How does cement contribute to reducing CO_2 emissions? Emission journey of INSEE cement

CONTENT:

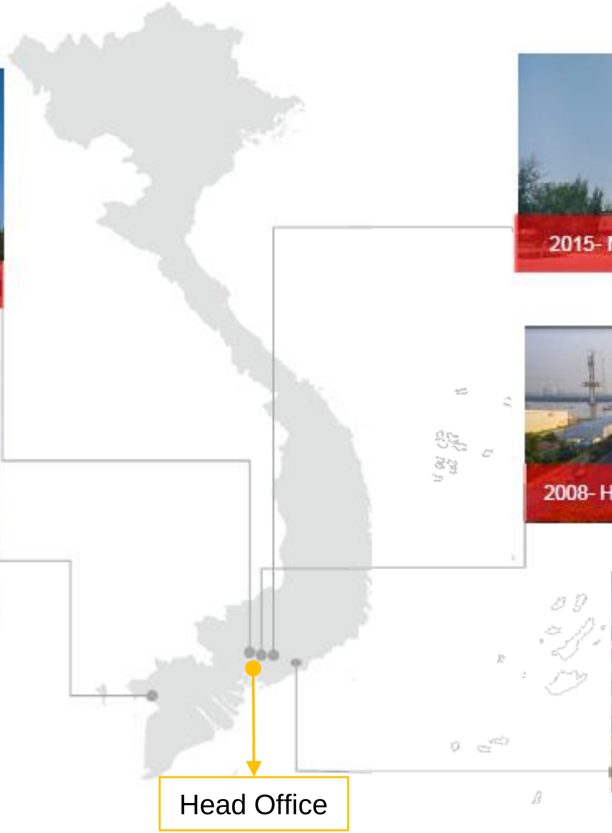
- INSEE Vietnam Introduction
- Solutions for “Green Cement” from INSEE
- Reference Project

INSEE Viet Nam

The leading company in the market of construction materials and solutions in the South of Vietnam

INSEE ECOCYCLE

Established from 2004



1,000

Employees

5

Cement Plants & Grinding Terminals

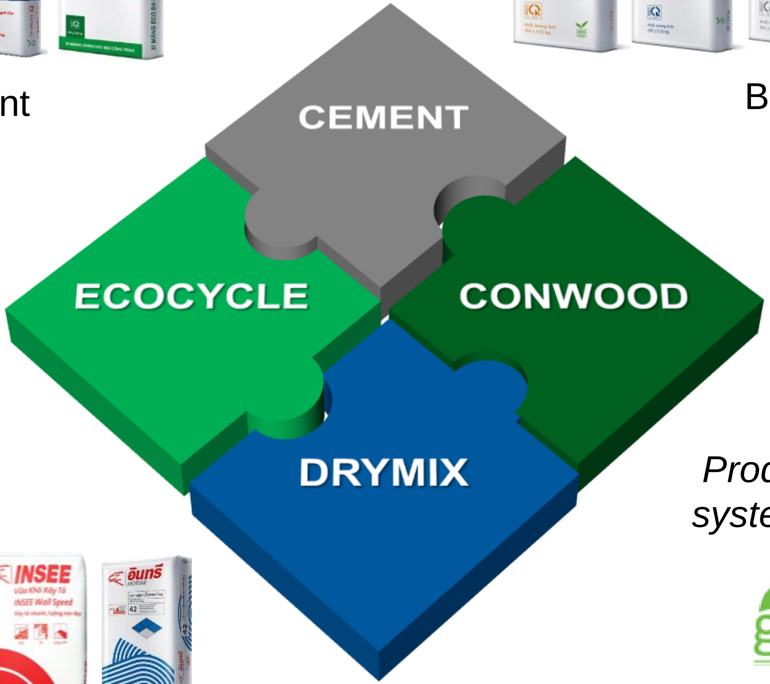
5,2 million

Tons cement

INSEE offers solutions in the building materials and waste management

Bag cement

Bulk cement



Products conform to the evaluation system of LEED, Green Mark, Lotus

MEET THE REQUIREMENT OF SINGAPORE GREEN CEMENT STANDARDS & CERTIFIED INTERNATIONAL EPD

DANH MỤC SẢN PHẨM XI MĂNG INSEE ĐẠT CHỨNG NHẬN "NHÃN XANH" DO SGBC PHÊ CHUẨN

Xi măng Dân dụng

SINGAPORE GREEN BUILDING PRODUCT SGBC LEADER

- **Xi Măng Đa Dụng INSEE Lavilla PCB40** – Đạt hạng 4 trong bảng đánh giá của SGBC
- **INSEE Extra Durable** – Đạt hạng 4 trong bảng đánh giá của SGBC

