

MONITORING REPORT OF SIAM CEMENT BIOMASS PROJECT



Document Prepared By South Pole Carbon Asset Management Ltd.

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Prepared By	South Pole Carbon Asset Management Ltd.
Contact	South Pole Carbon Asset Management Ltd. 2/22 Iyara Tower , 6th Floor Soi 2 , Chan Road , Thungwatdorn , Sathorn Bangkok 10120 , Thailand T +66 2 678 8977 , 9 W www.southpole.com

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status 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.

Table 1 : The detail of project participants

Name of participants	Name of the cement plant	Production capacity (tons/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)	10,500	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)	16,000	Thungsong , Nakorn Sri Thammarat

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 proposed project activity involves 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 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.

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.

This is the 1st verification of this project for the 2nd crediting period. Further background information on project activity can be found in the VCS Project Description (PD) and associated documents which are available on the VCS website:

http://vcsprojectdatabase.org/#/project_details/403

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.

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 total GHG emission reductions generated in this monitoring period from this project activity are 194,791 tCO₂e.

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 (Thung Song) Co.,Ltd. ¹
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 As per the Deed of partial release in respect of registration deed of representation , signed in 28/02/18 , only one Project Proponent remains in this project activity.

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	Mr.
Address	Technoparkstrasse 1 , Zurich , Switzerland 8005
Telephone	+66 2 678 8979
Email	registries@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 below.

Table 2 : The start date of projects

Project site	Start Date
The Siam Cement (Kaeng Khoi)	04/10/02
The Siam Cement (Ta Luang)	15/10/02
The Siam Cement (Khao Wong)	30/09/04
The Siam Cement (Lampang)	30/04/04
The Siam Cement (Thung Song)	19/01/03

1.6 Project Crediting Period

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

The duration of the project is estimated to be 10 years. After the initial crediting period of 10 years, subsequent renewals of the crediting time might be considered according to the status of the project activity and baseline revision at the time.

1.7 Project Location

Details of the project locations, both physical address and geographical location, are presented in Table 3 and Table 4.

Table 3 : The address of projects

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, Nakhon Si Thammarat, 80110, Thailand

Table 4 : The geographic coordinate of project locations

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

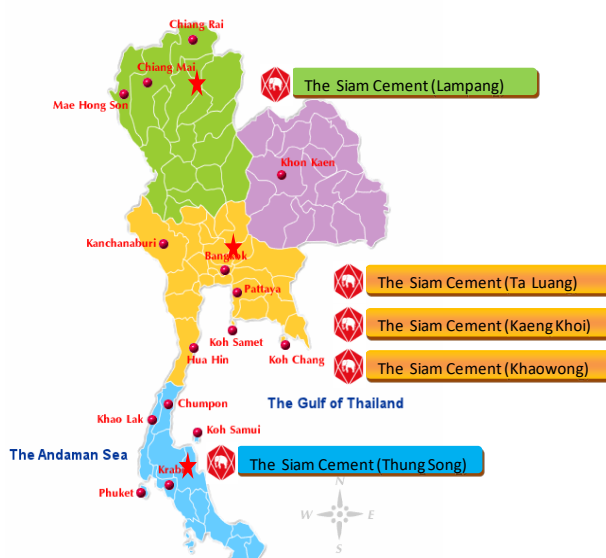


Figure 1 : The project locations in Thailand



Figure 2 : Project locations in Saraburi Province



Figure 3 : Project location in Lampang Province



Figure 4 : Project location in Nakorn Sri Thammarat Province

1.8 Title and Reference of Methodology

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 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.

1.9 Other Programs

Not Applicable

1.10 Sustainable Development

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 ‘Satane 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 foundation² ‘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.

² <http://www.scgfoundation.org/>

- 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 an annual basis, is available for public under the 'Sustainability Development' session on its website³.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project activity at Thung Song site has been implemented as per the initial project design mentioned in the registered VCS PD. The main processes and equipment for biomass feeding system are not modified or changed from original design.

