

MONITORING REPORT OF SIAM CEMENT BIOMASS PROJECT



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1 PROJECT DETAILS

1.1 Summary Description of Project

This grouped project is a combination of five GHG reduction projects in the same sectoral scope and methodology. All project activities in this group involve partial replacement of fossil fuels by alternative fuels or less carbon intensive fuels such as biomass residue in cement manufacture. As per UNFCCC guideline for the CDM project, the proposed projects can be categorized as large-scale project on sectoral scope No.4 “Manufacturing Industries”.

Each project site is illustrated as follows:

- The Siam Cement (Ta Luang) Co., Ltd (Ta Luang).
- The Siam Cement (Ta Luang) Co., Ltd (Khao Wong).
- The Siam Cement (Kaeng Khoi) Co., Ltd.
- The Siam Cement (Thung Song) Co., Ltd.
- The Siam Cement (Lampang) Co., Ltd.

They are the cement manufactures holding by SCG Cement Co., Ltd. The address for each site and installation capacity is shown in the table below:

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

All cement plants have invested into infrastructure including storage and handling system for alternative fuels and biomass residue.

By means of this monitoring report GHG reductions achieved by the project activities of this proposed grouped project are being verified and certified as per requirements of the Voluntary Carbon Standard (VCS) under monitoring methodology approved by UNFCCC; the ACM0003 version 07.2

This is the 3rd verification of this project. The 1st and 2nd verification reports were issued on 5th June 2010 and 13th November 2011.

Further background information on all project activities in the group can be found in the VCS Project Description (PD) and associated documents which are available on the VCS website: <https://vcsprojectdatabase2.apx.com/myModule/interactive.asp?Tab=Projects&a=2&i=403&lat=14.609331&lon=100.996356>

1.2 Sectoral Scope and Project Type

The project is a combination of five GHG reduction projects located in five different cement manufacturing units which are listed in paragraph 1.1. All project activities in this group involve partial replacement of fossil fuels by alternative fuels or less carbon intensive fuels in cement manufacturer. As per UNFCCC guideline for the CDM project, the proposed projects can be categorized as large-scale project on sectoral scope No.4 "Manufacturing Industries"

In accordance with the Voluntary Carbon Standard Program Guidelines, clause 5.2 (Group Projects), SCG Cement Co. Ltd will be responsible for the centralized GHG information system and controlling all associated with the project and its monitoring.

1.3 Project Proponent

Role	Project owner
Organization:	The Siam Cement (Kaeng Khoi) Co., Ltd.
Address:	1 Siam Cement Rd., Bangsue
City:	Bangkok
Country:	Thailand
Post zip	10800
Telephone:	+662 586 5684
FAX:	+662 586 3098
Represented by:	Somkiat Pananookooln Chanwut Limpichai
Title:	Managing Director/Energy Manager
Salutation:	Mr.

Role	Project owner
Organization:	The Siam Cement (Ta Luang) Co., Ltd.
Address:	1 Siam Cement Rd., Bangsue
City:	Bangkok
Country:	Thailand
Post zip	10800
Telephone:	+662 586 5684
FAX:	+662 586 3098
Represented by:	Sira Srisukri Chanwut Limpichai
Title:	Managing Director/Energy Manager

Salutation:	Mr.
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Role	Project owner
Organization:	The Siam Cement (Lampang) Co., Ltd.
Address:	1 Siam Cement Rd., Bangsue
City:	Bangkok
Country:	Thailand
Post zip	10800
Telephone:	+662 586 5684
FAX:	+662 586 3098
Represented by:	Sanit Kessuwan Chanwut Limpichai
Title:	Managing Director/Energy Manager
Salutation:	Mr.

Role	Project owner
Organization:	The Siam Cement (Thung Song) Co., Ltd.
Address:	1 Siam Cement Rd., Bangsue
City:	Bangkok
Country:	Thailand
Post zip	10800
Telephone:	+662 586 5684
FAX:	+662 586 3098
Represented by:	Nantapong Chantrakul Chanwut Limpichai
Title:	Managing Director/Energy Manager
Salutation:	Mr.

Role	Carbon consultant
Organization:	South Pole Carbon Asset Management Ltd.
Street/P.O.Box:	Technoparkstrasse 1
City:	Zurich
Postfix/ZIP:	8005
Country:	Switzerland
E-Mail:	i.puhl@southpolecarbon.com
URL:	www.southpolecarbon.com
Represented by:	Ingo Puhl
Title:	Managing Partner
Salutation:	Mr.
Mobile:	+ 66 86 778 2869
Direct tel:	+ 66 2 678 8979

1.4 Other Entities Involved in the Project

N/A

1.5 Project Start Date

Table 2 : The start date of projects

Project site	Start Date
The Siam Cement (Kaeng Khoi)	04 October 2002
The Siam Cement (Ta Luang)	15 October 2002
The Siam Cement (Khao Wong)	30 September 2004
The Siam Cement (Lampang)	30 April 2004
The Siam Cement (Thung Song)	19 January 2003

1.6 Project Crediting Period

Crediting period : From 1 April 2006 to 31 March 2016

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, Nakon 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

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 07.2

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project has been implemented as per the initial project design as mentioned in the registered VCS PD. The main processes and equipment for biomass feeding system are not modified or changed as determined in registered PD. The biomass processing and preparation is different at each site depending on the type of main biomass residue used at the site. There are two sites , Lampang and Kaeng Khoi , have the design changings from registered PD. These two sites do not claim the emission reductions in this monitoring period , the justification is provided in section 4.4.

2.2 Project Description Deviations

Deviation 1

Description of deviation

The $P_{\text{clinker},y}$ 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.¹
- 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 was also applied for the 1st and 2nd verification.

¹ The work instruction ; W-P-W1-001 is provided as the example of procedure to calculate the clinker procudtion (page 21).

Deviation 2Description of deviation

The quantity of biomass residue type k is the additional monitored parameter in this monitoring period.

Deviated approach

The biomass residue type k is the parameter, which needs to be monitored according to ACM0003 version 07.2. This parameter is monitored based on publically available data for available biomass to apply leakage estimation as per the methodological approach.

Justification of deviated approach

This parameter is applicable if approach L₂ is used to estimate the leakage emissions.

Deviation 3Description of deviation

The quantity of electricity consumed by project is the additional monitored parameter in this monitoring period.

Deviated approach

The EC_{PJ,y} is the parameter which needs to be monitored according to ACM0003 version 07.2.

