Partnership to strenghthern transparency for co-innovation (PaSTI) of the Mininstry of the Environment, Japan and the Ministry of Natural Resources and Environment, Vietnam

Task 2

RESEARCH ON PROGRESS MONITORING OF NDC FOR CONSTRUCTION SECTOR MEASURES

Hanoi, Viet Nam - March 2022

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1 Introduction

1.1 Assignment

This assignment is conducted within Framework between the Overseas Environmental Cooperation Center (OECC), Japan and EPRO Consulting Joint Stock Company (EPRO) for the **Partnership to strengthen transparency for co-innovation (PaSTI) of the Ministry of the Environment, Japan and the Ministry of Natural Resources and Environment, Vietnam.**

The main objective of the assignment is to provide initial background on Vietnam situation per guidance of OECC and logistic supports for further project idea development within the framework of PaSTi. In order to achieve this objective, the assignment includes five main tasks of:

- **Task 1**: Updating information on green finance in line with private sector's transparency and climate actions.
- **Task 2:** Research on progress monitoring of NDC for construction sector measures
- **Task 3:** Support to hold workshops on private sector transparency
- **Task 4**: Other matters for supporting MONRE, line ministries, the MOEJ and OECC
- **Task 5**: Translation and Interpretation on demand basis

This is report of Task 2.

1.2 Report

This report is prepared under guidance of OECC. The analysis is consolidated from existing data in Vietnam, mainly NDC, Nordic study in Cement sector in 2013-2014 and MOC study under green growth framework in 2018-2019 and consultation with MONRE, MOC and associations. This report includes following topics:

- National context: This chapter provides update on Law on Environmental protection, summary on NDC, development of cement sector and relevant researches to NDC tracking in cement sector
- Technological aspect: This chapter provides description on GHG emission reduction measures in cement sector and available data in implementation of these measures.
- Institutional aspect: Institutional set up for MRV in cement sector
- Conclusion and next step: Summary of findings and recommendation on next steps

2 National context

2.1 LEP update

The Vietnam Law on Environmental Protection (LEP) was recently revised and promulgated under Law no 72/2020/QH14 and became effective from 1 January 2022. There are three important articles on response to climate change. They are Article 91 on GHG emission mitigation, Article 94 on national database on climate change and Article 95 on national report on response to climate change.

Following the promulgation of LEP, in 2022, Vietnam has promulgated two important legal documents relating to progress monitoring of NDC. They are (1) Decree 06/2022/ND-CP dated 7 January 2022 on GHG mitigation and ozone layer protection and (2) Decision 01/2022/QDD-TTg dated 18 January 2022 on GHG emission areas and units to perform GHG inventory. Although there is no further guidance circular on GHG inventory and MRV for different areas and sectors, these two documents set a solid framework for GHG inventory, thus supporting progress monitoring of NDC.

2.1.1 GHG emission reduction

Decree 06/2022/NDD-CP includes chapter II on GHG emission reduction, development of carbon market. The overall objectives of National GHG emission reduction is presented below

Table 2-1. National GHG emission reduction target

Responsible Ministry	Area	Minimum GHG emisison reduciton targets to 2030 (Mil. ton $CO_{2eq.}$)*
Total GHG emission reduction by 2030, in which		**563,8**
Ministry of Industry and Trade (MOIT)	- Production of Energy	268,5
	- Energy Consumption in Industry	
Ministry of Transportation (MOT)	- Energy Consumption in transportation	37,5
Ministry of Agriculture and Rural Development (MARD)	- Energy Consumption in Agriculture	129,8
	- Production of agricultural products	
	- Forestry	
Ministry of Construction (MOC)	- Industrial Process	74,3
	- Energy Consumption in cement production	
	- Building	
Ministry of Natural Resources and Environment (MONRE)	- Waste treatment	53,7

Source: Decree 06/2022/ND-CP, annex 1

Note: * the GHG emission reduction in 2021 and 2022 will be estimated

Under Decree 06/2022/ND-CP, there are articles on development of a list of areas and unit to perform GHG emission inventory (Article 6), GHG emission inventory (Article 11) and MRV on GHG emission reduction (article 7, 9, 10). The sumary of these articles is presented in the Table 2-2 below.

Table 2-2. National framework on GHG emission reduction

Category	Content
Development of a list of areas and units to perform GHG emission inventory	List of emitters to conduct GHG emission inventory is available on biannual basic by the Government. They meet one of the following criteria: Annal GHG emission from 3,000 ton CO_{2eq}. or more Being a thermo power plant, industrial producer with annual energy consumption from 1,000 TOE or more Being a transportation company with fuel consumption from 1,000 TOE or more Being a commercial building with energy consumption from 1,000 TOE or more Being a solid waste treatment unit with annual capacity from 65,000 tonnes or more The first list of areas and units to perform GHG emission inventory was promulgated in 2022.
GHG emission inventory	Unlike previous design on National GHG inventory system under Decision 2359/QD-TTg, where MONRE was responsible for calculating GHG emission, under the Decree 06/2022/ND-CP, the GHG inventory is conducted by line ministry and large GHG emiter and submit to MONRE for consolidation. The Decree 06/2022/ND-CP includes 6 templates for national GHG inventory by (1) MOIT, (2) MOT, (3) MARD, (4) MONRE, (5) MOC and (6) unit. GHG emission inventory must follow IPCC guidelines. Under management of MOC, GHG emission inventory should be conducted for production of three construction materials of (1) cement, (2) lime and (3) glass and reported under four GHG categories of CO_2, CH_4, N_2O and HFCs. The template for GHG emission inventory of an unit is general and is in the form of a report headings only. The GHG emission inventory by line ministries and units will be performed biannually, starting with inventory in 2022. MONRE is responsible to issue guidelines on GHG emission inventory, factors and development of an online database. Each and every line ministry is supposed to develop an online database for GHG emission inventory. These are not yet available.
MRV on GHG emission reduction	GHG emission reduction target is approved in NDC for energy, AFOLU, IPPU and waste (see Table 2-1) MRV on GHG emission reduction must follow the procedure by authority bodies, ensuring the accuracy, transparency, continuous, consistency of the results. Verification of emission reduction report must follow the detailed guidance of MONRE and by specific units that meets conditions for verification. The MRV on GHG emission reduction will be implemented via national MRV system, which will be developed via an online system and operated by MONRE. 5 Ministries, MOIT, MOT, MARD, MONRE and MOC are responsible for promulgation of procedure, technical guidance on MRV and development of an online database with alignment to national online MRV database. These are not yet available.

2.1.2 List of GHG emission areas and units to perform GHG inventory

Decision 01/2022/QD-TTg defined six areas, 21 sub-areas and 1912 units from industry and trade (1662 units), transportation (70 units), construction (104 units) and natural resources and environment (76 units).

The construction sector is one of the six areas for GHG inventory. It includes activities from energy consumption and IPPU from production of construction materials. Amongst 104 units under management of construction, 50 are cement producers and the remining 54 units are buildings. The list of these 50 cement companies is attached in Annex エラー! 参照元が見つかりません。.

2.2 Vietnam cement sector

2.2.1 Capacity and Production

The following information is consolidated from annual cement reports of Vietnam Cement Association.

Overview

Vietnam is the third cement producer worldwide, after China and India. The main products are clinker (PC50, PC60), portland cement (PC40, PC50), Blended Portland Cement (PCB30, PCB40) and White Portland Cement (PCW). While the total capacity is around 110 Million tonnes per year, the domestic need is less than 65 Million tonnes per year, ie. around 59% of the designed capacity. With characteristics of being able to mobilise 120% of designed capacity, the export volumes has been increased from 33% in 2018 to 41% in 2021.

The development of cement sector is presented in the Table 2-3 below. It is expected that the cement production will reach 125 Million tonnes by 2025 and 150 Million tonnes by 2030.