SINGAPORE GREEN BUILDING PRODUCT SGBC EXCELLENT

- **INSEE Đa Dụng Power-S** – Đạt hạng 3 trong bảng đánh giá của SGBC
- **INSEE Xây Tô Wall Pro** – Đạt hạng 3 trong bảng đánh giá của SGBC
- **INSEE Đa Dụng Power Fast** – Đạt hạng 3 trong bảng đánh giá của SGBC
- **INSEE ECO Đa Dụng** – Đạt hạng 3 trong bảng đánh giá của SGBC

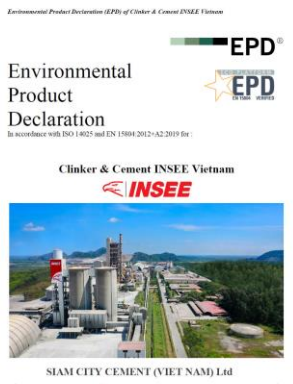
Xi măng Công nghiệp

SINGAPORE GREEN BUILDING PRODUCT SGBC LEADER

- **INSEE Stable Soil** – Đạt hạng 4 trong bảng đánh giá của SGBC
- **INSEE Extra Durable** – Đạt hạng 4 trong bảng đánh giá của SGBC

SINGAPORE GREEN BUILDING PRODUCT SGBC VERY GOOD

- **INSEE Easy Flow** – Đạt hạng 2 trong bảng đánh giá của SGBC
- **INSEE Quick Cast** – Đạt hạng 2 trong bảng đánh giá của SGBC

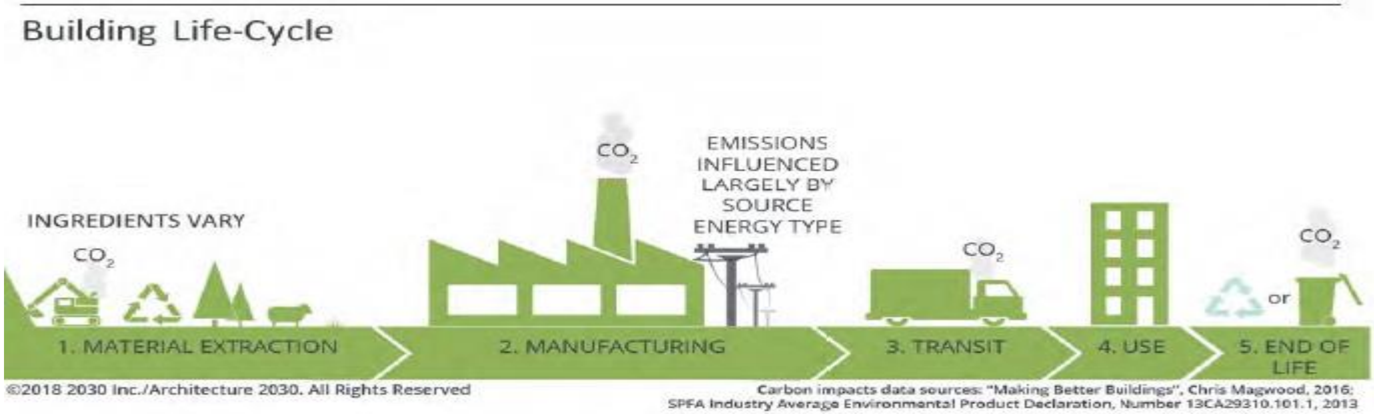


ECO PLATFORM EPD EN 15804 VERIFIED

INSEE is a pioneering enterprise with a full product portfolio certified with the "Green Label" approved by SGBC and VGBC, meeting the requirements of reputable assessment systems such as LEED, Lotus, and BCA Green Mark. INSEE is the first cement producer in Southeast Asia to receive International EPD certification

Solutions for “Green Cement” from INSEE

What is Embodied Carbon?