Justification of deviated approach

This parameter is used for calculating the CO₂ emissions from on-site electricity consumption by “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”

2.3 Grouped Project

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

3 DATA AND PARAMETERS**3.1 Data and Parameters Available at Validation**

Data Unit / Parameter:	FC _{i,x} , FC _{i,x-1} , and FC _{i,x-2}
Data unit:	ton
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 18
Purpose of the data:	This data is used for project emission calculation
Any comment:	-

Data Unit / 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:	Fuel consumption work journal at the project site
Value applied:	Presented in Table 18
Purpose of the data:	This data is used for project emission calculation
Any comment:	Only applicable if F3 has been determined as the most likely baseline scenario.

Data Unit / 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 18
Purpose of the data:	This data is used for baseline emission calculation
Any comment:	-

Data Unit / 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:	Since the values provided by the fuel supplier in invoices is not available, then the value measured

	by the project participants is taken.
Value applied:	Presented in Table 18
Purpose of the data:	This data is used for baseline emission calculation
Any comment:	-

Data Unit / 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:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in the table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventory are taken for calculation																																							
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
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Biodiesel	tCO ₂ /TJ	59.80	84.30																																					
Purpose of the data:	This data is used for baseline emission calculation																																							
Any comment:	-																																							

3.2 Data and Parameters Monitored

Data Unit / Parameter:	$FC_{PJ,k,y}$ and $FC_{PJ,i,y}$
Data unit:	ton
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	The quantity of solid fossil fuel and biomass

procedures to be applied:	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:	Continuous monitoring with daily recording and adjusting with stock checking report at the end of month.
Value monitored:	Presented in Table 17 , Table 18 and Table 19
Monitoring equipment:	The information of monitoring equipment is provided in the calibration sheet of ER calculation spread sheet.
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.
Calculation method:	-
Any comment:	The amount of fuels for trial projects ² which is not the normal operational used is not included in the ER calculation.

Data Unit / Parameter:	EF _{CO2,k,y}
Data unit:	tCO ₂ /GJ
Description:	Weighted average CO ₂ emission factor for biomass residue of type k (EF _{CO2,k,y}) and for fossil fuel of type i (EF _{CO2,FF,i}) in year y.
Source of data:	IPCC default values at the upper/lower limit of the

² The amount for these types of fuels is shown in the WJ but the heating value test is not carried out since the heat generated has no significant to the performance of combustion process.

	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 , the source of emission factor is from the CO₂ Accounting and Reporting Standard for the Cement Industry³ , provided by World Business Council for Sustainable Development.																																																																				
Description of measurement methods and procedures to be applied:	-																																																																				
Frequency of monitoring/recording:	-																																																																				
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><tr><td colspan="4">Alternative fossil fuel</td></tr><tr><td>waste oil</td><td>tCO₂/TJ</td><td>74</td><td></td></tr><tr><td>tyres</td><td>tCO₂/TJ</td><td>85</td><td></td></tr><tr><td>plastics</td><td>tCO₂/TJ</td><td>75</td><td></td></tr><tr><td>solvents</td><td>tCO₂/TJ</td><td>74</td><td></td></tr><tr><td>impregnated saw dust</td><td>tCO₂/TJ</td><td>75</td><td></td></tr><tr><td>mixed industrial waste</td><td>tCO₂/TJ</td><td>83</td><td></td></tr><tr><td>other fossil based wastes</td><td>tCO₂/TJ</td><td>80</td><td></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				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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Monitoring equipment:	-																																																																				
QA/QC procedures to be applied:	Any future revision of the IPCC and WBCSD Guidelines will be taken into account.																																																																				
Calculation method:	-																																																																				
Any comment:	EF _{CO₂,k,y} is zero for the biomass residues referred to page 29/40 ACM0003 version 07.2.																																																																				

Data Unit / Parameter:	NCV _{k,y} and NCV _{i,y}
Data unit:	GJ/ton
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

³ <http://wbcsdcement.org/index.php/key-issues/climate-protection/co2-accounting-and-reporting>

Source of data:	The NCV analysis results from internal laboratory.
Description of measurement methods and procedures to be applied:	The fuel sample is analyzed by internal laboratory. The results are saved in QIS (Quality Information System) by lab analyst.
Frequency of monitoring/recording:	This parameter will be measured daily or every batch / delivery depends on type of fuel. The monthly weighted-average figure from QIS is used in emission reduction calculation.
Value monitored:	Presented in Table 17 , Table 18 and Table 19
Monitoring equipment:	-
QA/QC procedures to be applied:	• The NCV is measured according to the national or international approved standards and procedures through a qualified laboratory. • The laboratory equipment is calibrated as per manufacturer's recommendation. • The documentation and calibration is controlled and managed in accordance with ISO9001 requirements
Calculation method:	-
Any comment:	• In case the NCV data is not available, it means there is not fuel delivered in that month. The NCV data from previous month will be used. • The NCV of fuel oil applied for all sites is from the annual average test result from internal laboratory. Since there are only 2 suppliers, Bangchak and Thai Oil , who supply the fuel oil to all sites. Then the same average value can be used for all sites.

Data Unit / Parameter:	AVD _y
Data unit:	km
Description:	Average round trip distance (from and to) between the alternative fuel supply sites and the site of the project plant during the year y.
Source of data:	The maximum round trip distance suggested in methodology ACM0003 version 07.2.
Description of measurement methods and procedures to be applied:	400 km is considered as the maximum round trip

	distance and is used for calculation.
Frequency of monitoring/recording:	-
Value monitored:	400
Monitoring equipment:	-
QA/QC procedures to be applied:	Any future revision of the methodologies will be taken into account.
Calculation method:	-
Any comment:	-

Data Unit / Parameter:	$EF_{km,CO_2,y}$
Data unit:	tCO ₂ /km
Description:	CO ₂ emission factor for the trucks represented per km of the distance travelled. .
Source of data:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Table 1-32 (for US heavy duty diesel vehicles, uncontrolled)
Description of measurement methods and procedures to be applied:	The value from IPCC is applied for the most conservative approach.
Frequency of monitoring/recording:	-
Value monitored:	0.001097
Monitoring equipment:	-
QA/QC procedures to be applied:	Any future revision of the methodologies will be taken into account.
Calculation method:	-
Any comment:	-

Data Unit / Parameter:	$AF_{T,k,y}$
Data unit:	ton
Description:	Quantity of biomass residue type k that has been transported to the project site during the year y.
Source of data:	Work Journal : WJ
Description of measurement methods and procedures to be applied:	Using weight scale to measure and monthly adjusted according to stock change.
Frequency of monitoring/recording:	Continuous monitoring with daily recording

