance with ISO14064-1:2018.
Materiality Level	5%
Level of Assurance	Reasonable
Verification evidence gathering procedures	• Evaluation of the monitoring and controls systems through interviewing employees observation or inquiry. • Verification of the data through sampling recalculation, retracing, cross checking and reconciliation.
Verification Standards	The verification was carried out in accordance with ISO 14064-3 and ISO 14065.
Note: Reporting company is responsible for the preparation and fair presentation of the GHG statement and report in accordance with the agreed criteria. BSI is responsible for expressing an opinion on the GHG statement based on the verification.	

Organizational GHG Statement

Organization		LONG SON COMPANY LIMITED (THANH HOA BRANCH - LONG SON CEMENT PLANT) Dong Son Ward, Bim Son Town, Thanh Hoa Province, Vietnam
Organizations GHG Report containing GHG Statement		GHG Inventory Report 2022 [10/06/2023]
Organizational Boundary		Operational Control
Scope of activities:		Manufacturing of clinker and portland cements
Reporting Boundary:	Direct GHG Emissions (Scope 1)	Category 1: - emissions from production of clinker, - emissions from use of diesel oil and coal for clinker kilns; and use of LPG for metal cutting, - emissions from use of gasoline for company vehicles, use of diesel oil for company forklifts and self-propelled crane, - emissions from wastewater treatment, and - fugitive emissions from fire extinguishers and refrigerants.
	Indirect GHG Emissions from imported energy (Scope 2)	Category 2: Indirect emissions from purchased electricity.

Exclusions from Reporting Boundary:	Category 3: - Indirect emissions from materials transportation, product delivery, business travel and employee commuting. Category 4: - Indirect emissions from tree care service, waste disposal service. Category 5 - Indirect emissions associated with end-use of sold products and end-life treatment. Category 6: - Indirect GHG emissions from other sources. Those are excluded as not required by intended users and insignificant emissions as per evaluation results.
Criteria for developing the organizational GHG Inventory:	ISO 14064-1:2018. GHG Inventory Report 2022 (10/06/2023)
Reporting Period	01/01/2022 - 31/12/2022

GHG emissions

	Location based, tCO2(e)
Reporting period	01/01/2022 – 31/12/2022
Scope 1: GHG non-biogenic emissions	6,681,290.03
Scope 1: GHG biogenic emissions	3.41
Scope 1: GHG removals	1,232.61
Scope 2: GHG indirect emissions	344,042.33
Total quantified	**7,024,103.16**

Verification Report

Verification Opinion

Verified as Satisfactory	
As a result of carrying out the verification of product life cycle greenhouse gas emissions, it is the opinion of BSI with reasonable assurance that	• No material misstatements in this product life cycle greenhouse gas emission assertion were revealed.
	• The product life cycle GHG data quality was verified to be acceptable against the requirements of ISO 14067:2018.
Lead Verifier	**Phan Tuan Hung**
Independent Reviewer	**Nguyen Dinh Minh Tam**
Signed on behalf of BSI	Le Duyen Anh - Managing Director BSI Vietnam
Issue Date	**02/05/2024**
BSI Vietnam: 15th Floor, APC Tower, 518B Dien Bien Phu Street, Ward 21, Binh Thanh District, Ho Chi Minh City, Vietnam	
NOTE: BSI Vietnam is independent to and has no financial interest in Long Son Company Limited (Thanh Hoa Branch - Long Son Cement Plant). This 3rd party Verification Opinion has been prepared for Long Son Company Limited (Thanh Hoa Branch - Long Son Cement Plant) only for the purposes of verifying its statement relating to its GHG emissions more particularly described in the scope above. It was not prepared for any other purpose. In making this Statement, BSI Vietnam has assumed that all information provided to it by Long Son Company Limited (Thanh Hoa Branch - Long Son Cement Plant) true, accurate and complete. BSI Vietnam accepts no liability to any third party who places reliance on this statement. This statement shall be valid for a maximum period of two years after the latest issue date on this certificate. Should there be a change in the life cycle of the product whose GHG emissions are being assessed, the validity of this opinion statement will cease.	

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Verification Engagement

Organization	LONG SON COMPANY LIMITED (THANH HOA BRANCH - LONG SON CEMENT PLANT) Dong Son Ward, Bim Son Town, Thanh Hoa Province, Vietnam
Responsible party	LONG SON COMPANY LIMITED (THANH HOA BRANCH - LONG SON CEMENT PLANT)
Verification Objectives	To express an opinion on whether the Product Carbon Footprint Statement which is historical in nature: • Is accurate, materially correct and is a fair representation of GHG data and information. • Has been prepared in accordance with ISO 14067:2018, the criteria used by BSI to verify the Product Carbon Footprint Statement
Materiality Level	5 %
Level of Assurance	Reasonable
Verification evidence gathering procedures	• Evaluation of the monitoring and controls systems through interviewing employees observation & inquiry • Verification of the data through sampling recalculation, retracing, cross checking and reconciliation
Verification Standards	The verification was carried out in accordance with ISO 14064-3:2019 and ISO 14065.

Product Carbon Footprint Statement

Products and Product declared unit	• Clinker (ton without packing) • Cement (ton without packing)
GHG study report containing Product Carbon Footprint Statement	The primary activity data include related facilities from its own processes under the operational control of the organization undertaking the CFP study - ISO 14067 GHG Study Report, issued on 16/01/2024
System Boundary	Cradle to gate
Product system boundary	The product system boundary is consistent with its system boundary definition in the product carbon footprint PCF report, including extraction, raw material acquisition, material handling, transportation activities and manufacturing in the product life cycle.
Cut-off criteria	95%
Criteria for developing the product carbon footprint	ISO 14067:2018 14067_CFP_Cement Long Son_260124 14067_CFP_ Report_Long Son_260124
Data collection Period	01/01/2022 – 31/12/2022

Product carbon footprint:

Declared ton of Product	Emissions (kgCO2e/ton)			
	Mining	Transportation	Manufacturing	Total
Clinker	0.65	1.64	823.12	825.41
Cement Type I / II - ASTM:C150	0.61	1.87	783.45	785.94
Cement Type IL - ASTM:C595	0.60	1.81	763.25	766.27
Cement CEM I - EN:197	0.61	1.87	783.45	785.94
Cement CEM II - EN:197	0.62	1.74	691.87	694.23
Cement PC 40 & 50 - TCVN:2682	0.60	1.81	763.85	766.27
Cement PCB 50 - TCVN:6260	0.54	2.01	594.05	597.05
Cement PCB 40 - TCVN:6260	0.53	1.95	524.60	527.07
Cement PCB 30 - TCVN:6260	0.54	1.66	476.89	479.09

3) Quang Ninh cement and construction / Lam Thach (Cements)

Environmental Product Declaration

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

EPD of multiple cement products, based on worst-case results: CEM I 52.5 N; CEM I 42.5 R; CEM I 52.5 N SR5; CEM I 42.5 N SR5; CEM I 42.5 N; TYPE I; TYPE II; TYPE V; TYPE G; PC 50; PC MSR 40; PC HSR 40; PC MSR 50; PC HSR 50; Type 5800 PSI

from

Quang Ninh Construction and Cement Joint Stock Company

Programme:	The International EPD® System / EPD Southeast Asia, https://www.epd-southeastasia.com/ - Hub The International EPD® System, www.environdec.com
Programme operator:	EPD International AB and Hub EPD Southeast Asia
EPD registration number:	EPD-IES-0016087
Publication date:	2024-08-14
Valid until:	2029-08-14

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 and the fully aligned Programme of the hub EPD Southeast Asia
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden Hub EPD Southeast Asia: Kencana Tower, Level M Business Park Kebon Jeruk Jl Raya Meruya Ilir No. 88 Jakarta Barat 11620 Indonesia
Website:	https://www.epd-southeastasia.com/ and www.environdec.com
E-mail:	admin@epd-southeastasia.com and 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 v.1.3.3 for construction products c-PCR-001 cement and lime, referring to EN 16908:2017+A1:2022 Cement and building lime *UN CPC code(s): 374*
PCR review was conducted by: The Technical Committee of the International EPD System. See www.environdec.com for a list of members. Review chair: No chair appointed. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Life Cycle Assessment (LCA)
LCA accountability: SGS INTRON B.V., Mathijs de Vaan
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: Claudia A. Peña, Director of PINDA LCT SpA 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:

- Owner of the EPD: Quang Ninh Construction and Cement Joint Stock Company.
- Address: Hop Thanh Area, Phuong Nam Ward, Uong Bi City, Quang Ninh Province, Vietnam.
- Contact: Ms. Luu Thi Phuong Thao.
- E-mail: thao.lp@vawaz.com.vn .
- Phone: (+84) 93456 8591.

Description of the organisation:

Lam Thach cement is a well-known commodity developed by Quang Ninh cement and construction Joint Stock Company. It is critically produced with advanced production line of waterless technology. The facilities are selectively updated according to European standards. The factory's location is adjacent to abundance input materials for cement production including Canxi carbonate or limestone, coal, clay, additives. Economically, it is a notable convenience for transportation not only via road network, but also waterway. This also an inevitable advantage for the people who are interested in doing business with our company.

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

Product-related or management system-related certifications:

ISO 9001: 2015, ISO 14001-2015.

Name and location of production site(s):

Lam Thach II Cement Factory.

Address: Hop Thanh area, Phuong Nam ward, Uong Bi city, Quang Ninh province, Vietnam.

Product information

Product description:

Cement is one of the most important building materials used in the construction industry, working as binder that sets, hardens and adheres to other materials to bind them together forming concrete, mortars, grouts and plasters. Cement is a so-called intermediate product with many different final uses. Cement may for example be used in ready-mix concrete, precast concrete, mortar, screed, base treatment for various types of infrastructures, etc.. Each final (concrete, mortar, grout, plaster) product and each application requires a different type of cement with a different composition, resulting in many cement types produced by cement manufacturers.

The cements can be packed in plastic or paper bags or could be transported as bulk using tanker trucks or ships.

Cement is defined in standards published by CEN/TC 51 (EN 197-1) as “a hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water”.

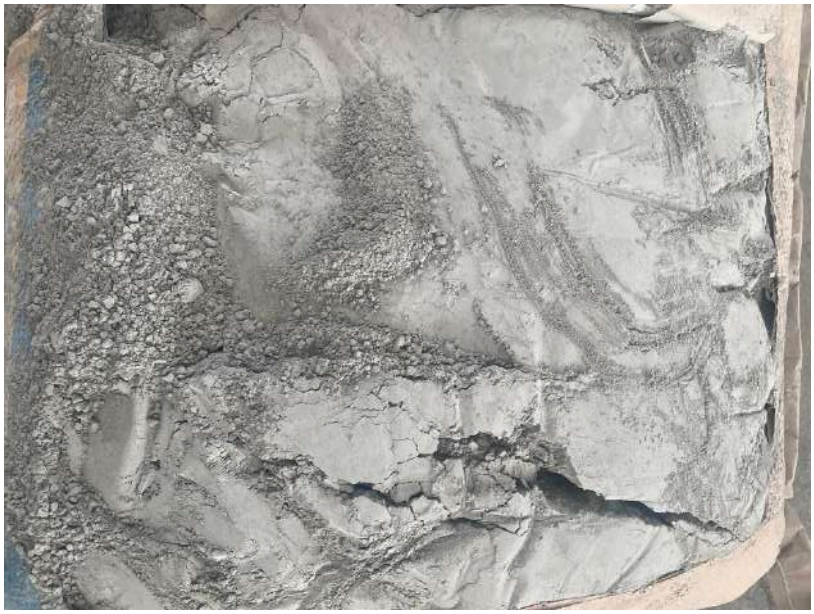
UN CPC code: 374.

Product name (multiple products) and product identification:
This EPD covers the cement types as mentioned in the Table below. These are cements with different compositions for application in various concrete mixtures, depending on the required performance of the application.
This EPD covers multiple products within a group of cement types. The EPD data is based on the worst-case approach, making it possible to group the cements. LCA-results are reported for the cement type within the group with the worst environmental performance in LCA-results, based on clinker content being the most important contributor to the environmental impact, and based on lowest recycled content: Type G. The LCA-results also apply to the other products within the group. The variation in GWP-GHG results is <10%.

Technical and functional characteristics are in accordance with the standards mentioned in the Table. The main product components are described in the system diagram in this EPD; the composition for the LCA is further specified in the section ‘Content information’ in this EPD.

Product	Significant characteristic & Recommended use	Technical properties	Product standard
CEM I 42.5R	• High residual coefficient of compressive strength, good consistency. • Reasonably strength process speed, anti-erosion. • Suitable for civil and industrial construction such as: bridge, road, skyscraper, hydro-electric building.	• Blaine: ○ R009: 1-2 % ○ Blaine: 4100-4200 cm^2/g • Compressive Strength: ○ R3: 27-29 MPa ○ R25: 46-48 MPa • Setting time: ○ Initial: 120-130 mins ○ Final: 170-180 mins • Soundness: 0-3 mm	TCVN6260:2020 ASTM C150-20 EN 197-1:2011 PNS 63:2019
CEM I 52.5 N **CEM I 42.5 N** **TYPE I** **PC 50** **Type 5800 PSI**	• High quality cement with outstanding advantages of high early and lately compressive strength. • High blaine, no additives, good soundness, low heat of hydration, low alkalinity. • Suitable for constructions requiring high technical such as: hydroelectric building, dam, bridge, road, Precast concrete components.	• Blaine: ○ R009: ≤ 1 % ○ Blaine: 3800-4000 cm^2/g • Compressive strength: ○ R3: 35-37 MPa ○ R25: 58-61 MPa • Setting time: ○ Initial: 110-120 mins ○ Final: 140-150 mins • Soundness: 0-3 mm • LOI: ≤ 3% • IR: ≤ 0,75%	TCVN2682:2020 ASTM C150:20 EN 197-1: 2011 PNS 07:2018
CEM I 52.5 N SR5 **CEM I 42.5 N SR5** **TYPE II; TYPE V; TYPE G** **PC MSR 40; PC HSR 40; PC MSR 50; PC HSR 50**	• Manufactured from sulphate-resistance clinker with different rate cause durability in corrosive environment, especially sulphate and saline environments. Suitable for construction in coastline, islands, projects in brackish water and saltwater areas,	• Blaine: ○ R009: ≤ 1 % ○ Blaine: 3800-4000 cm^2/g • Compressive Strength: ○ R3: 35-37 MPa ○ R25: 58-61 MPa • Setting time: ○ Initial: 110-120 mins ○ Final: 140-150 mins	TCVN 6067:2018 EN 197-1: 2011 PNS 07:2018

	underground projects, water supply and drainage projects, wastewater treatment, chemical factories, seafood processing plants. • Low heat radiation, suitable for large concrete structures such as irrigation dams, hydroelectric dams, etc.. • Low alkalies.	• Soundness: 0-3 mm • LOI: ≤ 3% • IR: ≤ 0,75%	



Geographical scope: Global.
The products are produced in Vietnam and sold in various countries. The geographical scope of the production (module A1-A3) is Vietnam.

LCA information

Declared unit: 1 000 kg cement CEM I 52.5 N; CEM I 42.5 R; CEM I 52.5 N SR5; CEM I 42.5 N SR5; CEM I 42.5 N; TYPE I; TYPE II; TYPE V; TYPE G; PC 50; PC MSR 40; PC HSR 40; PC MSR 50; PC HSR 50; Type 5800 PSI, for use in concrete, mortar, grout, etc..

Reference service life: Not applicable.

Time representativeness: Specific data for the production (module A3) cover the year 2022 (1 January 2022 – 31 December 2022). Background data are not older than 10 years.

