

SIAM CEMENT BIOMASS PROJECT



Document Prepared By South Pole Carbon Asset Management Ltd.

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Project Title	Siam Cement Biomass Project
Version	02.2
Date of Issue	3-January-2018 this version of the document issued
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The proposed grouped project has been implemented at The Siam Cement (Ta Luang) Co., Ltd., The Siam Cement (Kaeng Khoi) Co., Ltd., The Siam Cement (Thong Song) Co., Ltd., and The Siam Cement (Lampang) Co., Ltd. where Siam Cement Group (known as SCG) Cement Co., Ltd. has 100% shareholding in these four companies.



Figure 1: The Organization chart for this grouped project.

The installed capacity of each cement plant is illustrated in Table 1 below. Prior to the implementation of each project activity, the fossil fuel such as coal, coke, lignite, heavy fuel and diesel oil were consumed; no alternative fuels or less carbon intensive fuels were used.

Table 1: Details of cement plants in the grouped project¹

Name of Participants	Name of the cement plant	Production capacity (tonnes/day)	Site location
The Siam Cement (Kaeng Khoi) Co., Ltd.	The Siam Cement (Kaeng Khoi)	19,000	Kaeng Khoi , Saraburi
The Siam Cement (Ta Luang) Co., Ltd.	The Siam Cement (Ta Luang)	8,000	Ta Luang , Saraburi
The Siam Cement (Ta Luang) Co., Ltd	The Siam Cement (Khao Wong)	10,000	Khao Wong , Saraburi
The Siam Cement (Lampang) Co., Ltd	The Siam Cement (Lampang)	5,500	Chaehome , Lampang
The Siam Cement (Thung Song) Co., Ltd	The Siam Cement (Thung Song)	18,000	Thung Song , Nakon Si Thammarat

¹ Reference : Thai Cement Manufacture Association 2008 report a, page 10-11

To ensure that there are no significant changes during the validation period the average clinker production in 2008 is illustrated in the table below.

Table 2: The average clinker production in 2008²

Project Site	Clinker Production (ton/day)
The Siam Cement (Kaeng Khoi)	4,775.00
The Siam Cement (Ta Luang)	4,176.00
The Siam Cement (Khao Wong)	10,059.00
The Siam Cement (Lampang)	4,991.00
The Siam Cement (Thung Song)	5,167.00

As shown in Table 2 , the production capacity during the validation period did not significantly change over the values in the installation capacity shown in Table 1, published by The Cement Manufacture Association in 2008.

The proposed project activities involve the installation of storage and handling system for biomass residue. In order to implement the project activities a complete system for receiving, storing, and feeding biomass residue needs to be introduced.

The purpose of the project activity can be summarised as:

- Improving waste management system,
- Reduction of the dependence on fossil fuels, and
- Reduction of greenhouse gas emission through the decreasing of fossil fuel consumption.

Partial substitution of fossil fuels with alternative fuels and less carbon intensive fuels allows reduction of the GHG emission from fossil combustion in kiln processing. The proposed projects can reduce the usage of non-renewable energy. In addition to this the proposed projects can reduce the dependency on fossil fuels while, at the same time, enhance energy security by increasing diversity of fuel supply. Proposed projects are expected to promote excellence in technology in the region and in the industry by being a clean technology demonstration project.

Apart from the implementation of the proposed projects, the projects are expected to also provide;

- Additional income for local farmers,
- The creation of new jobs in the whole biomass supply chain, and
- A reduction of upstream environmental impacts related to coal mining, processing etc.

During the first crediting period, there were four sites from five sites of this bundle, have been excluded from the emission reduction calculations as follows;

- *The Siam Cement (Lampang): design change from the installation of gasifier;*
- *The Siam Cement (Kaeng Khoi): design change from the installation of solid waste pre-treatment unit;*
- *The Siam Cement (Ta Luang) at Ta Luang and Khao Wong sites: stop using biomass due to high biomass price and difficulty of biomass supply sourcing.*

² Reference : SCG work journal summary report, 2008

Therefore, there is only The Siam Cement (Thung Song), which is still applicable to claim the emission reductions from this bundle of project activities in the second crediting period.

The proposed project activity is expected to reduce 107,356 tCO₂e annually or total of 1,073,560 tCO₂e during 10-years of this second crediting period.

1.2 Sectoral Scope and Project Type

These project activities shall be carried out for the cement manufacturing industry, which can be categorized within the sectoral scope and methodology shown below.

Sectoral scope : No.04 - Manufacturing Industries

Methodology : ACM0003/Version 08.0

This project activity is a grouped project but not AFOLU project.

1.3 Project Proponent

Organization name	The Siam Cement (Kaeng Khoi) Co.,Ltd.
Contact person	Chanwut Limpichai
Title	Energy Manager
Address	1 Siam Cement Road , Bangsue Bangkok , Thailand 10800
Telephone	+662 586 5684
Email	chanwutl@scg.co.th

Organization name	The Siam Cement (Ta Luang) Co.,Ltd.
Contact person	Chanwut Limpichai
Title	Energy Manager
Address	1 Siam Cement Road , Bangsue Bangkok , Thailand 10800
Telephone	+662 586 5684
Email	chanwutl@scg.co.th

Organization name	The Siam Cement (Lampang) Co.,Ltd.
Contact person	Chanwut Limpichai
Title	Energy Manager

Address	1 Siam Cement Road , Bangsue Bangkok , Thailand 10800
Telephone	+662 586 5684
Email	chanwutl@scg.co.th

Organization name	The Siam Cement (Thung Song) Co.,Ltd.
Contact person	Wichet Chuchaeu Chanwut Limpichai
Title	Managing Director Energy Manager
Address	1 Siam Cement Road , Bangsue Bangkok , Thailand 10800
Telephone	+662 586 5684
Email	chanwutl@scg.co.th

1.4 Other Entities Involved in the Project

Organization name	South Pole Carbon Asset Management Ltd.
Role in the project	Consultant
Contact person	Santosh Kumar Singh
Title	Regional Director
Address	Technoparkstrasse 1 , 8005 , Zurich , Switzerland
Telephone	+662 678 8977,9
Email	s.singh@southpole.com

1.5 Project Start Date

The start date of project activities is the first date which start using biomass at cement kilns , with reference from the biomass consumption data in Work Journal , as per information presented in Table 3.

Table 3: Project start date

Project site	Start date
The Siam Cement (Kaeng Khoi)	04/10/2002
The Siam Cement (Ta Luang)	15/10/2002
The Siam Cement (Khao Wong)	30/09/2004
The Siam Cement (Lampang)	30/04/2004
The Siam Cement (Thung Song)	19/01/2003

As shown in Table 3, all projects in the bundle began reducing greenhouse gas emissions after 01/01/2002. Therefore all projects are applicable for non-AFOLU projects under VCS standard.

1.6 Project Crediting Period

Crediting period: 01/04/2016 to 31/03/2026 for the 2nd crediting period

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	X

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
Year 2016	80,517
Year 2017	107,356
Year 2018	107,356
Year 2019	107,356
Year 2020	107,356
Year 2021	107,356
Year 2022	107,356
Year 2023	107,356
Year 2024	107,356
Year 2025	107,356
Year 2026	26,839
Total estimated ERs	1,073,560
Total number of crediting years	10
Average annual ERs	107,356

1.8 Description of the Project Activity

In the absence of the proposed project activities, the biomass and other alternative fuels would not have been treated or combusted in the kiln processing to replace fossil fuels. After the implementation of the projects, alternative fuels and less carbon intensive fuels have been used as substitutes for fossil fuels. This achieves emission reduction by avoidance of carbon dioxide emission from substitution of fossil fuels with alternative fuels or less carbon intensive fuels.

The grouped project considers simple standard technologies which have been developed by the Engineering Department of SCG Cement Co., Ltd. The engineering team provided an insight into state of the art technologies and machines. However, the biomass processing and preparation is slightly different at each site depending on what main biomass residue is used at the site. The processing of biomass residue feeding into cement kilns at Thung Song site is described below:

The design process at this site is the most complicate. Since many different types of biomass residues can be utilized such as sawdust, rice husk, palm shell, and wood slab. As the moisture content of these biomass residues is quite high, they need to be dried before feeding into the process. Moreover wood slabs need to be resized into 2 cm wood chips by a wood chipper as shown in Figure 3.



Figure 2: Biomass residues to be used at Thung Song site



Figure 3: Wood Resizing Process

Before wood chips and other biomass residues are transported, they are dried by a drying process. The wood chips are then transported to the wood chip hopper before being mixed with other biomass residues from another transporting line.

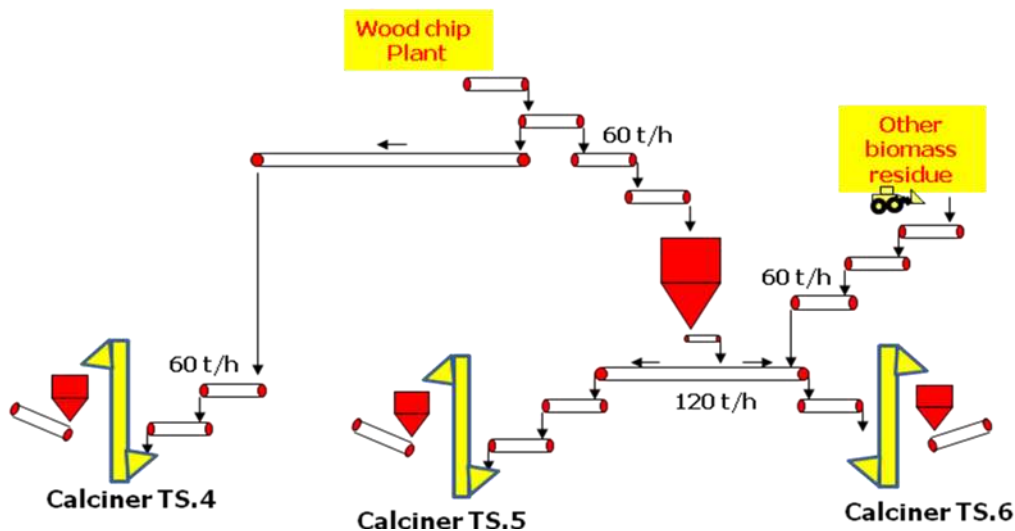


Figure 4: Flow Diagram of biomass transporting system

In order to enhance biomass residues burn-out efficiency, the feeding systems have been specifically designed and developed. The original feeding system has been changed to include a new feeding point. A light weight bucket elevator was installed to lift the biomass residue to the new feeding point as shown in Figure 4. The change in the feeding point alters the air in the feeding system to improve the combustion efficiency as shown in **Figure 6**.

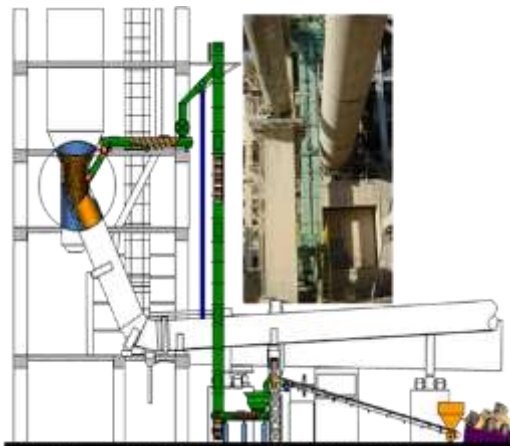


Figure 5: The new feeding point of biomass residue



Figure 6: New air feeding system

1.9 Project Location

The proposed projects are located in different areas around Thailand. Three of them are located in Saraburi province: Kaeng Khoi District, Ban Kor District and Phraputtabat District, approximately 120 km north of Bangkok. One project site is located in Lampang province, approximately 600 km to the north of Bangkok. The remaining project site is located in Nakhon Si Thammarat province, approximately 835 km to the south of Bangkok. Details of the location, both physical address and geographical location, are presented in table 4 and 5 below:

Table 4: Physical address

Project site	Address
The Siam Cement (Kaeng Khoi)	33/1 Moo3, Tambon Ban Pa, Kaeng Khoi District, Saraburi, 18110, Thailand
The Siam Cement (Ta Luang)	1 Moo 9, Tambon Ban Krao, Ban Mor District, Saraburi, 18270, Thailand
The Siam Cement (Khao Wong)	28 Moo 9, Tambon Khaowong, Phraputtabat District Saraburi 18120, Thailand
The Siam Cement (Lampang)	279 Moo 5, Tambon Bansa, Chaehom District, Lampang ,52120, Thailand
The Siam Cement (Thung Song)	52 Moo 6, Tambon Teewang, Thung Song District, Nakon Si Thammarat, 80110, Thailand

Table 5: Geographical coordinate

Project site	Latitude	Longitude
The Siam Cement (Kaeng Khoi)	14°36'33.59"N	100°59'46.88"E
The Siam Cement (Ta Luang)	14°34'10.00"N	100°45'56.10"E
The Siam Cement (Khao Wong)	14°45'08.56"N	100°47'15.21"E
The Siam Cement (Lampang)	18°33'22.66"N	99°34'23.08"E
The Siam Cement (Thung Song)	8° 6' 1.20" N	99° 41' 2.50" E

**Figure 7: Project Location**



Figure 8 : Project locations in Saraburi Province



Figure 9 : Project location in Lampang Province



Figure 10 : Project location in Nakorn Sri Thammarat Province

1.10 Conditions Prior to Project Initiation

Prior to project activity initiation, biomass and other alternative fuels were not treated or combusted in the process. The table below shows the fuels used in 2000 – 2002 which is three years before the use of biomass residue was introduced into cement manufacture.

Table 6: The type of fuels used in each site in 2000-2002³

Project Site	HFO	Coal	Lignite	Pet-Coke	Anthracite
The Siam Cement (Kaeng Khoi)	✓	✓	✓	–	✓
The Siam Cement (Ta Lung)	✓	✓	✓	✓	–
The Siam Cement (Khao Wong)	✓	✓	✓	–	–
The Siam Cement (Lampang)	✓	–	✓	–	–
The Siam Cement (Tong Song)	✓	✓	✓	✓	✓

The main fuels used in the clink production process, before the implemented use of the biomass residue system, was fossil fuels such as fuel oil, coal, lignite, petroleum coke and anthracite as shown in the Table above. According to the table above, during the last three years, prior to the start of the project activity, no biomass residue has been used in the project plant as a fuel.

The grouped project has been using mainly lignite and coal, a small percentage of pet-coke, anthracite and an insignificant quantity of fuel oil. The project plant fuel mix before the project activity was as follows:

Table 7: Fuel mix in each project site before implementation of project activity⁴

Project Site	HFO	Coal	Lignite	Pet-Coke	Anthracite
The Siam Cement (Kaeng Khoi)	1.14%	10.23%	64.91%	22.62%	1.11%
The Siam Cement (Ta Lung)	35.42%	21.71%	15.63%	27.24%	-
The Siam Cement (Khao Wong)	1.45%	4.66%	43.96%	44.03%	5.91%
The Siam Cement (Lampang)	0.93%	-	99.07%	-	-
The Siam Cement (Tong Song)	1.27%	40.23%	30.43%	19.25%	8.83%

³ Reference : Source: SCG work journal summary report year 2000 – 2002.