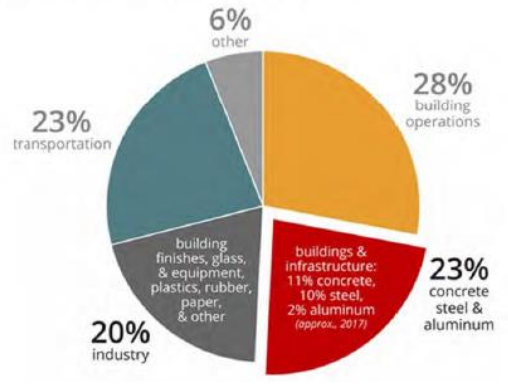


INSEE

What role does construction play in CO_2 emissions?

How responsible are concrete and cement for those emissions?

Structural Embodied Carbon - Globally

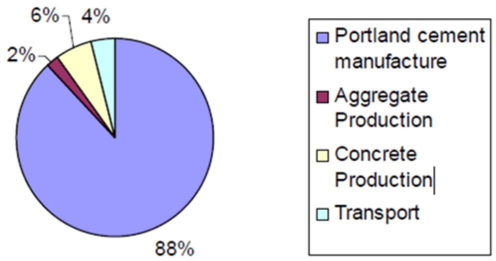


1. UNEP and IEA, "Global Status Report 2017: Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector," 2017.
2. OECD, "Global Material Resources Outlook to 2060: Economic Drivers

Just three materials are responsible for 23% of total global emissions (most of this used in the built environment).

- After water, **concrete** is the most widely used substance
  - Long life spans of concrete products
  - High strength – low cost
  - Flexibility (unique ability to be shaped and sculpted into anything)

Carbon Emission in concrete

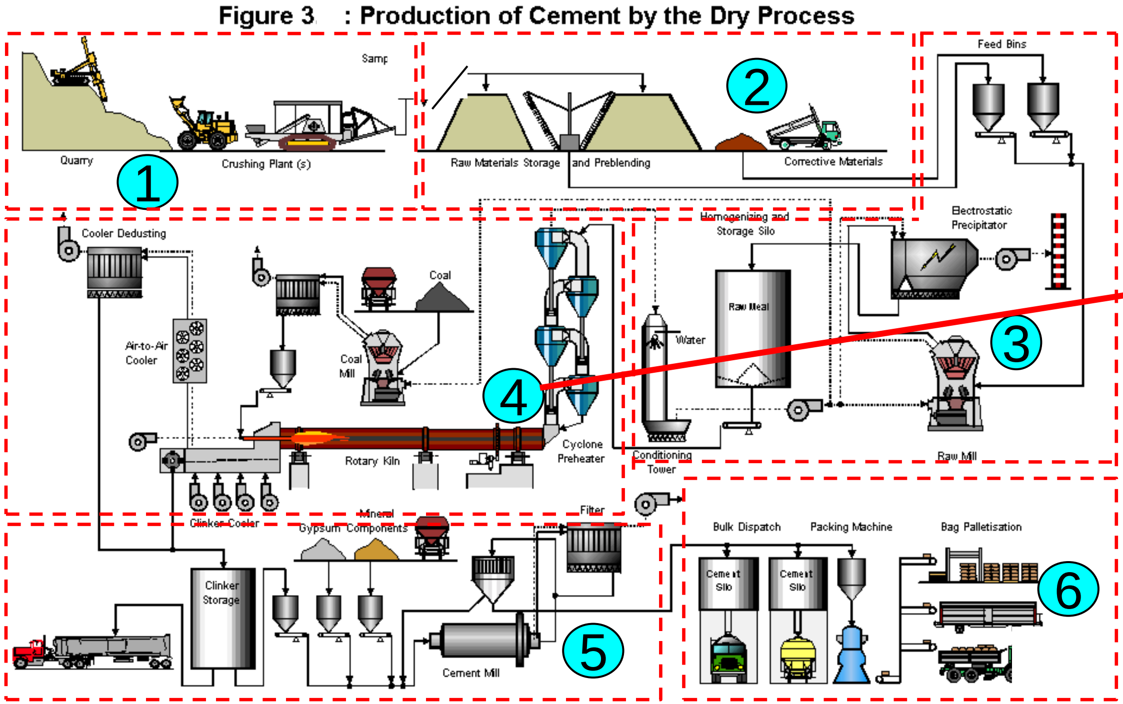


At only ~12 % concentration in concrete, CEMENT is responsible for 88-90% of the CO_2 emissions

Source: Low Carbon Concrete - Options for the Next Generation of Infrastructure
https://www.researchgate.net/publication/242155430d

How responsible are concrete and cement for those emissions?