Table 2-3. Overview of cement sector of Vietnam

No		Unit	2018	2019	2020	2021	2022 (predicted)
1	Number of kilns	Kiln	83	83	86	87	89
1.1	≥ 4000 tonnes/day	Kiln	29	29	32	33	35
1.2	2500-4000 tonnes/day	Kiln	13	13	13	13	13
1.3	≤2500 tonnes/day	Kiln	41	41	41	41	41
2	Capacity						
2.1	Design capacity	Million ton	97.91	97.91	104.31	106.61	113.41
2.2	Mobilised capacity	Million ton	N/A	N/A	104.22	106.65	117.58
3	Production*	Million ton	89.12	105.53	109.03	N/A	N/A
4	Consumption	Million ton	96.04	99.01	100.14	108.42	112.79
4.1	Domestic consumption	Million ton	63.95	64.92	62.12	62.72	66.48
4.2	Export	Million ton	32.09	34.09	38.02	45.70	46.31
a	*Clinker*	*Million ton*		*22.69*	*23.21*	*28.89*	*30.34*
b	*Cement*	*Million ton*		*11.40*	*14.81*	*16.81*	*15.97*
5	Import	Million ton	-	-	-	-	-

Source: Vietnam Cement Association's Annual Report 2018-2021, *GSO

From the Table 2-3 above, it is noted that the data published in Vietnam on cement production is sum of domestic consumption and export, which is sum of clinker and cement volume.

Clinker making

By the end of 2021, there are 87 rotation kilns with annual capacity of 106,61 Million tonnes. The cement kilns are mainly located in the North (58/87) and central of Vietnam (24/87). There are only 5 cement kilns in the South.

The kilns are characterised by small capacity of less than 2,500 tonnes/day (41/87) and there has been a slightly switch into larger side. In the end of 2021, seven small kilns stopped operation due to low efficiency. They are Huu Nghi 1 and 2 (Phu Tho), X77, Kien Khe (Ha Nam), Ang Son 1 (Quang Binh) and Luks 1 and 2 (Thua Thien Hue). The number of kilns between 2500-4000 tonnes/day remains the same as that of 2020 while one more kiln of more than 4000 tonnes/day had been put into operation in 2021.

Cement grinding

From clinker, cement is grinded mainly in the same place and additional 17 grinding and distribution stations outside the kilns location.

The list of cement plant is attached in Annex エラー! 参照元が見つかりません。.

2.2.2 Ownership

Vietnam's cement industry is operated under three types of ownership. They are: state owned, private and joint-venture with market share of 45%, 32% and 23% respectively.

- ***State owned companies:*** Vietnam Cement Corporation (VICEM) is a state-owned company under line management of the Ministry of Construction (MOC). VICEM plays a major role in the stabilization of production and distribution of the cement industry. VICEM own 10 cement companies and holds shares of 5 joint-ventures, 16 production lines.
- ***Private companies:*** Private companies covered about 41% of the total domestic consumption in 2020. Recently, holding groups like Xuan Thanh or The Vissai have been operating very well 8 cement facilities with updated technology and good operation practices.
- ***Joint venture companies:*** There are 7 Joint venture companies in cement sector. Usually, these are joint ventures between VICEM and a cement international group (Swiss, Taiwanese, Japanese, etc.). JV companies often operate in large scale production.

2.2.3 Cement development plan 2021-2030

Decision number 1226/QĐ-TTg dated 18 August 2020 on development strategy of construction materials in the period 2021-2030, orientation to 2050 sets the following targets for the period 2021-2030:

- Total capacity: no more than 125 Million tonnes in 2025 and no more than 150 Million tonnes in 2030
- Size of kilns: Only invest into clinker kiln with capacity from 5,000 tonnes/day or more and with waste heat recovery for electricity
- Clinker content in cement: average of 65%, ie. minimum additives of 35%
- Thermal energy consumption: ≤ 730 kcal/kg clinker
- Power consumption: ≤ 90 kWh/ton of cement, ≤ 65 kWh/ton of clinker
- GHG emissions ≤ 650 kg CO_2/ton of cement
- Installation of WHR system: 100% production line with a capacity of at least 2500 tonnes of clinker/day must install WHR for power generation by 2025

- Usage of additives: At least 20% and 30% of fly ash of heat power or other industrial waste will be used as an additive material by 2025 and 2030 respectively.
- Usage of alternative fuel: Alternative fuel to be used up to 15% of the total fuels consumption for clinker production

2.3 NDC for cement sector

2.3.1 GHG emission inventory

In 2020, Vietnam submitted update NDC with commitment of reducing GHG emission by 9% compared to the BAU scenario by 20309 with it own domestic resources and up to 27% with international support. Under this NDC, GHG inventory in 2014 and BAU scenario to 2030 was prepared and presented in the Table 2-4 below.

Table 2-4. Vietnam GHG inventory in 2014 and BAU scenario to 2030

Year	Energy	IPPU	Agriculture	LULUCF	Waste	Total
2014	171.6	38.6	89.9	-37.5	21.5	**284.0**
2020	347.5	80.5	104.5	-35.4	31.3	**528.4**
2025	500.7	116.1	109.2	-37.9	38.1	**726.2**
2030	678.4	140.3	112.1	-49.2	46.3	**927.9**

Source: Vietnam NDC 2020

Operation of cement sector contribute to GHG emission under energy and IPPU categories. Under NDC, there is no separate GHG inventory in energy sector for cement production, but IPPU. The methodology for GHG emission inventory is summarised in the Table 2-5 below.

Table 2-5. Cement GHG inventory in 2014 and BAU scenario to 2030 in IPPU

No	Category	Source	Unit	2014	2016
1	Cement consumed	GSO	tonnes	56,871,503	74,457,000
2	Cement imported	GSO	tonnes	-	-
3	Cement exported	GSO	tonnes	15,182,000	8,918,000
4	Cement in country	(1)-(2)+(3)	tonnes	72,053,503	83,375,000
5	Population	GSO	person	90,728,900	92,695,100
6	Production per capita	(4)/(5)*10^3	kg/person	794	899
7	Clinker fraction in cement	Nordic project	%	83%	83%
8	Clinker in cement	(1)*(7)	tonnes	47,203,347	61,799,310
9	Clinker imported	GSO	tonnes	-	-
10	Clinker exported	GSO	tonnes	15,182,000	8,918,000
11	Clinker produced	(8)-(9)+(10)	tonnes	62,385,347	70,717,310
12	Emission factor	IPPC Default values*	tonnes CO2eq./ton clinker	0.52	0.52
13	**CO_2 emission**	**(11)*(12)/10^3**	**thousand tonnes $CO_{2eq.}$**	**32,440**	**36,773**

Source: Vietnam NDC 2020, BUR3

Under national inventory, GHG emission from IPPU is calculated with assumption that the export volume of cement and clinker (item 3) can be used for determination of cement volume in the country (item 4) and the clinker fraction in cement (item 7) is 83% based on earlier study of NORDIC/MOC on NAMA for cement sector in 2013/2014. The emission factor (item 12) is consolidated from default value of 0.768 on ratio of CO_2 to CaO (0.786), of 0.65 on ratio CaO/clinker and of 1.02 on CKD ratio per IPCC national inventory guidelines.

Since the import/export of cement and clinker are equally as the sum of clinker and cement, the errors in calculating clinker produced (11) can be minimized by multiply (4) with (7) directly.

Follow this slight adjusted methodology from NDC calculation, BAU scenario on IPPU of cement sector is revised and updated for 2018 and 2020 (see Table 2-3) with assumption of the maximum cement production in 2025 and 2030 of 125 Million tonnes and 150 Million tonnes respectively (see 2.2.3) is presented below.

It is projected that by 2030, the GHG emission from IPPU in cement sector will be 64,740 thousand tonnes $CO_{2eq.}$, ie. 7% of the total GHG emission and 46% of IPPU emission of the country.

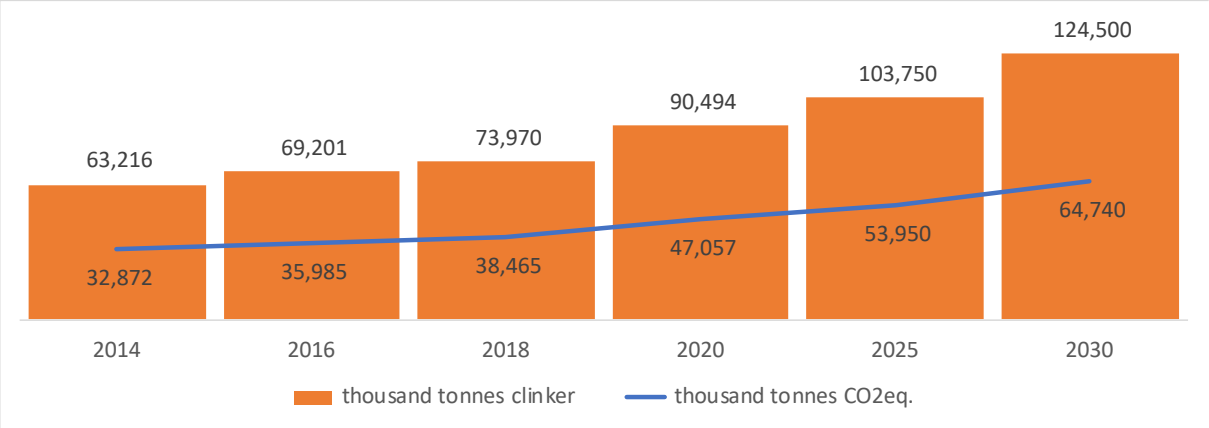


Figure 2-1. IPPU BAU scenario for cement sector

2.3.2 GHG emission targets and mitigation measures

NDC provides GHG emission reduction targets by sector and is presented in the Table 2-6 below.