⁴ Reference : Source: SCG work journal summary report year 2000 – 2002.

Table 8: The consumption of fossil fuel in 2000-2003 (ton/year)⁵

Fossil Fuel	The Siam Cement - Kaeng Khoi		
	2000	2001	2002
HFO	3,877.00	3,320.00	5,678.00
Coal	137,006.00	1,948.00	43,007.00
Lignite	468,388.00	647,769.00	533,107.00
Pet-Coke	56,917.00	104,250.00	157,989.00
Anthracite	-	14,077.00	4,545.00

Fossil fuel	The Siam Cement - Ta Luang (Ta Luang)		
	2000	2001	2002
HFO	885.21	825.00	4,866.00
Coal	16,923.18	5,944.00	31,708.00
Lignite	46,845.18	92,730.00	251,340.00
Pet-Coke	4,643.11	1,771.00	59,457.00
Anthracite	-	-	-

Fossil Fuel	The Siam Cement Ta Luang (Khao Wong)		
	2000	2001	2002
Fuel Oil	3,705.00	4,188.00	2,260.53
Coal	27,218.00	3,166.00	19,573.66
Lignite	189,534.00	140,995.00	270,215.15
Pet-Coke	129,514.00	143,749.00	106,027.47
Anthracite	2,835.00	48,758.00	8,477.07

Fossil Fuel	The Siam Cement Lampang		
	2000	2001	2002
Fuel Oil	519.00	477.00	682.33
Coal	-	-	-
Lignite	105,615.00	105,743.00	191,910.00
Pet-Coke	-	-	-
Anthracite	-	-	-

⁵ Reference : Source: SCG work journal summary report year 2000 – 2002.

Fossil Fuel	The Siam Cement Thung Song		
	2000	2001	2002
HFO	4,125.88	3,291.27	2,485.83
Coal	188,135.89	166,151.87	143,493.22
Lignite	50,424.16	208,228.94	225,796.25
Coke	143,272.24	101,586.38	105,029.18
Anthracite	-	-	16,878.89

The information presented above, three years before implementation of project activity, indicates there was no use of biomass in all the projects in this group. In the absence of the project activity the ratio of fuel mix would be similar as shown in Table 7.

Since implementing the project activity, some biomass residue has partially substituted fossil fuel in the grouped project. Rice husk is a main biomass residue used in all sites. However, some sites, such as Kaeng Khoi and Tong Song consume other kinds of biomass residue such as wood chip, palm shell, and bark as shown in Table 9.

Table 9: The type of biomass to be used in project activities⁶

Project Site	Biomass Residue									
	Rice husk	Palm shell	Palm fiber	Saw dust	Wood chip	Char Coal	Bark	Stump	Dust Wood	Palm Trunk
The Siam Cement (Kaeng Khoi)	✓	-	-	✓	✓	-	✓	-	-	-
The Siam Cement (Ta Luang)	✓	-	-	-	-	-	-	-	-	-
The Siam Cement (Khao Wong)	✓	-	-	-	-	-	-	-	-	-
The Siam Cement (Lampang)	✓	-	-	-	-	-	-	-	-	-
The Siam Cement (Thung Song)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The quantity of biomass used in project activities will be provided in the monitoring reports during verification.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

Each projects in this group is compliant with all relevant laws and regulations in Thailand. It is the first time in Thailand that SCG Cement Co. Ltd. has taken initiative to implement the project. The proponent requested formal permission from the relevant government bodies to start the project activity. The project has already received EIA clearances from the Thai EIA committee.

⁶ Reference : the SCG work journal summary report, 2006

1.12 Ownership and Other Programs

1.12.1 Project Ownership

The ownership of each project proponents can be verified through following documents ;

- Operation license
- Service agreement or Emission Reductions Purchasing Agreement

1.12.2 Emissions Trading Programs and Other Binding Limits

The net GHG emission reductions or removals generated by the project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions.

1.12.3 Other Forms of Environmental Credit

The project neither has nor intends to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program.

1.12.4 Participation under Other GHG Programs

The project is not registered under other GHG Programs.

1.12.5 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

This project does not intend to have the new instances, therefore the eligibility criteria is not applicable.

Leakage Management

Not Applicable.

Commercially Sensitive Information

Not Applicable.

Sustainable Development

The project activity contributes the sustainable development in more than one way.

Technology:

The use of biomass residue in cement kilns was new and no cement plant in Thailand had introduced the system before the successful development of the knowledge, technology and system by SCG Cement Co.,Ltd. This group project is a first of its kind in Thailand. The Engineering

Department of SCG Cement Co.,Ltd did the research and designed the system, and first implemented it at The Siam Cement (Kaeng Khoi) Co., Ltd. The knowledge and technology has been transferred to other sites such as Khao Wong site, Ta Lung site, Tung Song site and Lampang site. Although the main concept of the systems is the same, there are slight differences in technology used, depending on the type and quality of biomass residue around site location.

Since the type and quality of biomass residue is different at each site, biomass preparing systems are needed at some sites and not at others. One example such as the drying process installed in The Siam Cement (Thung Song) Co., Ltd. because the biomass used has more moisture content than other sites. The drying technology was first developed by SCG Cement Engineering Department at the Tung Song site as a pilot project. The result of the study was distributed to other sites by the Engineering Department. Another example in technology transfer is when the feeding point had to be reconsidered and changed from direct feeding systems to intermediate storage for stable feeding in order to increase capacity of burning the biomass. After the success at the Khao Wong site, this system was transferred to other sites. Also at the Khao Wong site, the biomass injection system had been developed to increase feed rate by reducing unstable feeding and improve consistency of rice husk distribution in the calciner. With this new feeding system, an increase in the biomass consumption to 22% by heat can be achieved and the calciner temperature can be better controlled compared to the first design of feeding system.

As noted in the examples above, the improvement of the knowledge and technology for using biomass residue in cement kiln have been developed and transferred into this group project since the first implementation. With the SCG knowledge sharing policy, the knowledge and technology about using biomass in cement kiln will be developed and transferred into the future.

Economic:

New jobs will be created during the construction and operation phases of the projects and regional economic development can foster through contracts to local firms. In addition, not only will partial reimbursement on the vast investment cost can be made through utilization of the projects, but the additional revenue from the sale of VCUs will also make the project happen.

Social:

The project activities provide direct and indirect employment to the local community during construction of the project activity as well as during operation. During construction, employment was offered for a lot of local unskilled labors, contributing to social wellbeing and economic wellbeing. The involvement of local employees in the project activity will help to enhance the skills of the labors in the region by training them in different technical areas. In addition the close collaboration between external experts and local counterparts is expected to promote long-term sustainable partnership, benefiting the local stakeholders.

The partial substitution of fossil fuels with alternative fuels and biomass from the projects is resulting in an increased availability of these fuels in the local market. The noise, arising from the machines is insignificant. There are no other occupational health issues identified. The safety aspects of operating the project activities will be sufficiently addressed.

Environmental:

Due to partial substitution of fossil fuels with alternative fuels and biomass in this grouped project, the GHG emission generated from fossil fuels have been reduced. In addition, not only have the

GHG generated from the projects been reduced, the GHG emission from upstream environmental impacts related to coal mining and processing have also been reduced as well as the usage of the natural source. The improving of waste management system is also another environmental benefit from these project activities.

Apart from the above contributions, The Siam Cement Group (SCG) has very strong portfolio in Sustainable Development. SCG conducts its business with sustainability throughout the entire supply chain. The examples of on-going projects regarding the sustainability development are presented below.

- In area of empowerment and enhancing quality of life of the community and society, SCG has scaled up the successful implementation of SCG Conserving Water for Tomorrow project add the Innovative Technology for Remediation of Saline Land project by setting up two Community Learning Centers to showcase good practice and lesson learnt. Titled 'Satanee Plook Khid Pun Sukh' (instilling thinking and sharing happiness station), these community-based Learning Centers located in Nakhonratchasima and Lampang provinces serve as on-site learning facilities for those interested in community empowerment on sustainable livelihoods.
- SCG foundation⁷ 'Power of Wisdom' which SCG has cooperated with other partners namely 'Man Pattana Foundation', to develop and offer a curriculum to train community leaders, opinion leaders, military officers and farmers, with a view to modernizing their paradigm with emphasis on logical thinking, problem-solving skill and self-sufficiency.
- In recognition of its commitment to sustainable business practice, SCG maintains its top ranking position in the Construction Materials Industry of Dow Jones Sustainability Indices for the 1st consecutive year. SCG strives to improve its transparency in disclosing information further, by committing to using global accepted sustainability reporting guidelines, the 4th generation of the Global Reporting Initiative (GRI-G4)

The information of Sustainability Performance data, SCG ECO Value and Sustainability Report, which will be updated on annually basis, is available for public under the 'Sustainability Development' session on its website⁸

Further Information

Not Applicable.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

The large – scale consolidate methodology – ACM0003 (version 08.0): Partial substitution of fossil fuels in cement or quicklime manufacture, is applied for this project activity.

⁷ <http://www.scgfoundation.org/>

⁸ http://www.scg.com/en/05sustainability_development/

This selected methodology also refers to the latest approved versions of the following approved methodologies and methodological tools:

- (a) “Combined tool to identify the baseline scenario and demonstrate additionality”, version 07.0;
- (b) “Upstream leakage emissions associated with fossil fuel use”, Version 02.0
- (c) “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”, version 03;
- (d) “Baseline , project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, version 03.0;
- (e) “Project and leakage emissions from transportation of freight”, version 01.1.0.

2.2 Applicability of Methodology

The proposed project activity meets each of the applicability conditions of the methodology ACM0003 version 08.0, justified as follows:

Applicability Criteria	Project Status
3. The methodology is applicable to project activities in the cement or quicklime industry where fossil fuel(s) used in an existing clinker or quicklime production facility are partially replaced by less carbon intensive fossil fuel(s) and/or alternative fuel(s).	The proposed project activities are the partially replacing of fossil fuels by biomass residues in cement plant. Therefore , the proposed project activity can fulfil this applicability condition.
4. The following conditions shall apply: (a) A significant investment is required to enable the use of the alternative fuel(s) and/or the less carbon intensive fossil fuel(s); (b) During the last three years prior to the start of the project activity, no alternative fuels have been used in the project plant; (c) The CO ₂ emissions reduction relates to CO ₂ emissions generated from fuel combustion only and is unrelated to the CO ₂ emissions from decarbonisation of raw materials (i.e. CaCO ₃ and MgCO ₃ bearing minerals); (d) The methodology is applicable only for installed capacity (expressed in tonnes clinker/year or tonnes quicklime/year) that exists by the time of validation of the project activity.	a) The significant investment is required for new machinery installation, including storage, handling and transporting systems to enable the use of alternative fuels and/or the less carbon intensive fossil fuels. b) According to the fuel consumption data in WJ during the last three years period, before the start of the project activities, no alternative fuels and biomass were consumed. However a small amount of alternative fuels was used in the testing phase of the projects. c) The CO ₂ emission reductions are only related to the CO ₂ generated by fuel burning requirement and not by decarbonisation of raw material. d) The installed capacity has not changed at project site during the time of validation as described in section 1.1. Therefore , the proposed project activities can fulfil all above applicability criterions.

5. In case of project activities using biomass residues or renewable biomass, the following applicability conditions apply: (a) The biomass is not chemically processed (e.g. esterification to produce biodiesel, production of alcohols from biomass, etc.) prior to combustion in the project plant but it may be processed mechanically or be dried at the project site. Moreover, any preparation of the biomass, occurring before use in the project activity, does not cause other significant GHG emissions (such as, for example, methane emissions from anaerobic treatment of waste water or from char coal production); (b) The biomass used by the project facility is stored under aerobic conditions.	a) The biomass residues used in the project plant are not chemically processed prior to combustion in the project plant. b) All biomass residues used in the project plant are stored under aerobic condition and the storage time is less than one year. Therefore , the proposed project activities can fulfil both applicability criterions.
6. If the land area is severely degraded, land degradation can be demonstrated using one or more of the following indicators: (a) Vegetation degradation, for example: (i) Crown cover of pre-existing trees has decreased in the recent past for reasons other than sustainable harvesting activities; (b) Soil degradation, for example: (i) Soil erosion has increased in the recent past; (ii) Soil organic matter content has decreased in the recent past; (c) Anthropogenic influences, for example: (i) There is a recent history of loss of soil and vegetation due to anthropogenic actions; and (ii) Demonstration that there exist anthropogenic actions/activities that prevent possible occurrence of natural regeneration.	This condition is not relevant to the project activities.
7. The methodology is not applicable to project activities that implement efficiency measures in production of clinker or quicklime, such as changing the configuration/number of pre-heaters.	The project will not implement any efficiency measures in clinker production. Therefore , the proposed project activities can fulfil this applicability condition.
8. Finally, this methodology is only applicable if F2 (the continuation of the current fuel mix) or F3 (a different fossil fuel mix portfolio) results	As per the description of baseline scenario provided in section 2.4 , the most plausible

to be the most plausible baseline scenario for the use of fuels in the cement or quicklime plant and if one or several of the following scenarios, as explained in the “Procedure for the selection of the most plausible baseline scenario and demonstration of additionality”, result to be the most plausible baseline scenario for the use of alternative fuels: (a) For the fate of any wastes originating from fossil sources: scenarios W1 and/or W3; (b) For the fate of any biomass residues: scenarios B1, B2 and/or B3; (c) For the fate of any renewable biomass: scenario R1.	baseline scenarios of this project activities are summarized as below; - the option F2 or F3 for the use of fuels in cement plant ; - the option W1 or W3 for using wastes originating from fossil sources ; - the option B3 for using of biomass residues. Therefore , the proposed project activities can fulfil this applicability condition.
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2.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from fossil fuels displaced in the project plant ($BE_{FF,y}$)	CO ₂	Yes	Main emission source
		CH ₄	No	Minor source. Neglected for simplicity
		N ₂ O	No	Minor source. Neglected for simplicity
	Methane emissions avoided from preventing disposal or uncontrolled burning of biomass residues	CO ₂	No	It is assumed that CO ₂ emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH ₄	Yes	Included if leakage can be ruled out.
		N ₂ O	No	Minor source
Project	Emissions from the use of alternative fuels and/or less carbon intensive fossil fuels ($PE_{k,y}$)	CO ₂	Yes	Main emission source
		CH ₄	No	Minor source. Neglected for simplicity
		N ₂ O	No	Minor source. Neglected for simplicity
	Emissions from additional electricity and/or fossil fuel consumption as a result of the project activity ($PE_{FC,y}$ and $PE_{EC,y}$)	CO ₂	Yes	Can be a significant emission source
		CH ₄	No	Minor source. Neglected for simplicity
		N ₂ O	No	Minor source. Neglected for simplicity
	Emissions from combustion of fossil fuels for transportation of alternative fuels to	CO ₂	Yes	Can be a significant emission source
		CH ₄	No	Minor source. Neglected for simplicity
		N ₂ O	No	Minor source. Neglected for simplicity

Source		Gas	Included?	Justification/Explanation
	the project plant ($PE_{T,y}$)			
	Emissions from the cultivation of renewable biomass at the dedicated plantation ($PE_{BC,y}$)	CO ₂	No	No use of biomass from dedicated plantation.
		CH ₄	No	No use of biomass from dedicated plantation.
		N ₂ O	No	No use of biomass from dedicated plantation.