Since there are plenty amount and various types of biomass residues in this region. The project activity aims to maximize the biomass usage in cement plant. Therefore the biomass consumption can be higher than the ex-ante estimated value which also results in the higher emission reductions achieved in this monitoring period.

2.2 Deviations

2.2.1 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 of 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 a daily basis.
- The clinker factor is from the result of LOI (Lost of Ignition), % ash, % dust loss and moisture content from internal laboratory.⁴

³ http://www.scg.com/en/05sustainability_development/

⁴ The work instruction; W-P-W1-001 is provided as the example of procedure to calculate the clinker production (page 21).

- 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.

2.2.2 Project Description Deviations

There is no project description deviations to be applied in this monitoring period.

2.3 Grouped Project

There is no new instance in this grouped project activities during this monitoring period.

2.4 Safeguards

2.4.1 No Net Harm

Not Applicable.

2.4.2 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 taken 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

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 each stakeholder group⁵.

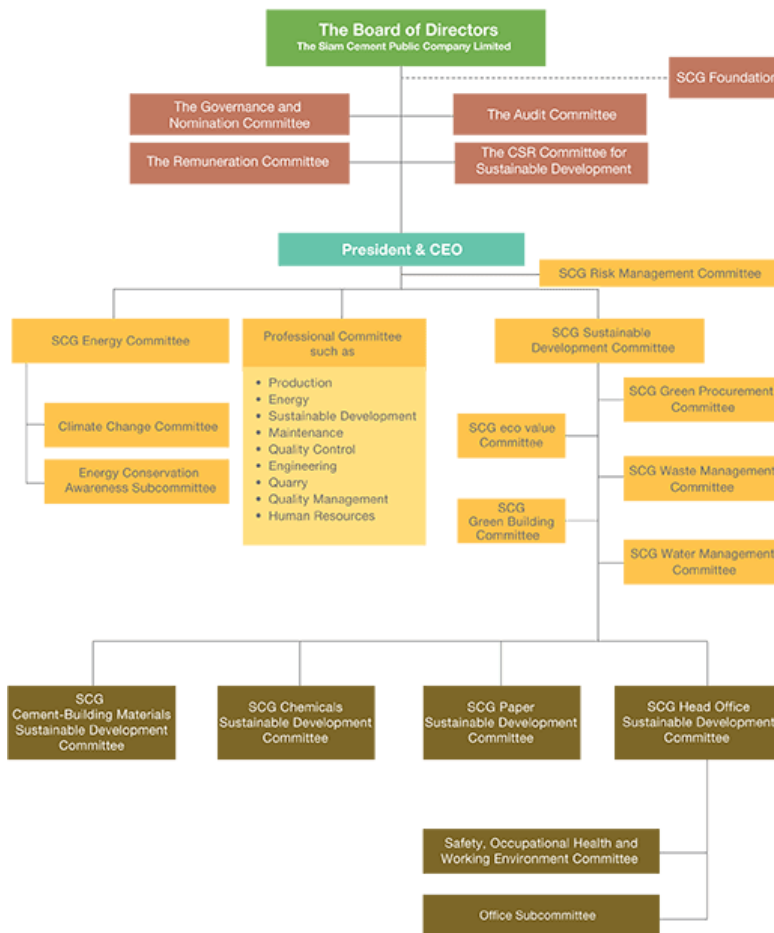


Figure 5: Sustainability management structure including CSR

⁵ http://www.scg.com/en/05sustainability_development/stakeholder-engagement.html



Figure 6: Stakeholder Engagement Overview

3 DATA AND PARAMETERS

3.1 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 used in the project plant in year x , $x-1$ and $x-2$ where x is the year prior to the start of the project activity and i are the fossil fuel types used in the project plant in the three years prior to the start of the project activity.
Source of data	Three years data from fuel consumption work journal at the project site.
Value applied:	Presented in Table 9
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data	Calculation of baseline emissions
Comments	-