Value monitored:	Presented in Table 18
Monitoring equipment:	The information of monitoring equipment is provided in the calibration sheet of ER calculation spread sheet.
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
Calculation method:	-
Any comment:	

Data Unit / Parameter:	TL _y
Data unit:	Ton
Description:	Average truck load of the trucks used during the year y.
Source of data:	Transportation regulation of Thailand
Description of measurement methods and procedures to be applied:	For a conservative calculation, the default value 15 tons/trip is used, since the on-site data is not available.
Frequency of monitoring/recording:	Every verification period.
Value monitored:	15
Monitoring equipment:	-
QA/QC procedures to be applied:	Any future revision of the regulation will be taken into account.
Calculation method:	-
Any comment:	-

Data Unit / Parameter:	FC _{i,j,y}
Data unit:	Liters/year
Description:	Quantity of alternative fuel type k for biomass handling
Source of data:	- KK , KW Consumption data provided by sub-contractor - TS

	Specific consumption figure which used for ex-ante estimation in the registered PD. The reference information is provided in section 5.4. • TL , LP Calculating by using the maximum specific consumption from KK , KW and TS.
Description of measurement methods and procedures to be applied:	-
Frequency of monitoring/recording:	Every verification period
Value monitored:	Presented in Table 10
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	This is the additional monitored parameter from the registered PD. Reference information is provided in section 5.4.

Data Unit / Parameter:	EF _{grid,y}
Data unit:	tCO ₂ /MWh
Description:	CO ₂ emission factor for grid electricity during the year y
Source of data:	Summary report : The study of emission factor for electricity generation of Thailand in year 2010 , published by Thailand Greenhouse Gas Management Organization. ⁴
Description of measurement methods and procedures to be applied:	Use the most update public data available
Frequency of monitoring/recording:	Update in every verification period.
Value monitored:	0.5113
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	This emission factor in this report is calculated by Methodological Tool (Version 02.2.1) "Tool to calculate the emission factor for an electricity

⁴ http://www.tgo.or.th/download/publication/GEF/2010/GEFReport_ENrevise4.pdf

	system”
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Data Unit / Parameter:	TDL _{j,y}
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source j.
Source of data:	Scenario A “Electricity consumption from the grid” is applicable in this case.
Description of measurement methods and procedures to be applied:	The latest version of the tool.
Frequency of monitoring/recording:	Every verification period.
Value monitored:	20%
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	Then default value of 20% is chosen for a conservative calculation.

Data Unit / Parameter:	P _{clinker,y}
Data unit:	ton
Description:	Production of clinker in year y
Source of data:	Work Journal : WJ as per description provided in deviation 1
Description of measurement methods and procedures to be applied:	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:	The amount of raw material is continuously monitored. Daily recording and adjusting with stock checking report at the end of month.
Value monitored:	Presented in Table 18
Monitoring equipment:	The information of monitoring equipment is provided in the calibration sheet of ER calculation spread sheet.
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
Calculation method:	-
Any comment:	-

Data Unit / Parameter:	$EF_{CO_2,BL,y}$
Data unit:	tCO ₂ /GJ
Description:	Carbon dioxide emissions factor for the fossil fuels displaced by the use of biomass residue in the project plant.
Source of data:	The annual weighted average value is calculated as determined in "Procedure for the selection of the most plausible baseline scenario"
Description of measurement methods and procedures to be applied:	-
Frequency of monitoring/recording:	Every verification period.
Value monitored:	Presented in Table 6
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	$EF_{BL,CO_2,y} = \frac{\sum_i FC_{BL,F3,i,y} * NCV_{i,y} * EF_{CO_2,i,y}}{\sum_i FC_{BL,F3,i,y} * NCV_i}$
Any comment:	The calculation method is described in Baseline emission calculation step 2 of the registered PD.

Data Unit / Parameter:	$FC_{BL,i,y}$
Data unit:	ton
Description:	Quantity of fossil fuel type i displaced in the project plant as a result of the project activity in year y.
Source of data:	The quantities and types of fossil fuels i that are displaced as a result of the project activity ($FC_{BL,i,y}$) should be determined consistent with the guidance above on the determination of the baseline CO ₂ emission factor ($EF_{CO_2,BL,y}$)
Description of measurement methods and procedures to be applied:	-

Frequency of monitoring/recording:	Every verification period
Value monitored:	Presented in Table 6
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	-

Data Unit / Parameter:	Biomass residue type K
Data unit:	-
Description:	Quantity of biomass residue type k that are utilized (eg. for energy generation or as feedstock) in the defined geographical region.
Source of data:	Thailand Alternative Energy Situation Report 2011 ⁵ , from Department of Alternative Energy Development and Efficiency (DEDE)
Description of measurement methods and procedures to be applied:	Use the latest update data from official sources.
Frequency of monitoring/recording:	Every verification period
Value monitored:	Presented in Table 13 ,Table 14 and Table 15
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	Please refer to deviation 2

Data Unit / Parameter:	Biomass residue type K
Data unit:	-
Description:	Quantity of available biomass residues of type k in the region
Source of data:	Thailand Alternative Energy Situation Report 2011 ⁶ , from Department of Alternative Energy Development and Efficiency (DEDE)
Description of measurement methods and procedures to be applied:	Use the latest update data from official sources.
Frequency of monitoring/recording:	Every verification period

⁵ http://www.dede.go.th/dede/images/stories/stat_dede/alternative_54/alternative_54.pdf

⁶ http://www.dede.go.th/dede/images/stories/stat_dede/alternative_54/alternative_54.pdf

Value monitored:	Presented in Table 13 ,Table 14 and Table 15
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	Please refer to deviation 2

Data Unit / Parameter:	EC _{PJ,y}
Data unit:	kWh
Description:	Quantity of electricity consumed by project electricity consumption source j in year (MWh/year)
Source of data:	- For TL, KK, TS, and LP ,the installed rated capacity of biomass related equipment is used to determine electricity consumption. - The energy meter at Khao Wong site is used to measure electricity consumption.
Description of measurement methods and procedures to be applied:	- The power consumption is calculated from the total kW and the number of operating hours within monitoring period (applicable for TL, KK, TS, and LP) - At Khao Wong site, the power meter continuously monitors the electricity consumption. The record is taken by operator on monthly basis.
Frequency of monitoring/recording:	Continuous monitoring with monthly recording
Value monitored:	Presented in Table 9
Monitoring equipment:	Multifunction power meter : E Power ECM 700
QA/QC procedures to be applied:	- The installed power capacity is updated when the changing in process equipment (applicable for TL, KK, TS, and LP). - At Khao Wong site, the electricity meter is calibrated at least once a year.
Calculation method:	-
Any comment:	Since the electricity meter at KW was not calibrated before July'2012 , the maximum error of 0.5% is applied for conservativeness approach as per EB 52 Annex 60. Please refer to the information in deviation 3.