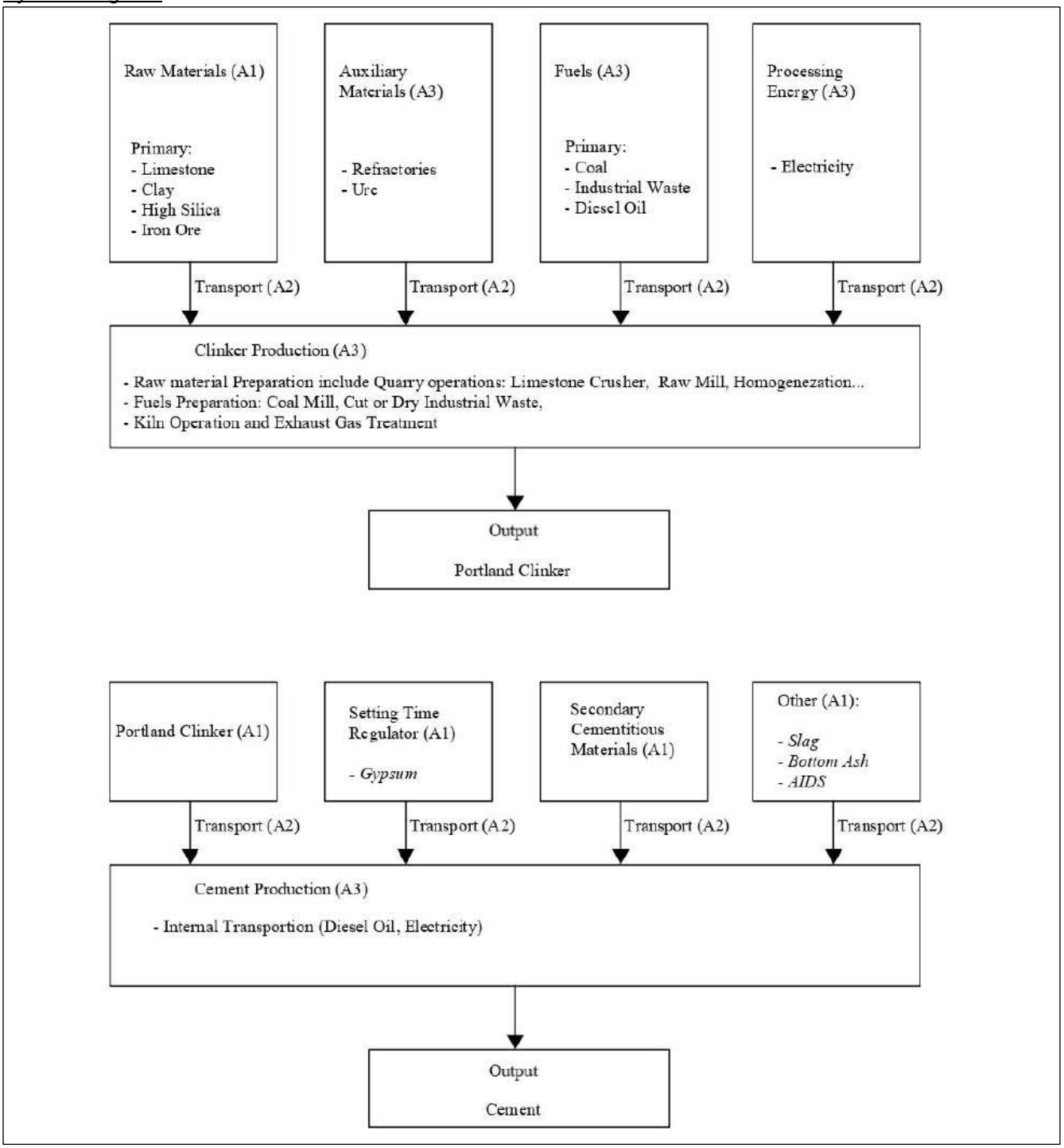
Database(s) and LCA software used: Simapro 9 and ecoinvent 3.8. The EN 15804 reference package based on EF 3.0 has been used.

Description of system boundaries:

d) Cradle to gate (A1–A3). These system boundaries are chosen since cement fulfils the following requirements from EN 15804 and the PCR:

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

System diagram:



Description manufacturing process:

Module A1 – Raw material production
The basic ingredient for cement is Portland clinker. The company produces its own clinker. This specific clinker (clinker LTII) production is included in A1. Next to own clinker, a small part is purchased externally. The other cement ingredients are also included in A1. Company data are collected for the clinker LTII. For external clinker, ecoinvent 3.8 data are used.

Module A2 – Transport of raw materials to LT-II
The ingredients are transported to the factory LT-II. Transport data are specific for the production location in Vietnam.

Module A3 - Manufacturing
The cement products are manufactured in one plant in Vietnam. Clinker is ground with other raw materials. All ingredients are dried before use. After grinding and mixing the raw materials to the right fineness, they product is transported to the silos from where the product is placed in means of transport (i.e. bags, bulk cement tanker truck, bulk cement tanker ship).
The purchased electricity used in the manufacturing process accounts for 0.3% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese national grid mix[1] as included in the ecoinvent 3.8 database, composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact of electricity as kg CO_2-eq/kWh (using the GWP-GHG indicator) used in manufacturing process: 0.562 kg CO_2-eq/kWh for the Vietnamese grid mix.

Ecoinvent processes are calculated including the infrastructure processes and capital goods. Capital goods and other infrastructure are also included in the foreground processes. Ecoinvent processes for landfill are calculated excluding long-term emissions.
Personnel-related impacts, use of offices etc. are excluded.

More information:
More information on QNC can be obtained at qncc.vn.
For more information about the LCA the LCA practitioner can be contacted via nl.intron@sgs.com.

Cut-offs
No cut-offs were applied. The material and energy data are based on full year figures and complete. No data gaps were identified.

Co-products and allocations
The various cement types are produced in one plant. The processing data of the cement plant are based on yearly consumption in 2022. The manufacturer allocated the electricity and water consumption to the various groups, based on actual consumptions for different cement types. Other data (diesel, emissions, production waste, packaging) are allocated on mass basis over all products.

Further allocation procedures for use of secondary raw materials and waste, are in line with EN 15804.

[1] The company doesn't buy a specific mix (option 1 from PCR section 4.8.1). The residual mix of the electricity supplier (option 2) is unknown and there are no ecoinvent data for the residual electricity mix on the Vietnamese market, nor easily accessible public data (option 3). Therefore, option 4 (electricity consumption on the market) is applied and the electricity was not used in processes over which the manufacturer has direct control. This seems justified since electricity is not a main contributor to the results.

A1-A3 Production cradle-to-gate
The purchased electricity used in the manufacturing process accounts for 0.7% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese grid mix as included in the ecoinvent 3.8 database composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact GWP-GHG indicator in A1-A3 is 8.85E+02 kg CO_2-eq..

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	Global	VN	VN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Specific data used	97%	100%	100%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – products	Wost case approach Variation <10%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – sites	0%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/ declared unit
Clinker	967 (875-967)	0	0
Limestone	0 (0-60)	0	0
Pozzolan	0 (0-70)	0	0
Gypsum	33 (33-55)	0	0
TOTAL	1 000	0	0
Packaging materials	**Weight, kg**	**Weight-% (versus the product)**	**Weight biogenic carbon, kg C/ declared unit**
Material 1 packaging paper	1.75	0.18%	8.1E-01
Material 2 packaging plastic	2.29	0.23%	0

The values outside the brackets indicate worst case scenario, the values withing the brackets indicate the range. Clinker and lime reflect the highest share in environmental impact. Therefore, the worst-case values from the range are chosen in the composition. To achieve a total weight of 1 000 kg for the declared unit, the content of the other components with less environmental impact (pozzolan and gypsum) are the lowest value of the range. There are no recycled or biogenic components influencing this choice, nor any hazardous substances which could influence the results.

The products do not contain Substances of Very High Concern in amounts greater than 1%.
According to REACH regulations the maximum chromate content is 2 ppm.
More information and safety instructions may be obtained via Quang Ninh Construction and Cement Joint Stock Company.

Results of the environmental performance indicators

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

NOTE: The worst case (i.e. highest clinker content) product is chosen as the 'representative' product within the group of cements. The decomposition (Bill of Materials) of the worst-case products and production flow diagram are provided in the sections before. Since the clinker content within a group does not vary more than 10% (from the average within the range), the LCA results and the GWP-GHG A1-A3 within the group do not differ more than 10%.

Mandatory impact category indicators according to EN 15804

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
GWP-fossil	kg CO_2 eq.	8.85E+02	1.29E+01	1.84E+01
GWP-biogenic	kg CO_2 eq.	1.16E+01[2]	-1.02E+00 (A1) / + 1.02E+00 (A5)	-6.71E-02***
GWP-luluc	kg CO_2 eq.	3.16E-01	1.12E-01	8.38E-02
GWP-total	kg CO_2 eq.	8.97E+02	1.20E+01	1.84E+01
ODP	kg CFC 11 eq.	9.81E-06	2.49E-06	2.54E-06
AP	mol H^+ eq.	2.26E+00	7.54E-02	9.41E-02
EP-freshwater	kg P eq.	6.94E-02	2.87E-04	3.48E-04
EP-marine	kg N eq.	7.02E-01	2.58E-02	2.81E-02
EP-terrestrial	mol N eq.	8.05E+00	2.80E-02	3.06E-01
POCP	kg NMVOC eq.	1.98E+00	7.98E-02	9.85E-02
ADP-minerals&metals* / **	kg Sb eq.	2.86E-04	4.86E-05	7.51E-05
ADP-fossil*	MJ	3.75E+03	1.93E+02	3.63E+02
WDP*	m^3	4.38E-01	1.68E+00	6.04E+00

[2] GWP-b values stem from generic ecoinvent background processes. There is no biogenic content in the product. The contribution of GWP-b to GWP-tot is just 1.3% and therefore not relevant.

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.*
*** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*
**** Small negative value due to various processes in ecoinvent. Not corrected because of negligible impact.*

Additional mandatory and voluntary impact category indicators

Results per declared unit 1 000 kg cement

Indicator	Unit	A1-A3	Optional paper packaging	Optional plastic packaging
GWP-GHG[3]	kg CO_2 eq.	8.85E+02	1.29E+01	1.84E+01
PM	disease inc.	7.16E-05	1.15E-06	1.27E-06
IRP*	kBq U-235 eq	5.57E+00	7.57E-01	9.12E-01
ETP-fw** / ***	CTUe	5.58E+03	2.49E+02	2.36E+02
HTP-c** / ***	CTUh	1.40E-07	7.36E-09	8.01E-09
HTP-nc** / ***	CTUh	5.70E-06	1.84E-07	2.13E-07
SQP** / ***	Pt	6.11E+02	5.00E+02	1.76E+02
Acronyms	PM = Particulate matter, IRP = Ionising radiation, ETP-fw = Ecotoxicity, freshwater, HTP-c = Human toxicity, cancer, HTP-nc = Human toxicity, non-cancer, SQP = Land use			

** Disclaimer: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator*
*** Disclaimer: 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*
**** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*

[3] 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 CO_2 is set to zero.

Resource use indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
PERE	MJ	1.12E+02	6.29E+01	1.11E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.12E+02	6.29E+01	1.11E+01
PENRE	MJ	4.15E+03	2.05E+02	3.88E+02
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	4.15E+03	2.05E+02	3.88E+02
SM	kg	1.63E+01	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.59E-01	4.81E-02	1.43E-01
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 declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Hazardous waste disposed	kg	2.91E-03	5.99E-04	4.86E-04
Non-hazardous waste disposed	kg	3.39E+01	1.15E+01	1.20E+01
Radioactive waste disposed	kg	5.92E-03	1.15E-03	1.28E-03

Output flow indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00

Additional environmental information

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

References

Background report SGS INTRON A132871-R20231358-MVa-F630301 SGS Vietnam Limited, 18 April 2024.

Cement and building lime (EN 16908:2017+A1:2022), product group classification: UN CPC 374 c-PCR to PCR 2019:14 C-PCR-001 (TO PCR 2019:14) version: 2022-05-18.

EN 15804+A2:2019/AC:2021, “Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products”.

EN 16908:2017+A1:2022. EN 16908:2017+A1:2022 Cement and building lime - Environmental product declarations - Product category rules complementary to EN 15804.

EPD cement Quang Ninh Construction and Cement Joint Stock Company – Lam Thach II Cement Factory, Report SGS INTRON B.V, version 3.

General Programme Instructions of the International EPD® System. Version 4.0.

ISO 14025:2010, “Environmental labels and declarations – Type III environmental declarations”.

ISO 14040:2006, “Environmental management - Environmental management -- Life cycle assessment - Principles and framework”.

ISO 14044+A2:2020, “Environmental management - Life cycle assessment - Requirements and guidelines”.

PCR 2019:14, v.1.3.3, Construction products of the International EPD® System.

Spatiotemporal Analysis of Carbon Emissions and Carbon Storage Using National Geography Census Data in Wuhan, China.

EPD owner:

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Verification by:

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Pinda.lct@gmail.com

Approved by:

The International EPD® System Technical Committee, supported by the Secretariat

EPD®

www.environdec.com

Environmental Product Declaration

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

EPD of multiple cement products, based on worst-case results: TYPE IL; CEM II 42.5 R; CEM II 52.5 N; Type 5200 PSI; Type 5600 PSI; PCB 50

from

Quang Ninh Construction and Cement Joint Stock Company

Programme:	The International EPD® System / EPD Southeast Asia, https://www.epd-southeastasia.com/ - Hub The International EPD® System, www.environdec.com
Programme operator:	EPD International AB and Hub EPD Southeast Asia
EPD registration number:	EPD-IES-0016084
Publication date:	2024-08-14
Valid until:	2029-08-14

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 and the fully aligned Programme of the hub EPD Southeast Asia
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden Hub EPD Southeast Asia: Kencana Tower, Level M Business Park Kebon Jeruk Jl Raya Meruya Ilir No. 88 Jakarta Barat 11620 Indonesia
Website:	https://www.epd-southeastasia.com/ and www.environdec.com
E-mail:	admin@epd-southeastasia.com and 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 v.1.3.3 for construction products c-PCR-001 cement and lime, referring to EN 16908:2017+A1:2022 Cement and building lime *UN CPC code(s): 374*
PCR review was conducted by: The Technical Committee of the International EPD System. See www.environdec.com for a list of members. Review chair: No chair appointed. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Life Cycle Assessment (LCA)
LCA accountability: SGS INTRON B.V., Mathijs de Vaan
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: Claudia A. Peña, Director of PINDA LCT SpA 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:

- Owner of the EPD: Quang Ninh Construction and Cement Joint Stock Company.
- Address: Hop Thanh Area, Phuong Nam Ward, Uong Bi City, Quang Ninh Province, Vietnam.
- Contact: Ms. Luu Thi Phuong Thao.
- E-mail: thao.lp@vawaz.com.vn .
- Phone: (+84) 93456 8591.

Description of the organisation:

Lam Thach cement is a well-known commodity developed by Quang Ninh cement and construction Joint Stock Company. It is critically produced with advanced production line of waterless technology. The facilities are selectively updated according to European standards. The factory's location is adjacent to abundance input materials for cement production including Canxi carbonate or limestone, coal, clay, additives. Economically, it is a notable convenience for transportation not only via road network, but also waterway. This also an inevitable advantage for the people who are interested in doing business with our company.

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

Product-related or management system-related certifications:

ISO 9001: 2015, ISO 14001-2015.

Name and location of production site(s):

Lam Thach II Cement Factory.

Address: Hop Thanh area, Phuong Nam ward, Uong Bi city, Quang Ninh province, Vietnam.

Product information

Product description:

Cement is one of the most important building materials used in the construction industry, working as binder that sets, hardens and adheres to other materials to bind them together forming concrete, mortars, grouts and plasters. Cement is a so-called intermediate product with many different final uses. Cement may for example be used in ready-mix concrete, precast concrete, mortar, screed, base treatment for various types of infrastructures, etc.. Each final (concrete, mortar, grout, plaster) product and each application requires a different type of cement with a different composition, resulting in many cement types produced by cement manufacturers.

The cements can be packed in plastic or paper bags or could be transported as bulk using tanker trucks or ships.

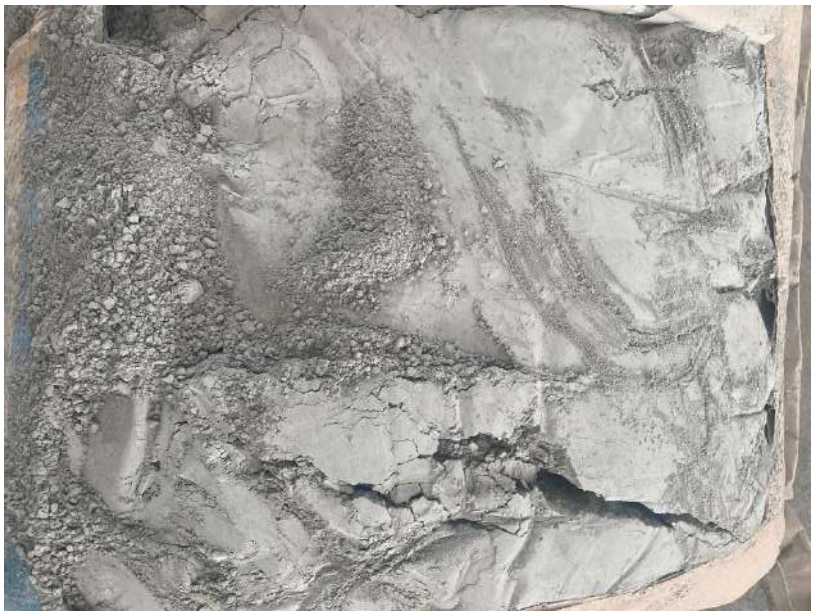
Cement is defined in standards published by CEN/TC 51 (EN 197-1) as “a hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water”.

UN CPC code: 374.

Product name (multiple products) and product identification:
This EPD covers the cement types as mentioned in the Table below. These are cements with different compositions for application in various concrete mixtures, depending on the required performance of the application.
This EPD covers multiple products within a group of cement types. The EPD data is based on the worst-case approach, making it possible to group the cements. LCA-results are reported for the cement type within the group with the worst environmental performance in LCA-results, based on clinker content being the most important contributor to the environmental impact, and based on lowest recycled content: CEM II 52.5 N. The LCA-results also apply to the other products within the group. The variation in GWP-GHG results is <10%.

Technical and functional characteristics are in accordance with the standards mentioned in the Table. The main product components are described in the system diagram in this EPD; the composition for the LCA is further specified in the section ‘Content information’ in this EPD.