Data / Parameter	$FC_{BL,F3,i,y}$
Data unit	Ton
Description	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
Source of data	Baseline scenario determination
Value applied:	Presented in Table 9
Justification of choice of data or description of measurement methods and procedures applied	From registered PD
Purpose of the 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 x , $x-1$ and $x-2$ where x 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:	Presented in Table 9
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data	Calculation of baseline emissions
Comments	-

Data / Parameter	NCV_i
Data unit	GJ/ton
Description	Net calorific value of fossil fuel types i where i is the fossil types used in the project plant in the 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:	Presented in Table 9
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 the data	Calculation of baseline emissions
Comments	-

Data / Parameter	EF _{CO₂,FF,i}																																							
Data unit	tCO ₂ /GJ																																							
Description	Weighted average CO ₂ emission factor for fossil fuel type i where i are the fossil 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																																					
Fossil																																								
Coal	tCO ₂ /TJ	92.80	100.00																																					
Coke	tCO ₂ /TJ	82.90	115.00																																					
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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																																					
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 the 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 k during the year y
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.
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Data / Parameter	EF _{CO₂,f}
Data unit	g CO ₂ /t km
Description	Default CO ₂ emission factor for freight transportation activity f
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 ⁶ . 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 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 ⁷ 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	The same value applied for the previous crediting period

⁶ 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.

⁷ 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.

measurement methods and procedures applied	
Purpose of Data	Calculation of project emissions
Comments	To be updated whenever the distance changes.

3.2 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 type k ($FC_{PJ,k,y}$) and 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 fuel and biomass fuel is continuously monitored by weight scale 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. - 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 monitored:	Presented in Table 8
Monitoring equipment	Presented in Table 10
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 the 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	tCO ₂ /GJ

Description	Weighted average CO ₂ emission factor for alternative or less carbon intensive fuels of type <i>k</i> (<i>EF_{CO2,k,y}</i>) and for fossil fuel of type <i>i</i> (<i>EF_{CO2,FF,i}</i>) in year <i>y</i>																																																												
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 Industry⁸ , provided by World Business Council for Sustainable Development. EF_{CO2,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 biomass⁹																																																												
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 monitored:	<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
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⁸ https://www.wbcsdcement.org/pdf/tf1_co2%20protocol%20v3.pdf

⁹ 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, 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 ($PE_{BC,y}$).

Monitoring equipment	-
QA/QC procedures to be applied	Any future revision of the IPCC and WBCSD Guidelines will be taken into account.
Purpose of the 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 type k (NCV _{k,y}) and fossil fuel types i (NCV _{i,y}) in year y									
Source of data	The following data sources may be used if the relevant conditions apply:<table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr><tr><td>(b) Measurements by the project participants</td><td>If (a) is not available</td></tr><tr><td>(c) Regional or national default values</td><td>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)</td></tr></table> - 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.		Data source	Conditions for using the data source	(a) Values provided by the fuel supplier in invoices	This is the preferred source	(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)
Data source	Conditions for using the data source									
(a) Values provided by the fuel supplier in invoices	This is the preferred source									
(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)									
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 monitored:	Presented in Table 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. 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 the data	Calculation of baseline and project emissions
Calculation method	-
Comments	-

Data / Parameter	$P_{\text{clinker},y}$
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 8
Monitoring equipment	Presented in Table 10
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	$EF_{\text{CO}_2, \text{BL}, y}$
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 "Procedure for the selection of the most plausible baseline scenario and demonstration of additionality".
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Continuously, aggregated at least annually
Value applied	Presented in Table 6
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 of 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	Presented in Table 10
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 ¹⁰
Description of measurement methods 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 ¹¹
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

¹⁰ http://tver.tgo.or.th/2015/file/download/Grid_Emission_Factor_124.pdf
¹¹ <https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?locations=TH&page=6>

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
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	-
Value applied	Presented in Table 7
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	Quantity 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	$FR_{f,m}$
Data unit	Tonnes
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

3.3 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.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 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)

$P_{clinker/quicklime,y}$	=	Production of clinker in year y (t)
$SEC_{clinker/quicklime,PJ,y}$	=	Specific energy consumption of the project plant in year y (GJ/t clinker or GJ/t quicklime)
$SEC_{clinker/quicklime,BL}$	=	Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker or GJ/t quicklime)