Table 2-6. GHG emission reduction targets by 2030

Sector	Unconditional contribution (from domestic resources)		Conditional contribution (from international support)		Total contribution	
	%	Million tonnes $CO_{2eq.}$	%	Million tonnes $CO_{2eq.}$	%	Million tonnes $CO_{2eq.}$
Energy	5.5	51.5	11.2	104.3	16.7	**155.8**
IPPU	0.8	7.2	0.1	0.8	0.9	**8.0**
Agriculture	0.7	6.8	2.8	25.8	3.5	**32.6**
LULUCF	1.0	9.3	1.3	11.9	2.3	**21.2**
Waste	1.0	9.1	2.6	24.0	3.6	**33.1**
Total	**9.0**	**83.9**	**18.0**	**166.8**	**27.0**	**250.8**

Source: Vietnam NDC 2020

NDC provides a list of mitigation measures in all sectors. For cement, there are 8 mitigation measures, 4 under IPPU sector, that contributes to 8.0 Million tonnes CO_{2eq} (100% emission reduction targets) and 4 under energy sector, that contributes to 3.7 Million tonnes CO_{2eq}. (2% of reduction targets). Amongst them, 7 measures will be implemented unconditionally.

- IPPU's measures: it is expected that the cement production reduces its clinker by 14%, ie. from 83% as in 2014 to 69% in 2030 by increasing contents of additives.
- Energy's measures: it is expected that the cement plants reduce, recover waste heat as well as optimize the grinding, calcination process.

The summary of mitigation measures in cement sector is presented in the Table 2-7 below.

Table 2-7. GHG emission mitigation measures in cement sector

No	Measure	Assumption	GHG reduction potential (million tonnes of CO_2eq)	
			2021-2030	2030
	IPPU measures		**41.1**	**8.0**
1	I1. Grinding fly ash in order to replace clinker in cement composition	By 2030, fly ash will replace 3.5% of clinker.	10.3	2.0
2	I2.Grinding Pozzolana in order to replace clinker in cement composition	By 2030, pozzolana will replace 3.5% of clinker.	10.3	2.0
3	I3. Grinding limestone in order to replace clinker in cement composition	By 2030, limestone will replace 5,6% of clinker.	16.4	3.2
4	I4. Grinding granulated blast furnace slag (GBFS) in order to replace clinker in cement composition*	By 2030, GBFS will replace 1.4% of clinker.	4.1	0.8
	Energy measures		**29.2**	**3.7**
5	E6. Optimizing clinker calcination process	By 2030, at least 50% of the total clinker will be produced with optimized calcination	3.1	0.4
6	E7. Using vertical grinder in cement production	By 2030, least 50% of the total cement will be grinded by vertical grinders	6.8	0.9
7	E8. Reducing heat loss in clinker kilns	By 2030, at least 40% of the total clinker will be produced in reduced heat loss.	4.3	0.6
8	E9. Recovery of waste heat from cement production	By 2030, at least 50% of the total cement will be produced with waste heat recovery system	15.0	1.8
	Unconditional contribution	**Total**	**66.2**	**10.9**
		IPPU	37.0	7.2
		Energy	29.2	3.7
	Conditional contribution	**Total**	**4.1**	**0.8**
		IPPU	4.1	0.8
		Energy	0	0
	TOTAL		**70.3**	**11.7**

Source: Vietnam NDC 2020, *measure with international supports

2.4 Data availability

Cement production is one of the key emission areas to take GHG inventory per decision 01/2022/QD-TTg, thus Tier 2 is applied, ie. clinker production must be identified for IPPU GHG emission while cement production and energy consumption must be identified for energy GHG emission. This chapter presents data availability and consistency of these two values. Further technical aspects on mitigation measures is presented in chapter 3.

Vietnam has promulgated a framework for GHG emission inventory and MRV but guidance, tools and application is not yet taken. The main data for GHG emission inventory and NDC monitoring for cement sector at this stage are available from the following sources:

- GSO: annual cement production. This is public available (see Table 2-3)
- Annual cement report from Vietnam Cement Association: capacity of kilns, cement production in total and per kilns, export volume of clinker and cement. This is not publicly available, but purchasable for the period 2014-2021 (see Annex 6.1 and Table 2-3)
- MOC survey for cement GHG emission inventory in 2019-2020 (see the list in Annex 6.1: inputs for GHG emission inventory from individual 65/83 kilns (86% clinker capacity) for the year 2018, 2019. IPPU GHG emission of cement sector is calculated with Tier 2.
- Nordic study for cement NAMA development in 2013-2014: inputs for GHG emission inventory from individual 47 kilns (100% of clinker capacity) for 5 year 2009-2014, clinker contents and mitigation measures under NDC. IPPU GHG emission of cement sector is calculated with Tier 2.
- NDC, BUR3, NC3 technical reports: Methodology, default factors and GHG emission inventory results of the year 2010, 2014, 2016. IPPU GHG emission of cement sector is calculated with Tier 1.
- Cement plants under Decision 01/2022/QDD-TTg and 1881/QD-TTg: Data on energy consumption and GHG emission inventory to be available in 2022 and 2020 respectively.

Availability of data

NDC showed that the GHG mitigation outputs is calculated by the difference between BAU scenario and actual inventory for cement sector. BAU scenarios values are not yet publicity available at both enterprise level and sectoral level. This is caused by lack of guidance for GHG emission inventory and projection.

Completion of data

The Annex 6.3 presented parameters for data collection for NDC. It showed that the actual GHG emission inventory for cement sector can hardly be conducted with top down approach for Tier 2 without a comprehensive survey that aim to identify the sectoral characteristics for GHG emission inventory as those values are not available publicly. This is the reason for GHG inventory in cement sector was conducted with Tier 1 by top down approach so far.

Consistency of data

The MOC survey in 2019-2020, data for GHG emission inventory of 79/111 cement production locations/companies has been collected for two year 2018, 2019 and is considered as the most completed database with bottom up approach. The Annex 6.2 showed data availability from individual cement plants by province. While it showed the gap in missing data, it also pointed out two province and city (Tay Ninh and Hai Phong) that require update data in recently launched annual cement report 2021. Data inconsistency between GSO and annual cement report on cement production is also observed. Under NDC, data of GSO is applied while the sectoral stakeholders use the data from annual report.

Both annual cement report and NDC add export volume of clinker with that of cement as volume of export cement. This brings confusion and inaccuracy.

When calculate the mitigation scenarios of the IPPC measures, the difference in GHG emission reduction from BAU and mitigation scenarios is slightly higher than mitigation target under NDC, ie. 10.9 Million ton CO_{2eq}. vs. 8.0 Million ton CO_{2eq}.

GHG emission mitigation observed

With both bottom up approach, the comparison with Nordic study in 2013-2014 and weighted average values under MOC study in 2019-2020 showed that emission factors for clinker production in Vietnam remains similar from 880kg CO_{2eq}. in 2009 to 876kg CO_{2eq}. in 2019. However, that of cement production has been reduced from 734kg CO_{2eq}. to 642kg CO_{2eq}. in 2019. The achievements was mainly contributed by reduction in clinker contents (see Figure 3-1) . It is noted that all these values are excluding GHG emission from biomass source.