Product	Significant characteristic & Recommended use	Technical properties	Product standard
Type 5200 PSI **CEM II/A-L 42.5R**	• High residual coefficient of compressive strength, good consistency. • Reasonably strength process speed, anti-erosion. • Suitable for civil and industrial construction such as: bridge, road, skyscraper, hydro-electric building.	• Blaine: o R009: 1-2 % o Blaine: 4100-4200 cm^2/g • Compressive Strength: o R3: 27-29 MPa o R25: 46-48 MPa • Setting time: o Initial: 120-130 mins o Final: 170-180 mins • Soundness: 0-3 mm	TCVN6260:2020 ASTM C150-20 EN 197-1:2011 PNS 63:2019
PCB50 **Type 5600 PSI** **Type IL** **CEM II 52.5 N**	• High quality cement with outstanding advantages of high early and lately compressive strength. • High blaine, no additives, good soundness, low heat of hydration, low alkalinity. • Suitable for constructions requiring high technical such as: hydroelectric building, dam, bridge, road, Precast concrete components.	• Blaine: o R009: ≤ 1 % o Blaine: 3800-4000 cm^2/g • Compresive strength: o R3: 35-37 MPa o R25: 58-61 MPa • Setting time: o Initial: 110-120 mins o Final: 140-150 mins • Soundness: 0-3 mm • LOI: ≤ 3% • IR: ≤ 0,75%	TCVN2682:2020 ASTM C150:20 EN 197-1: 2011 PNS 07:2018



Geographical scope: Global.
The products are produced in Vietnam and sold in various countries. The geographical scope of the production (module A1-A3) is Vietnam.

LCA information

Declared unit: 1 000 kg cement types TYPE IL; CEM II 42.5 R; CEM II 52.5 N; Type 5200 PSI; Type 5600 PSI; PCB 50 for use in concrete, mortar, grout, etc..

Reference service life: Not applicable.

Time representativeness: Specific data for the production (module A3) cover the year 2022 (1 January 2022 – 31 December 2022). Background data are not older than 10 years.

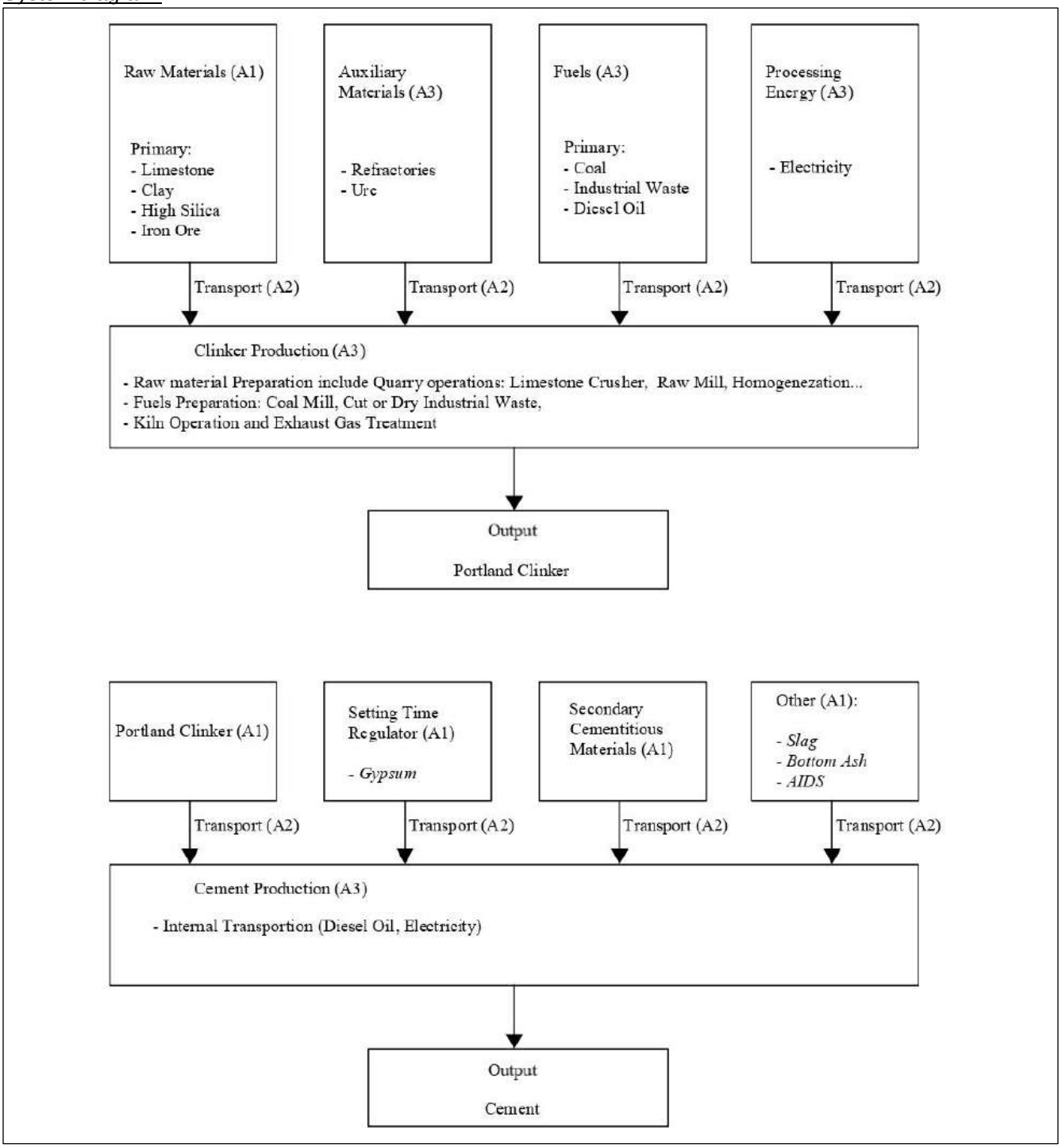
Database(s) and LCA software used: Simapro 9 and ecoinvent 3.8. The EN 15804 reference package based on EF 3.0 has been used.

Description of system boundaries:

d) Cradle to gate (A1–A3). These system boundaries are chosen since cement fulfils the following requirements from EN 15804 and the PCR:

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

System diagram:



Description manufacturing process:

Module A1 – Raw material production

The basic ingredient for cement is Portland clinker. The company produces its own clinker. This specific clinker (clinker LTII) production is included in A1. Next to own clinker, a small part is purchased externally. The other cement ingredients are also included in A1. Company data are collected for the clinker LTII. For external clinker, ecoinvent 3.8 data are used.

Module A2 – Transport of raw materials to LT-II
The ingredients are transported to the factory LT-II. Transport data are specific for the production location in Vietnam.

Module A3 - Manufacturing
The cement products are manufactured in one plant in Vietnam. Clinker is ground with other raw materials. All ingredients are dried before use. After grinding and mixing the raw materials to the right fineness, they product is transported to the silos from where the product is placed in means of transport (i.e. bags, bulk cement tanker truck, bulk cement tanker ship).
The purchased electricity used in the manufacturing process accounts for 0.3% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese national grid mix[1] as included in the ecoinvent 3.8 database, composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact of electricity as kg CO_2-eq/kWh (using the GWP-GHG indicator) used in manufacturing process: 0.562 kg CO_2-eq/kWh for the Vietnamese grid mix.

Ecoinvent processes are calculated including the infrastructure processes and capital goods. Capital goods and other infrastructure are also included in the foreground processes. Ecoinvent processes for landfill are calculated excluding long-term emissions.
Personnel-related impacts, use of offices etc. are excluded.

More information:
More information on QNC can be obtained at qncc.vn.
For more information about the LCA the LCA practitioner can be contacted via nl.intron@sgs.com.

Cut-offs
No cut-offs were applied. The material and energy data are based on full year figures and complete. No data gaps were identified.

Co-products and allocations
The various cement types are produced in one plant. The processing data of the cement plant are based on yearly consumption in 2022. The manufacturer allocated the electricity and water consumption to the various groups, based on actual consumptions for different cement types. Other data (diesel, emissions, production waste, packaging) are allocated on mass basis over all products.

Further allocation procedures for use of secondary raw materials and waste, are in line with EN 15804.

A1-A3 Production cradle-to-gate
The purchased electricity used in the manufacturing process accounts for 0.02% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese grid mix as included in the ecoinvent 3.8 database composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact GWP-GHG indicator in A1-A3 is 7.96E+02 kg CO_2-eq..

[1] The company doesn't buy a specific mix (option 1 from PCR section 4.8.1). The residual mix of the electricity supplier (option 2) is unknown and there are no ecoinvent data for the residual electricity mix on the Vietnamese market, nor easily accessible public data (option 3). Therefore, option 4 (electricity consumption on the market) is applied and the electricity was not used in processes over which the manufacturer has direct control. This seems justified since electricity is not a main contributor to the results.

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	Global	VN	VN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Specific data used	95%	100%	100%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – products	Worst case approach Variation <10%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – sites	0%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/ declared unit
Clinker	875 (750-875)	0	0
Limestone	40 (0-200)	0	0
Pozzolan	45 (0-150)	0	0
Gypsum	40 (40-55)	0	0
TOTAL	1 000	0	0
Packaging materials	**Weight, kg**	**Weight-% (versus the product)**	**Weight biogenic carbon, kg C/ declared unit**
Material 1 packaging paper	1.75	0.18%	8.1E-01
Material 2 packaging plastic	2.29	0.23%	0

The values outside the brackets indicate worst case scenario, the values withing the brackets indicate the range. Clinker and lime reflect the highest share in environmental impact. Therefore, the worst-case values from the range are chosen in the composition. To achieve a total weight of 1 000 kg for the declared unit, the content of the other components with less environmental impact (pozzolan and gypsum) are the lowest value of the range. There are no recycled or biogenic components influencing this choice, nor any hazardous substances which could influence the results.

The products do not contain Substances of Very High Concern in amounts greater than 1%.
According to REACH regulations the maximum chromate content is 2 ppm.
More information and safety instructions may be obtained via Quang Ninh Construction and Cement Joint Stock Company.

Results of the environmental performance indicators

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

NOTE: The worst case (i.e. highest clinker content) product is chosen as the 'representative' product within the group of cements. The decomposition (Bill of Materials) of the worst-case products and production flow diagram are provided in the sections before. Since the clinker content within a group does not vary more than 10% (from the average within the range), the LCA results and the GWP-GHG A1-A3 within the group do not differ more than 10%.

Mandatory impact category indicators according to EN 15804

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
GWP-fossil	kg CO_2 eq.	7.96E+02	1.29E+01	1.84E+01
GWP-biogenic	kg CO_2 eq.	1.05E+01[2]	-1.02E+00 (A1) / + 1.02E+00 (A5)	-6.71E-02***
GWP-luluc	kg CO_2 eq.	2.88E-01	1.12E-01	8.38E-02
GWP-total	kg CO_2 eq.	8.07E+02	1.20E+01	1.84E+01
ODP	kg CFC 11 eq.	9.13E-06	2.49E-06	2.54E-06
AP	mol H^+ eq.	2.01E+00	7.54E-02	9.41E-02
EP-freshwater	kg P eq.	6.19E-02	2.87E-04	3.48E-04
EP-marine	kg N eq.	6.31E-01	2.58E-02	2.81E-02
EP-terrestrial	mol N eq.	7.25E+00	2.80E-02	3.06E-01
POCP	kg NMVOC eq.	1.78E+00	7.98E-02	9.85E-02
ADP-minerals&metals* / **	kg Sb eq.	2.72E-04	4.86E-05	7.51E-05
ADP-fossil*	MJ	3.34E+03	1.93E+02	3.63E+02
WDP*	m^3	4.84E-01	1.68E+00	6.04E+00

[2] GWP-b values stem from generic ecoinvent background processes. There is no biogenic content in the product. The contribution of GWP-b to GWP-tot is just 1.3% and therefore not relevant.

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.*
*** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*
**** Small negative value due to various processes in ecoinvent. Not corrected because of negligible impact.*

Additional mandatory and voluntary impact category indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
GWP-GHG[3]	kg CO_2 eq.	7.96E+02	1.29E+01	1.84E+01
PM	disease inc.	7.03E-05	1.15E-06	1.27E-06
IRP*	kBq U-235 eq	5.11E+00	7.57E-01	9.12E-01
ETP-fw** / ***	CTUe	5.14E+03	2.49E+02	2.36E+02
HTP-c** / ***	CTUh	1.27E-07	7.36E-09	8.01E-09
HTP-nc** / ***	CTUh	5.14E-06	1.84E-07	2.13E-07
SQP** / ***	Pt	5.63E+02	5.00E+02	1.76E+02
Acronyms	PM = Particulate matter, IRP = Ionising radiation, ETP-fw = Ecotoxicity, freshwater, HTP-c = Human toxicity, cancer, HTP-nc = Human toxicity, non-cancer, SQP = Land use			

** Disclaimer: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator*
*** Disclaimer: 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*
**** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*

[3] 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 CO_2 is set to zero.

Resource use indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
PERE	MJ	8.85E+01	6.29E+01	1.11E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	8.85E+01	6.29E+01	1.11E+01
PENRE	MJ	3.70E+03	2.05E+02	3.88E+02
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	3.70E+03	2.05E+02	3.88E+02
SM	kg	6.50E+01	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.37E-01	4.81E-02	1.43E-01
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 declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Hazardous waste disposed	kg	2.68E-03	5.99E-04	4.86E-04
Non-hazardous waste disposed	kg	3.08E+01	1.15E+01	1.20E+01
Radioactive waste disposed	kg	5.48E-03	1.15E-03	1.28E-03

Output flow indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00

Additional environmental information

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

References

Background report SGS INTRON A132871-R20231358-MVa-F630301 SGS Vietnam Limited, 18 April 2024.

Cement and building lime (EN 16908:2017+A1:2022), product group classification: UN CPC 374 c-PCR to PCR 2019:14 C-PCR-001 (TO PCR 2019:14) version: 2022-05-18.

EN 15804+A2:2019/AC:2021, “Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products”.

EN 16908:2017+A1:2022. EN 16908:2017+A1:2022 Cement and building lime - Environmental product declarations - Product category rules complementary to EN 15804.

EPD cement Quang Ninh Construction and Cement Joint Stock Company – Lam Thach II Cement Factory, Report SGS INTRON B.V, version 3.

General Programme Instructions of the International EPD® System. Version 4.0.

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ISO 14040:2006, “Environmental management - Environmental management -- Life cycle assessment - Principles and framework”.

ISO 14044+A2:2020, “Environmental management - Life cycle assessment - Requirements and guidelines”.

PCR 2019:14, v.1.3.3, Construction products of the International EPD® System.

Spatiotemporal Analysis of Carbon Emissions and Carbon Storage Using National Geography Census Data in Wuhan, China.

EPD owner:

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EPD prepared by:

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Verification by:

Claudia A. Peña
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Approved by:

The International EPD® System Technical Committee, supported by the Secretariat

EPD®

www.environdec.com

Environmental Product Declaration

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

EPD of multiple cement products, based on worst-case results: CEM II 42.5 N; PCB 40; Type 4060 PSI; Type GU; Type 5000 PSI

from

Quang Ninh Construction and Cement Joint Stock Company

Programme:	The International EPD® System / EPD Southeast Asia, https://www.epd-southeastasia.com/ - Hub The International EPD® System, www.environdec.com
Programme operator:	EPD International AB and Hub EPD Southeast Asia
EPD registration number:	EPD-IES-0016060
Publication date:	2024-08-14
Valid until:	2029-08-14

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 and the fully aligned Programme of the hub EPD Southeast Asia
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden Hub EPD Southeast Asia: Kencana Tower, Level M Business Park Kebon Jeruk Jl Raya Meruya Ilir No. 88 Jakarta Barat 11620 Indonesia
Website:	https://www.epd-southeastasia.com/ and www.environdec.com
E-mail:	admin@epd-southeastasia.com and 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 v.1.3.3 for construction products c-PCR-001 cement and lime, referring to EN 16908:2017+A1:2022 Cement and building lime *UN CPC code(s): 374*
PCR review was conducted by: The Technical Committee of the International EPD System. See www.environdec.com for a list of members. Review chair: No chair appointed. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Life Cycle Assessment (LCA)
LCA accountability: SGS INTRON B.V., Mathijs de Vaan
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: Claudia A. Peña, Director of PINDA LCT SpA 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:

- Owner of the EPD: Quang Ninh Construction and Cement Joint Stock Company.
- Address: Hop Thanh Area, Phuong Nam Ward, Uong Bi City, Quang Ninh Province, Vietnam.
- Contact: Ms. Luu Thi Phuong Thao.
- E-mail: thao.lp@vawaz.com.vn .
- Phone: (+84) 93456 8591.

Description of the organisation:

Lam Thach cement is a well-known commodity developed by Quang Ninh cement and construction Joint Stock Company. It is critically produced with advanced production line of waterless technology. The facilities are selectively updated according to European standards. The factory's location is adjacent to abundance input materials for cement production including Canxi carbonate or limestone, coal, clay, additives. Economically, it is a notable convenience for transportation not only via road network, but also waterway. This also an inevitable advantage for the people who are interested in doing business with our company.

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

Product-related or management system-related certifications:

ISO 9001: 2015, ISO 14001-2015.

Name and location of production site(s):

Lam Thach II Cement Factory.

Address: Hop Thanh area, Phuong Nam ward, Uong Bi city, Quang Ninh province, Vietnam.