2.4 Baseline Scenario

The first step in specifying the baseline is to identify realistic and credible alternatives available to project participants that provide outputs or service comparable with the proposed grouped project. In this case the baseline scenario will consider only three segments, including fuel mix for cement manufacturing, alternative fuels, biomass residues. The renewable biomass will not be considered in this case because there is no site using renewable biomass from a new dedicated plantation in the project plants.

The alternatives to be analyzed for the fuel mix for cement manufacturing may include, inter alia:

Alternative Scenario	Description	Justification
F1	The proposed project activity not undertaken as a CDM project activity.	Once project activity started, there were no implementation of CDM and other GHG reduction programs in Thailand.
F2	Continuation of current practice, i.e., a scenario in which the company continues cement production using the existing technology, materials and fuel mix.	The cement manufacturing industry in Thailand is mainly using coal. In the absence of the project activity the usage of lignite and other carbon intensive fuels in cost effective way would have continued without involving any major capital investments.
F3	The continuation of using only fossil fuels and no alternative fuels; however, with a different fuel mix portfolio, taking into account relative prices of fuels available. The scenario(s) may be based on one fuel or a different mix of fuels.	The cement manufacturing industry in Thailand is mainly using coal. In this regard, continuing utilization of fossil fuels is most likely to happen in the absence of the project activity. In Thailand formal permission from government is required to start alternative fuel usage in cement manufacturing. This requires a significant amount of effort on part of project proponent. Then in the absence of the project activities the usage of lignite and other carbon intensive fuels in a cost effective way would have continued.

Alternative Scenario	Description	Justification
F4	The current used fuels are partially substituted with alternative fuels and/or less carbon intensive fossil fuels other than those used in the CDM project activity and/or any other fuel types, without using the CDM. If relevant, develop different scenarios with different mixes of alternative fuels or less carbon intensive fuels and varying degrees of fuel-switch from traditional to alternative fuels or less carbon intensive fuels.	The project activity scenario is characterized by a substantial use of alternative fuels such as wastes originating from fossil sources, biomass residues (excluding renewable biomass from a dedicated plantation). The project activity was the first of its kind in Thailand. Implementation of fuel mix, even in different proportions would involve serious investment on the part of project proponents which is not a possible baseline scenario.
F5	The construction and operation of a new cement plant.	SCG Cement Co., Ltd has no plan to construct the new cement plant in Thailand.

Refer to the publications provided by World Business Council for Sustainable Development (WBCSD) for Cement Sustainability Initiative (www.wbcscement.org) , *Most cement kilns today use coal and petroleum coke as primary fuels, and to a lesser extent natural gas and fuel oil. As these fuels burn they provide energy, and some leave fuel ash containing silica and alumina compounds (and other trace elements). These combine with the raw materials in the kiln, contributing to the structure of the clinker and forming part of the final product*⁹.

In 2006 , *the use of alternative fuels on global level was 7% in relation to the total fuel energy consumption for cement manufacturing. Almost 3% was covered by biomass and the remaining 90% was provided by conventional fuels , mainly coal*¹⁰.

In 2014 , *the use of alternative fuels on global level as 16% of total fuel energy demand for cement manufacturing. Almost 6% of the 16% was covered by biomass and the remaining 84% was provided by conventional fuels , mainly coal*¹¹.

As per the justifications above, F2 or F3 are the most plausible baseline scenario for all project activities in this grouped project, according to the fuel mix for cement manufacturing.

⁹ Section 2.2 , page 7 of https://www.wbcscement.org/pdf/CSI%20Guidelines%20for%20Co-Processing%20Fuels%20and%20Raw%20Materials%20in%20Cement%20Manufacturing_v2.pdf

¹⁰ Section 2.3.1 , page14 of 99 - <https://www.wbcscement.org/pdf/technology/Technology%20papers.pdf>

¹¹ Section 2.3 , page 15/190 - https://www.wbcscement.org/pdf/technology/CSI_ECRA_Technology_Papers_2017.pdf

In light of using alternative fuels, the project participants should determine what would happen to the alternative fuels in the absence of the project activity. Deferent alternative scenarios are justified below:

Alternative Scenario	Description	Justification
W1	Incineration of the waste in a waste incinerator without utilizing the energy from the incineration.	In the absence of the project activity, most wastes have gone to the incinerator without utilizing the energy from the incineration.
W2	Incineration of the waste in a waste incinerator with use of the energy (e.g. for heat and/or electricity generation)	Wastes used at project are not used for energy purpose.
W3	Disposal of the waste at a managed or unmanaged landfill.	Some of the waste has been disposed at landfill in the absence of the project activity
W4	The use of the waste at other facilities, e.g. other cement plants or power plants, as a feedstock or for the generation of energy.	When project started , there were no cement plants and power plants using waste as fuels to generate energy.
W5	The recycling or reutilization of the waste.	All wastes to be used at the project plant cannot be recycled or reutilized.
W6	The proposed project activity, not undertaken as a CDM project activity, i.e. the use of the waste in the project plant.	The proposed project activity is not undertaken as a CDM project activity.

As per justification above, W1 or W3 is the most plausible baseline scenario for all project activities in this grouped project, in terms of using wastes originating from fossil sources.

In the segment of using biomass residues as alternative fuels in project plants, the alternatives are analyzed may include, inter alia:

Alternative Scenario	Description	Justification
B1	The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.	In the absence of the project activities, the biomass residues are not dumped or left to decay under aerobic conditions. Most of them were burnt in an uncontrolled manner without utilizing them for energy purpose and some of them were left on the ground, in mainly aerobic conditions.
B2	The biomass residues are dumped or left to decay under	Biomass residues may be left to decay under anaerobic condition,

Alternative Scenario	Description	Justification
	clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.	however for a conservative estimate of baseline emissions this is not taken into account.
B3	The biomass residues are burnt in an uncontrolled manner without utilizing them for energy purposes.	Most of the biomass used in project plants is burnt in an uncontrolled manner without utilizing them for energy purposes.
B4	The biomass residues are sold to other consumers in the market and used by these consumers, such as for heat and/or electricity generation, for the generation of bio-fuels, as feedstock in processes (e.g. the pulp and paper industry), as fertilizer, etc.	Moreover, some biomass residue has been consumed by power plants in the area. The remaining biomass residue is left to decay in fields or burnt in open fields.
B5	The biomass residues are used for other purposes at the project site, such as for heat and/or electricity generation, for the generation of bio-fuels, as feedstock in processes. (e.g. the pulp and paper industry), as fertilizer, etc.	Biomass residues are used for other purposes at the project site. The biomass residues are used only for substitution of fossil fuels.
B6	The proposed project activity, not undertaken as a CDM project activity, i.e. the use of the biomass residue in the project plant.	The proposed project activity is not undertaken as a CDM project activity.

As per the justifications above, B3 is the most plausible baseline scenario for all project activities in this grouped project, in term of using biomass residues for substitution of fossil fuels.

According to the selection of the most plausible baseline scenario above, it can be concluded that this proposed project activity is applicable for ACM0003 version 08.0.

Demonstration the validity of baseline scenario

As per reference from the VCS standard (version 3 v3.7), section 3.8.5 : Renewal of Project Crediting Period , 2) *The validity of the original baseline scenario shall be demonstrated, or where invalid a new baseline scenario shall be determined, when renewing the project crediting period, as follows:*

Assessment as per VCS standard	Justification
(a) The validity of the original baseline scenario shall be assessed. Such assessment shall include an evaluation of the impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario.	Refer to section 1.11 of this PD, <i>The proposed project activity is in compliance with all local laws and regulations.</i> Additionally , there is no new national/sectoral policies have been announced by governments until the date of validation for renewal of crediting period. Therefore, there is no impact to the original baseline of project activity.
(b) Where it is determined that the original baseline is still valid, the GHG emissions associated with the original baseline scenario shall be reassessed using the latest version of the CDM Tool to assess the validity of the original/current baseline and to update the baseline at the renewable of a crediting period.	The assessment is provided in Table 10.
(c) Where it is determined that the original baseline scenario is no longer valid, the current baseline scenario shall be established in accordance with the VCS rules.	According to assessment result presented in Table 10 , the original baseline scenario is still valid. This section is not applicable.
(d) The project description, containing updated information with respect to the baseline, the estimated GHG emission reductions or removals and the monitoring plan, shall be submitted for validation.	The project description is updated and revised according to the latest approved version of ACM0003 including the relevant tools to the applied methodologies.

The assessment of original baseline using “*Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1*” is presented in following table;

Table 10 : Validity of original baseline scenarios

Assessment as per CDM tool	Justification
<i>Step 1:</i> Assess the validity of the current baseline for the next crediting period	
<i>Step 1.1:</i> Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies	The project complies with the national policies as the justification is provided in the previous section.

Step 1.2: Assess the impact of circumstances	There is no change in the circumstance that would impact the continuation using of fossil fuels for clinker production as a baseline scenario of the project.
Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.	The identified baseline scenario at the first validation of this project was the continuous using of the fossil fuels at cement kilns without any investment. The use of fossil fuels in cement production is the standard and traditional practice for cement production in Thailand. F: As per reference from the <i>Guidelines for Co-Processing Fuels and Raw Materials in Cement Manufacturing</i> published by World Business Council for Sustainable Development (WBCSD) for cement¹², <i>Most cement kilns today use coal and petroleum coke as primary fuels, and to a lesser extent natural gas and fuel oil.</i> W: From the reference of <i>Solid Waste Management in Thailand</i>¹³; • 36% of waste generated has been disposed by appropriate sanitary system which are incinerator and landfill systems, • 43% of waste generated has been disposed by improper methods. B: Referring to the latest information of biomass potential data reported by Department of Alternative Energy Development and Efficiency¹⁴, the biomass generation in 2016 is 134,134,102.21 tonnes while only 71,289,681.68 tonnes or 53% were utilized. The rest biomass residues were left as scrap or burnt on ground. Moreover, the technical lifetime of baseline system which is the lifetime of the cement

¹² https://www.wbcsdcement.org/pdf/CSI%20Guidelines%20for%20Co-Processing%20Fuels%20and%20Raw%20Materials%20in%20Cement%20Manufacturing_v2.pdf

¹³ <https://hls-esc.org/documents/8hlsesc/Thematic%20C1/Thematic%20%20C1%20-%20Thailand%20-%20Solid%20Waste%20Management%20in%20Thailand,%20Policy%20and%20Implementation%20by%20Dr.%20Wijarn%20Simachaya.pdf>

¹⁴ http://biomass.dede.go.th/biomass_web/index.html

	kiln , also exceeds the crediting period for which renewal is requested. Therefore , the scenario to continue the using of current baseline equipment(s) is still applicable for this crediting period.
Step 1.4: Assessment of the validity of the data and parameters	All data and parameters that were determined at the start of the crediting period are updated accordingly.

The justification provided above shows that the selected baseline scenarios in the 1st crediting period , are still valid for subsequent crediting period. Therefore, all data and parameters can be used for the renewed crediting period.

2.5 Additionality

As per reference from the VCS standard (version 3 v3.7) , section 3.8.5 : Renewal of Project Crediting Period , 1) *a full reassessment of additionality is not required when renewing the project crediting period. However, regulatory surplus shall be demonstrated in accordance with Section 4.6.3) and the project description shall be updated accordingly.*

Paragraph 4.6.3 of VCS standard states that:

Step 1: Regulatory surplus

The project shall not be mandated by any law, statute or other regulatory framework. For UNFCCC non-Annex I countries, laws, statutes, regulatory frameworks or policies implemented¹⁵ since 11 November 2001 that give comparative advantage to less emissions intensive technologies or activities relative to more emissions-intensive technologies or activities need not be taken into account. For all countries, laws, statutes, regulatory frameworks or policies implemented since 11 December 1997 that give comparative advantage to more emissions intensive technologies or activities relative to less emissions-intensive technologies or activities shall not be taken into account.

There is no current regulatory requirement for the using less-carbon alternative fuels in cement production in Thailand, together with the description provided in section 1.11 of this document. Therefore, The proposed project activity is a regulatory surplus as it is not being implemented to respond to laws or regulations.

The assessment of additionality from the prior PD is provided as follow.

According to the simplified modalities and procedures for CDM project activity, explanation must be provided to show that the project activity would not have occurred anyway due to at least one

¹⁵ Implemented in the context of this paragraph means enacted or introduced, consistent with use of the term under the CDM rules on so-called Type E+ and Type E- policies.

barrier. The additionality demonstration will follow the procedure regarding the “combined tool to identify the baseline scenario and demonstrate additionality” version 02.2 approved by UNFCCC.

STEP1: Identification of alternative scenarios;

STEP2: Barrier analysis;

STEP3: Investment analysis (if applicable); and

STEP4: Common practice analysis.

The summarized procedure in the ‘demonstrate additionality’ on page 3 of the “combined tool to identify the baseline scenario and demonstrate additionality”, describes how the emission of GHG (by source) in the baseline scenario is reduced to those that would have occurred in the absence of the project activity. The justification is as follows:

STEP 1: Identification of alternative scenarios

This step serves to identify all alternative scenarios to the proposed projects that can be the baseline scenario through the following sub-steps:

Step 1a: Define alternative scenarios to the proposed project activity

All alternative scenarios have been proposed in the methodology. The alternatives to be analysed for the fuel mix for cement manufacturing may include, inter alia:

F2: Continuation of current practice, i.e., a scenario in which the company continues cement production using the existing technology, materials and fuel mix.

F3: The continuation of using only fossil fuels and no alternative fuels, however, with a different fuel mix portfolio, taking into account relative prices of fuels available. The scenarios may be based on one fuel or a different mix of fuels.

Step 1b: Consistency with mandatory applicable laws and regulation.

Although there are some laws and regulations to control local air pollution, the project site has already identified and implemented the protection measures according to the regulations. The environmental risk identification and protection mechanisms are suggested in the approved EIA report.

Therefore, both of the alternatives proposed in step 1a are in compliance with all mandatory applicable legal and regulatory requirements.

As per described above, F2 and F3 are identified as alternative scenarios, and shall proceed for analysis to Step 2 (Barrier analysis).

STEP 2: Barrier analysis

This step serves to identify barriers and to assess which alternatives are prevented by these barriers. Apply the following sub-steps:

Step 2a: Identify barriers that would prevent the implementation of alternative scenarios

Establish a complete list of realistic and credible barriers that may prevent alternative scenarios to occur. Such realistic and credible barriers may include: investment barriers, technological barriers and lack of prevailing practice.

In this project activity, the technological barrier and lack of prevailing practice are considered as the two main barriers for the implementation of all project activities.

Step 2b: Eliminate alternative scenarios which are prevented by the identified barriers

Identify which alternative scenarios are prevented by at least one of the barriers listed in sub-step 2a, and eliminate those alternative scenarios from further consideration.