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:

$$BE_{FF,y} = \left[\sum_k (FC_{PJ,k,y} \times NCV_{k,y}) - FP_y \right] \times EF_{CO_2,BL,y} \quad \text{Equation (3)}$$

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)
$EF_{CO_2,BL,y}$	=	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 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 ($EF_{CO_2,BL,y}$) 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:

$$EF_{CO_2,BL,y} = \frac{\sum_i (FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}) \times NCV_i \times EF_{CO_2,FF,i}}{\sum_i (FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}) \times NCV_i} \quad \text{Equation (4)}$$

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)
- $FC_{i,x}$ = 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)
- $EF_{CO_2,FF,i}$ = CO₂ emission factor for fossil fuel type i (t CO₂/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

- (a) 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

- (b) 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)
- $EF_{burning,CH_4,k,y}$ = CH_4 emission factor for uncontrolled burning of the biomass residue type k during the year y (t CH_4 /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 CH_4 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 CH_4 per tonne of biomass as default value for the product of NCV_k and $EF_{burning,CH_4,k,y}$.¹²

The uncertainty of the CH_4 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 CH_4 emission factor. The level of the conservativeness factor depends on the uncertainty range of the estimate for the CH_4 emission factor. The appropriate conservativeness factor from Table 5 below shall be chosen and multiplied with the estimate for the CH_4 emission factor. For example, if the default CH_4 emission factor of 0.0027 t CH_4 /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 CH_4 /t biomass should be used.

Table 5: 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

¹² 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

Table 6 : Summary of Baseline Emissions calculation

BE Step 1		2016 (Apr - Dec)	2017 (Jan - Jun)
$FC_{PJ,i,y} \times NCV_{i,y}$	GJ	5,506,567	4,174,434
$FC_{PJ,k,y} \times NCV_{k,y}$	GJ	2,329,098	1,705,560
$SEC_{clinker,PJ,y}$	GJ/t clinker	3.36	3.33
$SEC_{clinker,BL,y}$	GJ/t clinker	3.12	3.12
FP_y	GJ	561,541.49	375,564.88
FP_y (conservative)	GJ	561,541	375,565

BE Step 2		2016 (Apr - Dec)	2017 (Jan - Jun)
$\sum FC_{PJ,k,y} \times NCV_{k,y}$	GJ	2,329,098	1,705,560
FP_y	GJ	561,541	375,565
$EF_{BL,CO_2,y}$ (option A)	tCO ₂ /GJ	0.0888	0.0888
$EF_{BL,CO_2,y}$ (option B)	tCO ₂ /GJ	0.0925	0.0926
$EF_{BL,CO_2,y}$ (option C)	tCO ₂ /GJ	0.0888	0.0888
$BE_{FF,y}$	tCO ₂	156,943	118,091

BE Step 3		2016 (Apr - Dec)	2017 (Jan - Jun)
$\sum FC_{PJ,k,y}$	ton	150,292	121,095
$EF_{burning,CH_4,k,y}$	tCH ₄ e/t	0.001971	0.001971
GW_{CH_4}	tCO ₂ e/tCH ₄	25	25
$BE_{CH_4,B1/B3,y}$	tCO ₂	7,406	5,967

4.2 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:

- a) Step 1. Calculate project emissions from the use of alternative fuels and/or less carbon intensive fossil fuels;
- b) Step 2. Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity;
- c) Step 3. Calculate project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant;
- d) 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) |
| $EF_{CO2,k,y}$ | = | 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 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:

$COEF_{i,y}$	=	CO ₂ emissions coefficient of fuel type i in year y (tCO ₂ /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 CO ₂ emission factor of fuel type i in year y (tCO ₂ /GJ)
i	=	Fuel types combusted in process j during the year y

- CO₂ emissions from on-site electricity consumption ($PE_{EC,y}$) should be calculated using the latest approved version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” , 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 TGO¹³. The data used for

¹³http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf

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 28/09/2017¹⁴ is shown in table below ;

ประเภทของโครงการ	Grid Emission Factor (tCO ₂ /MWh)		
	EF _{grid, OM}	EF _{grid, BM}	EF _{grid, CM}
โครงการทั่วไป	0.5719	0.5609	0.5664
โครงการผลิตพลังงานไฟฟ้าจากพลังงานลมและแสงอาทิตย์	0.5719	0.5609	0.5692

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.