Product information

Product description:

Cement is one of the most important building materials used in the construction industry, working as binder that sets, hardens and adheres to other materials to bind them together forming concrete, mortars, grouts and plasters. Cement is a so-called intermediate product with many different final uses. Cement may for example be used in ready-mix concrete, precast concrete, mortar, screed, base treatment for various types of infrastructures, etc.. Each final (concrete, mortar, grout, plaster) product and each application requires a different type of cement with a different composition, resulting in many cement types produced by cement manufacturers.

The cements can be packed in plastic or paper bags or could be transported as bulk using tanker trucks or ships.

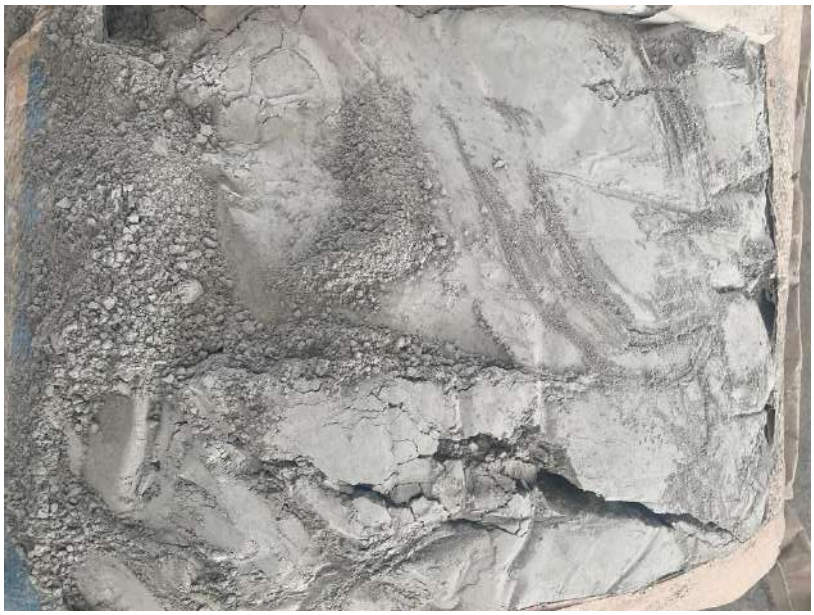
Cement is defined in standards published by CEN/TC 51 (EN 197-1) as “a hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water”.

UN CPC code: 374.

Product name (multiple products) and product identification:
This EPD covers the cement types as mentioned in the Table below. These are cements with different compositions for application in various concrete mixtures, depending on the required performance of the application.
This EPD covers multiple products within a group of cement types. The EPD data is based on the worst-case approach, making it possible to group the cements. LCA-results are reported for the cement type within the group with the worst environmental performance in LCA-results, based on clinker content being the most important contributor to the environmental impact, and based on lowest recycled content: Type 5000 PSI. The LCA-results also apply to the other products within the group. The variation in GWP-GHG results is <10%.

Technical and functional characteristics are in accordance with the standards mentioned in the Table. The main product components are described in the system diagram in this EPD; the composition for the LCA is further specified in the section ‘Content information’ in this EPD.

Product	Significant characteristic & Recommended use	Technical properties	Product standard
Type 4060 PSI **Type GU**	• High blaine and long setting time cause the high consistency and good workability. • Anti-erosion. Good water retention, long hydration process, water proofing. • Multi-purpose cement, suitable for civil and industrial construction with items such as: plastering, pouring concrete columns, roads.	• Blaine: ○ R009: 2-4 % ○ Blaine: 4200 - 4300 cm^2/g • Compressive strength: ○ R3: 17-19 MPa ○ R28: 36-38 MPa • Setting time: ○ Initial: 140-150 mins ○ Final: 190-200 mins • Soundness: 0-3 mm	TCVN6260:2020 ASTM C150-20 EN 197-1:2011 PNS 63:2019
PCB 40 **Type 5000 PSI** **CEM II/A-L 42.5N**	• High residual coefficient of compressive strength, good consistency. • Reasonably strength process speed, anti-erosion. • Suitable for civil and industrial construction such as: bridge, road, skyscraper, hydro-electric building.	• Blaine ○ R009: 1-2 % ○ Blaine: 4100-4200 cm^2/g • Compressive Strength: ○ R3: 27-29 MPa ○ R25: 46-48 MPa • Setting time: ○ Initial: 120-130 mins ○ Final: 170-180 mins • Soundness: 0-3 mm	TCVN6260:2020 ASTM C150-20 EN 197-1:2011 PNS 63:2019



Geographical scope: Global.
The products are produced in Vietnam and sold in various countries. The geographical scope of the production (module A1-A3) is Vietnam.

LCA information

Declared unit: 1 000 kg cement types CEM II 42.5 N; PCB 40; Type 4060 PSI; Type GU; Type 5000 PSI for use in concrete, mortar, grout, etc..

Reference service life: Not applicable.

Time representativeness: Specific data for the production (module A3) cover the year 2022 (1 January 2022 – 31 December 2022). Background data are not older than 10 years.

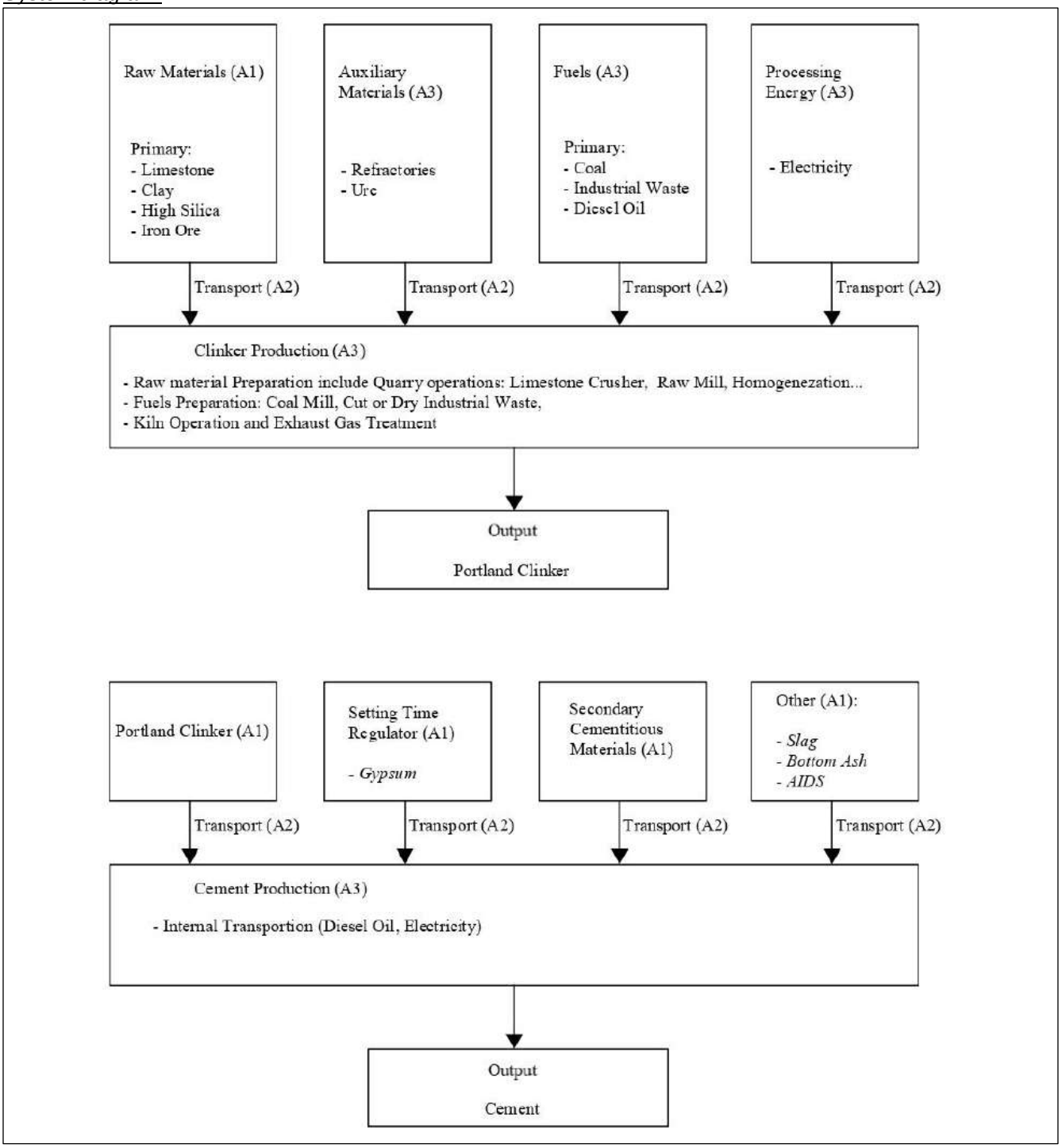
Database(s) and LCA software used: Simapro 9 and ecoinvent 3.8. The EN 15804 reference package based on EF 3.0 has been used.

Description of system boundaries:

d) Cradle to gate (A1–A3). These system boundaries are chosen since cement fulfils the following requirements from EN 15804 and the PCR:

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

System diagram:



Description manufacturing process:

Module A1 – Raw material production

The basic ingredient for cement is Portland clinker. The company produces its own clinker. This specific clinker (clinker LTII) production is included in A1. Next to own clinker, a small part is purchased externally. The other cement ingredients are also included in A1. Company data are collected for the clinker LTII. For external clinker, ecoinvent 3.8 data are used.

Module A2 – Transport of raw materials to LT-II
The ingredients are transported to the factory LT-II. Transport data are specific for the production location in Vietnam.

Module A3 - Manufacturing
The cement products are manufactured in one plant in Vietnam. Clinker is ground with other raw materials. All ingredients are dried before use. After grinding and mixing the raw materials to the right fineness, they product is transported to the silos from where the product is placed in means of transport (i.e. bags, bulk cement tanker truck, bulk cement tanker ship).
The purchased electricity used in the manufacturing process accounts for 0.3% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese national grid mix[1] as included in the ecoinvent 3.8 database, composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact of electricity as kg CO_2-eq/kWh (using the GWP-GHG indicator) used in manufacturing process: 0.562 kg CO_2-eq/kWh for the Vietnamese grid mix.

Ecoinvent processes are calculated including the infrastructure processes and capital goods. Capital goods and other infrastructure are also included in the foreground processes. Ecoinvent processes for landfill are calculated excluding long-term emissions.
Personnel-related impacts, use of offices etc. are excluded.

More information:
More information on QNC can be obtained at qncc.vn.
For more information about the LCA the LCA practitioner can be contacted via nl.intron@sgs.com.

Cut-offs
No cut-offs were applied. The material and energy data are based on full year figures and complete. No data gaps were identified.

Co-products and allocations
The various cement types are produced in one plant. The processing data of the cement plant are based on yearly consumption in 2022. The manufacturer allocated the electricity and water consumption to the various groups, based on actual consumptions for different cement types. Other data (diesel, emissions, production waste, packaging) are allocated on mass basis over all products.

Further allocation procedures for use of secondary raw materials and waste, are in line with EN 15804.

A1-A3 Production cradle-to-gate
The purchased electricity used in the manufacturing process accounts for 1.3% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese grid mix as included in the ecoinvent 3.8 database composed of 45% coal,37% hydro,17% gas and 1% other power. The climate impact GWP-GHG indicator in A1-A3 is 6.47E+02 kg CO_2-eq..

[1] The company doesn't buy a specific mix (option 1 from PCR section 4.8.1). The residual mix of the electricity supplier (option 2) is unknown and there are no ecoinvent data for the residual electricity mix on the Vietnamese market, nor easily accessible public data (option 3). Therefore, option 4 (electricity consumption on the market) is applied and the electricity was not used in processes over which the manufacturer has direct control. This seems justified since electricity is not a main contributor to the results.

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	Global	VN	VN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Specific data used	64%	100%	100%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – products	Worst case approach Variation <10%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – sites	0%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/ declared unit
Clinker	700 (660-700)	0	0
Limestone	75 (50-140)	0	0
Pozzolan	185 (185-250)	0	0
Gypsum	40 (40-50)	0	0
TOTAL	1 000	0	0
Packaging materials	**Weight, kg**	**Weight-% (versus the product)**	**Weight biogenic carbon, kg C/ declared unit**
Material 1 packaging paper	1.75	0.18%	8.1E-01
Material 2 packaging plastic	2.29	0.23%	0

The values outside the brackets indicate worst case scenario, the values withing the brackets indicate the range. Clinker and lime reflect the highest share in environmental impact. Therefore, the worst-case values from the range are chosen in the composition. To achieve a total weight of 1 000 kg for the declared unit, the content of the other components with less environmental impact (pozzolan and gypsum) are the lowest value of the range. There are no recycled or biogenic components influencing this choice, nor any hazardous substances which could influence the results.

The products do not contain Substances of Very High Concern in amounts greater than 1%.
According to REACH regulations the maximum chromate content is 2 ppm.
More information and safety instructions may be obtained via Quang Ninh Construction and Cement Joint Stock Company.

Results of the environmental performance indicators

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

NOTE: The worst case (i.e. highest clinker content) product is chosen as the 'representative' product within the group of cements. The decomposition (Bill of Materials) of the worst-case products and production flow diagram are provided in the sections before. Since the clinker content within a group does not vary more than 10% (from the average within the range), the LCA results and the GWP-GHG A1-A3 within the group do not differ more than 10%.

Mandatory impact category indicators according to EN 15804

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
GWP-fossil	kg CO_2 eq.	6.47E+02	1.29E+01	1.84E+01
GWP-biogenic	kg CO_2 eq.	8.34E+00[2]	-1.02E+00 (A1) / + 1.02E+00 (A5)	-6.71E-02***
GWP-luluc	kg CO_2 eq.	2.33E-01	1.12E-01	8.38E-02
GWP-total	kg CO_2 eq.	6.56E+02	1.20E+01	1.84E+01
ODP	kg CFC 11 eq.	8.67E-06	2.49E-06	2.54E-06
AP	mol H^+ eq.	1.69E+00	7.54E-02	9.41E-02
EP-freshwater	kg P eq.	4.70E-02	2.87E-04	3.48E-04
EP-marine	kg N eq.	5.17E-01	2.58E-02	2.81E-02
EP-terrestrial	mol N eq.	5.94E+00	2.80E-01	3.06E-01
POCP	kg NMVOC eq.	1.47E+00	7.98E-02	9.85E-02
ADP-minerals&metals* / **	kg Sb eq.	3.30E-04	4.86E-05	7.51E-05
ADP-fossil*	MJ	2.77E+03	1.93E+02	3.63E+02
WDP*	m^3	3.43E+00	1.68E+00	6.04E+00

[2] GWP-b values stem from generic ecoinvent background processes. There is no biogenic content in the product. The contribution of GWP-b to GWP-tot is just 1.3% and therefore not relevant.

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.*
*** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*
**** Small negative value due to various processes in ecoinvent. Not corrected because of negligible impact.*

Additional mandatory and voluntary impact category indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
GWP-GHG[3]	kg CO_2 eq.	6.47E+02	1.29E+01	1.84E+01
PM	disease inc.	6.85E-05	1.15E-06	1.27E-06
IRP*	kBq U-235 eq	4.44E+00	7.57E-01	9.12E-01
ETP-fw** / ***	CTUe	4.51E+03	2.49E+02	2.36E+02
HTP-c** / ***	CTUh	1.04E-07	7.36E-09	8.01E-09
HTP-nc** / ***	CTUh	4.19E-06	1.84E-07	2.13E-07
SQP** / ***	Pt	5.45E+02	5.00E+02	1.76E+02
Acronyms	PM = Particulate matter, IRP = Ionising radiation, ETP-fw = Ecotoxicity, freshwater, HTP-c = Human toxicity, cancer, HTP-nc = Human toxicity, non-cancer, SQP = Land use			

** Disclaimer: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.*
*** Disclaimer: 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.*
**** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*

[3] 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 CO_2 is set to zero.

Resource use indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
PERE	MJ	9.70E+01	6.29E+01	1.11E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	9.70E+01	6.29E+01	1.11E+01
PENRE	MJ	3.06E+03	2.05E+02	3.88E+02
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	3.06E+03	2.05E+02	3.88E+02
SM	kg	2.05E+02	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.89E-01	4.81E-02	1.43E-01
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 declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Hazardous waste disposed	kg	2.31E-03	5.99E-04	4.86E-04
Non-hazardous waste disposed	kg	2.48E+01	1.15E+01	1.20E+01
Radioactive waste disposed	kg	4.93E-03	1.15E-03	1.28E-03

Output flow indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00

Additional environmental information

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

References

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Cement and building lime (EN 16908:2017+A1:2022), product group classification: UN CPC 374 c-PCR to PCR 2019:14 C-PCR-001 (TO PCR 2019:14) version: 2022-05-18.

EN 15804+A2:2019/AC:2021, “Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products”.

EN 16908:2017+A1:2022. EN 16908:2017+A1:2022 Cement and building lime - Environmental product declarations - Product category rules complementary to EN 15804.

EPD cement Quang Ninh Construction and Cement Joint Stock Company – Lam Thach II Cement Factory, Report SGS INTRON B.V, version 3.