Technological barrier

The cement manufacturing industry in Thailand mainly uses fossil fuels for clinker production. In addition to improving waste management systems, the partial substitution of fossil fuels with biomass residue in the cement plants in SCG Cement Co, Ltd. was made to improve and reduce the environmental impact of manufacturing. There were some limitations to technology. The main technological barriers identified in the project activity scenario are:

- When using rice husks, the input of silica into the burner, and consequently into the kiln, is increased. As a consequence of this, the chemical process is affected and quality of the clinker could also be affected.
- The homogeneous energy flow is crucial for consistently high clinker quality. The homogeneous energy flow is controlled in the process, but the energy flow of alternative fuel is not as smooth as fossil fuel. Also biomass fuel has more affinity to moisture which increases the risk of clogging. Therefore the processing control requires serious and keen observation by the operation and quality personnel.
- When substituting partially for fossil fuels with alternative fuels and biomass residue, changes in the raw material components to meet the relevant quality standard is expected. The quality and quantity of raw material must be given strict consideration.
- Due to the different type of alternative fuels and the changes in the alternative fuels mix composition used in the clinker production, a disturbance in process is likely to happen.
- The type of refractory might need to be changed in order to ensure a long life.

To avoid these operation problems, the technology and knowledge development for using biomass residue in cement processing was introduced and transferred from one site to another. For example, to reduce unstable feeding and improve the consistency of rice husk, the new feeding point and design had been researched and is as shown in Figure 11.



Figure 11: the new feeding point and its design

Moreover, a new method of feeding had been introduced for effective biomass particle distribution into the calciner chamber, to avoid the damage resulting from the hot spot during biomass combustion in the chamber. This new method of feeding is shown in Figure 12.

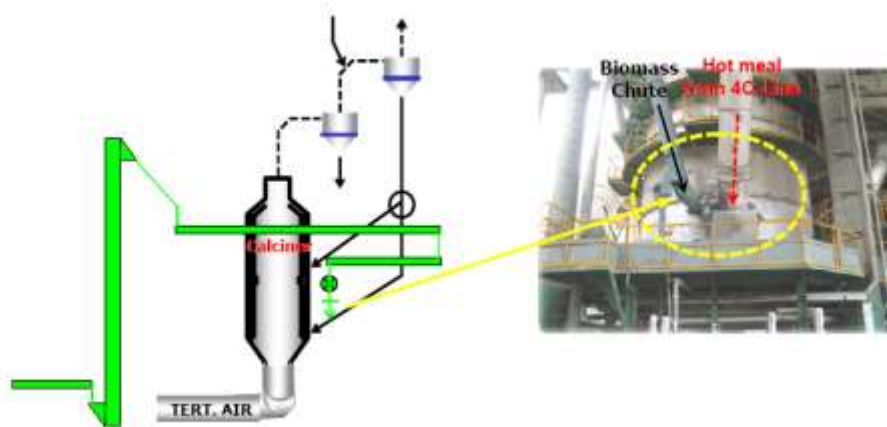


Figure 12: The new method of biomass feeding

Both of these improvements have been transferred to other sites and then later implementing at Kho Wong. However the method of biomass systems will be developed to increase the consumption of biomass into the future.

Another example of the transfer of knowledge is the drying technique that was studied for the Thung Song site. The site is located in the Southern part of Thailand which has rain all year, as a result there is a high moisture content in the biomass residue. The dryer has been studied and developed to solve this problem. Subsequently the hybrid dryer was developed by SCG engineering team. The mechanical fluidized bed dryer technology concept and flash dryer technology concept were combined together which became a new technology called a hybrid dryer. The main advantage of this combination of technology is the ability to operate with many kinds of biomass residues.

In order to progress technology developments for the use of biomass in cement manufacture, the new system designs have been studied and specifically developed at all sites since the first introduction at the Ta Luang and the Kaeng Khoi site. As a result the technological barrier is a main barrier in this group project.

Financial analysis

To invest in all project activities, the companies had to spend vast amounts of money for developing the technologies, including machines, process control system and staff training. Moreover the companies have to take a risk on new modifications and processing conditions which have not been operated before.

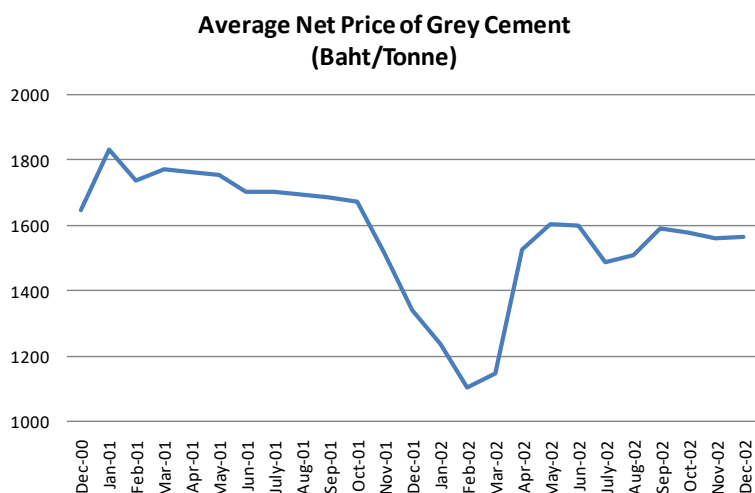


Figure 13: Average Net Price of Grey Cement

At the time when the investment decision was made the cement price had dropped and was fluctuating as shown in Figure 13. With the situation of cement prices at the time, the large investment was a risky option. Moreover, the investment in the new technologies was costly, (as shown in the table below) and risky from a business point of view.

The approximate investment for each project sites is shown below:

Table 11: Approximate investment to implement the use of biomass residue in each site

Project site	Total Investment (MBaht)
The Siam Cement (Kaeng Khoi)	89.44
The Siam Cement (Ta Luang)	26.01
The Siam Cement (Khao Wong)	31.69
The Siam Cement (Lampang)	8.20
The Siam Cement (Thung Song)	149.56

As shown in Table 11, a significant investment was required to enable the use of the biomass residue at each site. The investment at each site differed depending on the different type of biomass residue, the quality of biomass and the size of the cement plant. For example, at the Thung Song site,

biomass residue needs to be dried before feeding it into the kiln, while a dryer is not required for other sites. As a result, the investment cost for the Thong Song biomass residue system is higher than other sites. Moreover, the production capacity of Thong Song is quite high compared to others, and the system in Tong Song has been designed to process many kinds of biomass residues. Kaeng Khoi has also been designed to process many kinds of biomass residue, and therefore, the investment of both these sites is higher than others.

On the other hand the Lampang site, which has the lowest production capacity in the group project, uses only rice husk in process, and as a result the investment on the project activity is lower than others.

However, all sites in this group project required a significant investment to enable the use of biomass residue.

Barrier of prevailing practise:

As indicated, the technology and systems used in the project activities are the first implementation in cement manufacture. At the time there were no other project activities in cement manufacturing in Thailand substituting the fossil fuels with alternative fuels and biomass residue. Therefore, there are no similar options before this grouped project in cement manufacturing in Thailand.

Therefore, the group of cement plant in this grouped project is the first of its kind in Thailand.

STEP 3: Investment Analysis

The additionality tool requires either an investment analysis or a barrier analysis. A barrier analysis has been conducted for this proposed grouped project.

STEP 4: Common practice analysis

Step 4a. Analyse other activities similar to the proposed project activity.

There were no other activities similar to the project activity in Thailand before 2002.

Step 4b. Discuss any similar options that are occurring.

Use of alternative fuel and biomass residue in cement manufacturing were not a common practice in Thailand before 2002. This kind of initiative was the first of its kind in the country.

The barriers analysis confirms that all project activities in this grouped project are additional and would not have been developed in the absence of the registered VCS project activity.

2.6 Methodology Deviations

Deviation 1

Description of deviation

The $P_{clinker,y}$ is not monitored by the weight feeder.

Deviated approach

The daily clinker production, is calculated from the amount of raw meal and clinker factor. The summary of daily clinker production in a month is adjusted by the stock checking data at the end of month and reported in the Work Journal.

Justification of deviated approach

Since the amount of clinker production cannot be directly measured because of its high temperature. The amount the raw meal which is directly measured by weight feeder and the clinker factor is used for calculating the clinker production.

- The amount of raw meal is continuously monitored by the weight feeder and the data is recorded on daily basis.
- The clinker factor is from the result of LOI (Lost of Ignition) , % ash , % dust loss and moisture content from internal laboratory.
- The amount clinker produced in the stock checking report is from the truck scale and the available stock of clinker in the cement factory.
- The calculated amount of clinker produced is cross-checked and adjusted with the stock checking information on monthly basis to ensure the accuracy of the figures presented in the Work Journal.

This approach can improve the accuracy and reliability of monitoring data measured from monitoring devices. It was also applied for previous verifications and does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

The project reduces CO₂ emissions by using alternative fuels and/or less carbon intensive fossil fuels in the pre-calciner and the kiln for the production of clinker in cement manufacture or in the calcination kiln for the production of quicklime. If applicable, the project may also reduce CH₄ emissions from preventing disposal or uncontrolled burning of biomass residues. Baseline emissions are calculated as follows:

$$BE_y = BE_{FF,y} + BE_{CH_4,biomass,y} \quad \text{Equation (3)}$$

Where:

BE_y = Baseline emissions in year y (t CO₂)

$BE_{FF,y}$ = Baseline emission from fossil fuels displaced by alternative fuels or less carbon intensive fossil fuels in year y (t CO₂)

$BE_{CH_4,biomass,y}$ = Baseline methane emissions avoided during the year y from preventing disposal or uncontrolled burning of biomass residues (t CO₂e)

Baseline emissions are determined in the following steps:

- (a) Step 1. Estimate the project specific fuel penalty;
- (b) Step 2. Calculate baseline emissions from the fossil fuels displaced by the alternative or less carbon intensive fuel(s);
- (c) Step 3. Calculate baseline emissions from decay, dumping or burning of biomass residues.

Step 1: Estimate the project specific fuel penalty

A project specific fuel penalty is applied because the combustion of typically coarser biomass or other alternative fuels will reduce the heat transfer efficiency in the cement or quicklime manufacturing process. The use of alternative fuels will therefore require a greater heat input to produce the same quantity and quality of clinker or quicklime. The chemical content and ease of absorption into clinker or quicklime of all fuel ashes also differs, and this also contributes to the need for a project specific fuel penalty.

This project specific fuel penalty (FP_y) should be determined as follows:

$$FP_y = S_{PJ,k,y} \times P_{clinker,y} \times \text{MAX}(0, SEC_{clinker,PJ,y} - SEC_{clinker,BL}) \quad \text{Equation (4)}$$

Where:

FP_y	= Fuel penalty in year y (GJ)
$S_{PJ,k,y}$	= Share of the clinker produced while project alternative or less carbon intensive fuel or biomass was used in year y (mass fraction) , which equal to 1 or 100%
$P_{clinker,y}$	= Production of clinker in year y (t)
$SEC_{clinker,PJ,y}$	= Specific energy consumption of the project plant in year y (GJ/t clinker)
$SEC_{clinker,BL}$	= Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker)

The specific energy consumption in the project is calculated based on the quantity of all fuels used in the project plant and the quantity of clinker or quicklime produced in year y , as follows:

$$SEC_{clinker,PJ,y} = \frac{\sum_i (FC_{PJ,i,y} \times NCV_{i,y}) + \sum_k (FC_{PJ,k,y} \times NCV_{k,y})}{P_{clinker,y}} \quad \text{Equation (4)}$$

Where:

$SEC_{clinker,PJ,y}$	= Specific energy consumption of the project plant in year y (GJ/t clinker)
$FC_{PJ,i,y}$	= Quantity of fossil fuel type i fired in the project plant in year y (t)

$NCV_{i,y}$	=	Net calorific value of the fossil fuel type i in year y (GJ/t)
$FC_{PJ,k,y}$	=	Quantity of alternative fuel or less carbon intensive fossil fuel type k used in the project plant in year y (t)
$NCV_{k,y}$	=	Net calorific value of the alternative or less carbon intensive fuel type k in year y (GJ/t)
$P_{clinker,y}$	=	Production of clinker in year y (t)
k	=	Alternative fuel types and less carbon intensive fossil fuel types used in the project plant in year y
i	=	Fossil fuel types used in the project plant in year y that are not less carbon intensive fossil fuel types

As a conservative approach, the specific energy consumption in the absence of the project activity is calculated as the average annual ratio of fuel input per clinker production of the most recent three years prior to the start of the project activity, as follows:

$$SEC_{clinker,BL} = \frac{\frac{HG_x}{P_{clinker,x}} + \frac{HG_{x-1}}{P_{clinker,x-1}} + \frac{HG_{x-2}}{P_{clinker,x-2}}}{3} \quad \text{Equation (1)}$$

with

$$HG_x = \sum_i FC_{i,x} \times NCV_i \quad \text{Equation (2)}$$

Where:

$SEC_{clinker,BL}$	=	Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker)
HG_x	=	Heat generated from fuel combustion in the project plant in the historical year x (GJ)
$FC_{i,x}$	=	Quantity of fossil fuel type i used in the project plant in year x (t)
NCV_i	=	Net calorific value of the fossil fuel type i (GJ/t)
$P_{clinker,x}$	=	Production of clinker in year x (t)
x	=	Year prior to the start of the project activity
i	=	Fossil fuel types used in the project plant in the last three years prior to the start of the project activity

Step 2: Calculate baseline emissions from the fossil fuels displaced by the alternative or less carbon intensive fuel(s)

Baseline emissions from displacement of fossil fuels are calculated as follows:

$$BE_{FF,y} = \left[\sum_k (FC_{PJ,k,y} \times NCV_{k,y}) - FP_y \right] \times EF_{CO2,BL,y} \quad \text{Equation (3)}$$

Where:

$BE_{FF,y}$	=	Baseline emission from fossil fuels displaced by alternative fuels or less carbon intensive fossil fuels in year y (t CO ₂)
$FC_{PJ,k,y}$	=	Quantity of alternative fuel or less carbon intensive fossil fuel type k used in the project plant in year y (t)
$NCV_{k,y}$	=	Net calorific value of the alternative or less carbon intensive fuel type k in year y (GJ/t)
FP_y	=	Fuel penalty in year y (GJ)
$EF_{CO2,BL,y}$	=	Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels or less carbon intensive fossil fuels in the project plant in year y (t CO ₂ /GJ)
k	=	Alternative fuel types and less carbon intensive fossil fuel types used in the project plant in year y

The baseline emission factor ($EF_{CO2,BL,y}$) is estimated as the lowest of the following CO₂ emission factors:

- (a) The weighted average CO₂ emission factor for the fossil fuel(s) consumed during the most recent three years before the start of the project activity, calculated as follows:

$$EF_{CO2,BL,y} = \frac{\sum_i (FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}) \times NCV_i \times EF_{CO2,FF,i}}{\sum_i (FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}) \times NCV_i} \quad \text{Equation (4)}$$

Where:

$EF_{CO2,BL,y}$	=	Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels or less carbon intensive fossil fuels in the project plant in year y (t CO ₂ /GJ)
$FC_{i,x}$	=	Quantity of fossil fuel type i used in the project plant in year x (t)
NCV_i	=	Net calorific value of the fossil fuel type i (GJ/t)
$EF_{CO2,FF,i}$	=	CO ₂ emission factor for fossil fuel type i (t CO ₂ /GJ)
x	=	Year prior to the start of the project activity
i	=	Fossil fuel types used in the project plant in the last three years prior to the start of the project activity