Traditional cement production from limestone releases CO2 mainly from the Kiln process



Clinker + Gypsum + (MIC) = Cement

4 Kiln process to produce clinker

Concrete and Embodied Carbon

Portland cement (PC) production:

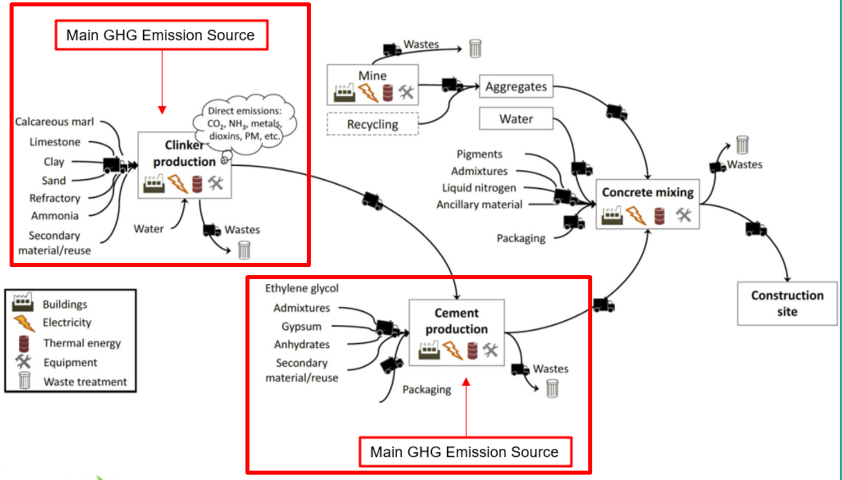
PC = Cement Clinker (CaO) + gypsum & limestone powder

$$CaCO3 + Heat (CO_2) \text{---}> CaO + CO_2$$

- Production of 1 ton of portland cement releases about 0.9-1.0 ton CO2
- Portland cement production equates to about 7-10% of world's CO2 emissions
- 1 CY Concrete = 600 lbs +/- portland cement -- Concrete truck (9 CY) = 2.7 tons CO2

Green Cement

How INSEE goes green in producing cement



Energy Efficiency

+

Alternative Fuel

= ↘ CO_2

+

Sample formulations for each standard

	CLASSIC	LOW CARBON		VERY LOW CARBON		ULTRA LOW CARBON
Cement type	**Portland cement – CEM I**	**Portland - composite cement – CEM II/B**	**Composite cement – CEM V**	**Blast furnace cement – CEM III/A or CEM I + S**	**Blast furnace cement - EMC I or EMC II + S or V or L**	**Alternative binder**
Clinker content (%)	95-100	65-79	A: 40-64 B: 20-38	A: 35-64 B: 20-34 C: 5-19	35	5
Substitutes	None	All possible types	Fly ash + slag	Slag	Slag, fly ash or filler	Activated slag
Regulatory approach	Standards-based **Standardised concrete**	Standards-based **Standardised concrete**	Standards-based **Standardised concrete**	Standards-based **Engineering concrete**	Performance-focused **High-performance concrete**	Performance-based approach/ (ETA underway) **Concrete with alternative binder**
CO_2 emissions (average value)	250	180	150	130	110	90
Reduction in CO_2 (/ CEM I base 250kg/m³)	**0%**	**-28%**	**-40%**	**-48%**	**-56%**	**-64%**
VC projects	-	-	-	ENS Cachan, Bordeaux Stadium and SEA	Testimonio Tower and SEA	L'Archipel

↘ **Clinker content** = ↘ CO_2

INSEE

Green Cement

How INSEE goes green in producing cement

Energy Efficiency

By **Waste Heat Recovery Power Plant**

and Renewable energy

Waste-heat recovery power plant
Capacity: 6.3 MW, contribute 25% electricity for HONC plant

Clinker cooling stage: Clinker is cooled down from 1450°C to <150°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.