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ISO 14040:2006, “Environmental management - Environmental management -- Life cycle assessment - Principles and framework”.

ISO 14044+A2:2020, “Environmental management - Life cycle assessment - Requirements and guidelines”.

PCR 2019:14, v.1.3.3, Construction products of the International EPD® System.

Spatiotemporal Analysis of Carbon Emissions and Carbon Storage Using National Geography Census Data in Wuhan, China.

EPD owner:

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The International EPD® System Technical Committee, supported by the Secretariat

EPD®

www.environdec.com

Environmental Product Declaration

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

EPD of multiple cement products, based on worst-case results: PCB 30; TYPE IP / P / IT; CEM II 32.5 N; CEM II 32.5 R

from

Quang Ninh Construction and Cement Joint Stock Company

Programme:	The International EPD® System / EPD Southeast Asia, https://www.epd-southeastasia.com/ - Hub The International EPD® System, www.environdec.com
Programme operator:	EPD International AB and Hub EPD Southeast Asia
EPD registration number:	EPD-IES-0016082
Publication date:	2024-08-14
Valid until:	2029-08-14

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 and the fully aligned Programme of the hub EPD Southeast Asia
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden Hub EPD Southeast Asia: Kencana Tower, Level M Business Park Kebon Jeruk Jl Raya Meruya Ilir No. 88 Jakarta Barat 11620 Indonesia
Website:	https://www.epd-southeastasia.com/ and www.environdec.com
E-mail:	admin@epd-southeastasia.com and 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 v.1.3.3 for construction products c-PCR-001 cement and lime, referring to EN 16908:2017+A1:2022 Cement and building lime *UN CPC code(s): 374*
PCR review was conducted by: The Technical Committee of the International EPD System. See www.environdec.com for a list of members. Review chair: No chair appointed. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Life Cycle Assessment (LCA)
LCA accountability: SGS INTRON B.V., Mathijs de Vaan
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: Claudia A. Peña, Director of PINDA LCT SpA 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:

- Owner of the EPD: Quang Ninh Construction and Cement Joint Stock Company.
- Address: Hop Thanh Area, Phuong Nam Ward, Uong Bi City, Quang Ninh Province, Vietnam.
- Contact: Ms. Luu Thi Phuong Thao.
- E-mail: thao.lp@vawaz.com.vn .
- Phone: (+84) 93456 8591.

Description of the organisation:

Lam Thach cement is a well-known commodity developed by Quang Ninh cement and construction Joint Stock Company. It is critically produced with advanced production line of waterless technology. The facilities are selectively updated according to European standards. The factory's location is adjacent to abundance input materials for cement production including Canxi carbonate or limestone, coal, clay, additives. Economically, it is a notable convenience for transportation not only via road network, but also waterway. This also an inevitable advantage for the people who are interested in doing business with our company.

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

Product-related or management system-related certifications:

ISO 9001: 2015, ISO 14001-2015.

Name and location of production site(s):

Lam Thach II Cement Factory.

Address: Hop Thanh area, Phuong Nam ward, Uong Bi city, Quang Ninh province, Vietnam.

Product information

Product description:

Cement is one of the most important building materials used in the construction industry, working as binder that sets, hardens and adheres to other materials to bind them together forming concrete, mortars, grouts and plasters. Cement is a so-called intermediate product with many different final uses. Cement may for example be used in ready-mix concrete, precast concrete, mortar, screed, base treatment for various types of infrastructures, etc.. Each final (concrete, mortar, grout, plaster) product and each application requires a different type of cement with a different composition, resulting in many cement types produced by cement manufacturers.

The cements can be packed in plastic or paper bags or could be transported as bulk using tanker trucks or ships.

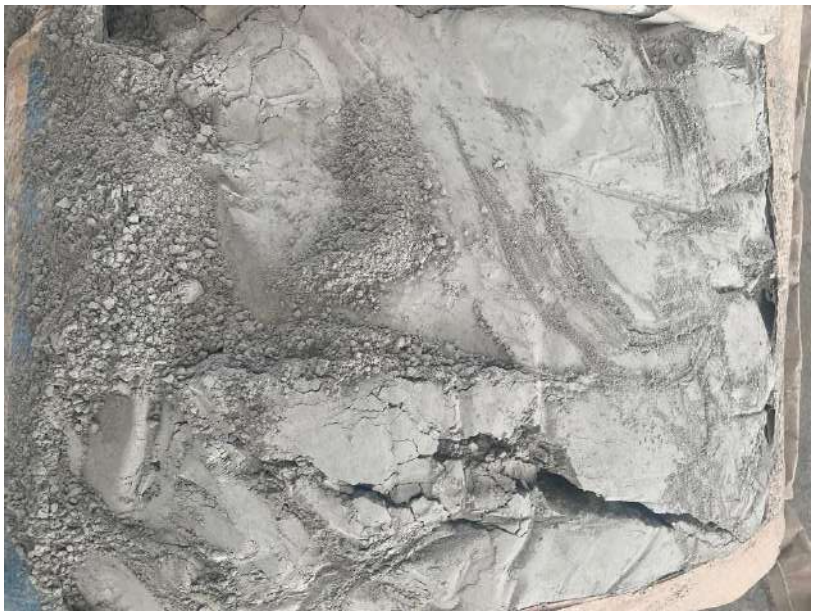
Cement is defined in standards published by CEN/TC 51 (EN 197-1) as “a hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water”.

UN CPC code: 374.

Product name (multiple products) and product identification:
This EPD covers the cement types as mentioned in the Table below. These are cements with different compositions for application in various concrete mixtures, depending on the required performance of the application.
This EPD covers multiple products within a group of cement types. The EPD data is based on the worst-case approach, making it possible to group the cements. LCA-results are reported for the cement type within the group with the worst environmental performance in LCA-results, based on clinker content being the most important contributor to the environmental impact, and based on lowest recycled content: CEM II 32.5 R. The LCA-results also apply to the other products within the group. The variation in GWP-GHG results is <10%.

Technical and functional characteristics are in accordance with the standards mentioned in the Table. The main product components are described in the system diagram in this EPD; the composition for the LCA is further specified in the section ‘Content information’ in this EPD.

Product	Significant characteristic & Recommended use	Technical properties	Product standard
PCB30 **CEM II/A-L 32.5R** **CEM II/A-L 32.5N** **Type P**	• High blaine and long setting time cause the high consistency and good workability. • Anti-erosion. Good water retention, long hydration process, water proofing. • Multi-purpose cement, suitable for civil and industrial construction with items such as: plastering, pouring concrete columns, roads.	• Blaine: ○ R009: 2-4 % ○ Blaine: 4200 - 4300 cm^2/g • Compressive strength: ○ R3: 17-19 MPa ○ R28: 36-38 MPa • Setting time: ○ Initial: 140-150 mins ○ Final: 190-200 mins • Soundness: 0-3 mm	TCVN6260:2020 ASTM C150-20 EN 197-1:2011 PNS 63:2019
Type IP **Type IT**	• High residual coefficient of compressive strength, good consistency. • Reasonably strength process speed, anti-erosion. • Suitable for civil and industrial construction such as: bridge, road, skyscraper, hydro-electric building.	• Blaine ○ R009: 1-2 % ○ Blaine: 4100-4200 cm^2/g • Compressive Strength: ○ R3: 27-29 MPa ○ R25: 46-48 MPa • Setting time: ○ Initial: 120-130 mins ○ Final: 170-180 mins • Soundness: 0-3 mm	TCVN6260:2020 ASTM C150-20 EN 197-1:2011 PNS 63:2019



Geographical scope: Global.
The products are produced in Vietnam and sold in various countries. The geographical scope of the production (module A1-A3) is Vietnam.

LCA information

Declared unit: 1 000 kg cement types PCB 30; TYPE IP / P / IT; CEM II 32.5 N; CEM II 32.5 R for use in concrete, mortar, grout, etc..

Reference service life: Not applicable.

Time representativeness: Specific data for the production (module A3) cover the year 2022 (1 January 2022 – 31 December 2022). Background data are not older than 10 years.

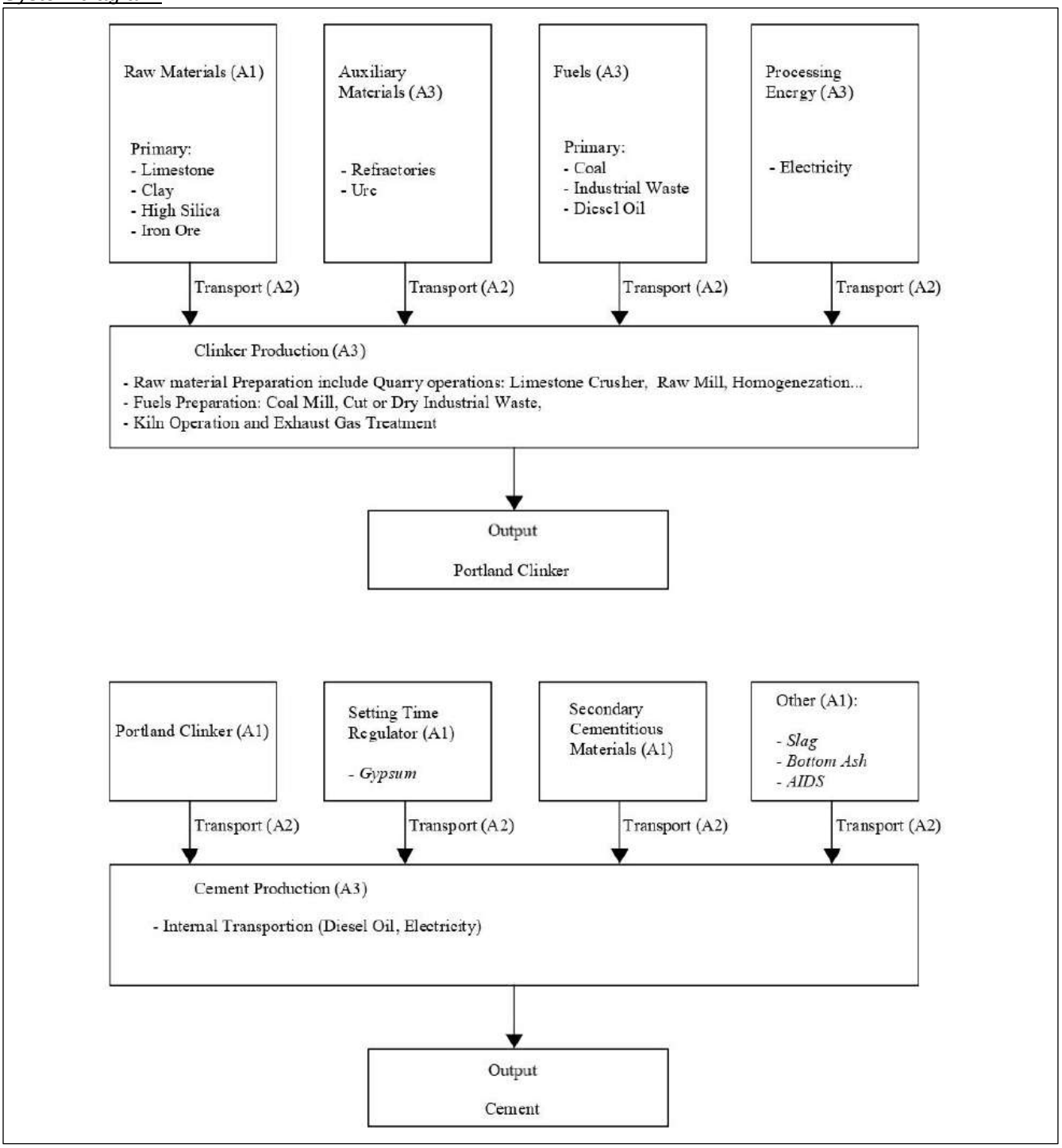
Database(s) and LCA software used: Simapro 9 and ecoinvent 3.8. The EN 15804 reference package based on EF 3.0 has been used.

Description of system boundaries:

d) Cradle to gate (A1–A3). These system boundaries are chosen since cement fulfils the following requirements from EN 15804 and the PCR:

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

System diagram:



Description manufacturing process:

Module A1 – Raw material production

The basic ingredient for cement is Portland clinker. The company produces its own clinker. This specific clinker (clinker LTII) production is included in A1. Next to own clinker, a small part is purchased externally. The other cement ingredients are also included in A1. Company data are collected for the clinker LTII. For external clinker, ecoinvent 3.8 data are used.

Module A2 – Transport of raw materials to LT-II
The ingredients are transported to the factory LT-II. Transport data are specific for the production location in Vietnam.

Module A3 - Manufacturing
The cement products are manufactured in one plant in Vietnam. Clinker is ground with other raw materials. All ingredients are dried before use. After grinding and mixing the raw materials to the right fineness, they product is transported to the silos from where the product is placed in means of transport (i.e. bags, bulk cement tanker truck, bulk cement tanker ship).
The purchased electricity used in the manufacturing process accounts for 0.3% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese national grid mix[1] as included in the ecoinvent 3.8 database, composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact of electricity as kg CO_2-eq/kWh (using the GWP-GHG indicator) used in manufacturing process: 0.562 kg CO_2-eq/kWh for the Vietnamese grid mix.

Ecoinvent processes are calculated including the infrastructure processes and capital goods. Capital goods and other infrastructure are also included in the foreground processes. Ecoinvent processes for landfill are calculated excluding long-term emissions.
Personnel-related impacts, use of offices etc. are excluded.

More information:
More information on QNC can be obtained at qncc.vn.
For more information about the LCA the LCA practitioner can be contacted via nl.intron@sgs.com.

Cut-offs
No cut-offs were applied. The material and energy data are based on full year figures and complete. No data gaps were identified.

Co-products and allocations
The various cement types are produced in one plant. The processing data of the cement plant are based on yearly consumption in 2022. The manufacturer allocated the electricity and water consumption to the various groups, based on actual consumptions for different cement types. Other data (diesel, emissions, production waste, packaging) are allocated on mass basis over all products.

Further allocation procedures for use of secondary raw materials and waste, are in line with EN 15804.

A1-A3 Production cradle-to-gate
The purchased electricity used in the manufacturing process accounts for 0.3% of the GWP-GHG results of modules A1-A3. The energy source of this electricity is the Vietnamese grid mix as included in the ecoinvent 3.8 database composed of 45% coal, 37% hydro, 17% gas and 1% other power. The climate impact GWP-GHG indicator in A1-A3 is 6.04E+02 kg CO_2-eq.

[1] The company doesn't buy a specific mix (option 1 from PCR section 4.8.1). The residual mix of the electricity supplier (option 2) is unknown and there are no ecoinvent data for the residual electricity mix on the Vietnamese market, nor easily accessible public data (option 3). Therefore, option 4 (electricity consumption on the market) is applied and the electricity was not used in processes over which the manufacturer has direct control. This seems justified since electricity is not a main contributor to the results.

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	Global	VN	VN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Specific data used	56%	100%	100%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – products	Worst case approach Variation <10%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Variation – sites	0%			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/ declared unit
Clinker	610 (530-610)	0	0
Limestone	110 (0-110)	0	0
Pozzolan	250 (250-450)	0	0
Gypsum	30 (30-40)	0	0
TOTAL	1 000	0	0
Packaging materials	**Weight, kg**	**Weight-% (versus the product)**	**Weight biogenic carbon, kg C/ declared unit**
Material 1 packaging paper	1.75	0.18%	8.1E-01
Material 2 packaging plastic	2.29	0.23%	0

The values outside the brackets indicate worst case scenario, the values withing the brackets indicate the range. Clinker and lime reflect the highest share in environmental impact. Therefore, the worst-case values from the range are chosen in the composition. To achieve a total weight of 1 000 kg for the declared unit, the content of the other components with less environmental impact (pozzolan and gypsum) are the lowest value of the range. There are no recycled or biogenic components influencing this choice, nor any hazardous substances which could influence the results.

The products do not contain Substances of Very High Concern in amounts greater than 1%.
According to REACH regulations the maximum chromate content is 2 ppm.
More information and safety instructions may be obtained via Quang Ninh Construction and Cement Joint Stock Company.

Results of the environmental performance indicators

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

NOTE: The worst case (i.e. highest clinker content) product is chosen as the 'representative' product within the group of cements. The decomposition (Bill of Materials) of the worst-case products and production flow diagram are provided in the sections before. Since the clinker content within a group does not vary more than 10% (from the average within the range), the LCA results and the GWP-GHG A1-A3 within the group do not differ more than 10%.

Mandatory impact category indicators according to EN 15804

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
GWP-fossil	kg CO_2 eq.	6.04E+02	1.29E+01	1.84E+01
GWP-biogenic	kg CO_2 eq.	7.88E+00[2]	-1.02E+00 (A1) / + 1.02E+00 (A5)	-6.71E-02***
GWP-luluc	kg CO_2 eq.	2.22E-01	1.12E-01	8.38E-02
GWP-total	kg CO_2 eq.	6.12E+02	1.20E+01	1.84E+01
ODP	kg CFC 11 eq.	8.13E-06	2.49E-06	2.54E-06
AP	mol H^+ eq.	1.55E+00	7.54E-02	9.41E-02
EP-freshwater	kg P eq.	4.41E-02	2.87E-04	3.48E-04
EP-marine	kg N eq.	4.83E-01	2.58E-02	2.81E-02
EP-terrestrial	mol N eq.	5.55E+00	2.80E-01	3.06E-01
POCP	kg NMVOC eq.	1.37E+00	7.98E-02	9.85E-02
ADP-minerals&metals* / **	kg Sb eq.	2.97E-04	4.86E-05	7.51E-05
ADP-fossil*	MJ	2.55E+03	1.93E+02	3.63E+02
WDP*	m^3	2.71E+00	1.68E+00	6.04E+00

[2] GWP-b values stem from generic ecoinvent background processes. There is no biogenic content in the product. The contribution of GWP-b to GWP-tot is just 1.3% and therefore not relevant.