- (b) The weighted average annual CO₂ emission factor of the fossil fuel(s) that are not less carbon intensive fossil fuels and that are used in the project plant in year *y*, calculated as follows:

$$EF_{CO_2,BL,y} = \frac{\sum_i FC_{PJ,i,y} \times NCV_{i,y} \times EF_{CO_2,FF,i,y}}{\sum_i FC_{PJ,i,y} \times NCV_{i,y}} \quad \text{Equation (5)}$$

Where:

- $EF_{CO_2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels or less carbon intensive fossil fuels in the project plant in year *y* (t CO₂/GJ)
- $FC_{PJ,i,y}$ = Quantity of fossil fuel type *i* fired in the project plant in year *y* (t)
- $NCV_{i,y}$ = Net calorific value of the fossil fuel type *i* in year *y* (GJ/t)
- $EF_{CO_2,FF,i,y}$ = Carbon dioxide emission factor for fossil fuel type *i* in year *y* (t CO₂/GJ)
- i* = Fossil fuel types used in the project plant in year *y* that are not less carbon intensive fossil fuel types

- (c) If F3 has been determined as the most likely baseline scenario: the weighted average annual CO₂ emission factor for the fossil fuel(s) that would have been consumed according to fuel mix determined in the “Procedure for the selection of the most plausible baseline scenario and demonstration of additionality” above, as follows:

$$EF_{CO_2,BL,y} = \frac{\sum_i FC_{BL,F3,i,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{\sum_i FC_{BL,F3,i,y} \times NCV_{i,y}} \quad \text{Equation (6)}$$

Where:

- $EF_{CO_2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels or less carbon intensive fossil fuels in the project plant in year *y* (t CO₂/GJ)
- $FC_{BL,F3,i,y}$ = Quantity of fossil fuel type *i* that would in the absence of the project activity be used in the project plant according to the selected baseline scenario F3 in year *y* (t)
- $NCV_{i,y}$ = Net calorific value of the fossil fuel type *i* in year *y* (GJ/t)
- $EF_{CO_2,i,y}$ = Carbon dioxide emission factor for fossil fuel type *i* in year *y* (t CO₂/GJ)
- i* = Fossil fuel types that are not less carbon intensive fossil fuel types and that would in the absence of the project activity be used in the project plant according to the selected baseline scenario F3 in year *y*

Step 3: Calculate baseline emissions from decay, dumping or burning of biomass residues

The calculation of baseline methane emissions from biomass residues dumped, left to decay or burnt in an uncontrolled manner without utilizing them for energy purposes depends on the

applicable baseline scenario (B1, B2 or B3). Baseline emissions from decay, dumping or burning of biomass residues are calculated as follows:

$$BE_{CH_4,biomass,y} = BE_{CH_4,B1/B3,y} + BE_{CH_4,B2,y} \quad \text{Equation (7)}$$

Where:

- $BE_{CH_4,biomass,y}$ = Baseline methane emissions avoided during the year y from preventing disposal or uncontrolled burning of biomass residues (t CO₂e)
- $BE_{CH_4,B1/B3,y}$ = Baseline methane emissions avoided during the year y from aerobic decay and/or uncontrolled burning of biomass residues (t CO₂e)
- $BE_{CH_4,B2,y}$ = Baseline methane emissions avoided during the year y from anaerobic decay of biomass residues at a solid waste disposal site (t CO₂e)

3.1 Uncontrolled burning or aerobic decay of the biomass residues (cases B1 and B3)

If the most likely baseline scenario for the use of a biomass residue type k , used as alternative fuel in the project plant, is that the biomass residue would be dumped or left to decay under mainly aerobic conditions (B1) or burnt in an uncontrolled manner without utilizing them for energy purposes (B3), baseline emissions are calculated assuming, for both scenarios viz., natural decay and uncontrolled burning, that the biomass residues would be burnt in an uncontrolled manner.

Baseline emissions avoided from aerobic decay and/or uncontrolled burning of biomass residues are calculated as follows:

$$BE_{CH_4,B1/B3,y} = GWP_{CH_4} \times \sum_k FC_{PJ,k,y} \times NCV_{k,y} \times EF_{burning,CH_4,k,y} \quad \text{Equation (8)}$$

Where:

- $BE_{CH_4,B1/B3,y}$ = Baseline methane emissions avoided during the year y from aerobic decay and/or uncontrolled burning of biomass residues (t CO₂e)
- GWP_{CH_4} = Global Warming Potential of methane valid for the commitment period (t CO₂e/t CH₄)
- $FC_{PJ,k,y}$ = Quantity of alternative fuel or less carbon intensive fossil fuel type k used in the project plant in year y (t)
- $NCV_{k,y}$ = Net calorific value of the alternative or less carbon intensive fuel type k in year y (GJ/t)
- $EF_{burning,CH_4,k,y}$ = CH₄ emission factor for uncontrolled burning of the biomass residue type k during the year y (t CH₄/GJ)
- k = Types of biomass residues used as alternative fuel in the project plant in year y for which the identified baseline scenario is B1 or B3

To determine the CH₄ emission factor, project participants may undertake measurements or use referenced default values. In the absence of more accurate information, it is recommended to use 0.0027 t CH₄ per tonne of biomass as default value for the product of NCV_k and $EF_{burning,CH_4,k,y}$.¹⁶

The uncertainty of the CH₄ emission factor is in many cases relatively high. In order to reflect this and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor must be applied to the CH₄ emission factor. The level of the conservativeness factor depends on the uncertainty range of the estimate for the CH₄ emission factor. The appropriate conservativeness factor from Table 12 below shall be chosen and multiplied with the estimate for the CH₄ emission factor. For example, if the default CH₄ emission factor of 0.0027 t CH₄/t biomass is used, the uncertainty can be deemed to be greater than 100% per cent, resulting in a conservativeness factor of 0.73. Thus, in this case, an emission factor of 0.001971 t CH₄/t biomass should be used.

Table 12: Conservativeness factors

Estimated uncertainty range (%)	Assigned uncertainty band (%)	Conservativeness factor where lower values are more conservative
Less than or equal to 10	7	0.98
Greater than 10 and less than or equal to 30	20	0.94
Greater than 30 and less than or equal to 50	40	0.89
Greater than 50 and less than or equal to 100	75	0.82
Greater than 100	150	0.73

Table 13 : Summary of Baseline Emission (BE) calculation

BE Step 1		2006	2007
$FC_{PJ,i,y} \times NCV_{i,y}$	GJ	7,409,003	10,303,741
$FC_{PJ,k,y} \times NCV_{k,y}$	GJ	1,563,693	1,841,464
$SEC_{clinker,PJ,y}$	GJ/t clinker	3.29	3.27
$SEC_{clinker,BL,y}$	GJ/t clinker	3.12	3.12
FP_y	GJ	453,734.83	570,895.14
FP_y (conservative)	GJ	453,735	570,895

BE Step 2		2006	2007
$\sum FC_{PJ,k,y} \times NCV_{k,y}$	GJ	1,563,693	1,841,464
FP_y	GJ	453,735	570,895
$EF_{BL,CO_2,y}$ (option A)	tCO ₂ /GJ	0.0888	0.0888
$EF_{BL,CO_2,y}$ (option B)	tCO ₂ /GJ	0.0908	0.0907
$EF_{BL,CO_2,y}$ (option C)	tCO ₂ /GJ	0.0888	0.0888
$BE_{FF,y}$	tCO ₂	98,554	112,815

BE Step 3		2006	2007
$\sum FC_{PJ,k,y}$	ton	150,078	223,624
$EF_{burning,CH_4,k,y}$	tCH ₄ e/t	0.001971	0.001971
GWP_{CH_4}	tCO ₂ e/tCH ₄	25	25
$BE_{CH_4,B1/B3,y}$	tCO ₂	7,395	11,019

¹⁶ 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

3.2 Project Emissions

Project emissions include project emissions from the use of alternative fuels and/or less carbon intensive fossil fuels ($PE_{k,y}$), project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity ($PE_{EC,y}$ and $PE_{FC,y}$), project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant ($PE_{T,y}$), and, if applicable, project emissions from the cultivation of renewable biomass at the dedicated plantation ($PE_{BC,y}$):

$$PE_y = PE_{k,y} + PE_{FC,y} + PE_{EC,y} + PE_{T,y} + PE_{BC,y} \quad \text{Equation (1)}$$

Where:

PE_y	=	Project emissions during the year y (t CO ₂ e)
$PE_{k,y}$	=	Project emissions from combustion of alternative fuels and/or less carbon intensive fossil fuels in the project plant in year y (t CO ₂)
$PE_{FC,y}$	=	Project emissions from additional fossil fuel combustion as a result of the project activity in year y (t CO ₂)
$PE_{EC,y}$	=	Project emissions from additional electricity consumption as a result of the project activity in year y (t CO ₂)
$PE_{T,y}$	=	CO ₂ emissions during the year y due to transport of alternative fuels to the project plant (t CO ₂)
$PE_{BC,y}$	=	Project emissions from the cultivation of renewable biomass at the dedicated plantation in year y (t CO ₂ e)

Project emissions are calculated in the following steps:

- Step 1. Calculate project emissions from the use of alternative fuels and/or less carbon intensive fossil fuels;
- Step 2. Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity;
- Step 3. Calculate project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant;
- Step 4. Calculate project emissions from the cultivation of renewable biomass at the dedicated plantation.

Step 1: Calculate project emissions from the use of alternative fuels and/or less carbon intensive fossil fuels

Project emissions from the use of alternative fuels and/or less carbon intensive fossil fuels in the project plant are calculated as follows:

$$PE_{k,y} = \sum_k FC_{PJ,k,y} \times NCV_{k,y} \times EF_{CO2,k,y} \quad \text{Equation (2)}$$

Where:

$PE_{k,y}$	=	Project emissions from combustion of alternative fuels and/or less carbon intensive fossil fuels in the project plant in year y (t CO ₂)
$FC_{PJ,k,y}$	=	Quantity of alternative fuel or less carbon intensive fossil fuel type k used in the project plant in year y (t)
$EF_{CO_2,k,y}$	=	Carbon dioxide emissions factor for alternative or less carbon intensive fossil fuels type k in year y (t CO ₂ /GJ)
$NCV_{k,y}$	=	Net calorific value of the alternative or less carbon intensive fossil fuel type k in year y (GJ/t)
k	=	Alternative fuel types and less carbon intensive fossil fuel types used in the project plant in year y

Step 2: Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity

The use of alternative fuels or less carbon intensive fossil fuels may result in additional fossil fuel and/or electricity consumption at the project site or off-site. This may include, inter alia, the following emission sources:

- (a) Drying or mechanical treatment of the fuels;
- (b) On-site transportation of the fuels;
- (c) Flue gas treatment required as a result of the project activity.

Only the on-site transportation of the fuels is considered as source of project emissions.

- 1) CO₂ emissions from on-site combustion of fossil fuels ($PE_{FC,y}$) should be calculated using the latest approved version of the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” , version 03 as follows;

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad \text{Equation (3)}$$

Where:

$PE_{FC,j,y}$	=	CO ₂ emissions from fossil fuel combustion in process j during the year y (tCO ₂ /yr);
$FC_{i,j,y}$	=	Quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr);
$COEF_{i,y}$	=	CO ₂ emission coefficient of fuel type i in year y (tCO ₂ /mass or volume unit)
i	=	Fuel types combusted in process j during the year y

The CO₂ emission coefficient $COEF_{i,y}$ can be calculated using the following selected Option B , as per the availability of data on the fossil fuel type i , as follows:

Option B: The CO₂ emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO₂ emission factor of the fuel type i , as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y} \quad \text{Equation (6)}$$

Where:

- $COEF_{i,y}$ = CO₂ emissions coefficient of fuel type i in year y (tCO₂/mass or volume unit);
- $NCV_{i,y}$ = Weighted average net calorific value of fuel type i in year y (GJ/mass or volume unit);
- $EF_{CO2,i,y}$ = Weighted average CO₂ emission factor of fuel type i in year y (tCO₂/GJ)
- i = Fuel types combusted in process j during the year y

- 2) CO₂ emissions from on-site electricity consumption ($PE_{EC,y}$) should be calculated using the latest approved version of the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, version 03.0. Electricity consumption from each relevant source should be monitored and summed up to $EC_{PJ,y}$.

As per the reference tool, the scenario A : Electricity consumption from grid, is chosen with the Option A1 to obtain the grid emission factor.

Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the “Tool to calculate the emission factor for an electricity system” ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$). The $EF_{grid,CM,y}$ reported and published by Thailand Greenhouse Gas Management Organization will be used in the calculation.

The combined margin emission factor for Grid system in Thailand is calculated and reported by Thailand Greenhouse Gas Management Organization or TGO¹⁷. The data used for national grid emission calculation is provided by Energy Regulatory Commission or ERC. The $EF_{grid,CM,y}$ from latest available version of the grid emissions study will be used.

The result of grid emission factor for general project reported by the “*Thailand Grid Emission Factor for GHG Reduction Project/Activity*”, published by TGO on 28/09/2017 is shown in table below ;

Tool	Weight	Emission Factor	Unit
Operating Margin: OM	0.5	0.5719	tCO ₂ /MWh
Build Margin: BM	0.5	0.5609	
Combined Margin: CM – General Project		0.5664	

Refer to clause 84 (b) of ‘*Tool to calculate the emission factor for an electricity system*’, version 05.0, All other projects: $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period, and $w_{OM} = 0.25$ and $w_{BM} = 0.75$ for the second and third crediting period.

¹⁷http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \text{Equation (16)}$$

Where :

$EF_{grid,BM,y}$	Build margin CO2 emission factor in year y (t CO ₂ /MWh)
$EF_{grid,OM,y}$	Operating margin CO2 emission factor in year y (t CO ₂ /MWh)
w_{OM}	Weighting of operating margin emissions factor (per cent)
w_{BM}	Weighting of operating margin emissions factor (per cent)

The $EF_{grid,CM,y}$ is re-calculated by using equation (16) , the value to be used is 0.5637.

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y}) \quad \text{Equation (7)}$$

Where:

$PE_{EC,y}$	= Project emissions from electricity consumption in year y (tCO ₂ /yr);
$EC_{PJ,j,y}$	= Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr);
$EF_{EF,j,y}$	= Emission factor for electricity generation for source j in year y (t CO ₂ /MWh)
$TDL_{j,y}$	= Average technical transmission and distribution losses for providing electricity to source j in year y

Step 3: Project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant

Project participants shall determine CO₂ emissions resulting from transportation of alternative fuels to the project plant. In many cases transportation is undertaken by vehicles. Project participants shall calculate these project emissions following the methodological tool “Project and leakage emissions from transportation of freight” , version 01.1.0.

As per the tool , the option B approach is chosen to calculate the emissions from the combustion of fossil fuels for transportation of alternative fuels to the project plant by using conservative default values.