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

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

¹⁴ http://tver.tgo.or.th/2015/file/download/Grid_Emission_Factor_124.pdf

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.
- 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 <i>m</i> (tCO ₂);
$D_{f,m}$	=	Return trip distance from transportation of freight monitoring period <i>m</i> (tCO ₂);
$FR_{f,m}$	=	Total mass of freight transported in freight transportation activity <i>f</i> in monitoring period <i>m</i> (t)
$EF_{CO_2,f}$	=	Default CO ₂ emission factor for freight transportation activity <i>f</i> (g CO ₂ /t km)
<i>f</i>	=	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 7 : Summary of Project Emissions calculation

PE Step 1		2016 (Apr - Dec)	2017 (Jan - Jun)
$PE_{k,y}$		40,725	21,487

PE Step 2		2016 (Apr - Dec)	2017 (Jan - Jun)
2.1 Electricity			
$EC_{p,j,y}$	MWh	4,456	2,971
$EF_{grid,y}$	tCO ₂ /MWh	0.5637	0.5637
$TDL_{j,y}$	%	6.073%	6.073%
$PE_{EC,y}$	tCO ₂ e	2,664	1,776
2.2 On-site transportation			
Biomass residues	ton	150,292	121,095
$FC_{i,j,y}$	litres/ton	0.4955	0.4955
	litres/year	74,470	60,003
$NCV_{i,y}$	MJ/litre	36.42	36.42
$EF_{CO_2,i,y}$	tCO ₂ /TJ	74.8	74.8
$PE_{FC,y}$	tCO ₂ e	202.87	163.46
PE_y	tCO ₂ e	2,867.31	1,939.75

PE Step 3		2016 (Apr - Dec)	2017 (Jan - Jun)
$FR_{f,m}$	ton/y	150,292	121,095
$D_{f,m}$	km	400	400
$EF_{CO_2,f}$	gCO ₂ /t km	245	245
$PE_{TR,y}$	tCO ₂ e	14,729	11,867

4.3 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:

$$LE_{US,y} = \sum_x EF_{US,x,default} \times (FC_{PJ,x,y} - FC_{BL,x,y}) \quad \text{Equation (9)}$$

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. In this monitoring period, the results of FP_y are positive for both years. Therefore the leakage emissions can be considered as zero.

4.4 Net GHG Emission Reductions and Removals

The total emission reduction achieved by these project activities within this monitoring period is presented in table below.

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
Year 2016 (Apr – Dec)	164,348	58,321	0	106,027
Year 2017 (Jan – Jun)	124,058	35,294	0	88,764
Total	288,406	93,615	0	194,791

Justification for the increasing of emission reductions in this monitoring period

In 2016, the actual ERs is 106,027 tCO₂e which is 31.68% higher than 80,517. The same situation in 2017, which the actual ERs is 65.36% higher than 53,678 tCO₂e for 6 months (ex-ante value is 107,356 tCO₂e/y).

The significant increment of the ex-post ER is because of the amount of biomass residues used in cement production is higher than ex-ante estimation. Since there are plenty of biomass residues available, as well as variety of biomass types in this region, which can be used as fuel sources for cement production at Thung Song site. Thus the cement plant are continuously attempting to use biomass as much as possible, in order to reduce the emission from burning of fossil fuel.