Capacity 6.3 MW

-25% electricity consumption

Equivalent to:

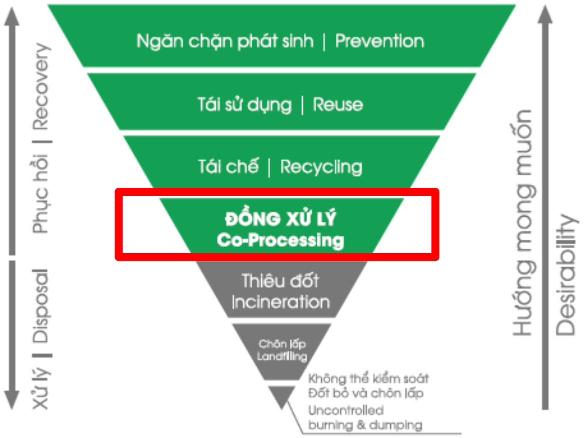
- CO_2 reduction of 25,300 t/y
- Saving 9,000 t/y of coal antracite
- Saving 6,450 t/y of HFO
- 18,300 families in one year
  (assumption 2400 kwh / house / year)

Investing Solar Photovoltaic system to reduce National Grid electric system consumption

Green Cement

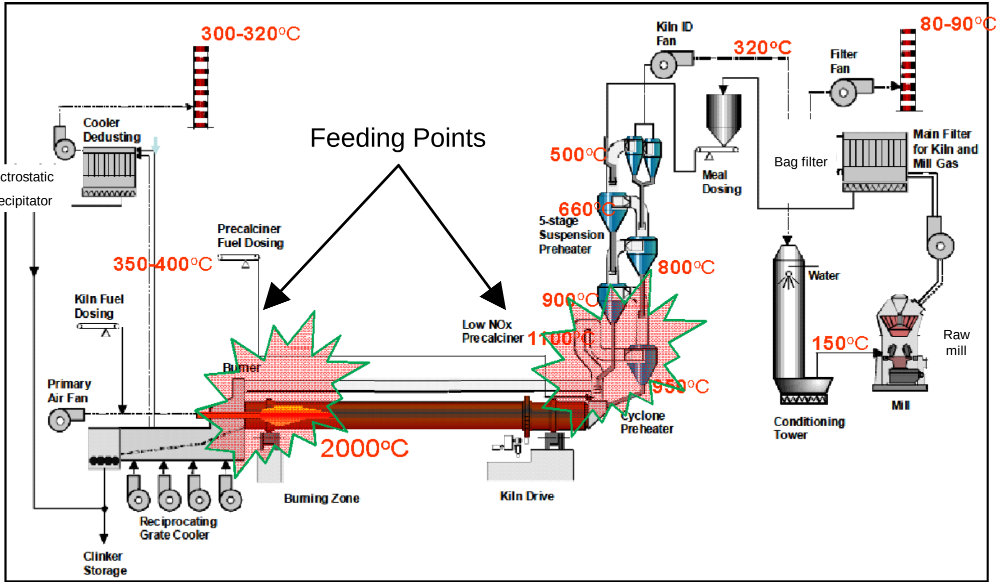
How INSEE goes green in producing cement

Alternative Fuel



Những ưu điểm của công nghệ Đồng xử lý trong lò nung xi măng

- Nhiệt độ cao và ổn định (~ 2.000 °C)
- Thời gian lưu cháy dài (khí ~8 giây, rắn 30 phút)
- Môi trường kiềm và quy trình tự lọc sạch (CaO)
- Công suất lớn (30 tấn chất thải/giờ)
- Hệ thống kiểm soát phát thải liên tục 24/7
- Giảm phát thải CO2 & khí thải độc hại
- Không tro thải. Không chôn lấp
- Công nghệ phát triển bền vững



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.

Low CO2 emission by using **blended cement** is considered as the sustainable material to meet both environmental and urban development.