3.3 Description of the 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-calcliner and the kiln for the production of clinker in cement manufacturing. CH₄ emissions from preventing disposal or uncontrolled burning of biomass residues are included in this emission.

$$BE_y = BE_{FF,y} + BE_{CH4,biomass,y}$$

Where :

BE _y	=	Baseline emissions in year y (tCO ₂)
BE _{FF,y}	=	Baseline emission from fossil fuels displaced by alternative fuels or less carbon intensive fossil fuels in year y (tCO ₂)
BE _{CH4,biomass,y}	=	Baseline methane emissions avoided during the year y from preventive disposal or uncontrolled burning of biomass residues (tCO ₂ e)

Baseline emissions are determined in the following step:

Step 1. Estimate the project specific “fuel penalty”

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

$$FP_y = P_{clinker,y} * (SEC_{clinker,PJ,y} - SEC_{clinker,BL})$$

Where :

FP_y	=	Fuel penalty in year y (GJ)
$P_{clinker,y}$	=	Production of clinker in year y (ton)
$SEC_{clinker,PJ,y}$	=	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 produced in year, as follows:

$$SEC_{clinker,PJ,y} = \frac{\sum_i (FC_{PJ,y} * NCV_{i,y}) * \sum_k (FC_{PJ,k,y} * NCV_{k,y})}{P_{clinker,y}}$$

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 (ton)
$NCV_{i,y}$	=	Net calorific value of the fossil fuel type i in year y (GJ/ton)
$FC_{PJ,k,y}$	=	Quantity of alternative fuel or less carbon intensive fossil fuel type k used in the project plant in year y (ton)
$NCV_{k,y}$	=	Net calorific value of the alternative or less carbon intensive fuel type k used in the project plant in year y (ton)
$P_{clinker,y}$	=	Production of clinker in year y (ton)
k	=	Alternative fuel types and less carbon intensive fossil fuel type 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 type

$$SEC_{clinker,BL} = MIN \left(\frac{HG_x}{P_{clinker,x}} ; \frac{HG_{x-1}}{P_{clinker,x-1}} ; \frac{HG_{x-2}}{P_{clinker,x-2}} \right)$$

With :

$$HG_x = \sum_i FC_{i,x} * NCV_i$$

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 year x (GJ)
$FC_{i,x}$	=	Quantity of fossil fuel type i used in the project plant in year x (tons)
NCV_i	=	Net calorific value of the fossil fuel type i (GJ/ton)
$P_{clinker,x}$	=	Production of clinker in year x (tons)
x	=	Year prior to the start of the project activity
i	=	Fossil fuel types used in the project plant in the last 3 years prior to the start of the project activity

Table 5 : Summary of fuel penalty

Project site		TL		KW		KK		TS		LP	
Year		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
FC _{PJ,k,y} x NCV _{i,y}	GJ	5,137,775	8,218,220	6,480,729	8,581,984	16,342,682	18,856,927	11,361,773	13,326,621	3,675,890	5,083,596
FC _{PJ,k,y} x NCV _{k,y}	GJ	674,335	931,333	1,312,583	1,750,730	1,265,606	1,878,538	1,278,372	1,749,854	487,479	498,540
P _{clinker,y}	tonne	1,672,624	2,652,479	2,592,280	3,230,104	5,089,833	6,284,492	3,731,075	4,650,635	1,189,155	1,621,242
SCE _{clinker,PJ,y}	GJ/ton	3.47	3.45	3.01	3.20	3.46	3.30	3.39	3.24	3.50	3.44
SCE _{clinker,BL}	GJ/ton	3.41	3.41	3.04	3.04	3.08	3.08	3.12	3.12	3.01	3.01
Fpy (calculation)	GJ	113,949	113,300	(84,078)	517,112	1,919,440	1,364,213	996,159	562,713	587,360	706,762
Fpy (conservative)	GJ	113,949	113,300	-	517,112	1,919,440	1,364,213	996,159	562,713	587,360	706,762

Step 2. Calculate baseline emission from the fossil displaced by the alternative or less carbon intensive fuel(s)

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

$$BF_{FF,y} = \left[\sum_k (FC_{PJ,k,y} * NCV_{k,y}) - FP_y \right] * EF_{CO_2,BL,y}$$

Where :

- BF_{FF,y} = Baseline emission from fossil fuels displaced by alternative fuels or less carbon intensive fuels in year y (tCO₂)
- FC_{PJ,k,y} = Quantity of alternative fuels or less carbon intensive fossil fuel type k used in the project plant in year y (tons)
- NCV_{k,y} = Net calorific value of the alternative or less carbon intensive fuel type k in year y (GJ/ton)
- 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 (tCO₂/GJ)
- k = Alternative fuel types and less carbon intensive fossil fuel types used in the project plant in year y

Since 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 "Procedure for the selection of the most plausible baseline scenario" as follows:

$$EF_{BL,CO_2,y} = \frac{(\sum_i FC_{BL,F3,i,y} * NCV_{i,y} * EF_{CO_2,i,y})}{(\sum_i FC_{BL,F3,i,y} * NCV_i)}$$

Where :

- EF_{BL,CO₂,i,y} = Carbon dioxide emissions factor for the fossil fuels displaced by the used of alternative fuels or less carbon intensive fossil fuels in the project plant In year y (tCO₂/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 (ton)
- NCV_{i,y} = Net calorific value of the fossil fuel type i in year y (tCO₂/GJ)
- EF_{CO₂,i,y} = Carbon dioxide emission factor fuel type i in year y (tCO₂/GJ)
- i = Fossil fuel types that are less carbon intensive fossil fuel types and that would in the absence of the project activity be used in the project plant

Table 6 : The result of baseline emissions calculation step 2

Project Site		TL		KW		KK		TS		LP	
Year		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
$\sum FC_{PJ,k,y} \times NCV_{k,y}$	GJ	674,335	931,333	1,312,583	1,750,730	1,265,606	1,878,538	1,278,372	1,749,854	487,479	498,540
FP_y	GJ	113,949	113,300	-	517,112	1,919,440	1,364,213	996,159	562,713	587,360	706,762
$EF_{BL,CO_2,y} \text{ (option A)}$	tCO ₂ /GJ	0.0891	0.0891	0.0863	0.0863	0.0891	0.0891	0.0888	0.0888	0.0908	0.0908
$EF_{BL,CO_2,y} \text{ (option B)}$	tCO ₂ /GJ	0.0918	0.0921	0.0918	0.0920	0.0918	0.0916	0.0926	0.0926	0.0908	0.0908
$EF_{BL,CO_2,y} \text{ (option C)}$	tCO ₂ /GJ	0.0891	0.0891	0.0863	0.0863	0.0891	0.0891	0.0888	0.0888	0.0908	0.0908
$BE_{FF,y}$	tCO ₂	49,957	72,926	113,321	106,503	(58,289)	45,852	25,058	105,407	(9,065)	(18,898)