APPENDIX 1 : ADDITIONAL INFORMATION

1. Summary of monitoring data

Table 8 : Monitored data of Thung Song site

TS	2016 (Apr - Dec)			2017 (Jan - Jun)		
	Amount	LHV	Heat	Amount	LHV	Heat
Type of fuel	ton-AF	GJ/ton	GJ	ton-AF	GJ/ton	GJ
Clinker	2,330,842			1,763,781		
Running Hrs.	6,922			6,922		
HFO-used oil	1,782	40.40	72,016	1,149	40.40	46,421
Coal	17,903	25.96	464,776	17,262	25.10	433,233
Coal HH	99,815	24.58	2,453,842	39,847	25.44	1,013,542
Coal MH	94,545	25.60	2,419,951	104,828	25.25	2,646,451
Coal Low Grade	4,004	23.97	95,982	1,434	24.26	34,788
Total	218,049	25.25	5,506,567	164,521	25.37	4,174,434
Rubber tire	9,977	31.13	310,604	2,536	31.49	79,854
RDF	108	20.58	2,213	153	28.23	4,318
RDF ECO	6,379	26.71	170,360	6,144	28.12	172,781
Total	16,463	29.35	483,177	8,834	29.09	256,954
50-wood chip	7,372	12.74	93,945	459	13.02	5,976
Saw dust	50,720	12.34	626,076	23,751	12.83	304,743
73-wood chip	5,198	10.06	52,295	9,666	10.02	96,891
Coconut dust	17,582	15.91	279,722	6,710	15.98	107,208
Charcoal	52	13.80	715			
Bark	42,845	11.41	488,743	48,666	11.71	569,763
Dust wood	4,744	12.43	58,982	8,665	12.54	108,624
Crushed bark	21,779	11.27	245,442	23,177	11.02	255,402
Total	150,292	12.28	1,845,920	121,095	11.96	1,448,606

2. Summary of baseline (historical) data

Table 9 : Historical data of Thung Song site

Fuel Type		TS			
Fossil		2000	2001	2002	Total
Fuel Oil	ton-dry	4,126	3,291	2,486	9,903
Coal	ton-dry	188,136	166,152	143,493	497,781
Lignite	ton-dry	50,424	208,229	225,796	484,449
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
Fuel Oil	GJ/ton	40.39	40.39	40.39	40.39
Coal	GJ/ton	25.12	25.83	25.39	25.44
Lignite	GJ/ton	18.85	20.48	19.32	19.77
Pet-Coke	GJ/ton	33.98	32.81	32.22	33.11
Anthracite	GJ/ton			26.46	26.46
HG = FC x NCV	GJ	2000	2001	2002	Average
Fuel Oil	GJ	166,665	132,951	100,415	
Coal	GJ	4,726,725	4,292,170	3,643,295	
Lignite	GJ	950,726	4,263,615	4,363,495	
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
HG/Pclinker	GJ/ton	3.17	3.17	3.12	
FC x NCV x EF		2000	2001	2002	Total
Fuel Oil	GJ	12,583	10,038	7,581	
Coal	GJ	438,640	398,313	338,098	
Lignite	GJ	86,421	387,563	396,642	
Pet-Coke	GJ	403,603	276,288	280,524	
Anthracite	GJ	-	-	42,256	
EFBL, CO ₂ , y	tCO ₂ /GJ	0.0879	0.0892	0.0892	0.0888