↘ Clinker content

- **Portland Cement** – “PC” or “OPC” (TCVN 2682, ASTM C150, CEM I)

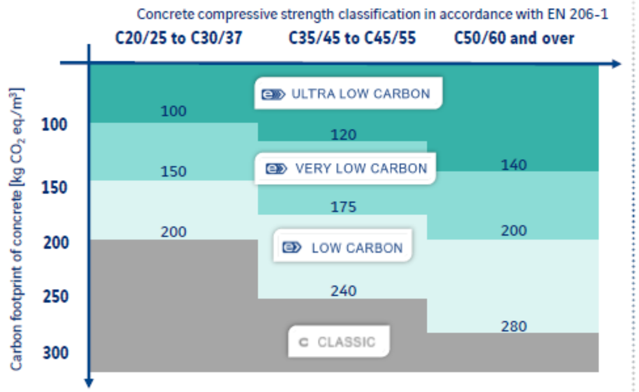
  Main components: clinker & gypsum (set regulator)
  Interground into a fine powder

High CO2 emission

- **Blended cements** (PCB40 – TCVN 6260, ASTM C595, ASTM C1157, CEM II - V)

  Main components: clinker, additives & gypsum
  Possible additives:
  - Puzzolanic materials (natural or fly ash, silica fume)
  - Blastfurnace slag (steel industry)
  - Limestone

Low carbon concrete



- Both type of cements have to comply to comparable performance requirements (setting time, strength etc)

Lower emission cement = blended cement

Green Cement

Draft TCVN for Cement is built on the basis of EN 197-1:2011 standard

TCVN **TIÊU CHUẨN QUỐC GIA**

TCVN .....:XXXX

Xuất bản lần 1

- Tên theo hợp đồng nhiệm vụ KHCN:

XI MĂNG – YÊU CẦU KỸ THUẬT

- Tên theo Hội đồng khoa học Viện VLXD:

XI MĂNG – PHẦN 1: THÀNH PHẦN, YÊU CẦU KỸ THUẬT VÀ TIÊU CHÍ PHÙ HỢP ĐỐI VỚI XI MĂNG THÔNG DỤNG

Cement – Part 1: Composition, specifications and conformity criteria for common cements

TCVN....:XXXX được xây dựng dựa trên cơ sở tiêu chuẩn EN 197-1:2011 Cement Part 1: Composition, specifications and conformity criteria for common cement (Xi măng - Phần 1: Thành phần, yêu cầu kỹ thuật và tiêu chí phù hợp đối với xi măng thông dụng).

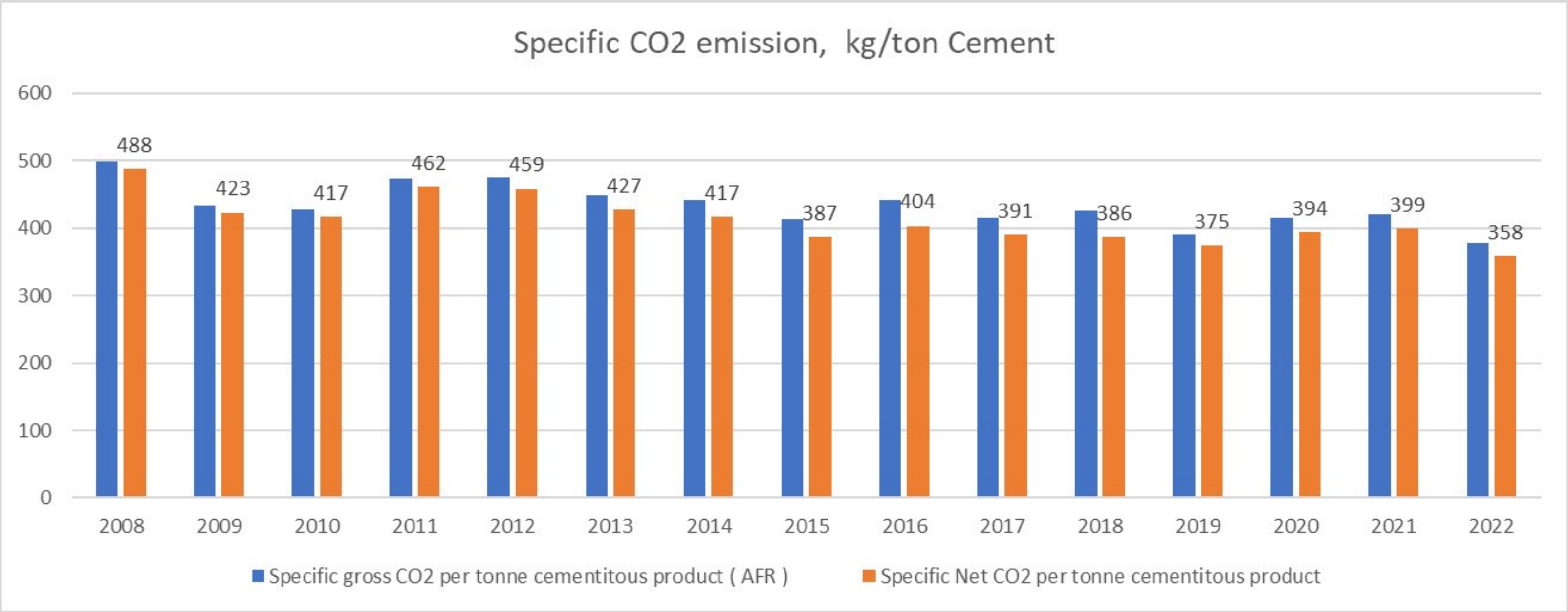
TCVN....:XXXX do Viện Vật liệu xây dựng – Bộ Xây dựng biên soạn, Bộ Xây dựng đề nghị, Tổng cục Tiêu chuẩn Đo lường Chất lượng thẩm định, Bộ Khoa học và Công nghệ công bố.