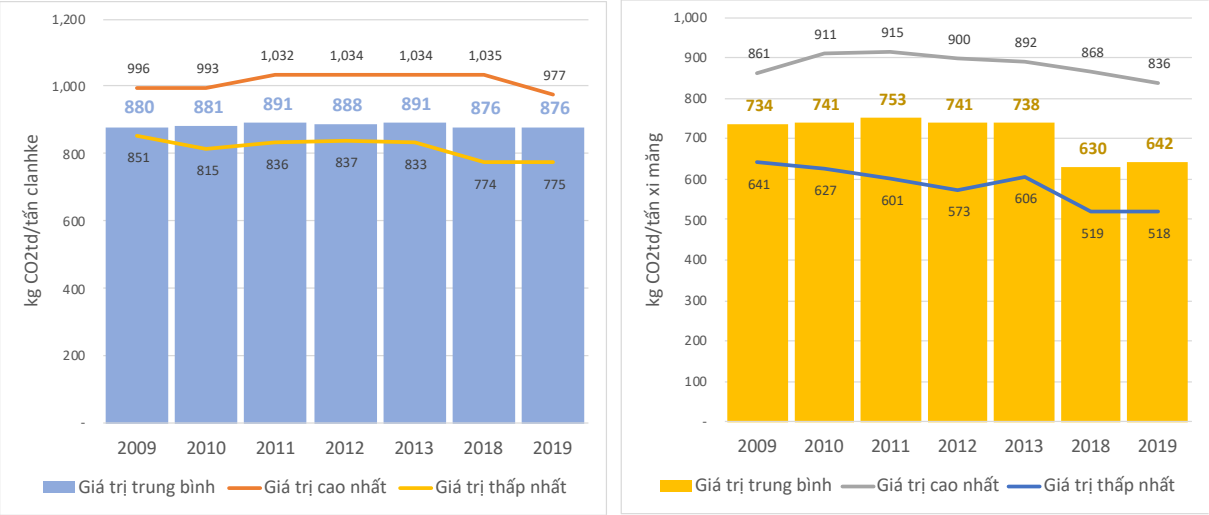


Figure 2-2. GHG emission factors for clinker and cement production

3 Technological aspects

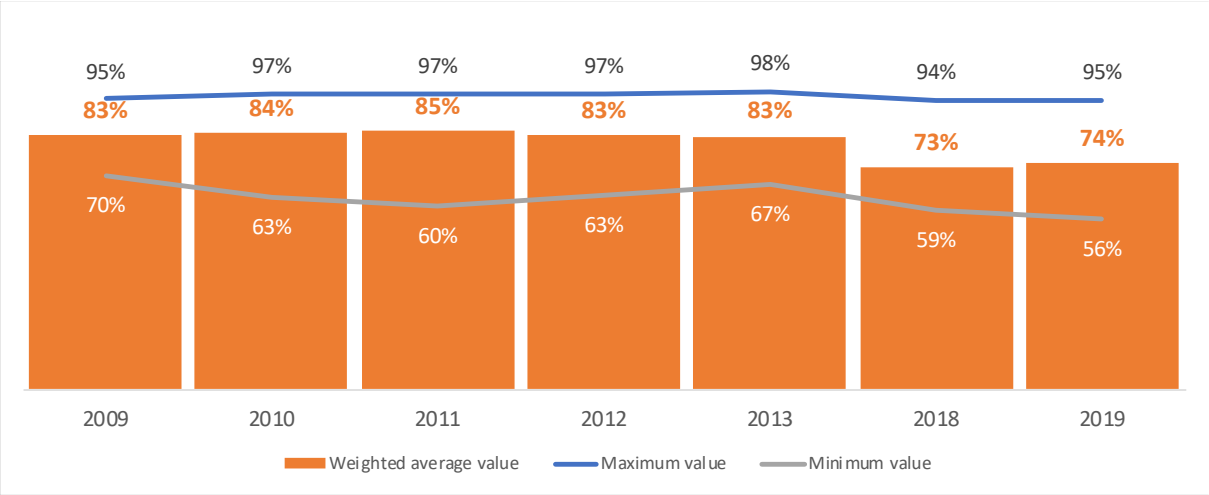
There is no MRV on GHG emission reduction in cement sector. The following chapter presents response under MOC study.

3.1 IPPU measures

IPPU measures aims to reduce clinker contents in cement by 14%, ie. from 83% in 2014. to 69% in 2030. It is expected that the 14% of clinker contents in cement will be replaced by fly ash (3.5%), pozzolana (3.5%), limestones (5.6%) and blast furnace slag (1.4%).

Decision number 1226/QĐ-TTg dated 18 August 2020 on development strategy of construction materials in the period 2021-2030, orientation to 2050 sets the target to reduce clinker contents to 65% by 2030. It also sets a target that at least 20% and 30% of fly ash of heat power or other industrial waste will be used as an additive material by 2025 and 2030 respectively.

MOC study in 2020 showed that on average, the clinker content has been reduced from 83% in 2013 to 74% in 2019, ie. additional 9% of additives to replace clinker. There is no difference in maximum clinker content, but significant change in minimum contents and it can be as low as 56%.



Source: Nordic study 2014, MOC study 2020

Figure 3-1. Clinker content in cement products

The MOC study did not study on the contribution of different additives. By the end of 2020, 61% of cement companies use fly ash, 48% of cement companies use blast furnace ash, and 18% of cement companies use other materials such as pozzolana, thermal power ash, bottom ash. Unlike prediction in NDC, the usage of blast furnace, which is expected with international support, seems to be common in cement production while the largest contribution from replacement of clinker by limestones (5.6%) is not yet observed under this survey.

Currently the additives are used between 0.5-27%. The cement plant has plan to increase additives up to 40% (blast furnace) and 30% (others).

There is no difference in in IPPU measures between 2018 and 2019 as the IPPU GHG emission factor for clinker production in 2018 and 2019 are both 516 kg CO_{2eq}./ton clinker. However, it is less than IPCC default value used under NDC (520 kgCO_{2eq}./ton).

Table 3-1. IPPU GHG emission factor in 2018 and 2019

IPPU		2018	2019
Number of kiln surveyed	Kiln	65	65
Clinker capacity surveyed	tonnes/day	230,550	230,550
Clinker produced	tonnes	69,425,891.00	70,664,878.00
GHG emission	ton CO2eq	35,794,554.26	36,433,808.45
GHG emission factor	kg CO2/tonne	516.18	516.19

Source: MOC study 2020

3.2 Energy measures

Amongst four energy mitigation measures, there is data available on the E9 (waste heat recovery). The MOC study did not cover the implementation of the three other measures, ie. E6 on optimization of calcination process, E7 on using vertical grinder in cement production and E8 on reducing heat loss in clinker kiln.

The measure E9 assumed that 50% of clinker will be produced with waste heat recovery system. Decision number 1226/QĐ-TTg dated 18 August 2020 on development strategy of construction materials in the period 2021-2030, orientation to 2050 sets the target for clinker production as that 100% production line with a capacity of at least 2500 tonnes of clinker/day to install WHR for power generation by 2025.

Annex 6.1 presents a list of cement companies with WHR systems. There are 23 WHR systems with total power capacity of 171.4 MW are under operation and from the kilns of more than 2,500 tonnes/day. The total clinker capacity of these kilns is 121,600 tonnes/day, ie. 41% of total clinker capacity in 2021. 19 cement plants has plan to install new or increase capacity of WHR systems.

There will be 11 new cement kilns to put into operation during 2022-2024. These are more than 3,300 tonnes/day. The installation of these kilns will include WHR system of 93.30 tonnes/day. When they are put into operation, it will be 52% of clinker produced with WHR system.

Decision number 1226/QĐ-TTg dated 18 August 2020 on development strategy of construction materials in the period 2021-2030, orientation to 2050 sets two target related to energy measures. They are

- to reduce power consumption to ≤ 90 kWh/ton for cement production and ≤ 65 kWh/ton for clinker production and
- Using alternative fuel up to 15% of the total fuels consumption for clinker production

There is no difference in energy consumption for clinker production, but cement production due to the reduction in clinker ratio by additives. The energy consumption in 2019 met energy consumption targets under Decision 1226/QDD-TTg. The Table 3-2 below summarise the energy benchmark over the time.

Table 3-2. Energy benchmarks of cement production

Category	Unit	2009	2010	2011	2012	2013	2018	2019
Energy consumption								

Category	Unit	2009	2010	2011	2012	2013	2018	2019
Clinker	MJ/tonnes	3,814	3,817	3,920	3,891	3,915	3,810	3,813
Cement	MJ/tonnes	3,217	3,248	3,346	3,281	3,282	2,828	2,877
Electricity consumption								
Clinker	kWh/tonnes	60	60	59	61	60	61	60
Cement	kWh/tonnes	92	89	85	84	84	78	76

Source: Nordic study 2014, MOC study 2020

There is no full data available on ratio of alternative fuels. Using waste as alternative fuel is most popular with ratio applied up to 60%. Biomass, tire and waste oil are also considered.

Currently the alternative fuels are used between 1-15% (solid waste) and 1-10% (others). The cement plant has plan to increase additives up to 60% (solid waste). There was no cement plant use tire as alternative fuel. However, 3 has plan to use tire to replace 5-10% fuel demand.