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

In this case only scenario B3 is the applicable baseline. Then the calculation for methane baseline emissions will be as follows:

$$BE_{CH_4,B1/B3,y} = GWP_{CH_4} * \sum_k FC_{PJ,k,y} * NCV_{k,y} * EF_{burning,CH_4,k,y}$$

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 (tCO ₂ e)
GWP_{CH_4}	=	Global warming potential of methane valid for the commitment period (tCO ₂ e/tCH ₄)
$FC_{PJ,k,y}$	=	Quantity of alternative fuel or less carbon intensive fossil fuel type k in year y (ton)
$NCV_{k,y}$	=	Net calorific value of the alternative or less carbon intensive fossil fuel type k in year y (GJ/ton)
$EF_{burning,CH_4,k,y}$	=	CH ₄ emissions factor for uncontrolled burning of the biomass residue type k during the year y (tCH 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 and for which leakage effects could be ruled out with one of the approaches L ₁ , L ₂ or L ₃ described in the leakage section

As per recommendation in methodology, 0.0027 tCH₄ per ton of biomass should be used as default value for the project. To provide 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 Table 2 in methodology, page 18, is shown the conservativeness factor and for this case, the uncertainty can be deemed to be greater than 100%, resulting in a conservativeness factor of 0.73. Thus an emission factor of 0.001971 tCH₄/t biomass should be used.

Table 7 : The result of baseline emission calculation step 3

Project site		TL		KW		KK		TS		LP	
Year		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
$FC_{PJ,k,y} \times EF$	tCH ₄	102.26	139.58	199.89	260.58	242.78	340.78	200.95	279.40	69.71	65.29
GWP_{CH_4}	tCO ₂ e/tCH ₄	21	21	21	21	21	21	21	21	21	21
$BE_{CH_4,B1/B3,y}$	tCO ₂ e	2,147	2,931	4,198	5,472	5,098	7,156	4,220	5,867	1,464	1,371

Table 8 : Summary of baseline emissions

Year	TL			KW			KK			TS			LP		
	BE _y	BE _{FF,y}	BE _{CH₄,biomass,y}	BE _y	BE _{FF,y}	BE _{CH₄,biomass,y}	BE _y	BE _{FF,y}	BE _{CH₄,biomass,y}	BE _y	BE _{FF,y}	BE _{CH₄,biomass,y}	BE _y	BE _{FF,y}	BE _{CH₄,biomass,y}
2011	52,104	49,957	2,147	117,518	113,321	4,198	(53,190)	(58,289)	5,098	29,278	25,058	4,220	(7,601)	(9,065)	1,464
2012	75,857	72,926	2,931	111,976	106,503	5,472	53,008	45,852	7,156	111,275	105,407	5,867	(17,526)	(18,898)	1,371

4.2 Project Emissions

Quantify project emissions and/or removals. Project emissions include project emission from the use of alternative fuels and/or less carbon intensive fossil fuel ($PE_{k,y}$), 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 emission from combustion of fossil fuels for transportation of alternative fuels to the project plant ($PE_{T,y}$). In this grouped project activities the project emission from the cultivation of renewable biomass at the dedicated plantation is not included.

$$PE_y = PE_{k,y} + PE_{FC,y} + PE_{EC,y} + PE_{T,y}$$

Where :

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

Project emissions are calculated in the following steps:

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

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

Where :

$$PE_{k,y} = \sum_k FC_{PJ,k,y} * NCV_{k,y} * EF_{CO2,k,y}$$

$PE_{k,y}$	=	Project emissions from the combustion of alternative fuels and/or less carbon intensive fossil fuels in the project plant in year y (tCO ₂)
$FC_{PJ,k,y}$	=	Quantity of alternative fuel or less carbon intensive fossil fuel type k in year y (ton)
$NCV_{k,y}$	=	Net calorific value of the alternative or less carbon intensive fossil fuel type k in year y (GJ/ton)
$EF_{CO2,k,y}$	=	Carbon dioxide emissions factor of alternative fuels or less carbon intensive fossil fuels type k in year y (tCO ₂ /GJ)

k = Alternative fuel types and less carbon intensive fossil fuel used in the project plant in year y

Table 9 : The result of project emission calculation step 1

Project site		TL		KW		KK		TS		LP	
Year		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
PE _{k,y}	tCO ₂ e	2,437	2,220	8,687	10,904	72,517	98,492	12,720	13,533	830	46

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 which included

- Mechanical treatment of the fuels; and
- On-site transportation of the fuels.

CO₂ emission from on-site electricity consumption (PE_{EC,y}) will be calculated using the latest approved version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. Then the project emission from electricity consumption is calculated as follows:

$$PE_{EC,y} = \sum EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y})$$

Where :

PE_{EC,y} = Project emissions from the additional electricity consumption as a result of project activity in year y (tCO₂/y)

EC_{PJ,j,y} = Quantity of electricity consumed by project electricity consumption source j in year (MWh/year)

EF_{EL,j,y} = Emission factor for electricity generation for source j in year (tCO₂/MWh)

TDL_{j,y} = Average technical transmission and distribution losses for providing electricity to source j in year

The quantity of electricity consumed by project activity will be calculated from the machine specification multiplied by operating time, since the consumption of electricity by project activity is not available. Moreover emission factor for electricity generation is taken from the calculation by Thailand Greenhouse Gas Management Organization⁷

The average technical transmission and distribution losses use conservative default values of 20%, according to “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”

CO₂ emission from on-site combustion of fossil is calculated using the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” version 02 approved by the CDM Executive Board (CDM EB) and validity from 2nd of August 2008.