Bảng 1 - 27 sản phẩm trong họ xi măng thông dụng

Các loại chính	Kí hiệu của 27 sản phẩm (Các loại xi măng thông dụng)		Thành phần (phần trăm khối lượng[a])										
			Các cấu tử chính										Các cấu tử phụ bổ sung
			Clanhke	Xỉ lò cao	Silica-fume	Các Puzzolan: Tự nhiên	Các Puzzolan: Tự nhiên nung phân hủy	Tro bay: Silic	Tro bay: Canxi	Đá phiến sét nung	Đá vôi	Đá vôi	
			K	S	D[b]	P	Q	V	W	T	L	LL	
CEM I	Xi măng poóc lăng	CEM I	95-100	-	-	-	-	-	-	-	-	-	0-5
CEM II	Xi măng poóc lăng xỉ	CEM II/A-S	80-94	6-20	-	-	-	-	-	-	-	-	0-5
		CEM II/B-S	65-79	21-35	-	-	-	-	-	-	-	-	0-5
	Xi măng poóc lăng silicafume	CEM II/A-D	90-94	-	6-10	-	-	-	-	-	-	-	0-5
	Xi măng poóc lăng puzzolan	CEM II/A-P	80-94	-	-	6-20	-	-	-	-	-	-	0-5
		CEM II/B-P	65-79	-	-	21-35	-	-	-	-	-	-	0-5
		CEM II/A-Q	80-94	-	-	-	6-20	-	-	-	-	-	0-5
		CEM II/B-Q	65-79	-	-	-	21-35	-	-	-	-	-	0-5
	Xi măng poóc lăng tro bay	CEM II/A-V	80-94	-	-	-	-	6-20	-	-	-	-	0-5
		CEM II/B-V	65-79	-	-	-	-	21-35	-	-	-	-	0-5
		CEM II/A-W	80-94	-	-	-	-	-	6-20	-	-	-	0-5
	Xi măng poóc lăng đá vôi	CEM II/A-L	80-94	-	-	-	-	-	-	-	6-20	-	0-5
		CEM II/B-L	65-79	-	-	-	-	-	-	-	21-35	-	0-5
		CEM II/A-LL	80-94	-	-	-	-	-	-	-	-	6-20	0-5
		CEM II/B-LL	65-79	-	-	-	-	-	-	-	-	21-35	0-5
	Xi măng poóc lăng hỗn hợp[c]	CEM II/A-M	80-88	12-20									0-5
		CEM II/B-M	65-79	< ---------------- --------------- 21-35 -------------------------------- >									
CEM III	Xi măng xỉ lò cao	CEM III/A	35-64	36-65	–	-	-	-	-	-	-	-	0-5
		CEM III/B	20-34	66-80	-	-	-	-	-	-	-	-	0-5
		CEM III/C	5-19	81-95	–	-	-	-	-	-	-	-	0-5
CEM IV	Xi măng puzzolan[c]	CEM IV/A	65-89	-	<----------- 11-35 ----------->					-	-	-	0-5
		CEM IV/B	45-64	-	< ----------- 36-55 ------------>					-	-	-	0-5
CEM V	Xi măng hỗn hợp[c]	CEM V/A	40-64	18-30	–	< ----18-30---->			-	-	-	-	0-5
		CEM V/B	20-38	31-49	–	< ----31-49---->			-	-	-	-	0-5

CO2 emission
Where INSEE is now?