Option B : Using conservative default value

Under this option, the following data shall be monitored separately for each freight transportation activity f to estimate the emissions:

- The quantity of freight transported ($FR_{f,m}$)
The biomass is the fuel for freight transportation. The same amount of $FC_{PJ,k,y}$ is used.
- The origin and destination of the freight transported and the road (or rail line) distance between the origin and the destination ($D_{f,m}$)
The average round trip distance between the biomass residue supply sites and the site of project plant is conservatively estimated at 400 km.

- c) The vehicle class used, if the freight is transported by road
The vehicle class chosen for this case is the Light vehicles – with GVM less or equal to 26 tonnes.

$$PE_{TR,m} = \sum_f D_{f,m} \times FR_{f,m} \times EF_{CO_2,f} \times 10^{-6} \quad \text{Equation (8)}$$

Where:

$PE_{TR,m}$	=	Project emissions from transportation of freight monitoring period m (tCO ₂);
$D_{f,m}$	=	Return trip distance from transportation of freight monitoring period m (tCO ₂);
$FR_{f,m}$	=	Total mass of freight transported in freight transportation activity f in monitoring period m (t)
$EF_{CO_2,f}$	=	Default CO ₂ emission factor for freight transportation activity f (g CO ₂ /t km)
f	=	Freight transportation activities conducted in the project activity in monitoring period

Step 4: Calculate project emissions from the cultivation of renewable biomass at the dedicated plantation

The project does not involve the cultivation of biomass at the dedicated plantation. Thus , the project emissions from this source can be neglected.

Table 14 : Summary of Project Emission (PE) calculation

PE Step 1		2006	2007
$PE_{k,y}$		-	-

PE Step 2		2006	2007
2.1 Electricity			
$EC_{PJ,y}$	MWh	5,941	5,941
$EF_{grid,y}$	tCO ₂ /MWh	0.5637	0.5637
$TDL_{j,y}$	%	6.073%	6.073%
$PE_{EC,y}$	tCO _{2e}	3,553	3,553
2.2 On-site transportation			
Biomass residues	ton-dry	150,078	223,624
$FC_{i,j,y}$	litres/ton	0.4955	0.4955
	litres/year	74,364	110,806
$NCV_{i,y}$	MJ/litre	36.42	36.42
$EF_{CO2,i,y}$	tCO ₂ /TJ	74.8	74.8
$PE_{FC,y}$	tCO _{2e}	202.58	301.86
PE_y	tCO _{2e}	3,755.17	3,854.44

PE Step 3		2006	2007
$FR_{f,m}$	ton/y	150,078	223,624
$D_{f,m}$	km	400	400
$EF_{CO2,f}$	gCO ₂ /t km	245	245
$PE_{TR,y}$	tCO _{2e}	14,708	21,915

3.3 Leakage

For this type of project activity, leakage ($LE_{FF,upstream,y}$) has to be considered.

In case of project activities using (a) less carbon intensive fossil fuel(s), leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH₄ emissions and CO₂ emissions from associated fuel combustion and flaring.

Upstream leakage emission from fossil fuel use may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This shall be determined using the latest version of the methodological tool “Upstream leakage emissions associated with fossil fuel use”.

Where total net leakage effects from upstream emissions are negative ($LE_{FF,upstream,y} < 0$), project participants should assume $LE_{FF,upstream,y} = 0$.

As per reference the tool “Upstream leakage emissions associated with fossil fuel use”, version 02.0 ; Leakage upstream emissions shall be determined using one of the following two options:

Option (A): simple approach based on default emission factors; or

Option (B): detailed approach based on the upstream emissions stages.

The option (A) is chosen because the upstream emissions do not occur within the project boundary of the project activity.

Option (A): Simple approach based on default emission factors

Leakage upstream emissions are calculated as follows:

$$LE_{US,y} = \sum_x EF_{US,x,default} \times (FC_{PJ,x,y} - FC_{BL,x,y}) \quad \text{Equation (1)}$$

Where:

- $LE_{US,y}$ = Leakage upstream emissions in year y (t CO₂e/yr)
- $FC_{PJ,x,y}$ = Quantity of fossil fuel type x used in the project situation in year y (TJ/yr)
- $FC_{BL,x,y}$ = Quantity of fossil fuel type x used in the baseline situation in year y (TJ/yr)
- $EF_{US,x,default}$ = Default emission factor for upstream emissions associated with consumption of fossil fuel type x (t CO₂e/TJ)
- x = Fossil fuel types used in the project and/or baseline situation and for which upstream emissions should be determined

Select $EF_{US,x,default}$ from Table 3 of the applied tool, for the corresponding fossil fuel type x.

Table 3. Default emission factors for upstream emissions for different types of fossil fuels ($EF_{US,x,default}$)

Fossil fuel type		Default emission factor (t CO ₂ e/TJ)
Natural Gas (NG)		2.9
Natural Gas Liquids (NGL)		2.2
Liquefied Natural Gas (LNG)		16.2
Compressed Natural Gas (CNG)		10
Light Fuel Oil (Diesel)		16.7
Heavy Fuel Oil (Bunker or Marine Type)		9.4
Gasoline		13.5
Kerosene (household and aviation)		8.5
LPG (including butane and propane)		8.7
Coal/lignite (unknown mine location(s) or coal/lignite not 100 per cent sourced from within host country)	Lignite	2.9
	Surface mine, or any other situation	2.8
	Underground (100 per cent source)	10.4
Coal/lignite (coal/lignite 100 per cent sourced from within host country)	Lignite	6.0
	Surface mine, or any other situation	5.8
	Underground (100 per cent source)	21.4

If $LE_{US,y}$ is calculated as a value of less than 0, in case of positive FP_y , then a value of 0 shall be used instead. This approach can be cross-checked during the verification, zero upstream leakage emissions should be confirmed by the negative FP_y result.

3.4 Net GHG Emission Reductions and Removals

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (14)}$$

Where:

ER_y = Emission reductions during the year y (t CO₂/yr)

BE_y = Baseline emissions during the year y (t CO₂e/yr)

PE_y = Project emissions during the year y (t CO₂e/yr)

LE_y = Leakage emissions during the year y (t CO₂e/yr)

Table 15 : Summary of Emission Reductions calculation

Baseline Emissions (BE)		2006	2007
BE _{FF,y}	tCO ₂	98,554	112,815
BE _{CH4,B1/B3,y}	tCO ₂	7,395	11,019
BE _y	tCO ₂	105,949	123,834
Project Emissions (PE)		2006	2007
PE _{k,y}	tCO ₂	-	-
PE _{EC,y}	tCO ₂	3553	3553
PE _{FC,y}	tCO ₂	202.58	301.86
PE _{T,y}	tCO ₂	14,708	21,915
PE _y	tCO ₂	18,463	25,770
Emission Reduction (ERs)		2006	2007
ER _y	tCO ₂ e	87,486	98,064
Conservative ERs	tCO ₂ e	87,486	98,064

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
Year 2016	99,412	18,895	0	80,517
Year 2017	132,550	25,193	0	107,356
Year 2018	132,550	25,193	0	107,356
Year 2019	132,550	25,193	0	107,356
Year 2020	132,550	25,193	0	107,356
Year 2021	132,550	25,193	0	107,356
Year 2022	132,550	25,193	0	107,356
Year 2023	132,550	25,193	0	107,356
Year 2024	132,550	25,193	0	107,356
Year 2025	132,550	25,193	0	107,356
Year 2026	33,137	6,298	0	26,839
Total	1,325,500	251,930	0	1,073,560

4 MONITORING

4.1 Data and Parameters Available at Validation

Data / Parameter	FC _{i,x} , FC _{i,x-1} and FC _{i,x-2}
Data unit	Tonnes
Description	Quantity of fossil fuel of type <i>i</i> used in the project plant in year <i>x</i> , <i>x-1</i> and <i>x-2</i> where <i>x</i> is the year prior to the start of the project activity and <i>i</i> are the fossil fuel types used in the project plant in the last three years prior to the start of the project activity
Source of data	Three years data from fuel consumption data from Work Journal report
Value applied	Provided in Table 16 and Table 17
Justification of choice of data or description of measurement methods and procedures applied	The fossil fuels consumption is continuously monitored via weight feeders and summarized in Work Journal report on monthly basis.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	FC_{BL,F3,i,y}
Data unit	Ton
Description	Quantity of fossil fuel type <i>i</i> that would in the absence of the project activity be used in the project plant according to the selected baseline scenario F3 in year <i>y</i>
Source of data	Fuel consumption from Work Journal report
Value applied	Provided in Table 16 and Table 17
Justification of choice of data or description of measurement methods and procedures applied	From registered PD
Purpose of Data	Calculation of baseline emissions
Comments	Only applicable if F3 has been determined as the most likely baseline scenario.

Data / Parameter	P_{clinker,x}, P_{clinker,x-1} and P_{clinker,x-2}
Data unit	Ton
Description	Production of clinker in year <i>x</i> , <i>x-1</i> and <i>x-2</i> where <i>x</i> is the year prior to the start of the project activity
Source of data	Three years data from production data logs at the project site
Value applied	Provided in Table 16 and Table 17
Justification of choice of data or description of measurement methods and procedures applied	From registered PD
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	NCV_i
Data unit	GJ/mass or volume units
Description	Net calorific value of the fossil fuel type <i>i</i> where <i>i</i> are the fossil fuel types used in the project plant in the last three years prior to the start of the project activity
Source of data	Option (b) : Measurements by the project participants , is the preferable source of data for this project activities.
Value applied	Provided in Table 16 and Table 17

Justification of choice of data or description of measurement methods and procedures applied	Data source (b) as per the ACM0003 version 08.0
Purpose of Data	Calculation of baseline emissions
Comments	Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.

Data / Parameter	EF _{CO2,FF,i}																																				
Data unit	t CO ₂ /GJ																																				
Description	Weighted average CO ₂ emission factor for fossil fuel type <i>i</i> where <i>i</i> are the fossil fuel types used in the project plant in the last three years prior to the start of the project activity																																				
Source of data	Option (d) : IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories																																				
Value applied	<table><tr><th>Fuel Type</th><th>Unit</th><th>Lower</th><th>Upper</th></tr><tr><td>Fossil</td><td></td><td></td><td></td></tr><tr><td>Coal</td><td>tCO₂/TJ</td><td>92.80</td><td>100.00</td></tr><tr><td>Coke</td><td>tCO₂/TJ</td><td>82.90</td><td>115.00</td></tr><tr><td>Heavy fuel</td><td>tCO₂/TJ</td><td>75.50</td><td>78.80</td></tr><tr><td>Diesel oil</td><td>tCO₂/TJ</td><td>72.60</td><td>74.80</td></tr><tr><td>Lignite</td><td>tCO₂/TJ</td><td>90.90</td><td>115.00</td></tr><tr><td>Anthracite</td><td>tCO₂/TJ</td><td>94.60</td><td>101.00</td></tr><tr><td>Biodiesel</td><td>tCO₂/TJ</td><td>59.80</td><td>84.30</td></tr></table>	Fuel Type	Unit	Lower	Upper	Fossil				Coal	tCO ₂ /TJ	92.80	100.00	Coke	tCO ₂ /TJ	82.90	115.00	Heavy fuel	tCO ₂ /TJ	75.50	78.80	Diesel oil	tCO ₂ /TJ	72.60	74.80	Lignite	tCO ₂ /TJ	90.90	115.00	Anthracite	tCO ₂ /TJ	94.60	101.00	Biodiesel	tCO ₂ /TJ	59.80	84.30
Fuel Type	Unit	Lower	Upper																																		
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Coal	tCO ₂ /TJ	92.80	100.00																																		
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Anthracite	tCO ₂ /TJ	94.60	101.00																																		
Biodiesel	tCO ₂ /TJ	59.80	84.30																																		
Justification of choice of data or description of measurement methods and procedures applied	Data source (d) as per the ACM0003 version 08.0																																				
Purpose of Data	Calculation of baseline emissions																																				
Comments	-																																				

Data / Parameter	EF_{burning,CH4,k,y}
Data unit	t CH ₄ /t biomass
Description	CH ₄ emission factor for uncontrolled burning of the biomass residue type <i>k</i> during the year <i>y</i>
Source of data	ACM0003 version 08.0
Value applied	0.001971
Justification of choice of data or description of measurement methods and procedures applied	Default value from the applied methodology
Purpose of Data	Calculation of baseline emissions
Comments	Monitoring of this parameter for project emissions is only required if CH ₄ emissions from biomass combustion are included in the project boundary. Note that a conservative factor shall be applied, as specified in the baseline methodology.

Data / Parameter	EF_{CO2,f}
Data unit	g CO ₂ /t km
Description	Default CO ₂ emission factor for freight transportation activity <i>f</i>
Source of data	Tool 12 'Project and leakage emissions from transportation of freight', version 01.1.0
Value applied	245 for Light vehicles, with GVM less or equal to 26 tonnes
Justification of choice of data or description of measurement methods and procedures applied	Default values as per the applied tool. Applicable to Option B. The default CO ₂ emission factors take into account emissions generated by loaded outbound trips and empty return trips. The default emission factors have been obtained from two sources. For light vehicles, the emission factor was obtained from empirical data from European vehicles ¹⁸ . For heavy vehicles, the emission factor has been derived based on custom design transient speed-time-gradient drive cycle (adapted from the international FIGE cycle), vehicle dimensional data, mathematical analysis of loading scenarios, and dynamic modelling based on engine power profiles, which, in turn, are a function of gross

¹⁸ Les émissions de CO₂ par les poids lourds français entre 1996 et 2006 ont augmenté moins vite que les volumes transportés'. Commissariat Général au Développement Durable. # 25, 2009.

	vehicle mass (GVM), load factor, speed/acceleration profiles and road gradient. The following assumptions on key parameters have been made: an average driving speed of 30 km/h, an average gradient of 1%, and a load factor attained when biomass ¹⁹ is transported were assumed
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$D_{f,m}$
Data unit	Kilometre
Description	Return trip distance between the origin and destination of freight transportation activity f in monitoring period m
Source of data	Records of vehicle operator or records by project participants.
Value applied	400
Justification of choice of data or description of measurement methods and procedures applied	The same value applied for the previous crediting period
Purpose of Data	Calculation of project emissions
Comments	To be updated whenever the distance changes.

4.2 Data and Parameters Monitored

Data / Parameter	$FC_{PJ,k,y}$ and $FC_{PJ,i,y}$
Data unit	Tonnes
Description	Quantity of alternative fuel or less carbon intensive fossil fuel of type k ($FC_{PJ,k,y}$), fossil fuel of type i ($FC_{PJ,i,y}$) used in the project plant in year y
Source of data	Work Journal (WJ)
Description of measurement methods and procedures to be applied	The quantity of solid fossil fuels and biomass fuels is continuously monitored by weight feeder equipment. The data from all inline measuring equipment is connected to Distributed Control System (DCS) at the control room. The data recording from DCS is carried out by cell operator on daily basis.

¹⁹ Biomass is the most commonly transported material in existing CDM projects where transportation is not the main project activity. Due to a low bulk density of biomass, volumetric loading was used to derive the emission factor assuming that project proponents will extend the height of side panels to the height of 2.4 m to maximize their trip efficiency.