⁷ http://www.tgo.or.th/download/publication/GEF/2010/GEFReport_ENrevise4.pdf

According to the tool, CO₂ emission from fossil fuel combustion in on-site transportation is calculated based on the quantity of fuels combusted and the CO₂ emission coefficient of those fuels, as follows;

$$PE_{FC,j,y} = \sum FC_{i,j,y} * COEF_{i,y}$$

Where :

- PE_{FC,j,y} = CO₂ emissions from fossil fuel combustion in process j during year y (tCO₂/y)
- FC_{i,j,y} = Quantity of fuel type i combusted in process j during the year y (mass or volume unit / year)
- COEF_{i,y} = CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)
- i = the fuel types combusted in process j during the year y

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

$$COEF_{i,y} = NCV_{i,y} * EF_{CO2,i,y}$$

Where :

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

Table 10 : The results of project emission calculation step 2

2.1 Additional electricity	Unit	TL		KW		KK		TS		LP	
		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Electricity consumption; EC	kWh	767,372	1,184,312	884,225	1,015,708	18,286,604	22,110,161	4,951,198	5,941,437	536,533	717,585
EF	tCO ₂ /MWh	0.5113	0.5113	0.5113	0.5113	0.5113	0.5113	0.5113	0.5113	0.5113	0.5113
TDL	%	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
PE	tCO ₂	471	727	543	623	11,220	13,566	3,038	3,645	329	440

2.2 On-site transportation		TL		KW		KK		TS		LP	
		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Biomass		51,883	70,816	101,414	132,206	123,177	172,896	101,953	141,757	35,368	33,126
Biomass Residue total	Ton (dry basis)	51,883	70,816	101,414	132,206	123,177	172,896	101,953	141,757	35,368	33,126
FC _{i,j,y}	litre/year	50,648	69,131	99,000	118,800	40,638	49,591	50,518	70,241	34,526	32,337
	litre/ton			0.976	0.899	0.330	0.287	0.4955			

Parameters	Unit	TL		KW		KK		TS		LP	
		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Average amount of fossil fuel for biomass handling; FC	litre/year	50,648	69,131	99,000	118,800	40,638	49,591	50,518	70,241	34,526	32,337
NCV for diesel	MJ/litre	36.42	36.42	36.42	36.42	36.42	36.42	36.42	36.42	36.42	36.42
EF _{CO2}	tCO ₂ /TJ	74.80	74.80	74.80	74.80	74.80	74.80	74.80	74.80	74.80	74.80
PE	tCO ₂	138	188	270	324	111	135	138	191	94	88
PE _{FC,y}	tCO ₂	609	915	812	947	11,331	13,701	3,175	3,837	423	528

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

As per methodology, the option 1 approach is chosen to calculate the emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant which is based on the basis of distance and the number of trips (or the average truck load) as follows:

$$PE_{T,y} = \frac{\sum_k AF_{T,k,y}}{TL_y} * AVD_y * EF_{km,CO_2,y}$$

Where :

PE _{T,y}	=	CO ₂ emissions during the year y due to transport of alternative fuels to the project plant (tCO ₂)
N _y	=	Number of truck trips during the year y
EF _{km,CO₂,y}	=	Average CO ₂ emission factor for form trucks measured during the year y (tCO ₂ /km)
AF _{T,k,y}	=	Quantity of alternative fuel type k that has been transported to the project Site during the year y (mass or volume units)
TL _y	=	Average truck load for trucks used (tons or litre) during the year y
k	=	Types of alternative fuels used in the project plant and that have been transported to the project plant in year y

Table 11 : The result of project emission calculation step 3

Parameters	Unit	TL		KW		KK		TS		LP	
		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Quantity of biomass residue; AF	tonnes	51,883	70,816	101,414	132,206	123,177	172,896	101,953	141,757	35,368	33,126
Average truck load; TL	tonnes/trip	15	15	15	15	15	15	15	15	15	15
Average round trip; AVD	km	400	400	400	400	400	400	400	400	400	400
EF	tCO ₂ /km	0.001097	0.001097	0.001097	0.001097	0.001097	0.001097	0.001097	0.001097	0.001097	0.001097
PE	tCO ₂	1,518	2,072	2,967	3,867	3,603	5,058	2,982	4,147	1,035	969

Table 12 : The summary of project emissions

Year	TL				KW				KK				TS				LP			
	PE _y	PE _{ky}	PE _{FCy}	PE _{TY}	PE _y	PE _{ky}	PE _{FCy}	PE _{TY}	PE _y	PE _{ky}	PE _{FCy}	PE _{TY}	PE _y	PE _{ky}	PE _{FCy}	PE _{TY}	PE _y	PE _{ky}	PE _{FCy}	PE _{TY}
2011	4,564	2,437	609	1,518	12,466	8,687	812	2,967	87,451	72,517	11,331	3,603	18,878	12,720	3,175	2,982	2,288	830	423	1,035
2012	5,207	2,220	915	2,072	15,718	10,904	947	3,867	117,251	98,492	13,701	5,058	21,517	13,533	3,837	4,147	1,543	46	528	969

4.3 Leakage

The main source of leakage for this group project activity is an increase in emission from fossil fuel combustion due to the diversion of rice husk from other uses to the project plant as a result of the project activity. The L₂ option in methodology ACM0003 version 07.2 is used to demonstrate that the rice husk used in the group project does not increase fossil fuel consumption elsewhere. It is required to demonstrate that there is an abundant surplus of the rice husk in the region of the project activity, which is not utilized.

The biomass potential data from Thailand Alternative Energy Situation Report 2011⁸ demonstrates the availability of biomass which is not utilized and deducted by forecasted

⁸ http://www.dede.go.th/dede/images/stories/stat_dede/alternative_54/alternative_54.pdf

consumption in each area. The rice husk information is chosen for consideration , except Thung Song site. This site mainly consumes the biomass residue from coconut husk and para rubber (fuel wood , frond and leaves , saw dust) then the availability is considered from all these kinds of biomass. The data is presented in unit ktoe or kilo ton oil equivalent. The calorific values of 42.244 GJ/toe is applied for conversion from ktoe to GJ. And the energy content of 14.4 and 12.68 MJ/kg respectively for paddy husk and agricultural waste are used for conversion into tonne.