Solar power is not yet the choice of cement plant. Amongst survey plants, there was only one company with solar power. Due to the draft revision of power development plan 8, that postponed the connection of solar power projects, the plan of another 10 cement plants for solar power from 2-30MW might not be realised by 2030.

3.3 Other IPPU measures

There are 5 cement plants with CO_2 recovery plan from 5-20%.

4 Institutional aspect

The operation of cement sector is under the line management of MOC.

Similar to other industrial product, the cement plants are responsible for compliance and reporting on environmental performance to MONRE, on energy consumption to MOIT, on quality to MOST, on planning and investment and green growth investment to MPI..., and on financial issues as tax, fees and revenues to MOF and their provincial departments.

The most important stakeholders to cement sectors in NDC monitoring are:

Ministry of Construction (MOC)

The MOC is the line ministry for the cement sector, in charge of development and implementation of construction material strategy, including cement sector at all levels. There are three related Department under MOC:

- Building Material Department: being responsible for drafting the development strategy for construction materials and monitor the development of the sector, including cement.
- Science, Technology and Environment Department: is the Coordinating Unit for the Nordic Partnership Initiative Pilot Program to develop a NAMA framework for cement sector, including energy efficiency measures and GHG inventory in 2019-2020. The Department is responsible for climate response in construction sector, leads and coordinates with other line ministries in compliance of cement companies in quality, energy efficiency, investment and others.
- Viet Nam Institute for Building Material (VIBM): is assisting MOC for strategy and policy development as well as providing training and consulting services.

Viet Nam National Cement Association (VNCA)

The Viet Nam National Cement Association has 80 active members including cement companies and cement suppliers. VNCA is steered by representatives from MOC, cement companies and provincial department of construction. VNCA produces annual cement reports and update monthly.

Ministry of Natural Resources and Environment (MONRE)

The MONRE has responsibility to control indicators of environmental requirements in cement production, in order to limit the impact on the landscape, ecology and restrictions small-scale projects without advanced technology.

MONRE, Department of Climate Change and Ozone Layer Protection will be responsible for designating a cement plant in conducting GHG emission inventory, taking action on GHG emission reduction. MONRE assigns unit to verify GHG emission reduction.

Ministry of Industry and Trade (MOIT)

MOIT is responsible for implementation of energy efficiency law, in which the designated energy cement companies must report to.

5 Conclusion and next steps

In order to monitor NDC targets for construction sector, particularly cement sector, it is important to highlight the following gap:

- GHG emission inventory and BAU scenario: Under NDC, GHG emission inventory was calculated with Tier 1 and GSO cement production data, which is not yet aligned with the sectoral data under national cement report. The export volume of cement are sum of clinker and cement exported. This should be revised and updated with Tier 2. Guidelines on GHG emission inventory at company and sector level should be prepared to confirm the methodology.
- IPPU GHG mitigation measures: The actual implementation of GHG emission mitigation measures in IPPU did not happen as anticipated, ie. the use of blast furnace ash is rather popular while that of limestones as additives to clinker is not well observed. There might also be additional IPPU measures in CO_2 recovery in near future. This list may need to revise and update. The clinker content can be as low as 65% instead of 69% unconditionally.
- Energy GHG mitigation measures: Amongst 4 energy measures, only one on waste heat recovery can be monitored. The others need additional definition. The implementation of the three remaining measures are unsecured as no specific framework to support those was found.
- GHG emission mitigation targets: The implementation of IPPU mitigation measures in cement sector contribute to completion of IPPU mitigation targets of the country.
- GHG emission factors: IPPU GHG emission factors for clinker production in 2018, 2019 has been defined (516 kg CO_{2eq}/tonne). The GHG emission factors for clinker production and cement production (IPPU and energy) has been defined, showing the reduction in GHG emission intensity. However, the absolute values can only be confirmed with issue on official methodology for BAU scenario.
- The current database from MOC is rather comprehensive and coverage of 88% clinker capacity in 2019. This can be a good database to support cement plant and MOC to perform GHG emission inventory with updated input data at higher level of accuracy.

6 Annex

6.1 Annex 1. List of cement companies

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
		TOTAL	**51**	**91**	**50**	**80**	**87**	**291,150**	**160,610**	**171,40**	
1	An Giang Cement Plant	An Giang	x			x					
2	Siam city Cement in BRVT	Ba Ria - Vung Tau	x	x							
3	Huong Son Cement Plant	Bac Giang		x	x	x	1	1,000	350		
4	BICEM Company JSC	Binh Dinh	x	x		x					
5	FICO Binhf Duong Co., Ltd	Binh Duong	x	x		x					
6	Ha Tien Kien Giang Becamex	Binh Duong	x	x		x					
7	Ba Dinh Investment and Construction JSC Badico	Binh Duong	x			x					
8	Binh Phuoc Cement Plant	Binh Phuoc		x	x	x	1	6,000	2,200		
9	Tay Do Cement JSC	Can Tho	x	x		x					
10	Can Tho Mineral and Cement JSC	Can Tho	x	x		x					
11	720 JSC.	Can Tho	x			x					
12	Cao Bang Construction Company	Cao Bang	x			x					
13	Vicem Hai Van JSC	Da Nang	x	x		x					
14	Mien Trung Cement Co., Ltd	Da Nang	x	x							
15	Da nang Cement Co., Ltd.	Da Nang	x			x					
16	Ngu Hanh Son Cement JSC.	Da Nang	x			x					
17	Tay Nguyen Construction Materials	Dak Nong	x			x					

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
18	Dien Bien Cement Plant	Dien Bien		x	x	x	1	1,000	350		
19	Mang Trang Fico JSC.	Dong Nai	x			x					
20	Vissai Ha Nam Cement Plant	Ha Nam		x	x	x	2	5,800	2,110		
	Vissai 3	Ha Nam					1	2,500	910	4.0	2016
	Vissai 4	Ha Nam					1	3,300	1,200	5.0	2017
21	Xuan Thanh Cement Plant	Ha Nam		x	x		2	14,500	5,410	24.8	2018
	Xuan Thanh 1	Ha Nam					1	2,500	910		
	Xuan Thanh 2	Ha Nam					1	12,000	4,500		
22	Hoang Long Cement Plant	Ha Nam		x	x	x	1	1,600	620		
23	Thanh Thang Cement Plant	Ha Nam		x	x		4	19,000	7,250		
	Thanh Thang 1	Ha Nam					1	1,000	350		
	Thanh Thang 2	Ha Nam					1	6,000	2,300	7.5	2017
	Thanh Thang 3	Ha Nam					1	6,000	2,300	7.5	2017
	ThanhThang 4	Ha Nam					1	6,000	2,300	7.5	2021
24	But Son Cement Plant	Ha Nam		x	x	x	2	8,000	2,800		
	But Son1	Ha Nam					1	4,000	1,400		
	But Son 2	Ha Nam					1	4,000	1,400		
25	Kien Khe	Ha Nam					1	300	120		
26	Thanh An 77	Ha Nam					1	300	120		
27	Sai Son Cement JSC.	Ha Noi		x		x	1	3,300	1,200	5.0	2018
28	Sai Son Cement JSC (grinding only)	Ha Noi	x	x							
29	Phuc Son Cement Plant	Hai Duong		x	x	x	2	10,000	3,600		
	Phuc Son 1	Hai Duong					1	5,000	1,800		
	Phuc Son 2	Hai Duong					1	5,000	1,800		
30	Phu Tan Cement Plant	Hai Duong		x	x		1	1,300	420		

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
31	Hoang Thach Cement Plant	Hai Duong		x	x	x	3	9,700	3,500		
	Hoang Thach 1	Hai Duong					1	3,100	1,100		
	Hoang Thach 2	Hai Duong					1	3,300	1,200		
	Hoang Thach 3	Hai Duong					1	3,300	1,200		
32	Thanh Cong Construction Material Co., Ltd.	Hai Duong	x			x					
33	Minh Tuan Cement Materials Trading Company - LTD	Hai Duong	x			x					
34	Duyen Linh Cement JSC.	Hai Duong	x			x					
35	Thanh Cong III	Hai Duong		x	x	x	1	1,000	350		
36	Phu Yen Construction Materials	Hai Duong	x			x					
37	Hai Phong Cement Plant	Hai Phong		x	x	x	1	3,300	1,200		
38	Chinfon Cement Plant	Hai Phong		x	x	x	2	8,000	2,800	12.9	2014
	Chinfon 1	Hai Phong					1	4,000	1,400		
	Chìnon 2	Hai Phong					1	4,000	1,400		
39	High Tech Construction Material JSC.	Hai Phong	x			x					
40	Proma Industry JSC.	Hai Phong	x								
41	Can Tho - Hau Giang Cement Co., Ltd	Hau Giang	x	x							
42	Phu Huu Cement Grinding Station	HCMC	x	x		x					
43	Thang Long Cement JSC.	HCMC	x	x							
44	Ha Long Cement JSC.	HCMC	x	x		x					
45	TAFICO Cement Plant	HCMC	x	x							
46	Crown Sai Gon JV	HCMC	x	x							
47	Chinfon Cement JSC. - Hiep Phuoc Grinding Station	HCMC	x	x		x					