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.*
*** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*
**** Small negative value due to various processes in ecoinvent. Not corrected because of negligible impact.*

Additional mandatory and voluntary impact category indicators

Results per declared unit 1 000 kg cement

Indicator	Unit	A1-A3	Optional paper packaging	Optional plastic packaging
GWP-GHG[3]	kg CO_2 eq.	6.04E+02	1.29E+01	1.84E+01
PM	disease inc.	2.29E-05	1.15E-06	1.27E-06
IRP*	kBq U-235 eq	4.18E+00	7.57E-01	9.12E-01
ETP-fw** / ***	CTUe	4.25E+03	2.49E+02	2.36E+02
HTP-c** / ***	CTUh	9.78E-08	7.36E-09	8.01E-09
HTP-nc** / ***	CTUh	3.92E-06	1.84E-07	2.13E-07
SQP** / ***	Pt	5.04E+02	5.00E+02	1.76E+02
Acronyms	PM = Particulate matter, IRP = Ionising radiation, ETP-fw = Ecotoxicity, freshwater, HTP-c = Human toxicity, cancer, HTP-nc = Human toxicity, non-cancer, SQP = Land use			

** Disclaimer: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator*
*** Disclaimer: 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*
**** Disclaimer: The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.*

[3] 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 CO_2 is set to zero.

Resource use indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
PERE	MJ	7.52E+01	6.29E+01	1.11E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	7.52E+01	6.29E+01	1.11E+01
PENRE	MJ	2.82E+03	2.05E+02	3.88E+02
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.82E+03	2.05E+02	3.88E+02
SM	kg	2.65E+02	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.57E-01	4.81E-02	1.43E-01
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 declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Hazardous waste disposed	kg	2.21E-03	5.99E-04	4.86E-04
Non-hazardous waste disposed	kg	2.35E+01	1.15E+01	1.20E+01
Radioactive waste disposed	kg	4.65E-03	1.15E-03	1.28E-03

Output flow indicators

Results per declared unit 1 000 kg cement				
Indicator	**Unit**	**A1-A3**	**Optional paper packaging**	**Optional plastic packaging**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00

Additional environmental information

Lam Thach cement was awarded ISO certificate, and several rewards as a product of premium quality in different national fairs.

References

Background report SGS INTRON A132871-R20231358-MVa-F630301 SGS Vietnam Limited, 18 April 2024.

Cement and building lime (EN 16908:2017+A1:2022), product group classification: UN CPC 374 c-PCR to PCR 2019:14 C-PCR-001 (TO PCR 2019:14) version: 2022-05-18.

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PCR 2019:14, v.1.3.3, Construction products of the International EPD® System.

Spatiotemporal Analysis of Carbon Emissions and Carbon Storage Using National Geography Census Data in Wuhan, China.

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The International EPD® System Technical Committee, supported by the Secretariat

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4) **Tung Ho (Steel)**

Programme: The International EPD® System / EPD Southeast Asia,
https://www.epd-southeastasia.com/
Programme operator: EPD Southeast Asia

EPD registration number: S-P-04681
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Valid until: 2028-10-06

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

ENVIRONMENTAL PRODUCT DECLARATION

From:
TUNG HO STEEL VIETNAM CORPORATION (THSVC)

- In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:
- Multiple steel products:
- Deformed bar
- Wire rod
- Deformed bar in coil

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Southeast Asia EPD

TUNG HO GROUP THSVC
CÔNG TY TNHH THÉP TUNG HO VIỆT NAM

THSVC
CÔNG TY TNHH THÉP TUNG HO VIỆT NAM

INDEX

1 PROGRAMME INFORMATION

Programme:	EPD Southeast Asia, hub of The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden HubEPD Southeast Asia: Kencana Tower, Level M Business Park Kebon Jeruk Jl Raya Meruya Ilir No. 88 Jakarta Barat 11620 Indonesia
Website:	https://www.epd-southeastasia.com/
Email:	info@environdec.com and admin@epd-southeastasia.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 v.1.2.5, Construction products, EPD International 2022-11-01, valid until 2024-12-20
UN CPC code(s): 4121

PCR review was conducted by: The Technical Committee of the International EPD® System.
See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, ADDERE Research & Technology, Chile.
Tel: +56 9 9359 9210; E-Mail: cpena@addere.cl
The review panel may be contacted via the Secretariat www.environdec.com/contact.

Life Cycle Assessment (LCA)

LCA accountability: SGS INTRON B.V., A. Schuurmans

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: Claudia A. Peña, ADDERE Research & Technology
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.

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EPD® THE INTERNATIONAL EPD® SYSTEM

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.

2 COMPANY INFORMATION

Owner of the EPD:
TUNG HO STEEL VIETNAM CORPORATION (THSVC)

Contact: Nguyen An Anh Vu
Email: a0582@tunghosteel.com
Phone: +84 947 282 324

Description of the organisation: Tung Ho Steel is established in 1962 in Taiwan and is still headquartered in Taiwan. In 2016, the Vietnamese company Fuco Steel was acquired and renamed Tung Ho Steel Vietnam Corporation (THSVC). THSVC's energy and resource management aims at an effective use of energy and an environmental policy focusing amongst others on reusing waste and reducing CO_2 emissions. This EPD is part of their environmental communication with stakeholders.

Product-related or management system-related certifications: ISO 9001:2015, ISO 17025:2017, ISO 14001

Name and location of production site(s):
THSVC has one production facility in Phu My: Phu My II Industrial Zone, Phu My Ward, Phu My Township, Ba Ria Vung Tau Province, Vietnam Vietnam.

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3 PRODUCT INFORMATION

This EPD covers multiple products as described below. Since the production of 1 ton steel product is the same for each of the products, the declared unit of 1 ton and the environmental impacts per ton apply to all 3 products. The EPD is therefor based on average results per ton.

Product name (multiple products): deformed bar, wire rod and deformed bar in coil

Deformed bar

Wire rod

Deformed bar in coil

Product identification: As per standards mentioned in Table below: TCVN1651-2, CNS 560 A2006, JIS G3112, ASTM A615, ASTM A706, GB1499-2, KS D3504, BS 4449, AS/NZS 4671, TCVN 1651-1, CNS 560 A2006, JIS G3112, ASTM A615, ASTM A706, GB1499-2, KS D3504, BS 4449, AS/NZS 4671

Product description: The products are predominantly used as reinforcement in concrete structures in the construction sector. The available length ranges from 6 m to 22 m. Diameter ranges for the deformed bar are D10 – D50, for the wire rod D5.5 – D20 and for the deformed steel bar in coil D6 – D20.

Applicable standards are:

Steel product	Applicable standards	Sizes
Deformed bar	TCVN1651-2 CNS 560 A2006 JIS G3112 ASTM A615 ASTM A706 GB1499-2 KS D3504 BS 4449 AS/NZS 4671	Diameter: D10-D50 D10-D50 D10-D51 #3-#14 N3-N14 D10-D50 D10-D51 10mm -40mm 6.0-40.0mm Length: 6m-22m
Wire rod	TCVN 1651-1	Diameter: D5.5-D20
Deformed Steel Bar in Coil	CNS 560 A2006 JIS G3112 ASTM A615 ASTM A706 GB1499-2 KS D3504 BS 4449 AS/NZS 4671	Diameter: D6-D20

UN CPC code: 4121 Products of iron and steel

Geographical scope: Global

The products are produced in Vietnam and sold in various countries. The geographical scope of the production (module A1-A3) is Vietnam, whereas for transport to customers (module A4) and end-of-life (module C) generic data for global use or 'rest of world' (global without Europe) are applied.

4 LCA INFORMATION

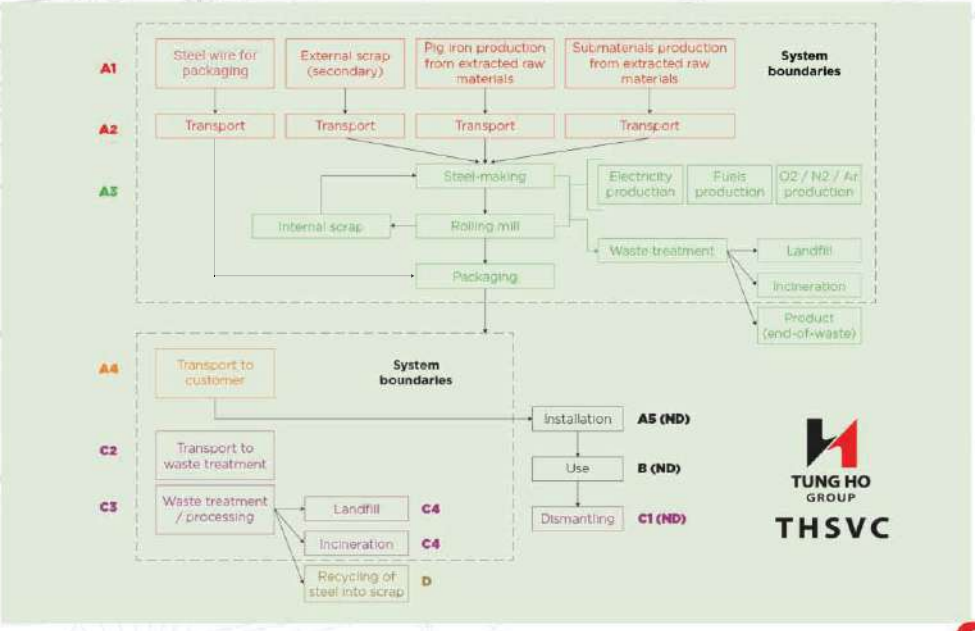
- **Declared unit**:
"1 (one) ton of Tung Ho Steel Vietnam Corporation steel product (deformed bar, wire rod and deformed bar in coil)"

- **Reference service life**: not applicable

- **Time representativeness**: Data for the production (module A3) cover the year 2021. Background data are not older than 10 years.

- **Database(s) and LCA software used**: Simapro 9 and EcoInvent 3.6

- **Description of system boundaries**:
b) Cradle to gate with options: modules A1 - A3, A4, C1 - C4 and module D.
Since the installation (module A5) and use (module B) depend on the application, which can vary, these modules are not considered.



DESCRIPTION OF MODULES

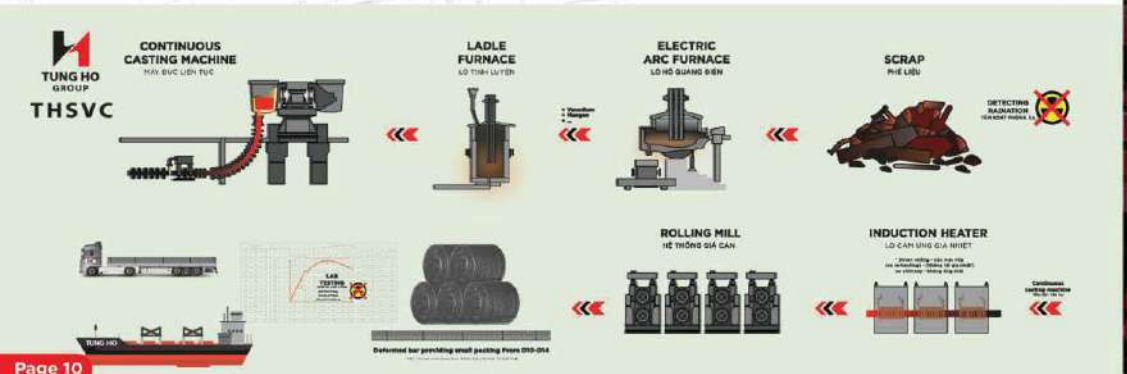
Module A1 + A2: Raw material supply and transport to factory

The main input material is steel scrap. THSVC buys scrap steel scrap from various external sources. This scrap is considered a secondary raw material free of environmental burden. Transport of all specific suppliers to Tung Ho in Vietnam are included.
Small amounts of pig iron are also used, modelled as primary production and with specific transport to Tung Ho.

Finally, a range of sub-materials is added as input of the EAF. These materials function as alloying compounds and as substances aiding the reaction processes. The total input of sub-materials over the reference year 2021 is included as well as the specific transport to factory.

Module A3: Manufacturing

The system diagram for Module A3 is shown below. THVSC's factory in Vietnam comprises a steel-making plant with capacity 1 000 000 ton per year, and a subsequent rolling mill plant with capacity 600 000 ton per year (https://www.thsvc.com.vn/Productionprocess#gsc.tab=0). THSVC buys scrap and produces steel out of this by an electric arc furnace process. The output of the melting process is the input for the rolling mill. Products of THSVC are: billets (output of steel-making plant, input for the rolling), and the products from the rolling line: deformed bar, sections, wire rod en deformed bar in coil. Steel sections can also be produced but are not considered in this study. The products are packed with wire rod before being transported to the customer.
The production process and steps are the same for each of the products. Full year input / output data are collected and allocated to the products per ton of steel produced. No by-products are produced. All inputs and outputs are allocated to the steel products. Internal scrap waste is recycled and considered to be in closed loop in module A3.



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Module C End-of-life

At the end-of-life the steel is demolished as part of a building product. A generic demolition process for stony building materials, including reinforced concrete, is used in module C1. Since construction steel is recycled all over the world, an end-of-life scenario is chosen in which 95% of the steel is recycled as scrap. Transport to a sorting site over 100 km (module C2) and sorting and pressing to prepare for recycling (module C3) are included. The remaining 5% losses and inefficiencies are assumed to be landfilled (C4).

Module D Recycling

In Module D, the net flow to recycling is taken into account for loads and benefits of the steel scrap recycling into new steel.

→ Whereas Modules A1-A3 represent the actual processes, the Modules A4, C and D represent **scenarios. The scenarios included are currently in use and are representative for one of the most probable alternatives.**

Module A4 Transport to customer

In A4, transport to site, bulk transport applies. The default EcoInvent process Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U, is used.
Since transport differs to various customers, a fictive transport distance of 100 km is applied. The results can be linearly scaled for specific transport distances (e.g. 200 km is twice the values for 100 km).

MORE INFORMATION

• More information on THSVC can be obtained at:
https://www.thsvc.com.vn/Profile#gsc.tab=0
• For more information about the LCA the LCA practitioner can be contacted via nl.intron@sgs.com .

CUT-OFFS

No specific assumptions were made in this LCA, nor are cut-offs applied. The material and energy data are based on full year figures and complete. No data gaps were identified.

A1 - **A3** Production cradle-to-gate
The purchased electricity used in the manufacturing process accounts for 43.7% of the GWP-GHG results of modules A1 - A3. The energy source of this electricity is the Vietnamese grid mix as included in the EcoInvent database (GWP-GHG 0.133 CO2-eq/MJ = 0.278 CO2-eq/kWh). The climate impact GWP-GHG indicator in A1-A3 is 1.01E03.

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**	**D5**
Modules declared	x	x	x	x	ND	ND	ND	ND	ND	ND	ND	ND	x	x	x		x
Geography	global	global	global	global									global	global	global	global	global
Specific data used	Manufacturing data (A3) and transport distance to production (A2) are specific. Other data generic.			generic									generic	generic	generic	generic	generic
Variation – products	< 10%																
Variation – sites	Not applicable																

5 CONTENT INFORMATION

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/kg
Steel	1 ton	90,2	0
Packaging materials	**Weight, kg**	**Weight-% (versus the product)**	**Weight biogenic carbon, kg C/kg**
Steel wire rod	1,26 per ton	0,01	0

The products are made of usual construction steel and do not contain Substances of Very High Concern in amounts greater than 1%.