3. Information of monitoring equipment specification and calibration

Table 10 : Monitoring equipment at Thung Song site

Project Site	Meter Name	Type	Tag No.	Accuracy	Calibration History				
					2013	2014	2015	2016	2017
TS	WF-Biomass		228_92		23-Oct-13	19-Apr-14 10-Aug-14	2-Aug-15	4-May-16	22-Jul-17
TS	WF-Biomass		228_95		23-Oct-13	19-Apr-14 10-Aug-14	2-Aug-15	4-May-16	22-Jul-17 27-Jul-17
TS	WF-Biomass		6796-03		19-Sep-13	19-Mar-14 4-Sep-14	10-Feb-15 20-Oct-15	18-Jun-16	18-Sep-17 21-Sep-17
TS	WF-Biomass		6796-06		19-Sep-13	19-Mar-14 4-Sep-14	10-Feb-15 20-Oct-15	18-Jun-16	18-Sep-17 21-Sep-17
TS	WF-Biomass		K4J32		20-Jun-13	Kiln 4 stop			
TS	WF-Solid fuel	Coriolis	791-10	1%	23-Oct-13	29-Jul-14	24-Jul-15	25-Jul-16	22-Jul-17
TS	WF-Solid fuel	Pfister	792-10	1%	23-Oct-13	29-Jul-14	24-Jul-15	22-Jul-16	22-Jul-17
TS	WF-Solid fuel	Pfister	793-10	1%	23-Oct-13	29-Jul-14	24-Jul-15	22-Jul-16	22-Jul-17
TS	WF-Solid fuel	Coriolis	6791-10	1%	10-Dec-13	29-Jul-14	24-Jul-15	25-Jul-16	22-Jul-17
TS	WF-Solid fuel	Coriolis	6792-10	1%	10-Dec-13	29-Jul-14	24-Jul-15	25-Jul-16	22-Jul-17
TS	WF-Solid fuel	Coriolis	6793-10	1%	10-Dec-13	29-Jul-14	24-Jul-15	25-Jul-16	22-Jul-17
TS	WF-Solid fuel	Coriolis	K4J20	1%	21-Jun-13	29-Jul-14	24-Jul-15	25-Jul-16	22-Jul-17
TS	WF-Solid fuel	Coriolis	K5J20	1%	21-Jun-13	29-Jul-14	24-Jul-15	25-Jul-16	22-Jul-17
TS	Truck scale	Mettler Toledo Model IND 310	BIX03 00461186FL	40 kg	13-Mar-13	11-Mar-14		24-Mar-16	
TS	Truck scale	Mettler Toledo Model IND 780	BIX04 B312160815	40 kg	27-May-13	11-Mar-14		24-Mar-16	27-Feb-17
TS	Truck scale	Mettler Toledo Model IND 560	XIX05 B211772421	40 kg	3-Apr-13	14-Jan-14		24-Mar-16	
TS	Truck scale	Mettler Toledo Model IND 780	XIX06 B308063872	40 kg	3-Apr-13	15-Jan-14		24-Mar-16	
TS	Bomb calorimeter	LECO AC-350	C-26		10-Feb-13 10-Aug-13	10-Aug-14 23-Dec-14	10-Feb-15 10-Aug-15	10-Feb-16 10-Aug-16	10-Feb-17 10-Aug-17
TS	Bomb calorimeter	LECO AC-500	C-25		10-Jan-13 10-Jul-13	10-Jan-14 10-Jul-14	10-Jan-15 10-Jul-15	10-Jan-16 10-Jul-16	10-Jan-17

4. The specific fuel consumption for biomass handling equipment (from the registered PD)

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.

The test was done by measuring the biomass transferred quantity and fuel consumed by each equipment in one hour. The total specific fuel consumption is 0.4955 liters/ton of biomass. The consumption details and the process diagram are presented below.

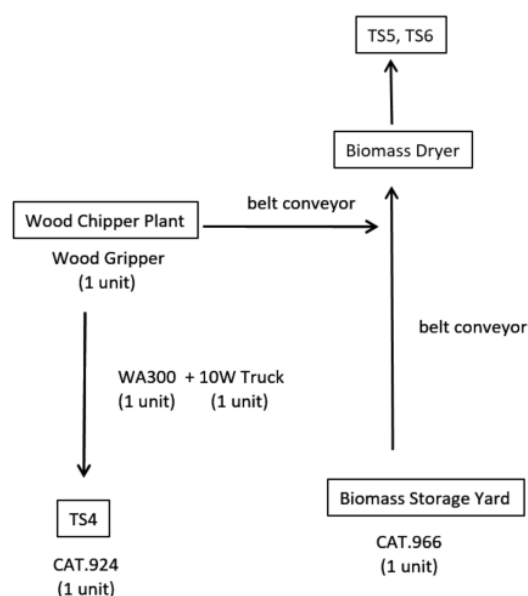


Figure 7 : Process diagram of biomass preparation unit

Table 11 : 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 (from the registered PD)

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