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
48	Siam City Cement Co., Ltd. - Hiep Phuoc Grinding Station	HCMC	x	x							
49	Siam City Cement Co., Ltd - Cat Lai Station	HCMC	x	x							
50	X18 Cement JSC.	Hoa Binh		x	x	x	1	1,000	350		
51	Vinh Son Cement Co. Ltd.	Hoa Binh		x	x		1	1,500	600		
52	Trung Son Cement Co., Ltd.	Hoa Binh		x	x		1	2,500	910		
53	Cam Ranh Cement Grinding Plant	Khanh Hoa	x	x		x					
54	Insee (Hong Chong) Cement Plant	Kien Giang		x	x	x	1	4,000	1,400	6.3	2012
55	Kien Luong Cement Plant	Kien Giang	x	x	x	x					
56	Ha Tien Cement JSC.	Kien Giang	x	x		x					
57	Kien Luong (Ha Tien 2) Cement Plant	Kien Giang		x		x	2	7,000	2,500		
	Kien Luong 1	Kien Giang					1	3,000	1,100	3.0	2002
	Kien Luong 2	Kien Giang					1	4,000	1,400		
58	Ha Tien Kien Giang JSC.	Kien Giang	x	x							
59	Vissai Dong Banh Cement Plant	Lang Son		x	x	x	1	2,500	910		
60	Hong Phong Cement Plant	Lang Son		x	x	x	1	1,000	350		
61	Long An Cement Grinding Station	Long An	x	x							
62	Song Lam 2 Cement Plant	Nghe An		x	x	x	1	1,500	600		
63	Song Lam 1 Cement Plant	Nghe An	x	x	x						
64	Vicem Hoang Mai Cement Plant	Nghe An		x	x	x	1	4,000	1,400		
65	Song Lam Cement JSC.	Nghe An		x		x	2	12,000	4,400		

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
	Song Lam 1.1	Nghe An					1	6,000	2,200	7.0	2016
	Song Lam 1.2	Nghe An					1	6,000	2,200	7.0	2016
66	Tan Thang Cement Plant	Nghe An		x	x	x	1	5,000	1,800		
67	Vissai Ninh Binh Cement Plant	Ninh Binh		x	x	x	2	8,500	3,110		
	Vissan 1	Ninh BInh					1	2,500	910	4.0	2018
	Vissan 2	Ninh Binh					1	6,000	2,200	8.0	2018
68	Duyen Ha Cement Plant	Ninh Binh		x		x	2	6,500	2,400		
	Duyen Ha 1	Ninh Binh					1	1,500	600		
	Duyen Ha 2	Ninh Binh					1	5,000	1,800		
69	Huong Duong Cement JSC.	Ninh Binh		x		x	2	5,000	1,820		
	Huong Duong 1	Ninh BInh					1	2,500	910	5.0	2021
	Huong Duong 2	Ninh Binh					1	2,500	910	5.0	2021
70	Tam Diep Cement Co. Ltd.	Ninh Binh		x		x	1	4,000	1,400		
71	He Duong Cement JSC.	Ninh Binh		x		x	1	5,000	1,800		
72	LUKs Ninh Thuan Co., Ltd.	Ninh Thuan	x	x		x					
73	Vinh Phu Cement Plant	Phu Tho		x		x	1	1,000	350		
74	Song Thao Cement Plant	Phu Tho		x	x	x	1	2,500	910		
75	Huu Nghi Cement Plant	Phu Tho		x	x		3	2,600	920		
	Hưu Nghi 1	Phu Tho					1	600	220		
	Hưu Nghi 2	Phu Tho					1	1,000	350		
	Hưu Nghi 3	Phu Tho					1	1,000	350		
76	Song Gianh Cement Plant	Quang Binh		x	x	x	1	4,000	1,400	7.5	2018
77	Van Hoa (Quang Phuc) Cement Plant	Quang Binh		x	x	x	1	5,000	1,800	6.5	2018
78	Ang Son Cement Plant	Quang Binh		x	x	x	2	2,200	800		
	Ang Son 1	Quang Binh					1	1,000	350		
	Ang Son 2	Quang Binh					1	1,200	450		

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
79	Van Ninh Cement Plant	Quang Binh		x	x	x					
80	Thanh My 1 Cement Plant	Quang Nam		x	x	x	1	3,300	1,200		
81	IDICO Co., Ltd.	Quang Ngai	x	x							
82	Cam Pha Cement Plant	Quang Ninh		x	x	x	1	6,000	2,200		
83	Quang Binh Construciton Materials Co., Ltd.	Quang Ninh	x	x							
84	Quang Ninh Cement and Construction Material JSC.	Quang Ninh	x	x							
85	Ha Long Cement JSC.	Quang Ninh		x		x	1	5,500	2,000		
86	Thang Long Cement JSC.	Quang Ninh		x		x	1	6,000	2,200		
87	Lam Thach Cement Plant	Quang Ninh		x	x	x	2	2,400	900		
	Lam Thach 1	Quang Ninh					1	1,200	450		
	Lam Thach 2	Quang Ninh					1	1,200	450		
88	Bim Son Cement JSC - Quang Tri Branch	Quang Tri	x	x		x					
89	Minh Hung JSC.	Quang Tri	x			x					
90	Son La Cement Plant	Son La		x	x	x	1	2,500	910		
91	Tay Ninh Cement Plant	Tay Ninh		x	x		1	4,000	1,400		
92	Quan Trieu Cement Plant	Thai Nguyen		x	x	x	1	2,000	700		
93	Quang Son Cement Plant	Thai Nguyen		x	x	x	1	4,000	1,400		
94	La Hien VVMI Cement Plant	Thai Nguyen		x	x	x	2	2,300	870		
	La Hien 1	Thai Nguyen					1	700	270		
	La Hien 2	Thai Nguyen					1	1,600	600		
95	Bim Son Cement Plant	Thanh Hoa		x	x	x	2	9,500	3,400		
	Bim Son 2	Thanh Hoa					1	4,000	1,400		
	Bim Son 3	Thanh Hoa					1	5,500	2,000		
96	Nghi Son Cement Plant	Thanh Hoa					2	12,000	4,400		
	Nghi Son 1	Thanh Hoa		x	x	x	1	6,000	2,200		
	Nghi Son 2	Thanh Hoa					1	6,000	2,200		

No	Name (English)	Province	Grinding only	DEUs	GHG inventory	MOC database	No of kilns	tonnes clinker/day	Thousand tonnes cement/year	WHR (MW)	Year
97	Cong Thanh Cement Plant	Thanh Hoa		x	x	x	2	12,500	4,910		
	Cong Thanh 1	Thanh Hoa					1	2,500	910	3.0	2009
	Cong Thanh 2	Thanh Hoa					1	10,000	4,000	12.5	2017
98	Long Son Cement Plant	Thanh Hoa		x	x	x	3	18,000	6,800		
	Long Son 1	Thanh Hoa					1	6,000	2,200	7.5	2014
	Long Son 2	Thanh Hoa					1	6,000	2,300	7.5	2016
	Long Son 3	Thanh Hoa					1	6,000	2,300	7.5	2021
99	Luks Cement Plant	Thua Thien Hue		x	x	x	4	7,050	2,550		
	Luks 1	Thua Thien Hue					1	1,000	350		
	Luks 2	Thua Thien Hue					1	1,000	350		
	Luks 3	Thua Thien Hue					1	1,750	650		
	Luks 4	Thua Thien Hue					1	3,300	1,200		
100	Dong Lam Cement Plant	Thua Thien Hue		x	x	x	1	5,000	2,000		
101	Long Tho JSC.	Thua Thien Hue	x			x					
102	Tan Quang Cement Plant	Tuyen Quang		x	x	x	1	2,500	910		
103	Tuyen Quang Cement Plant	Tuyen Quang		x	x	x	1	700	270		
104	406 enterpise -622 Co., Ltd.	Vinh Long	x								
105	Viet Hoa Cement JV	Vinh Long	x			x					
106	Yen Bai Cement Plant	Yen Bai	x	x	x						
107	Yen Bai Mineral JSC	Yen Bai		x			1	1,000	350		
108	Yen Binh Cement Plant	Yen Bai		x	x	x	1	2,500	910		
109	Mong Son JSC.	Yen Bai	x	x							
110	Vietnam Mineral JSC.	Yen Bai	x	x							
111	Yen Bai Cement and Mineral JSC	Yen Bai	x	x							