6 RESULTS OF THE ENVIRONMENTAL PERFORMANCE INDICATORS

Results per declared unit 1 t steel product

Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP-total	kg CO_2 eq.	1,01E+03	1,35E+01	3,52E+00	9,60E01	5,50E+01	5,68E-01	-1,36E+02
GWP-fossil	kg CO_2 eq.	1,01E+03	1,35E+01	3,50E+00	9,59E01	5,84E+01	5,67E-01	-1,38E+02
GWP-biogenic	kg CO_2 eq.	-1,14E+00	6,23E-03	2,03E-02	4,43E04	-3,46E+00	1,12E -03	1,44E+00
GWP-luluc	kg CO_2 eq.	4,84E01	4,95E03	6,66E-04	3,51E-04	6,46E02	1,58E-04	1,02E-01
ODP	kg CFC 11 eq.	4,67E05	2,98E06	4,54E-07	2,12E-07	7,11E -06	2,33E-07	-3,37E-06
AP	mol H^+ eq.	7,72E+00	7,83E02	2,20E-02	5,56E-03	6,46E01	5,38E-03	-5,32E-01
EP-freshwater	kg P eq.	3,78E02	1,36E-04	1,09E-04	9,68E06	3,34E03	6,35E-06	-4,87E-03
EP-marine	kg N eq.	1,44E+00	2,76E02	8,75E-03	1,96E-03	1,43E-01	1,85E-03	-9,88E-02
EP-terrestrial	mol N eq.	1,60E+01	3,04E-01	9,71E-02	2,16E-02	1,65E+00	2,04E-02	-1,15E+00
POCP	kg NMVOC eq.	4,66E+00	8,68E-02	2,64E02	6,17E-03	4,52E01	5,93E-03	-7,84E-01
ADP-minerals & metals*	kg Sb eq.	2,87E-03	3,42E-04	9,88E06	2,43E05	2,87E-03	5,19E-06	-9,32E-05
ADP-fossil*	MJ	1,11E+04	2,04E+02	4,70E+01	1,45E+01	7,17E+02	1,58E+01	-9,64E+02
WDP*	m^3	1,43E+02	7,28E-01	2,13E-01	5,18E-02	7,64E+00	7,10E-01	-2,63E+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							

Additional mandatory and voluntary impact category indicators

Results per declared unit 1 t steel product								
Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP-GHG[1]	kg CO_2 eq.	1,01E+03	1,35E+01	3,50E+00	9,59E-01	5,84E+01	5,67E-01	-1,38E+02
PM	disease inc.	1,63E-04	1,21E -06	4,84E07	8,61E-08	8,31E-06	1,04E-07	-7,98E-06
IRP*	kBq U235 eq	1,83E+01	8,53E01	1,49E-01	6,06E-02	2,62E+00	6,50E02	2,36E+00
ETP-fw**	CTUe	1,51E+04	1,81E+02	3,81E+01	1,29E+01	3,22E+03	1,03E+01	-4,63E+03
HTP-c**	CTUh	1,05E-06	5,89E09	9,05E10	4,19E-10	7,80E08	2,38E-10	-1,77E-08
HTP-nc**	CTUh	1,10E -05	1,98E-07	2,56E08	1,41E -08	3,55E06	7,31E-09	2,67E05
SQP**	Pt	2,06E+03	1,77E+02	7,85E+00	1,25E+01	1,40E+03	3,32E+01	-2,13E+02
Acronyms	PM = Particulate matter, IRP = Ionising radiation, ETP-fw = Ecotoxicity, freshwater, HTP-c = Human toxicity, cancer, HTP-nc = Human toxicity, non-cancer, SQP = Land use							

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

*** Disclaimer: 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. Disclaimers shall be added, if required by EN 15804.*

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 CO_2 is set to zero.

Resource use indicators

Results per declared unit 1 t steel product								
Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
PERE	MJ	1,95E+03	2,55E+00	2,68E+00	1,81E -01	9,90E+01	1,28E-01	2,80E+01
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	1,95E+03	2,55E+00	2,68E+00	1,81E -01	9,90E+01	1,28E-01	2,80E+01
PENRE	MJ	1,19E+04	2,16E+02	5,02E+01	1,54E+01	7,63E+02	1,68E+01	-1,00E+03
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	1,19E+04	2,16E+02	5,02E+01	1,54E+01	7,63E+02	1,68E+01	-1,00E+03
SM	kg	2,17E+03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	4,20E+00	2,48E-02	1,57E-02	1,76E-03	2,72E-01	1,69E-02	-4,99E-01
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 declared unit 1 t steel product								
Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed	kg	1,42E-02	5,16E-04	8,19E-05	3,67E-05	2,12E-03	2,37E-05	-1,65E-02
Non-hazardous waste disposed	kg	9,27E+01	1,29E+01	6,56E+00	9,38E-01	2,21E+01	1,08E+02	-1,35E+01
Radioactive waste disposed	kg	1,96E-02	1,34E-03	2,11E -04	9,50E05	3,35E-03	1,04E-04	8,16E-04

Output flow indicators

Results per declared unit 1 t steel product								
Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
Components for re-use	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Material for recycling	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,05E+03	0,00E+00	0,00E+00
Materials for energy recovery	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy, electricity	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy, thermal	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Interpretation and contribution analysis

The Figure below shows the contribution of the various Modules to the GWP-total:

Modules A1 and A3 contribute most.

7 REFERENCES

General Programme Instructions of the International EPD® System. Version 4.0.

PCR 2019:14. Construction products. V1.2.5 EPD International 2022-11-01, valid until 2024-12-20

EN 15804 (incl. A1:2013 en A2:2019), "Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products"

ISO 14040, "Environmental management - Environmental management -- Life cycle assessment - Principles and framework", ISO14040:2006

ISO 14044, "Environmental management - Life cycle assessment - Requirements and guidelines", ISO14044:2006

International Organization for Standardization, ISO/DIS 21930, "Sustainability in building construction – Environmental declaration of building products", ISO/DIS 21930:2007

International Organization for Standardization, ISO/TR 14025, "Environmental labels and declarations – Type III environmental declarations", ISO/TR 14025:2000

https://english.rvo.nl/sites/default/files/2020/03/The-Netherlands-list-of-fuels-version-January-2020.pdf

EPD owner:

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CÔNG TY TNHH THÉP TUNG HO VIỆT NAM
www.thsvc.com.vn/Profile#gsc.tab=0

EPD prepared by:

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EPD®
THE INTERNATIONAL EPD® SYSTEM
The International EPD® System Technical Committee, supported by the Secretariat

5) VAS Nghi Son (Steel)

EPD® THE INTERNATIONAL EPD® SYSTEM

Southeast Asia EPD

ECO PLATFORM EPD VERIFIED

Environmental Product Declaration

In accordance with **ISO 14025:2006** and

EN 15804:2012+A2:2019/AC:2021 for:

Rebar

This EPD of multiple products, covers a range of rebar product, based on the weighted average results of the product group across various standards applicable to rebars.

Product standards covered in this EPD are TCVN 1651 – 2:2018, ASTM A615/A615M – 20, BS4449:2005+A3:2016, CS2:2012, SS560:2016, JIS G3112:2020, and AS/NZS 4671:2019.

VAS Group Nghi Son Joint Stock Company [VAS Group]

Nghi Son Iron Steel Complex,
Nghi Son Economic Zone, Hai Thuong Ward,
Nghi Son Town, Thanh Hoa, Vietnam

VAS Group

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

EPD registered through the fully aligned regional hub
EPD Southeast Asia,
https://www.epd-southeastasia.com/

Programme operator
EPD International AB

Regional Hub
EPD Southeast Asia

EPD registration number
S-P-13773

Publication date
2024-05-10

Valid until
2029-05-10

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

Table of Contents

General information

Programme information

Programme	**The International EPD ® System** EPD registered through the fully aligned regional hub: EPD Southeast Asia
Address:	**EPD International AB** Box 210 60, SE-100 31 Stockholm, Sweden **EPD Southeast Asia** Kencana Tower Level M, Business Park Kebon Jeruk Jl. Raya Meruya Ilir No. 89, Jakarta Barat 11620, Indonesia **Website** www.environdec.com www.epd-southeastasia.com **Email** 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): Product Category Rules (PCR): PCR 2019:14 of Construction products, version 1.3.3 UN CPC: 41242	
PCR review was conducted by: The Technical Committee of the International EPD® System.	**Review chair:** No chair appointed The review panel may be contacted via the Secretariat www.environdec.com/contact.
Life Cycle Assessment (LCA) LCA accountability: PT Life Cycle Indonesia Corresponding practitioner: Jessica Hanafi, Ph.D., Gloria FJ Kartikasari, Vivian, Elbert Fernando Tjandra	
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: Claudia A. Peña, Director of PINDA LCT SpA, pinda.lct@gmail.com **Approved by:** The International EPD® System Technical Committee, supported by the Secretariat	
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

VAS Group Nghi Son Joint Stock Company [VAS Group]

Contact

vasg.epd@vasgroup.vn

Product certifications

+ JIS G3112:2020
+ ASTM A615/A615M-20
+ SAE J403:2014
+ BS4449:2005+A3:2016
+ QCVN 7:2019/BKHCN
+ TCVN 11384: 2016
+ TCVN 1651-1:2018
+ TCVN 1651-2:2018

Management system certification

+ TCVN ISO 9001:2015/ ISO 9001:2015
+ ISO 14001:2015/ TCVN ISO 14001:2015
+ ISO 45001:2018

Name and location of production site(s)

Nghi Son Iron Steel Complex, Nghi Son Economic Zone, Hai Thuong Ward, Nghi Son Town, Thanh Hoa, Vietnam.

Description of the organisation

VAS Group Nghi Son Thanh Hóa Site (VAS Group) is a leading steel manufacturing company in Vietnam. The company is known for producing steel products that adhere to various international standards, including the Standard Regulation QCVN:2011/BKHCN, Vietnamese Standards (TCVN), Japanese Industrial Standards (JIS), American Society for Testing and Materials (ASTM), British Standard (BS 4449:2005), and Construction Standard Hong Kong (CS2:2012). The production processes conform to global standards and have been accredited by numerous international institutes. VAS Group: VAS Steel Nghi Son Thanh Hóa Site is determined to continuously improve its products and processes to achieve excellence where the products not only concern their customers but are also responsible for society and the environment.

Product information

Product name

Rebar

Product identification

VAS Vietnam's rebar have been granted the Vietnam and international standard, TCVN 1651-1:2008, TCVN 1651-2:2018, JIS G 3112:2010, ASTM A615 /A615M-20, and BS4449:1997.

Product description

Rebar from VAS Vietnam Company are meticulously manufactured from carefully selected materials, ensuring they are in an optimal metallurgical state for further works. Rebar is typically made from steel, providing structural support and resilience against tensile forces that concrete alone cannot withstand. It primarily used in the construction industry to reinforce concrete and building structures, including roofs, floors, walls, roads and bridges. The detailed specifications of each rebar such as dimensions, and mechanical properties vary depending on the product types and range. VAS Vietnam's rebar is produced in shape and can be divided into type of section, with length up to 12 m. The results in the EPD are based on a weighted average of all standards and grades, providing a clearer depiction of the products covered and taking into account the total production of VAS Vietnam's steel products over a one-year period within the study timeframe.

UN CPC code

UN CPC 41242 - Other bars and rods of iron or non-alloy steel, not further worked than forged, hot-rolled, hot-drawn or extruded, but including those twisted after rolling.

Geographical Scope

Manufactured in Nghi Son Iron Steel Complex, Nghi Son Economic Zone, Hai Thuong Ward, Nghi Son Town, Thanh Hoa Province, Vietnam and Supplied to Global.

Mechanical Properties

Properties	Range	Average
Diameter	D10mm – D40mm	15.78
Nominal Diameter	D10mm - D40mm	15.78
Cross Section Area	78.5 to 1 257 mm^2	225
Unit Weight	0.617 to 9.86 kg/m	1.77
Weight tolerance	±4 to ±6 %	±5%

Product Standard and Grade

This EPD covers rebar products that comply with the specified standards and grades:

Standard	Grade
TCVN 1651 – 2:2018	CB 300 – V, CB 400 – V, CB 500 – V
ASTM A615/A615M – 20	Gr 40 (280), Gr 60 (420)
BS4449:2005+A3:2016	B500A, B500B, B500C
CS2:2012	250, 500B, 500C
SS560:2016	B500A, B500B, B500C
JIS G3112:2020	SD390
AS/NZS 4671:2019	500N

LCA information

Declared unit

1 tonne of rebar

Time representativeness

Specific data for the manufacturing collected from 2022-01-01 to 2022-12-31. The 10-year requirement for generic data has been met.

Database(s) and LCA software used

Generic data for upstream and downstream processes use Ecoinvent 3.9.1 database and modelled by using SimaPro Developer software version 9.5.0.1. No datasets older than 10 years were used.

Description of system boundaries

The system boundary was chosen based on the goal and scope of the study and in accordance with EN 15804:2012+A2:2019, i.e. EPD type B which comprises a "cradle-to-gate" with modules C1–C4 (the end-of-life stages), and module D (benefits and loads beyond the system boundary), and optional modules A4. Modules A5 and B1-B7 have not been included due to the inability to predict how the material will be used in the construction process and use stage. All losses were accounted in the modules where they occurred. The study does not cover for environmental impacts from construction, production equipment, and other capital goods, as well as personnel-related impacts like transportation to and from work.

Results from modules A1-A3 should not be used alone. Module C must be considered for a comprehensive assessment. Ignoring module C may lead to incomplete conclusions and errors in decision making. The processes below are included in the product system to be studied:

1 Upstream (A1-A2)

a. Production of raw materials (Sorted scrap steel)
b. Production of electricity and fuel gas (i.e. natural gas)
c. Transportation of raw/auxiliary materials from the supplier to manufacturing plant
d. Extraction of water (i.e. lake and underground water)
e. Port Activities (Unloading)

2 Core (A3)

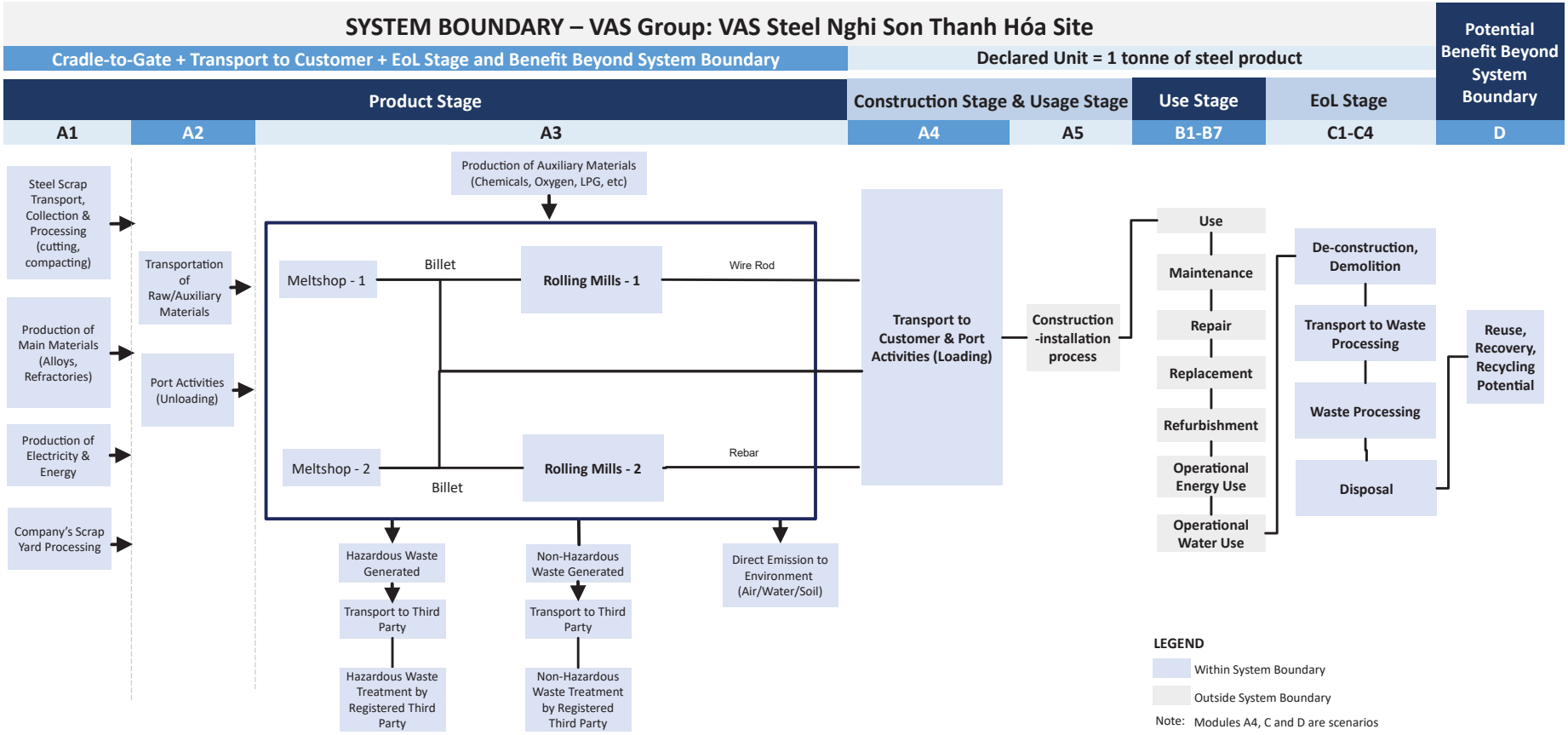
- Production of auxiliary materials (e.g., Chemicals, etc.)
- Induction Furnace
- Continuous Casting Machine
- Marking process for Billet,Wire Rod Mill for Wire Rod, and Rebar Mill for Rebar
- Packaging
- Utilities: water treatment, wastewater treatment, waste collection, electricity substation
- Direct emission to the environment
- Transport to waste processing unit
- Waste processing including waste treatment process by a registered third party for hazardous waste

3 Downstream (A4, C1-C4, D)

a. Port Activities (Product Loading)
b. Transport product to customer
c. Deconstruction & Demolition
d. Disposal
e. Reuse/Recovery/Recycling of the end of life of the products
f. Scrap Yard (Sorting, Cutting, Shredding)

Port activities for the unloading of steel scrap and loading of products, are included as they fall under the operational control of the company.