Table 13 : The rice husk availability data of Lampang site

Year 2011	Rice Husk Potential - LP		
	ktoe	GJ	Ton
Chiang Rai	71.71	3,029,317	210,369
Lampang	18.26	771,375	53,568
Lampoon	7.2	304,157	21,122
Chiang Mai	28.91	1,221,274	84,811
Tak	9.46	399,628	27,752
Kampaengphet	74.99	3,167,878	219,991
Sukhothai	56.15	2,372,001	164,722
Phrae	11.93	503,971	34,998
Nan	8.3	350,625	24,349
Uthradith	36.36	1,535,992	106,666
Pitsanuloke	86.14	3,638,898	252,701
Pichit	97.29	4,109,919	285,411
Nakornsawan	138.55	5,852,906	406,452
Total	645.25	27,257,941	1,892,913

Average consumption in this monitoring period 28,883 ton/year
% usage by Project activities 1.53%
Availability 98.47%

Table 14 : The rice husk availability data of Ta Luang , Keang Khoi and Khao Wong sites

Year 2011	Rice Husk Potential - TL , KK , KW		
	ktoe	GJ	Ton
Bangkok	12.07	509,885	35,409
Nonthaburi	11.29	476,935	33,120
Samutprakarn	3.1	130,956	9,094
Samutsakorn	1.43	60,409	4,195
Nakornpathom	39.68	1,676,242	116,406
Saraburi	29.12	1,230,145	85,427
Lopburi	55.12	2,328,489	161,701
Singhburi	35.57	1,502,619	104,349
Chainat	72.99	3,083,390	214,124
Uthaitani	30.74	1,298,581	90,179
Suphanburi	102.83	4,343,951	301,663
Angthong	31.25	1,320,125	91,675
Kanchanaburi	26.79	1,131,717	78,591
Ratchaburi	29.03	1,226,343	85,163
Phetchburi	26.44	1,116,931	77,565
Ayutthaya	76.79	3,243,917	225,272
Nakornnayok	25.37	1,071,730	74,426
Praeeenburi	28.66	1,210,713	84,077
Srakaew	21.1	891,348	61,899
Samutsongkram	0.23	9,716	675
Chacherngsao	51.39	2,170,919	150,758
Chanthaburi	1.24	52,383	3,638
Rayong	1.22	51,538	3,579
Chonburi	5.18	218,824	15,196
Total	718.63	30,357,806	2,108,181

Average consumption in this monitoring period 194,513

% usage by Project activities 9%

Availability 91%

Table 15 : The biomass availability data of Thung Song site

Year 2011	Biomass Residue Potential - TS coconut husk, fuel wood, frond & leaves , saw dust		
	ktoe	GJ	Ton
Ranong	4.01	169,398	13,359
Suratthani	78.02	3,295,877	259,927
Phang Nga	21.43	905,289	71,395
Phuket	4.57	193,055	15,225
Krabi	17.72	748,564	59,035
Trang	42.75	1,805,931	142,424
Nakorn Sri Thammarat	53.48	2,259,209	178,171
Patthalung	15.46	653,092	51,506
Songkhla	45.35	1,915,765	151,086
Satun	9.58	404,698	31,916
Pattani	19.39	819,111	64,599
Total	311.76	13,169,989	1,038,643

Consumption 127,318

% usage by Project activities 12%

Availability 88%

The quantity of available biomass in all areas, 200 kilometres of boundary from project sites, is more than 25% than the quantity of biomass that would be utilized by project activities. Hence the leakage emissions from project activities are considered as zero as per approach L₂.

4.4 Summary of GHG Emission Reductions and Removals

The total emission reduction achieved by these project activities within this monitoring period is presented in Table 16.

Table 16 : Summary of emission reductions

Site / Year	2011	2012	Total
TL	47,540	70,649	118,189
KW	105,052	96,257	201,309
KK	0	0	0
TS	10,399	89,758	100,157
LP	0	0	0
Total	162,991	256,664	419,655

Justification for the increasing of emission reductions in this monitoring period

There is only one site that the achieved emission reductions are higher than the ex-ante estimated volume in the registered PD in this monitoring period, Ta Luang. The reason for increasing in emission reductions is the bigger amount of biomass residue used in cement production. From the previous monitoring period, the average percentage of heat supplied by biomass residue was 2% comparing to the total energy consumption. In this monitoring period, this percentage is increased to 10%. This increasing results in the higher baseline emissions.

Overall, the total emission reduction is less than the PD estimate.

Justification for the zero emission reductions from Lampang

There is the design change in Lampang site. The fluidized bed gasifier has been installed for utilization of low grade lignite. This gasification process is not included in the baseline scenario and the low grade lignite was not utilized before the installation of this gasifier. Hence, the emission reduction achieved from Lampang site is neglected in this monitoring period.

Justification for the zero emission reductions from Kaeng Khoi

The solid waste pre-treatment plant has been installed at Kaeng Khoi site by SCI Eco Services Company. The objective of this project is for increasing the amount of solid waste to be fired at cement kiln. This project has been commissioned at the end of year 2010 and fully operated in 2011. This additional unit is considered as design change. Since in the registered PD, only biomass is used as the alternative fuels at this site. This solid waste unit is not identified in the registered PD. Hence, the emission reduction achieved from Kaneg Khoi site is neglected in this monitoring period.

5 ADDITIONAL INFORMATION

5.1 Summary of monitored data

Table 17 : The consumption and NCV data of fossil fuel

Fuel Type		TL		KW		KK		TS		LP	
Fossil		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Fuel Oil	Ton	1,502	1,518	295	1	5,282	4,454	2,475	3,138	469	738
Coal	Ton	86,629	139,813	144,761	206,940	335,889	312,268	450,825	504,100		
Lignite	Ton	11,121	12,050	157,308	180,843	435,078	529,252		0	137,293	190,061
Lignite - other	Ton	100,070	122,252							86,932	96,357
Petcoke	Ton			1,836	0		9,952				
Anthrasite	Ton			1.84							
Bituminus	Ton	37,795	98,714			70,970	111,063	19,718	0		
Net Calorific Value (LHV)		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Fuel Oil	GJ/ton	40.69	41.20	40.69	41.20	40.69	41.20	40.69	41.20	40.69	41.20
Coal	GJ/ton	24.42	23.65	23.20	24.29	22.69	23.21	23.94	26.18		
Lignite	GJ/ton	18.15	18.57	19.39	19.66	16.17	16.53			18.22	19.89
Lignite - other	GJ/ton	19.28	19.40							13.29	13.21
Petcoke	GJ/ton			32.69		32.64					
Anthrasite	GJ/ton			31.39							
Bituminus	GJ/ton	21.96	22.83			20.73	21.18	23.75			

Table 18 : The consumption and NCV data of Biomass

Fuel Type		TL		KW		KK		TS		LP	
Biomass Residue		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Rice Husk	Ton	49,651	64,459	54,372	79,077	25,903	83,145	3,308	6,985	33,968	18,984
Saw dust	Ton							28,278	34,716	1,112	12,534
Biomass	Ton	2,232	6,357	47,042	53,129	97,274	89,751	70,367	100,056	288	1,608
Net Calorific Value (LHV)		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Rice Husk	GJ/ton	12.90	12.90	14.07	14.01	12.17	12.22	10.89	10.06	13.73	14.33
Saw dust	GJ/ton							12.48	12.21	16.65	16.92
Biomass	GJ/ton	15.16	15.70	11.64	12.10	9.77	9.61	12.64	12.55	8.97	8.97