6.2 Annex 2. Cement activity and data availability by province

No	Province	Number of location			Activities 2021			Data available 2019					
		All locations	With kiln	Grinding only	No of kilns	Capacity (tonnes clinker/day)	Capacity (1000 tonnes cement/year)	All location	With kiln	Grinding only	No of kilns	Capacity (ton clinker/day)	% in clinker capacity
	TOTAL	**111**	**60**	**51**	**87**	**291,150**	**106,610**	**79**	**49**	**30**	**65**	**230,550**	**79%**
1	An Giang	1	0	1	-	-	-	1	0	1	-	-	
2	Ba Ria - Vung Tau	1	0	1	-	-	-	0	0	0	-	-	
3	Bac Giang	1	1	0	1	1,000	350	1	1	0	1	1,000	100%
4	Binh Dinh	1	0	1	-	-	-	1	0	1	-	-	
5	Binh Duong	3	0	3	-	-	-	3	0	3	-	-	
6	Binh Phuoc	1	1	0	1	6,000	2,200	1	1	0	1	5,500	92%
7	Can Tho	3	0	3	-	-	-	3	0	3	-	-	
8	Cao Bang	1	0	1	-	-	-	1	0	1	-	-	
9	Da Nang	4	0	4	-	-	-	3	0	3	-	-	
10	Dak Nong	1	0	1	-	-	-	1	0	1	-	-	
11	Dien Bien	1	1	0	1	1,000	350	1	1	0	1	1,000	100%
12	Dong Nai	1	0	1	-	-	-	1	0	1	-	-	
13	Ha Nam	7	7	0	13	49,500	18,430	3	3	0	5	14,500	29%
14	Ha Noi	2	1	1	1	3,300	1,200	1	1	0	-	-	0%
15	Hai Duong	8	4	4	7	22,000	7,870	7	3	4	6	21,050	96%
16	Hai Phong*	4	2	2	3	11,300	4,000	3	2	1	3	14,000	124%
17	Hau Giang	1	0	1	-	-	-	0	0	0	-	-	
18	HCMC	8	0	8	-	-	-	3	0	3	-	-	
19	Hoa Binh	3	3	0	3	5,000	1,860	1	1	0	1	1,000	20%
20	Khanh Hoa	1	0	1	-	-	-	1	0	1	-	-	
21	Kien Giang	5	2	3	3	11,000	3,900	4	2	2	2	7,000	64%
22	Lang Son	2	2	0	2	3,500	1,260	2	2	0	2	3,500	100%
23	Long An	1	0	1	-	-	-	0	0	0	-	-	
24	Nghe An	5	4	1	5	22,500	8,200	4	4	0	5	22,500	100%
25	Ninh Binh	5	5	0	8	29,000	10,530	5	5	0	8	29,000	100%
26	Ninh Thuan	1	0	1	-	-	-	1	0	1	-	-	
27	Phu Tho	3	3	0	5	6,100	2,180	2	2	0	2	3,700	61%
28	Quang Binh	4	4	0	4	11,200	4,000	4	4	0	2	5,500	49%
29	Quang Nam	1	1	0	1	3,300	1,200	1	1	0	1	3,300	100%
30	Quang Ngai	1	0	1	-	-	-	0	0	0	-	-	

No	Province	Number of location			Activities 2021			Data available 2019					
		All locations	With kiln	Grinding only	No of kilns	Capacity (tonnes clinker/day)	Capacity (1000 tonnes cement/year)	All location	With kiln	Grinding only	No of kilns	Capacity (ton clinker/day)	% in clinker capacity
31	Quang Ninh	6	4	2	5	19,900	7,300	4	4	0	5	19,900	100%
32	Quang Tri	2	0	2	-	-	-	2	0	2	-	-	
33	Son La	1	1	0	1	2,500	910	1	1	0	1	2,500	100%
34	Tay Ninh*	1	1	0	1	4,000	1,400	0	0	0	1	4,500	113%
35	Thai Nguyen	3	3	0	4	8,300	2,970	3	3	0	4	8,100	98%
36	Thanh Hoa	4	4	0	9	52,000	19,510	3	3	0	8	47,800	92%
37	Thua Thien Hue	3	2	1	5	12,050	4,550	3	2	1	3	9,500	79%
38	Tuyen Quang	2	2	0	2	3,200	1,180	2	2	0	2	3,200	100%
39	Vinh Long	2	0	2	-	-	-	1	0	1	-	-	
40	Yen Bai	6	2	4	2	3,500	1,260	1	1	0	1	2,500	71%

* Provinces that Annual Cement Report should be updated as survey results in 2019 has shown higher clinker capacity

6.3 Annex 3. Data availability for GHG emission inventory by parameters

No	CSI code	Category	Unit	Enterprise level	sectoral level	Source for sectoral data
1	GENERAL INFORMATION					
	1	Name of factory		Y	Y	Annual cement report
	2	Name of company		Y	Y	
	6	Type of kiln		Y	Y	
	6a	Nominal clinker capacity		Y	Y	
	6b	Type of factory		Y	Y	
	6c	Nominal cement capacity		Y	Y	
2	CLINKER AND CEMENT PRODUCTION					
2.1	**Clinker**					
	8	Quantity of produced clinker	[t/yr]	Y	N	Calculated via cement production
	9	Quantity of clinker bought from other companies or imported	[t/yr]	Y	Y	Annual cement report
	10	Quantity of clinker sole to other companies or exported	[t/yr]	Y	Y	Annual cement report
	10a	Amount of clinker changed in the stores (+ = increase; - = decrease)	[t/yr]	Y	N	Survey
	10b	Amount of clinker circulated internally (+ = received; - = sent)	[t/yr]	Y	N	Survey
	10c	Clinker from internal transfer of processed cement (+ = received; - = sent)	[t/yr]	Y	N	Survey
2.2	**Mineral ingredients (MIC) are used to Portland and blends cement production**					
	12	Gypsum	[t/yr, dry weight]	Y	N	Survey
	13	Limestone	[t/yr, dry weight]	Y	N	Survey
	14	Slag	[t/yr, dry weight]	Y	N	Survey
	15	Fly ash	[t/yr, dry weight]	Y	N	Survey
	16	Puzzolana	[t/yr, dry weight]	Y	N	Survey
	17	Others (exp. CKD)	[t/yr, dry weight]	Y	N	Survey
	17a	MIC from internal transfer of treated cement	[t/yr, dry weight]	Y	N	Survey
2.3	**Treated mineral ingredients (MIC) sold externally or circulated internally** (dried weight)					
	19a	Treated slag sold externally	[t/yr, dry weight]	Y	N	Survey
	19b	Treated fly ash and other puzzolana sold externally	[t/yr, dry weight]	Y	N	Survey
	19c	Total number of MIC transferred and handled internally (+ = received; - = sent)	[t/yr, dry weight]	Y	N	Survey
2.4	**Mass of dusts (dried weight)**					