	The fuel oil volume is continuously monitored by flow meter. The cell operators record the totalized flow at the flow meter before and after the operation of fuel oil supply pump. The daily monitored data is checked and adjusted with stock checking report at the end of month. The final figures are summarized in Work Journal (WJ) by engineer.
Frequency of monitoring/recording	Recorded continuously and aggregated at least annually
Value applied	Presented in Table 18 , Table 19 and Table 20
Monitoring equipment	As per information provided in Appendix 1 - 3
QA/QC procedures to be applied	- The monitoring equipment is calibrated according to calibration plan and/or shutdown plan of kiln. - The documentation and calibration is controlled and managed in accordance with ISO9001 requirements.
Purpose of data	Calculation of baseline and project emissions
Calculation method	-
Comments	-

Data / Parameter	$EF_{CO_2,k,y}$ and $EF_{CO_2,FF,i,y}$
Data unit	t CO ₂ /GJ
Description	Weighted average CO ₂ emission factor for alternative or less carbon intensive fuels of type k ($EF_{CO_2,k,y}$) and for fossil fuel of type i ($EF_{CO_2,FF,i}$) in year y
Source of data	For fossil fuels - Option (d) : IPCC default values at the upper/lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. For alternative fuels - Option (c) : Regional or national default values. The source of emission factor is from the CO₂ Accounting and Reporting Standard for the Cement Industry²⁰ , provided by World Business Council for Sustainable Development. $EF_{CO_2,k,y}$ is zero for the following alternative fuels: - Wastes originating from fossil sources where W1 has been identified as the most plausible baseline scenario; - Biomass residues; - Renewable biomass²¹

²⁰ <http://wbcsdcement.org/index.php/key-issues/climate-protection/co2-accounting-and-reporting>

²¹ In case of waste originating from fossil sources and baseline scenario W1, the waste would also be combusted in the absence of the project activity, without displacing any fossil fuels. In case of biomass residues it is assumed that CO₂ emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector and that the biomass residues are available in surplus. If this condition is not met any more during the crediting period,

Description of measurement methods and procedures to be applied	-																																																												
Frequency of monitoring/recording	For (c) and (d): any future revision of the IPCC and WBCSD Guidelines should be taken into account																																																												
Value applied	<table><tr><th>Fuel Type</th><th>Unit</th><th>Lower</th><th>Upper</th></tr><tr><td colspan="4">Fossil</td></tr><tr><td>Coal</td><td>tCO₂/TJ</td><td>92.80</td><td>100.00</td></tr><tr><td>Coke</td><td>tCO₂/TJ</td><td>82.90</td><td>115.00</td></tr><tr><td>Heavy fuel</td><td>tCO₂/TJ</td><td>75.50</td><td>78.80</td></tr><tr><td>Diesel oil</td><td>tCO₂/TJ</td><td>72.60</td><td>74.80</td></tr><tr><td>Lignite</td><td>tCO₂/TJ</td><td>90.90</td><td>115.00</td></tr><tr><td>Anthracite</td><td>tCO₂/TJ</td><td>94.60</td><td>101.00</td></tr><tr><td>Biodiesel</td><td>tCO₂/TJ</td><td>59.80</td><td>84.30</td></tr></table> <table><tr><th>Alternative fossil fuel</th><th>Unit</th><th>Upper</th></tr><tr><td>waste oil</td><td>tCO₂/TJ</td><td>74</td></tr><tr><td>tyres</td><td>tCO₂/TJ</td><td>85</td></tr><tr><td>plastics</td><td>tCO₂/TJ</td><td>75</td></tr><tr><td>solvents</td><td>tCO₂/TJ</td><td>74</td></tr><tr><td>impregnated saw dust</td><td>tCO₂/TJ</td><td>75</td></tr><tr><td>mixed industrial waste</td><td>tCO₂/TJ</td><td>83</td></tr><tr><td>other fossil based wastes</td><td>tCO₂/TJ</td><td>80</td></tr></table>	Fuel Type	Unit	Lower	Upper	Fossil				Coal	tCO ₂ /TJ	92.80	100.00	Coke	tCO ₂ /TJ	82.90	115.00	Heavy fuel	tCO ₂ /TJ	75.50	78.80	Diesel oil	tCO ₂ /TJ	72.60	74.80	Lignite	tCO ₂ /TJ	90.90	115.00	Anthracite	tCO ₂ /TJ	94.60	101.00	Biodiesel	tCO ₂ /TJ	59.80	84.30	Alternative fossil fuel	Unit	Upper	waste oil	tCO ₂ /TJ	74	tyres	tCO ₂ /TJ	85	plastics	tCO ₂ /TJ	75	solvents	tCO ₂ /TJ	74	impregnated saw dust	tCO ₂ /TJ	75	mixed industrial waste	tCO ₂ /TJ	83	other fossil based wastes	tCO ₂ /TJ	80
Fuel Type	Unit	Lower	Upper																																																										
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Monitoring equipment	-																																																												
QA/QC procedures to be applied	Any future revision of the IPCC and WBCSD Guidelines will be taken into account.																																																												
Purpose of data	Calculation of baseline and project emissions																																																												
Calculation method	-																																																												
Comments	-																																																												

Data / Parameter	NCV_{k,y} and NCV_{i,y}				
Data unit	GJ/tonne				
Description	Weighted average net calorific value of the alternative or less carbon intensive fuel types <i>k</i> (NCV _{k,y}) and fossil fuel types <i>i</i> (NCV _{i,y}) in year <i>y</i>				
Source of data	The following data sources may be used if the relevant conditions apply: <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <tr> <td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr> </tbody> </table>	Data source	Conditions for using the data source	(a) Values provided by the fuel supplier in invoices	This is the preferred source
Data source	Conditions for using the data source				
(a) Values provided by the fuel supplier in invoices	This is the preferred source				

CO₂ emissions are taken into account by applying a leakage penalty (see leakage section). In case of renewable biomass, emissions from the cultivation of the biomass are estimated separately ($PE_{BC,y}$).

	(b) Measurements by the project participants	If (a) is not available
	(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fossil fuels and should be based on well documented, reliable sources (such as national energy balances)
	- Most of the fossil and biomass fuels are tested by internal laboratory for data source (b); - The heating value of HFO is provided by supplier as per data source (a). - The National's default heating value as per source (c) will be used if the data from source (b) is not available.	
Description of measurement methods and procedures to be applied	For (a) and (b): measurements should be undertaken in line with national or international fuel standards. The fuel sample is analysed by internal laboratory. The results are saved in QIS (Quality Information System) by lab analyst.	
Frequency of monitoring/recording	For (a) and (b): the NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For (c): review appropriateness of the values annually.	
Value applied	Presented in Table 18 , Table 19 and Table 20	
Monitoring equipment	-	
QA/QC procedures to be applied	Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.	
Purpose of data	Calculation of baseline and project emissions	
Calculation method	-	
Comments	-	

Data / Parameter	P_{clinker,y}
Data unit	Ton
Description	Production of clinker in year y
Source of data	Work Journal (WJ)
Description of measurement methods and procedures to be applied	Refer to the methodology deviation 1 , the quantity of clinker produced is calculated from amount of raw material with clinker factor and adjusting with stock checking report at the end of month. The final figures are summarized in WJ.

Frequency of monitoring/recording	Recorded/calculated and reported on monthly basis
Value applied	Presented in Table 18 , Table 19 and Table 20
Monitoring equipment	As per information provided in Appendix 1 – 3
QA/QC procedures to be applied	- The monitoring equipment is calibrated according to calibration plan and/or shutdown plan of kiln. - The documentation and calibration is controlled and managed in accordance with ISO9001 requirements.
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	EF_{CO₂,BL,y}
Data unit	t CO ₂ /GJ
Description	Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels or less carbon intensive fossil fuels in the project plant
Source of data	Calculated as follows as the lowest of the following CO₂ emission factors: (a) The weighted average annual CO₂ emission factor for the fossil fuel(s) consumed and monitored ex ante during the most recent three years before the start of the project activity; (b) The weighted average annual CO₂ emission factor of the fossil fuel(s) consumed in the project plant in year y that are not less carbon intensive fossil fuels; (c) If F2 has been determined as the most likely baseline scenario: the weighted average annual CO₂ emission factor for the fossil fuel(s) that would have been consumed according to fuel mix determined in the “Procedure for the selection of the most plausible baseline scenario and demonstration of additionality” above.
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Continuously, aggregated at least annually
Value applied	Presented in Table 13
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions

Calculation method	-
Comments	-

Data / Parameter	$FC_{PJ,i,k,y}$
Data unit	Litres/ton
Description	Quantity of fossil fuel type i fired in the project plant while project alternative or less carbon intensive fuel or biomass was used in year y
Source of data	Measurements crossed with operation logs
Description of measurement methods and procedures to be applied	Use mass or volume meters, crossed with operation logs showing when alternative or less carbon intensive fuel was used. The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records
Frequency of monitoring/recording	Recorded continuously and aggregated at least annually
Value applied	The same value as $FC_{PJ,i,y}$
Monitoring equipment	As per information provided in Appendix 1 - 3
QA/QC procedures to be applied	- The monitoring equipment is calibrated according to calibration plan and/or shutdown plan of kiln. - The documentation and calibration is controlled and managed in accordance with ISO9001 requirements.
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	As alternative to monitoring, the value of this parameter may be conservatively set to $FC_{PJ,i,y}$, assuming alternative or less carbon intensive fuel was used throughout the monitored period

Data / Parameter	$EF_{grid,CM,y}$
Data unit	t CO ₂ /MWh
Description	Combined margin emission factor for the grid in year y
Source of data	The latest National value reported by Thailand Greenhouse Gas Management Organization ²²
Description of measurement methods	-

²²http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf

and procedures to be applied	
Frequency of monitoring/recording	To be updated in every verification periods
Value applied	0.5637
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	This emission factor in this report is calculated by the latest version of Methodological Tool “Tool to calculate the emission factor for an electricity system”

Data / Parameter	TDL_{j,y}
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	The latest available of National data , World Bank indicator ‘Electric power transmission and distribution loss (%of output)’ for Thailand ²³
Description of measurement methods and procedures to be applied	As per the option 1 of the applied tool : Use recent, accurate and reliable data available within the host country.
Frequency of monitoring/recording	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years
Value applied	6.073% - in 2014
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	EC_{PJ,j,y}
Data unit	MWh/y

²³ <https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?locations=TH&page=6>

Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data	Use electricity meters installed at the electricity consumption sources.
Description of measurement methods and procedures to be applied	Direct measurement or calculated based on measurements from more than one electricity meters
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	5,941 – fixed value from the 1 st crediting period
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	As per the description of comment provided in Data/Parameter table 10 of the applied tool , option b is chosen , <i>Estimation of electricity consumption as highest daily value among the daily monitored values multiplied by the number of days' data were missing.</i> The reference of maximum data is provided in Appendix 1 - 5.

Data / Parameter	FC_{i,j,y}
Data unit	Litres/ton biomass
Description	y of fuel type i combusted in process j during the year
Source of data	Specific consumption figure which used for ex-ante estimation in the previous crediting period.
Description of measurement methods and procedures to be applied	Described in Appendix 1 - 4
Frequency of monitoring/recording	-
Value applied	0.4955
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	
Comments	-

Data / Parameter	NCV _{i,y}
Data unit	MJ/Litre
Description	Weighted average net calorific value of fuel type i in year y
Source of data	Option c) Regional or national default values , is chosen. The reference from reports of Department Alternative Energy Development and Efficiency is used.
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Review appropriateness of the values annually
Value applied	36.42
Monitoring equipment	-
QA/QC procedures to be applied	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	EF _{CO₂,i,y}
Data unit	tCO ₂ /GJ
Description	Weighted average CO ₂ emission factor of fuel type i in year y
Source of data	Option d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories is selected for this case.
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Any future revision of the IPCC Guidelines should be taken into account.
Value applied	74.8
Monitoring equipment	-
QA/QC procedures to be applied	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.

Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	FR_{t,m}
Data unit	Ton
Description	Total mass of freight transported in freight transportation activity f in monitoring period m
Source of data	The same value as FC _{PJ,k,y}
Description of measurement methods and procedures to be applied	The biomass is the most commonly transported material in this project activity.
Frequency of monitoring/recording	Recorded continuously and aggregated at least annually
Value applied	The same value as FC _{PJ,i,y}
Monitoring equipment	As per information provided in Appendix 1 : 3
QA/QC procedures to be applied	- The monitoring equipment is calibrated according to calibration plan and/or shutdown plan of kiln. - The documentation and calibration is controlled and managed in accordance with ISO9001 requirements.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	Applicable to option B : Using conservative default values

4.3 Monitoring Plan

A monitoring plan has been developed to ensure that accurate and relevant measurements and observations are made to document cement production metrics , energy usage and equipment operation, including possible sources of emissions and leakage. This plan reflects good monitoring practice appropriate to this type of project activity and meets the requirements of the methodologies involved.

The Cell operators are responsible for recording the data from DCS (Distributed Control System) into daily log sheet and input in daily report file. The daily report file is checked by the Cell Head and engineer respectively. At the end of month , the engineer will prepare the Work Journal , WJ by using the data from daily report and adjusting by the data from stock checking report.

Data in electronic format from each site will be centralised at SCG's Engineering Department and then submitted to consultant for emission calculations.

The data backup at each site and SCG's Engineering Department is periodically carried out as per the data management procedure of ISO9001. The data submitted to consultant is saved on consultant's server and backed up at least once a month.

5 SAFEGUARDS

5.1 No Net Harm

There is no any negative environmental and socio-economic impacts created by project activities.

5.2 Environmental Impact

Environmental Impact Assessment (EIA) Report is required by the government for this type of project; all project activities in the grouped project had a completed report before starting the construction. The project participants have undertaken an analysis of the environmental impact of the project activity to ensure minimum impacts on the environment and to determine any mitigation measures if such impacts are significant.

The EIA Report from each project plant has been approved by the Office of Natural Resources and Environmental Policy and Planning (ONEP). According to ONEP approval, the project complies with environmental registration in Thailand. Also environmental impacts in the projects have been identified in EIA report. The details of the analysis of the environmental impact in each project site will be provided to DOE on Validation.

In addition, the environment baseline was studied and analysed before identifying the environmental impacts of the project activity and its correction and prevention were considered. The main identified environmental impacts are air pollution, water pollution and noise. The details are in the EIA report which is able to provided to DOE on the Validation site visit.

Furthermore, dust and small particles from rice husk have been considered during the operation. The dust collector and belt cover was installed to reduce the dust and small particle around the working area.

5.3 Local Stakeholder Consultation

Stakeholder consultation was carried out by the project owner at all sites which was reported in the EIA report. The consultation included an explanation of the project activity to the participants.

Place and date of meeting

Stakeholder consultation was held at each site on the date shown below. Participants were able to examine the location where the proposed project will be take place.

Project site	Stakeholders consultation date
The Siam Cement (Kaeng Khoi)	22/11/1999
The Siam Cement (Ta Luang)	01/11/1999
The Siam Cement (Khao Wong)	23/12/1999
The Siam Cement (Lampang)	27/09/2001
The Siam Cement (Thung Song)	22/02/2002

Meeting participants

The participants in these meeting included local residents, local government officers, local shopkeepers and other members of the community.

Language

Documentation and meeting were conducted in Thai (local language).