System diagram



More information

Relevant websites for more information regarding the process in manufacturing:

https://vasgroup.vn/

Key Assumptions and Limitations

1. Production process of all materials (e.g SiO_2, lubricating oil, etc.) and electricity are modelled using data available in commercial databases. Dataset of electricity mix in Vietnam used is estimated using database from Ecoinvent 3.
2. Air Emissions produced by burned diesel, LPG, and coal are estimated using database from Ecoinvent 3. For LPG, the emissions of CO_2, CH_4, and NO_2 is modified to 2 980 kg/tonne 0.237 kg/tonne and 0.00473 kg/tonne (GHG Protocol, 2017).
3. Several wastes produced such as slag, refractories, scale, paper bag, and plastic bag is used again internally. The other such as dust, dried sludge, sorted materials, and used oil is send to third party. The treatment in third party for dust is pressing reused block bricks, for used oil is Physical chemistry which are burning then solidification, and the rest is incineration and solidification.
4. In this study, the direct emission in form of CO_2 emitted from induction furnace is not measured and assumed to be negligible according to the IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Industrial Processes and Product Use.
5. Energy consumption and emissions from the transportation process of scrap steel, raw materials, and waste are modelled using available data in the Ecoinvent database by considering the type of transportation used and the transport distance.
6. Data for land use is aggregate for Production Area of Wire Rod (IF-1, CCM-1, and Wire Rod Mill) and Rebar (IF-2, CCM-2, Rebar Mill).
7. The data collected for electricity consumption is aggregation of each processing area which also cover the electricity required for the utilities of the related area (IF-1 & CCM-1, IF-2 & CCM-2, Wire Rod Mill, and Rebar Mill).

Cut-off rules

In accordance with EN 15804:2012+A2:2019/AC:2021, all available data shall be included. In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1 % of renewable and non-renewable primary energy usage and 1 % of the total mass input of that unit process. The total of neglected input flows per module, e.g. per module A1-A3, C1-C4 and module D shall be a maximum of 5 % of energy usage and mass. If there is missing specific data, proxy data or extrapolation or generic data from the database or literature will be used

Data Quality

- Time related coverage: specific data were collected from 2022-01-01 to 2022-12-31, and generic data are representative of the year 2021.
- Geographic coverage: specific data were collected from area under study, i.e., VAS Steel Nghi Son Thanh Hóa Site, Vietnam Generic data were collected from global average data.
- Technological coverage: specific data were collected from current steel making process under study. Generic data from global average with technology aspects were similar with what described in the process under study, but merits improvement as processes were not modelled with specific data.

Data quality for both specific and generic data were sufficient to conduct life cycle assessment in accordance with the defined goal and scope.

Allocation

In this study, the process of Induction Furnace and continuous casting machine requires allocation as the Billet product would be either directly sold or further processed into Wire Rod or Rebar. There are no other co-products in this study and mass allocation is applied mainly to Induction Furnace, and Continuous Casting Machine.

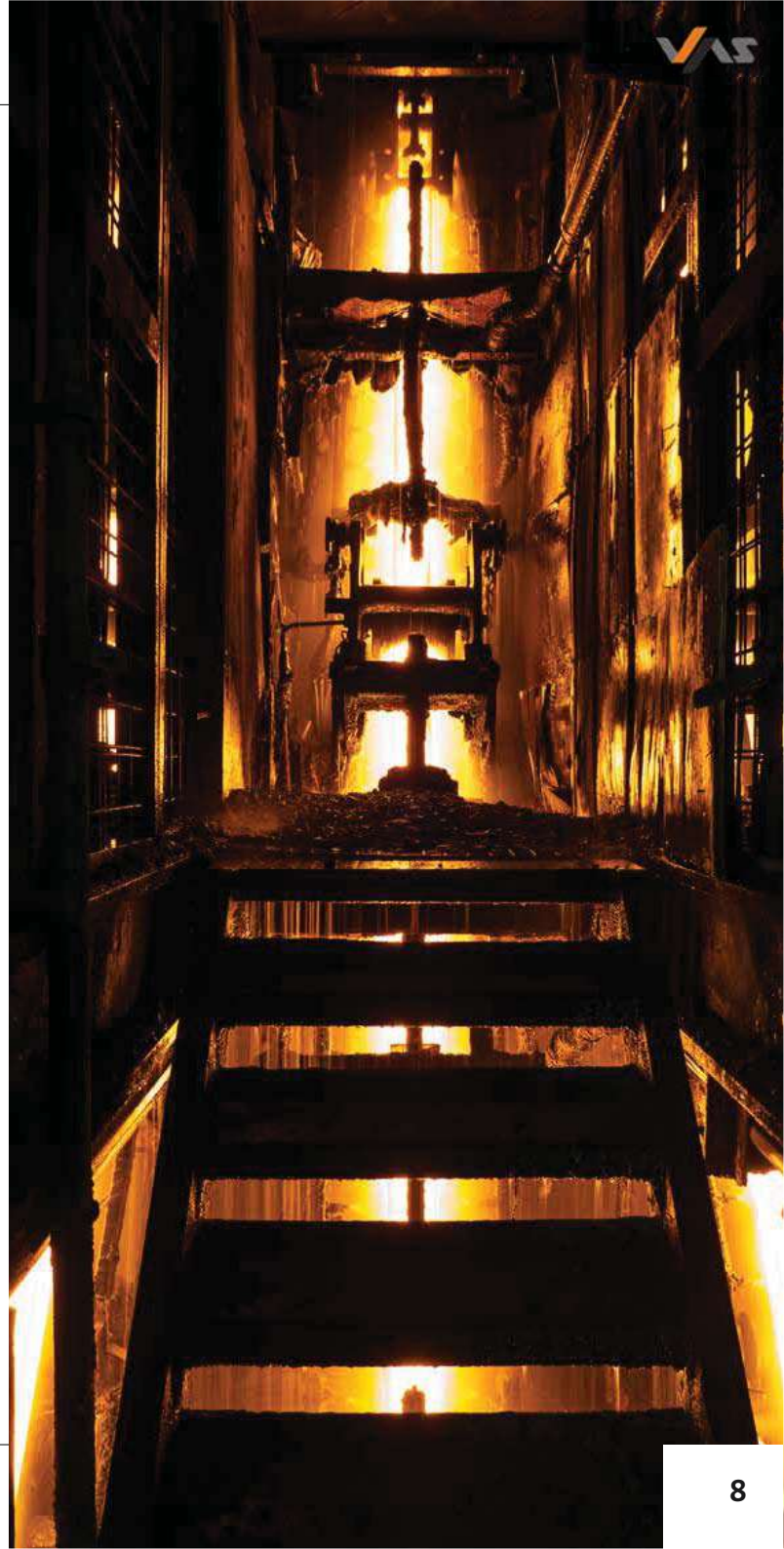
For steel scrap used in Induction Furnace, the impact counted in steel scrap is the transportation process of the waste, covering the Port Unloading process and scrap yard (waste sorting, if applicable) as both processes is still within the company control.

In this steel product system, a closed loop process is applied. Recovered steel scrap for recycling is allocated a credit (or benefit) associated with the avoided impacts of the virgin material. When the scrap is used in the manufacture of a new product, there is an allocation (or debit) associated with the scrap input. If the amount of recovered steel scrap for recycling is less than what the product system requires/ steel scrap needed in the manufacture, then the environmental burdens associated with meeting the raw material demand are included in this closed-loop model. On the other hand, if the amount of recovered steel scrap for recycling is larger than what the product system requires/ steel scrap needed in the manufacture, then the product system receives a net credit, equivalent to the net amount of virgin material avoided.

The end-of-waste state of the steel scrap is reached when the steel scrap is processed in the waste processing (Module C3). The steel scrap is sorted and pressed into blocks and ready to be used for other specific purposes. After the point of end-of-waste, the downstream emissions related to transportation process from recycler to manufacture is attributed to the processing unit that uses the secondary material.

The assessed products are distributed to around Vietnam and exported to Cambodia that spread out all over the world. In this study, applying the Pareto rules on the products distribution, only countries that are within 80% market share were taken into account, as presented in Vietnam. The recovery rate for recycling is obtained from weighted average and differentiated based on customers' countries. The remaining unrecovered steel scrap is considered as material losses that will go to other disposal scenarios to landfill. Mass allocation may be used if there are several disposal scenarios.

For the end-of-life of waste generated in the manufacturing process (e.g. Slag and Refractories, dust, etc.), polluter pays principle are applied for each type of waste. Materials sent to landfill or incineration are subject to a multi-input allocation process, where emissions are determined based on the physical/chemical properties of the material. Overhead processes associated with landfill or incineration are allocated based on the mass of the waste flows. This applies to steel scrap and waste generated in manufacturing process.



LCA Scenarios and Additional Technical Information

1. Chemical data for which there is no specific MSDS available use general data composition or generic data.

2. The projected lifetime of land is assumed last for 50 years.

3. The electricity grid in module A3 was based on the Ecoinvent database for Vietnam which is highly reliant on coal (48%), hydropower (30%), and gas-fired (18%). The climate impact (GWP-GHG) of the electricity is 0.676 kg CO_2 eq./kWh.

4. Energy consumption and emissions from the transportation process of auxiliary material and waste (suppliers to manufacturing plant and transport to waste processing) are estimated using available data in the Ecoinvent database (market database).

5. The type of truck used for transportation within the country is in the range 7.5 to 16 tonnes with EURO4 emission is used, owing to the need to transport heavier loads across longer distances. On the other hand, the transportation used between the country are truck in the range 7.5 to 16 tonnes with EURO4 emission and container ship is used.

6. Transportation in Vietnam were estimated based on World Bank for average rigid truck travelled 250 kilometres a day (2008).

7. Amount of diesel used for demolition process was modelled using Ecoinvent database for global data, i.e.,0.626 MJ diesel/kg steel.

8. Amount of diesel and electricity consumption for waste processing was modelled using Ecoinvent database for global data on sorting and pressing iron scrap, i.e., 0.1MJ diesel/kg steel and 0.01 kWh/kg steel.

9. Waste processing and disposal of scrap steel are modelled using available generic data from Ecoinvent database by considering what kind of waste treatment and disposal of scrap steel that occurred the most

10. The average steel recycling rate in Vietnam is 90% (ERIA, 2022).

11. Around 98% steel scrap is recycled locally in Vietnam while 2% is exported to other countries which are India, South Korea, and Thailand. (The Observatory of Economic Complexity, 2020).

12. VAS uses external scrap in its steel production. Net scrap was calculated by excluding the amount of internal scrap (home scrap). The potential environmental benefit calculated for the end-of-life stage (Module D) was based on the net amount of scrap left in the system.

13. The LCA calculation methodology is EN 15804+A2 (EF Package 3.1).

14. The infrastructure data covered in this study is part of the used database.

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	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	VN, GLO	VN, GLO	VN	VN, GLO	-	-	-	-	--	-	-	-	VN, GLO	VN, GLO	VN, GLO	VN, GLO	VN, GLO
Specific data used	>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	<10%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

Content declaration

Product content	Weight, %									
Virgin Sources (Iron)	0%									
Recycled Material (pre- and post-consumer, i.e., Scrap Steel)	100%									
Standard	**% Carbon (C)**	**% Manganese (Mn)**	**% Silica (Si)**	**% Phosphorus (P)**	**% Sulphur (S)**	**% Chromium (Cr)**	**% Nickel (Ni)**	**% Copper (Cu)**	**% Nitrogen (N)**	**Cev**
Range of values covering all standard and grades	0.06-0.37	max 1.8	max 0.55	max 0.05	max 0.05	-	-	max 0.85	max 0.014	0.42-0.65
Average of values covering all standard and grades	0.24	1.8	0.55	0.05	0.05	-	-	0.82	0.0127	0.52
Packaging materials										
No packaging used for the products										
Dangerous substances from the candidate list of SVHC for Authorisation										
No dangerous substances										

Results of the environmental performance indicators

The estimated impact results provided in this EPD report are solely relative statements and do not serve as indicators of the end points of the impact categories, surpassing threshold values, safety margins, or risks. The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.

Mandatory impact category indicators according to EN 15804:2012+A2:2019/AC:2021

Results per 1 tonne of Rebar								
Impact Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	7.38E+02	4.88E+01	6.21E+01	4.70E+01	2.93E+01	4.97E+00	1.17E+02
GWP-biogenic[A]	kg CO_2 eq.	5.50E-01	1.35E-02	8.61E-03	1.33E-02	8.59E-02	1.36E-03	-1.13E-01
GWP-luluc[A]	kg CO_2 eq.	1.69E-01	2.62E-02	7.01E-03	2.46E-02	2.98E-02	2.47E-03	6.66E-02
GWP-total	kg CO_2 eq.	7.39E+02	4.88E+01	6.21E+01	4.70E+01	2.94E+01	4.97E+00	1.17E+02
ODP	kg CFC 11 eq.	4.78E-06	7.31E-07	9.86E-07	7.12E-07	3.87E-07	7.53E-08	3.86E-06
AP	mol H^+ eq.	7.77E+00	2.97E-01	5.56E-01	2.06E-01	3.36E-01	2.31E-02	2.66E-01
EP-freshwater	kg P eq.	2.83E-02	3.88E-04	2.24E-04	3.85E-04	1.14E-03	3.95E-05	-1.38E-02
EP-marine	kg N eq.	1.29E+00	9.77E-02	2.67E-01	7.55E-02	7.19E-02	8.69E-03	4.36E-02
EP-terrestrial	mol N eq.	1.43E+01	1.06E+00	2.90E+00	8.14E-01	8.19E-01	9.38E-02	1.05E+00
POCP	kg NMVOC eq.	4.07E+00	3.45E-01	8.50E-01	2.80E-01	2.44E-01	3.18E-02	6.95E-01
ADP-minerals & metals[2 A]	kg Sb eq.	9.16E-04	1.50E-04	2.17E-05	1.52E-04	1.60E-03	1.52E-05	2.07E-03
ADP-fossil[2]	MJ	7.73E+03	6.88E+02	8.14E+02	6.70E+02	3.44E+02	7.05E+01	1.07E+03
WDP[2 A]	m^3	6.10E+01	2.28E+00	1.72E+00	2.27E+00	3.30E+00	2.32E-01	1.02E+02

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

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

[3] 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.

[A] The environmental performance results are grouped (annual average) that is representative for all grades of the product because the average overall variation is no more than 10%. However, there are difference in variation for GWP biogenic (52%), GWP Luluc (18%), ADP minerals & metals (13%), WDP (20%), PM (25%), IRP (34%), ETP-fw (32%), HTP-c (184%), and SQP (20%). This is due to the variation of silica and manganese composition

Potential environmental impact – additional environmental information according to EN 15804:2012+A2:2019/AC:2021

Results per 1 tonne of Rebar								
Impact Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
PM[A]	Disease incidence	1.62E-05	3.89E-06	1.59E-05	3.89E-06	4.08E-06	4.59E-07	7.29E-06
IRP[1 A]	kBq U235 eq.	2.39E+00	2.38E-01	1.65E-01	2.38E-01	2.08E-01	2.42E-02	1.29E+00
ETP-fw[2 A]	CTUe	2.92E+03	3.78E+02	3.89E+02	3.70E+02	2.81E+02	3.86E+01	-1.33E+03
HTP-c[2 A]	CTUh	2.24E-06	2.22E-08	1.90E-08	2.15E-08	4.15E-08	2.17E-09	-1.38E-06
HTP-nc[2 A]	CTUh	6.11E-06	4.72E-07	1.32E-07	4.76E-07	1.81E-06	4.81E-08	-1.20E-05
SQP[2 A]	dimension-less	1.48E+03	3.90E+02	5.48E+01	4.01E+02	6.37E+02	4.42E+01	4.59E+02

Additional mandatory and voluntary impact category indicators

Results per 1 tonne of Rebar								
Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
GWP-GHG[3]	kg CO_2 eq.	7.39E+02	4.89E+01	6.22E+01	4.71E+01	2.95E+01	4.98E+00	1.18E+02

- **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
- **PM** : Particulate Matter emissions
- **IRP** : Ionizing radiation - human healt
- **ETP-fw** : Eco-toxicity – freshwater
- **HTP-c** : Human toxicity - cancer effects
- **HTP-nc** : Human toxicity - non-cancer effects
- **SQP** : Land use related impacts / soil quality

Waste production and output flows

Resource use indicators

Results per 1 tonne of Rebar								
Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
PERE	MJ	1.24E+03	8.64E+00	4.62E+00	8.51E+00	5.20E+01	8.66E-01	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRE	MJ	8.22E+03	7.32E+02	8.65E+02	7.12E+02	3.67E+02	7.49E+01	0.00E+00
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	kg	1.07E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	3.47E+01	5.93E-01	4.23E-01	5.90E-01	8.61E-01	6.01E-02	-6.77E+00

Waste indicators

Results per 1 tonne of Rebar								
Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed	kg	6.60E+03	3.20E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.55E+01
Non-hazardous waste disposed	kg	4.96E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.48E+00
Radioactive waste disposed	kg	2.36E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Output flow indicators

Results per 1 tonne of Rebar								
Parameter	Unit	Total A1 -A3	A4	C1	C2	C3	C4	D
Components for re-use	kg	8.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.00E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

- **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

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Environmental Product Declaration

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