No	CSI code	Category	Unit	Enterprise level	sectoral level	Source for sectoral data
	22	BPD escaped from the kilns	[t/yr, dry weight]	N	N	IPCC guuidelines
	23	CKD escaped from the kilns	[t/yr, dry weight]	N	N	IPCC guuidelines
	24	Ratio of combusting CKD_d (Specified value of the company or default value is 0% (dry kiln), 100% (other kilns)	[%]	N	N	IPCC guuidelines
2.5	**Power**					
	33a	Electricity produced from the internal power generation system	[MWh/yr]	Y	N	Survey
	33b	Electricity produced from excess heat recovery	[MWh/yr]	Y	N	Survey
	33c	Power consumption for cement production (from national grid)	[MWh/yr]	Y	N	Survey
	33e	Power consumption for clinker production (exp. from quarry to storage of clinker)	[MWh/yr]	Y	N	Survey
2.6	**Tier 1, if applicable**					
	34m	Emission factor standard [default 525 kg of CO_2/ton of clinker]	[$kgCO_2/t_{cli}$]	N	N	IPCC guuidelines
	34n	The content of organic carbon in raw powder (average), default value is 0.2% or specified value of the company	[%, dry weight]	N	N	IPCC guuidelines
	34o	Ratio of raw powder: clinker, default value is 1.55 or specified value of the company	[%, dry weight]	N	N	IPCC guuidelines
3	**FUEL FOR KILN OPERATION**					
	101	***Conventional fossil fuel (excluding drying raw materials and fuels)***				
	102	Coal + anthracites	[t/yr]	Y	N	Survey
	103	Coke	[t/yr]	Y	N	Survey
	104	Heavy fuels	[t/yr]	Y	N	Survey
	105	Diesel	[t/yr]	Y	N	Survey
	106	Natural gases	[1000 Nm^3/yr]	Y	N	Survey
	107	Shale	[t/yr]	Y	N	Survey
	107a	Lignite	[t/yr]	Y	N	Survey
	108	***Mixed and alternative fuels (excluding drying raw material and fuels)***				
	109	Waste oil	[t/yr]	Y	N	Survey
	110	Tires	[t/yr]	Y	N	Survey
	111	RDF including plastics	[t/yr]	Y	N	Survey
	112	Solvent	[t/yr]	Y	N	Survey
	113	Impregnated sawdust	[t/yr]	Y	N	Survey
	113a	Mixed industrial wastes	[t/yr]	Y	N	Survey
	114	Other fossil wastes and mixed fuels	[t/yr]	Y	N	Survey
	115	***Biomass fuels (excluding drying raw materials and fuels)***				
	116	Dried sludge	[t/yr]	Y	N	Survey
	117	Wood, un-impregnated sawdust	[t/yr]	Y	N	Survey
	118	Papers, cartonnes	[t/yr]	Y	N	Survey
	119	Animal powder	[t/yr]	Y	N	Survey
	120	Powder of animal bones	[t/yr]	Y	N	Survey

No	CSI code	Category	Unit	Enterprise level	sectoral level	Source for sectoral data
	121	Animal fats	[t/yr]	Y	N	Survey
	122	Agriculture wastes, organics, diapers, charcoal	[t/yr]	Y	N	Survey
	123	Other biomass	[t/yr]	Y	N	Survey
3.2	**Fuels consumption for drying raw materials and fuels**					
	124	Conventional fossil fuels	[t/yr]	Y	N	Survey
	124a	Coals + anthracites + Lignite	[t/yr]	Y	N	Survey
	124b	Coke	[t/yr]	Y	N	Survey
	124c	Heavy oil	[t/yr]	Y	N	Survey
	124d	Diesel	[t/yr]	Y	N	Survey
	124e	Natural gases	[1000 Nm^3/yr]	Y	N	Survey
	124f	Shale	[t/yr]	Y	N	Survey
	125	Mixed and alternative fuels	[t/yr]	Y	N	Survey
	125a	Fossil wastes and mixed fuels	[t/yr]	Y	N	Survey
	126	Alternative biomass fuels	[t/yr]	Y	N	Survey
	126a	Other biomass	[t/yr]	Y	N	Survey
3.3	**Calorific values of fuels**					
	131	Low calorific of conventional fossil fuels	[GJ/t]	Y	Y	MOIT
	132	Coals + anthracites	[GJ/t]	Y	Y	MOIT
	133	Coke	[GJ/t]	Y	Y	MOIT
	134	Heavy fuels	[GJ/t]	Y	Y	MOIT
	135	Diesel	[GJ/t]	Y	Y	MOIT
	136	Natural gases	[GJ/1000 Nm^3]	Y	Y	MOIT
	137	Shale	[GJ/t]	Y	N	IPCC guuidelines
	137a	Lignite	[GJ/t]	Y	N	IPCC guuidelines
	138	Low calorific of mixed and alternative fuels			Y	IPCC guuidelines
	139	Waste oils	[GJ/t]	Y	N	IPCC guuidelines
	140	Tires	[GJ/t]	Y	N	IPCC guuidelines
	141	RDF including plastics	[GJ/t]	Y	N	IPCC guuidelines
	142	Solvent	[GJ/t]	Y	N	IPCC guuidelines
	143	Impregnated sawdust	[GJ/t]	Y	N	IPCC guuidelines
	143a	Mixed industrial wastes	[GJ/t]	Y	N	IPCC guuidelines
	144	Other fossil wastes and mixed fuels	[GJ/t]	Y	N	IPCC guuidelines
	145	Low calorific of biomass fuels			N	IPCC guuidelines
	146	Dried sludge	[GJ/t]	Y	N	IPCC guuidelines
	147	Wood, un-impregnated sawdust	[GJ/t]	Y	N	IPCC guuidelines
	148	Papers, cartonnes	[GJ/t]	Y	N	IPCC guuidelines
	149	Animal powder	[GJ/t]	Y	N	IPCC guuidelines
	150	Powder of animal bones	[GJ/t]	Y	N	IPCC guuidelines
	151	Animal fats	[GJ/t]	Y	N	IPCC guuidelines
	152	Agriculture wastes, organics, charcoals	[GJ/t]	Y	N	IPCC guuidelines

No	CSI code	Category	Unit	Enterprise level	sectoral level	Source for sectoral data
	153	Other biomass	[GJ/t]	Y	N	IPCC guuidelines
4	FUELS CONSUMPTION OUTSIDE OF THE KILNS					
	301	***On-site equipment and vehicles using fossil fuels***				
	301a	Diesel	[t/yr]	Y	N	Survey
	301b	Petroleum	[t/yr]	Y	N	Survey
	301ba	Other fossil fuels	[t/yr]	Y	N	Survey
	301c	Fuels for on-site equipment and vehicles (containing biomass)			N	Survey
	301d	Bio-Diesel and mixture	[t/yr]	Y	N	Survey
	302	Fuels for warming and cooling systems			N	Survey
	302a	Diesel	[t/yr]	Y	N	Survey
	302b	Petroleum	[1000 Nm^3/yr]	Y	N	Survey
	302c	Other fossil fuels	[t/yr]	Y	N	Survey
	303	***Fuels for drying mineral materials for cement production***				
	303k	Conventional fossil fuels			N	Survey
	303a	Coals + anthracites + Lignite	[t/yr]	Y	N	Survey
	303b	Coke	[t/yr]	Y	N	Survey
	303c	Heavy fuels	[t/yr]	Y	N	Survey
	303d	Diesel	[t/yr]	Y	N	Survey
	303e	Natural gases	[1000 Nm^3/yr]	Y	N	Survey
	303f	Shale	[t/yr]	Y	N	Survey
	303g	Fuels and mixed alternative fuels			N	Survey
	303h	Mixed fuels and other fossil fuels	[t/yr]	Y	N	Survey
	303i	Alternative biomass fuels			N	Survey
	303j	Other biomass	[t/yr]	Y	N	Survey
	304	***Fuels consumption for one –site power generation***				
	304aa	Fossil fuels			N	Survey
	304a	Coals + anthracites + Lignite	[t/yr]	Y	N	Survey
	304b	Coke	[t/yr]	Y	N	Survey
	304c	Heavy fuels	[t/yr]	Y	N	Survey
	304d	Diesel	[1000 Nm^3/yr]	Y	N	Survey
	304i	Natural gases	[t/yr]	Y	N	Survey
	304j	Shale	[t/yr]	Y	N	Survey
	304f	***Fuels and mixed alternative fuels***				
	304g	Mixed fuels and other fossil fuels	[t/yr]	Y	N	Survey
	304h	Alternative biomass fuels			N	Survey
	304e	Other biomass	[t/yr]	Y	N	Survey
5	FUELS CONSUMPTION FOR WHOLE PLANT /SECTOR					
	Fossil fuels					
		Coals + anthracites + Lignite	[t/yr]	Y	N	Survey
		Coke	[t/yr]	Y	N	Survey
		Heavy fuels	[t/yr]	Y	N	Survey

No	CSI code	Category	Unit	Enterprise level	sectoral level	Source for sectoral data
		Diesel	[1000 Nm^3/yr]	Y	N	Survey
		Natural gases	[t/yr]	Y	N	Survey
		Shale	[t/yr]	Y	N	Survey
	Fuels and mixed alternative fuels				N	Survey
		Mixed fuels and other fossil wastes	[t/yr]	Y	N	Survey
	Alternative biomass fuels				N	Survey
		Other biomass	[t/yr]	Y	N	Survey