CO2 Emission Decrease Roadmap at INSEE VN from 1988 to 2020



INSEE Cement greatly minimize the impact on the environment

LIFE CYCLE ASSESSMENT & EPD RESULT

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.

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.

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.

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.

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.

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.

INSEE Cement greatly minimize the impact on the environment

Comparison CO_2 emissions between OPC cement & INSEE cement

PORTLAND CEMENT (PC/ OPC)	HYDRAULIC CEMENT / BLENDED CEMENT (PCB) INSEE SOLUTION - LOW CO_2 CEMENT

Ordinary Portland cement

898

$kgCO_2eq/ton$ (*)

(*) Average European CEM I - Anderson, J., & Moncaster, A. (2020). Embodied carbon of concrete in buildings, Part 1: analysis of published EPD. Buildings and Cities

17% - 51% CO_2 (reduction)

BAG SEGMENT

582 ↓ (35%) $kgCO_2eq/ton$

505 ↓ (43%) $kgCO_2eq/ton$

508 ↓ (43%) $kgCO_2eq/ton$

BULK SEGMENT

743 ↓ (17%) $kgCO_2eq/ton$

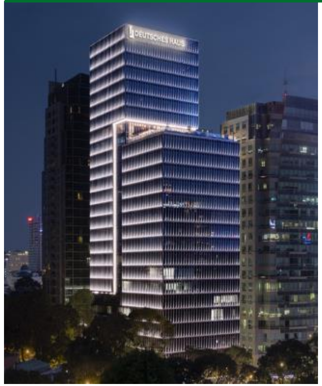
438 ↓ (51%) $kgCO_2eq/ton$

Reference Project

DEUTSCHES HAUS PROJECT

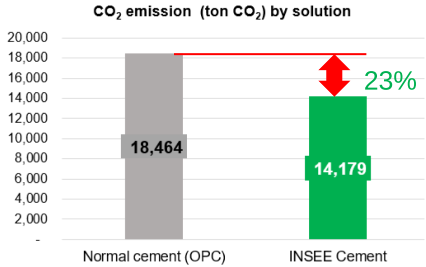
Ho Chi Minh City

V concrete: ~45k m^3



Product: INSEE Easy Flow
INSEE Extra Durable

Reduce: 4.286 ton.eq CO_2 emission



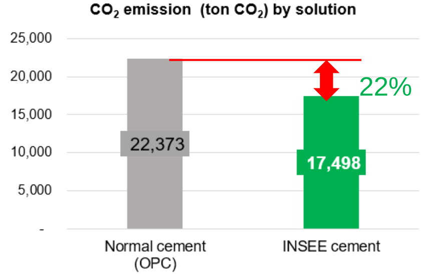
CAO LANH BRIDGE

Dong Thap

V concrete: ~50k m^3

Product: INSEE Easy Flow

Reduce: 4.875 ton.eq CO_2 emission



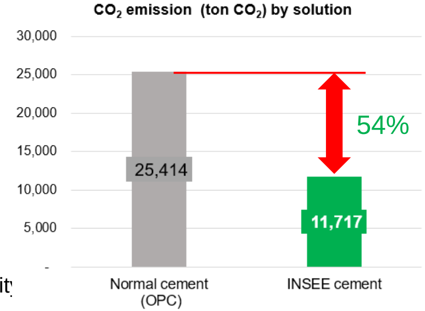
DUYEN HAI THERMAL POWER PLANT (DH3 EXTENTION)

Tra Vinh

V cement: ~27k ton

Product: INSEE Stable Soil

Reduce: 13.697 ton.eq CO_2 emission



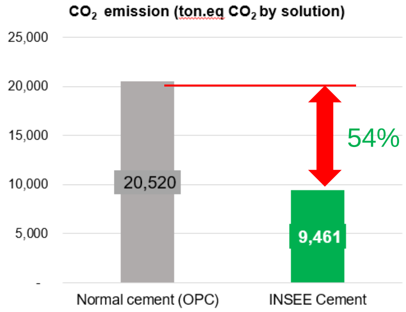
SAIGON INTERNATIONAL TERMINALS VIETNAM PORT

Ba Ria Vung Tau

V concrete: ~45k m^3

Product: INSEE Extra Durable

Reduce: 11.059 ton.eq CO_2 emission



INSEE