Table 19 : The consumption and NCV data of alternative fuels

Fuel Type		TL		KW		KK		TS		LP	
Alternative fuel		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Mixed solid waste	Ton	612	404	751	726	863	995			1,252	56
Waste Oil	Ton					8,686	0	77	0	162	629
Other 1	Ton	368	478	2,877	2,851	-	12,758	5,203	5,678		
Other 2	Ton			1,827	1,889	19,950	43,665				
Other 3	Ton				906	4,572	286				
Net Calorific Value (LHV)		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Mixed solid waste	GJ/ton	24.01	19.00	24.01	19.00	25.75	20.25			7.99	9.89
Waste Oil	GJ/ton					36.87		40.34	40.34		
Other 1	GJ/ton	39.30	39.30	17.81	17.81		29.16	28.24	28.04		
Other 2	GJ/ton			20.10	28.60	22.04	19.12				
Other 3	GJ/ton				16.28	26.80					

5.2 Summary of baseline data

Table 20 : Summary of data in three years before the implementation of project

Fuel Type		TL			KW			KK		
Fossil		2000	2001	2002	2000	2001	2002	2000	2001	2002
Fuel Oil	ton-dry	885	825	4,866	3,705	4,188	2,261	3,877	3,320	5,678
Coal	ton-dry	16,923	5,944	31,708	27,218	3,166	19,574	137,006	1,948	43,007
Lignite	ton-dry	46,845	92,730	251,340	189,534	140,995	270,215	468,388	647,769	533,107
Pet-Coke	ton-dry	4,643	1,771	59,457	129,514	143,749	106,027	56,917	104,250	157,989
Anthracite	ton-dry	-	-	-	2,835	48,758	8,477	-	14,077	4,545
Heating Value		2000	2001	2002	2000	2001	2002	2000	2001	2002
Fuel Oil	GJ/ton	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39
Coal	GJ/ton	24.31	25.41	25.09	24.95	26.70	28.47	25.74	25.74	25.74
Lignite	GJ/ton	18.21	18.12	17.16	21.42	20.79	20.26	17.99	17.99	17.99
Pet-Coke	GJ/ton	30.13	30.47	32.63	32.96	32.25	33.76	32.46	32.44	32.44
Anthracite	GJ/ton	-	-	-	29.25	27.80	27.86	-	27.21	27.21
		2000	2001	2002	2000	2001	2002	2000	2001	2002
HG = FC x NCV	GJ	1,440,040	1,918,788	7,244,873	9,241,177	9,175,860	9,938,830	13,956,145	15,600,885	16,174,720
Pclinker	ton	410,188	557,145	2,126,642	3,041,073	3,017,068	3,254,406	4,527,703	4,912,623	5,045,459
HG/Pclinker	GJ/ton	3.5107	3.4440	3.4067	3.0388	3.0413	3.0540	3.0824	3.1757	3.2058
Fuel Type		TS			LP					
Fossil		2000	2001	2002	2000	2001	2002			
Fuel Oil	ton-dry	4,126	3,291	2,486	519	477	682			
Coal	ton-dry	188,136	166,152	143,493	-	-	-			
Lignite	ton-dry	50,424	208,229	225,796	105,615	105,743	191,910			
Pet-Coke	ton-dry	143,272	101,586	105,029	-	-	-			
Anthracite	ton-dry	-	-	16,879	-	-	-			
Heating Value		2000	2001	2002	2000	2001	2002			
Fuel Oil	GJ/ton	40.39	40.39	40.39	40.39	40.39	40.39			
Coal	GJ/ton	25.12	25.83	25.39	-	-	-			
Lignite	GJ/ton	18.85	20.48	19.32	18.10	17.94	17.82			
Pet-Coke	GJ/ton	33.98	32.81	32.22	-	-	-			
Anthracite	GJ/ton	-	-	26.46	-	-	-			
		2000	2001	2002	2000	2001	2002			
HG = FC x NCV	GJ	10,712,666	12,021,515	11,937,768	1,933,066	1,916,424	3,446,558			
Pclinker	ton	3,381,254	3,797,506	3,825,211	642,816	603,902	1,063,054			
HG/Pclinker	GJ/ton	3.1683	3.1656	3.1208	3.0072	3.1734	3.2421			

5.3 Monitoring equipment specification and calibration information

The information of the monitoring equipment , specification and calibration history is presented in the calibration sheet of the ER calculation spread sheet. The calibration report and calibration plan will be presented during site visit.

5.4 Other information used for emission calculation in this monitoring period

1) The specific fuel consumption for biomass handling equipment

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.

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

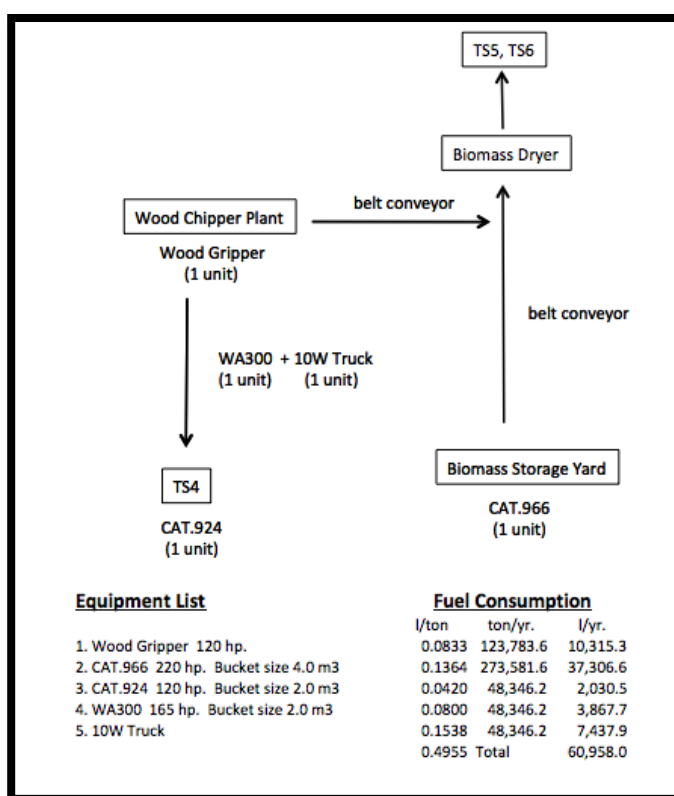


Figure 5 : Diagram of biomass handling process at Thunsong site