Meeting procedures

- Purpose of consultation
- Description of the project and its environmental impacts
- General feedback

5.4 Public Comments

Summary of the comments received

After the meeting, participants were afforded the opportunity to ask questions regarding the project activity. The overall response to the project was encouraging and positive to local environment and social-economic conditions i.e. the stakeholders appreciate the wastewater and biomass treatment in a more efficient way in which irritable odour can be avoided while creating new jobs. In all, no adverse reactions, comments, or clarifications were received during the Stakeholder Consultation process. The project participants did not recognize any need to make changes to the project design or monitoring plans.

Current Practice

Siam Cement Group (SCG) has implemented the Stakeholder Engagement by announcing the stakeholder practice policy in 2014 , to set up a clear practice guideline for engaging to each stakeholder group²⁴. The comments from stakeholders, and the approach will be handled by the SCG Cement-Building Materials Sustainable Development committee.

²⁴ http://www.scg.com/en/05sustainability_development/stakeholder-engagement.html

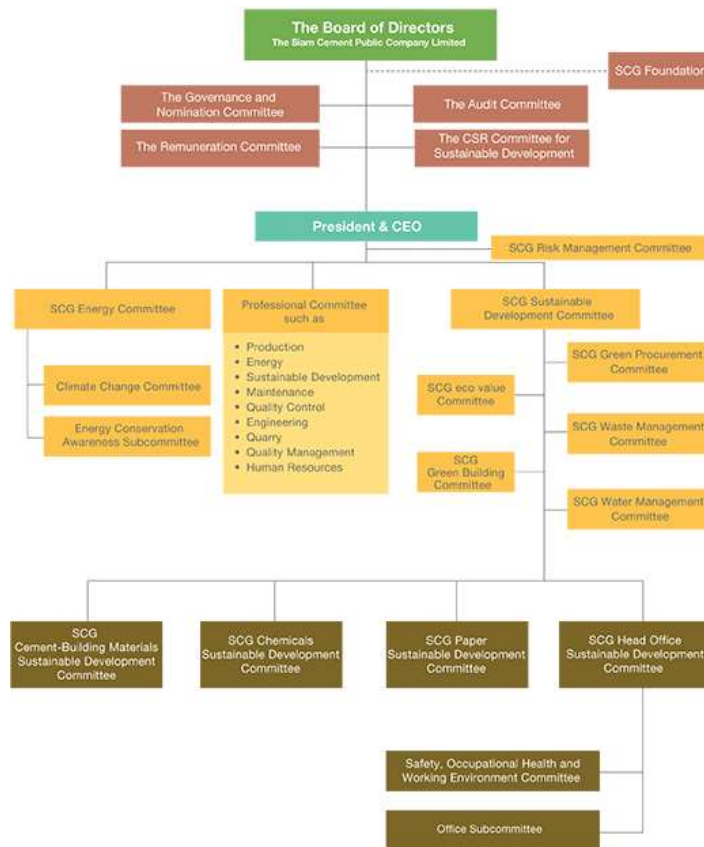


Figure 14: Sustainability management structure including CSR



Figure 15: Stakeholder Engagement Overview

APPENDIX 1 : OTHER INFORMATION

1. Summary of baseline (historical) data

Table 16 : Historical data of Ta Luang , Khao Wong and Kaeng Khoi sites

Fuel Type		TL				KW				KK			
		2000	2001	2002	Total	2000	2001	2002	Total	2000	2001	2002	Total
Fossil													
Fuel Oil	ton-dry	885	825	4,866	6,576	3,705	4,188	2,261	10,154	3,877	3,320	5,678	12,875
Coal	ton-dry	16,923	5,944	31,708	54,575	27,218	3,166	19,574	49,958	137,006	1,948	43,007	181,961
Lignite	ton-dry	46,845	92,730	251,340	390,915	189,534	140,995	270,215	600,744	468,388	647,769	533,107	1,649,264
Pet-Coke	ton-dry	4,643	1,771	59,457	65,871	129,514	143,749	106,027	379,290	56,917	104,250	157,989	319,156
Anthracite	ton-dry	-	-	-	-	2,835	48,758	8,477	60,070	-	14,077	4,545	18,622
Heating Value		2000	2001	2002	Average	2000	2001	2002	Average	2000	2001	2002	Average
Fuel Oil	GJ/ton	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39
Coal	GJ/ton	24.30	25.41	25.09	24.88	24.95	26.70	28.47	26.44	25.74	25.74	25.74	25.74
Lignite	GJ/ton	18.21	18.12	17.16	17.51	21.42	20.79	20.26	20.75	17.99	17.99	17.99	17.99
Pet-Coke	GJ/ton	30.13	30.46	32.63	32.40	32.96	32.25	33.76	32.91	32.46	32.44	32.44	32.44
Anthracite	GJ/ton	0.00	0.00	0.00	0.00	29.25	27.80	27.86	27.88	0.00	27.21	27.21	27.21
HG = FC x NCV	GJ	2000	2001	2002	Total	2000	2001	2002	Average	2000	2001	2002	Average
Fuel Oil	GJ	35,758	33,326	196,562		149,663	169,174	91,314		156,611	134,111	229,362	
Coal	GJ	411,229	151,037	795,550		679,164	84,540	557,242		3,527,069	50,149	1,107,168	
Lignite	GJ	852,967	1,680,437	4,312,638		4,060,567	2,930,958	5,474,624		8,425,008	11,651,578	9,589,125	
Pet-Coke	GJ	139,876	53,941	1,940,124		4,268,854	4,635,753	3,579,497		1,847,457	3,382,026	5,125,400	
Anthracite	GJ	-	-	-		82,929	1,355,435	236,153		-	383,021	123,665	
Pclinker	ton	410,188	557,145	2,126,642	1,031,325	3,041,073	3,017,068	3,254,406	3,104,182	4,527,703	4,912,623	5,045,459	4,828,595
HG/Pclinker	GJ/ton	3.51	3.44	3.41		3.04	3.04	3.05		3.08	3.18	3.21	
FC x NCV x EF		2000	2001	2002	Total	2000	2001	2002	Total	2000	2001	2002	Total
Fuel Oil	GJ	2,700	2,516	14,840		11,300	12,773	6,894		11,824	10,125	17,317	
Coal	GJ	38,162	14,016	73,827		63,026	7,845	51,712		327,312	4,654	102,745	
Lignite	GJ	77,535	152,752	392,019		369,106	266,424	497,643		765,833	1,059,128	871,651	
Pet-Coke	GJ	11,596	4,472	160,836		353,888	384,304	296,740		153,154	280,370	424,896	
Anthracite	GJ	-	-	-		7,845	128,224	22,340		-	36,234	11,699	
EFBLCO ₂ ,y	tCO ₂ /GJ	0.0903	0.0906	0.0885	0.0891	0.0871	0.0871	0.0881	0.0875	0.0901	0.0891	0.0883	0.0891

Table 17 : Historical data of Thung Song and Lampang sites

Fuel Type		TS				LP			
		2000	2001	2002	Total	2000	2001	2002	Total
Fossil									
Fuel Oil	ton-dry	4,126	3,291	2,486	9,903	519	477	682	1,678
Coal	ton-dry	188,136	166,152	143,493	497,781	-	-	-	-
Lignite	ton-dry	50,424	208,229	225,796	484,449	105,615	105,743	191,910	403,268
Pet-Coke	ton-dry	143,272	101,586	105,029	349,888	-	-	-	-
Anthracite	ton-dry	-	-	16,879	16,879	-	-	-	-
Heating Value		2000	2001	2002	Average	2000	2001	2002	Average
Fuel Oil	GJ/ton	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39
Coal	GJ/ton	25.12	25.83	25.39	25.44	0.00	0.00	0.00	0.00
Lignite	GJ/ton	18.85	20.48	19.32	19.77	18.10	17.94	17.82	17.92
Pet-Coke	GJ/ton	33.98	32.81	32.22	33.11	0.00	0.00	0.00	0.00
Anthracite	GJ/ton			26.46	26.46	0.00	0.00	0.00	0.00
HG = FC x NCV	GJ	2000	2001	2002	Average	2000	2001	2002	Average
Fuel Oil	GJ	166,665	132,951	100,415		20,965	19,268	27,563	
Coal	GJ	4,726,725	4,292,170	3,643,295		-	-	-	
Lignite	GJ	950,726	4,263,615	4,363,495		1,912,101	1,897,156	3,418,995	
Pet-Coke	GJ	4,868,550	3,332,781	3,383,884		-	-	-	
Anthracite	GJ	-	-	446,680		-	-	-	
Pclinker	ton	3,381,254	3,797,506	3,825,211	3,667,990	642,816	603,902	1,063,054	769,924
HG/Pclinker	GJ/ton	3.17	3.17	3.12		3.01	3.17	3.24	
FC x NCV x EF		2000	2001	2002	Total	2000	2001	2002	Total
Fuel Oil	GJ	12,583	10,038	7,581		1,583	1,455	2,081	
Coal	GJ	438,640	398,313	338,098		-	-	-	
Lignite	GJ	86,421	387,563	396,642		173,810	172,451	310,787	
Pet-Coke	GJ	403,603	276,288	280,524		-	-	-	
Anthracite	GJ	-	-	42,256		-	-	-	
EFBLCO ₂ ,y	tCO ₂ /GJ	0.0879	0.0892	0.0892	0.0888	0.0907	0.0907	0.0908	0.0908

2. Ex-ante estimated data for emission reductions calculation

Table 18 : Operation data from Work Journal 2006

Year 2006	Clinker	Lignite			HFO			Biomass		
		Usage	LHV	Heat	Usage	LHV	Heat	Usage	LHV	Heat
Month	ton	ton-dry	kcal/kg	GJ	ton-dry	kcal/kg	GJ	ton-dry	kcal/kg	GJ
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
4	211,412	24,143	5,329	538,679	224	9,650	9,041	15,105	2,504	158,323
5	340,581	40,908	5,251	899,333	67	9,650	2,713	24,299	2,379	242,069
6	282,362	31,076	5,296	689,075	99	9,650	4,003	21,306	2,639	235,371
7	309,679	33,907	5,423	769,905	179	9,650	7,230	21,584	2,692	243,232
8	365,847	44,115	5,678	1,048,725	170	9,650	6,864	14,523	2,264	137,675
9	280,355	34,414	5,827	839,578	190	9,650	7,691	8,224	2,256	77,693
10	324,587	37,133	5,708	887,478	102	9,650	4,110	17,887	2,216	165,936
11	312,348	34,975	5,701	834,788	144	9,650	5,830	15,280	2,726	174,391
12	302,552	36,384	5,578	849,707	105	9,650	4,254	11,871	2,596	129,001
Total	2,729,725	317,055	23.21	7,357,267	1,281	40.40	51,736	150,078	10.42	1,563,693

Table 19 : Operation data from Work Journal 2007

Year 2007	Clinker	Lignite			HFO			Biomass		
		Usage	LHV	Heat	Usage	LHV	Heat	Usage	LHV	Heat
Month	ton	ton-dry	kcal/kg	GJ	ton-dry	kcal/kg	GJ	ton-dry	kcal/kg	GJ
1	370,623	42,745	5,478	980,411	241	9,650	9,752	19,523	2,035	166,319
2	374,624	42,446	5,478	973,569	92	9,650	3,718	25,317	2,035	215,673
3	372,652	44,728	5,478	1,025,911	195	9,650	7,867	22,589	2,035	192,437
4	406,546	50,204	5,478	1,151,504	456	9,650	18,440	20,662	2,035	176,022
5	342,925	41,193	5,559	958,695	336	9,650	13,584	18,957	2,054	163,005
6	438,934	50,819	5,695	1,211,763	128	9,650	5,183	26,067	1,995	217,756
7	183,570	21,047	5,584	492,038	264	9,650	10,656	11,998	2,069	103,925
8	288,691	35,793	5,296	793,583	67	9,650	2,703	21,137	1,915	169,458
9	267,147	31,647	5,531	732,835	1,301	9,650	52,547	18,911	1,778	140,784
10	260,073	31,480	5,530	728,813	40	9,650	1,632	16,429	1,898	130,584
11	228,817	25,647	5,787	621,394	105	9,650	4,257	18,193	1,717	130,799
12	174,145	21,250	5,564	495,016	195	9,650	7,872	3,841	2,158	34,702
Total	3,708,748	438,998	23.16	10,165,532	3,421	40.40	138,209	223,624	8.23	1,841,464

Table 20 : Summary of ex-ante data

TS	Monthly average 2006			Monthly average 2007			Ex-ante : Yearly		
	Amount	LHV	Heat	Amount	LHV	Heat	Amount	LHV	Heat
Type of fuel	ton-AF	GJ/ton	GJ	ton-AF	GJ/ton	GJ	ton-AF	GJ/ton	GJ
Clinker	303,303			309,062			3,674,191		
Lignite	35,228	23.21	817,474	36,583	23.16	847,128	430,869	23.18	9,987,611
HFO	142	40.40	5,748	285	40.40	11,517	2,564	40.40	103,596
Biomass	16,675	10.42	173,744	18,635	8.23	153,455	211,864	9.27	1,963,194

3. Information of monitoring equipment

Monitoring equipment	Description	Accuracy	Calibration Frequency
Biomass feeder			Internal calibration will be carried out as per kiln shutdown plan.
Fossil fuel feeder	Coriolis Pfister	+/- 1%	Internal calibration will be carried out as per kiln shutdown plan.
Truck scale		+/- 40 kg	External calibration every 2 years by Central Bureau of Weights and Measures.
Standard weight	External certify	-	External calibration every 5 years

The procedure for determining the specific fuel consumed by biomass handling equipment was conducted at Thung Song site. This trial was based on the assumption that this site has the highest biomass consumption and various types of biomass as per explanation in page 16 of the registered PD.

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graph TD; WCP[Wood Chipper Plant] --> WG[Wood Gripper (1 unit)]; WG --> WT[WA300 + 10W Truck (1 unit)]; WT --> BS[Biomass Storage Yard (1 unit)]; BS --> BD[Biomass Dryer]; BD --> TS5TS6[TS5, TS6]; WCP --> TS4[TS4];
```

Table 21 : Specific consumption of Biomass handling equipment

Machine	Fuel usage (Litre/hr.)	Capacity (ton/hr.)	Fuel consumption (Litre/ton)
1. Wood gripper 120 hp.	4	48.02	0.0833
2. CAT 966 220 hp.	23	168.62	0.1364
3. CAT 924 120 hp.	8	190.48	0.042
4. WA300 165 hp.	10	125.00	0.08
5. 10W Truck	5.5	35.76	0.1538

5. The electricity consumption of biomass transportation unit

kW Biomass Thung song plant					
	Nameplate cap	2005	2006	2007	2008
	kW	kWh	kWh	kWh	kWh
Wood chipper		1,929,200	1,705,680	1,410,120	2,020,480
Biomass Dryer		-	-	1,604,603	2,988,605
Biomass Transport					
- Supply +Star screen	20.7	151,243	148,899	158,006	153,318
- Transport TS4	18.1	84,344	117,854	112,617	120,617
- Transport TS5	35	237,669	251,761	267,159	243,645
- Transport TS6	56	409,160	393,254	406,785	414,773
Total Elec consumption	129.8	2,811,615	2,617,448	3,959,289	5,941,437