

“SIAM CEMENT BIOMASS PROJECT”



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Summary:

KBS Certification Services Pvt. Ltd. has been contracted by “South Pole Carbon Asset Management Ltd.” to undertake independent validation of the renewable crediting period of the project activity with the title “Siam Cement Biomass Project” and VCS registry no. 403, with regard to the relevant requirements of VCS Standard Version 3.7.

KBS Certification Services Pvt. Ltd. has performed the validation of renewable of the crediting period of the project activity with the title “Siam Cement Biomass Project” and VCS registry no. 403. An independent and objective review of the project document (revised) and the new project baseline along with the other relevant documents is reviewed against the requirement of the VCS Standard v3.7 and “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” Version 03.0.1.

The report is based on the assessment of the revised project document, revised ex-ante emission reduction calculation sheet, application of standard auditing techniques including but not limited to desk review, follow up actions (e.g., on site visit, electronic (telephonic or e-mail) interviews) and also the review of the applicable approved methodological and relevant tools, guidances and CDM decisions.

In the course of validation, 02 Corrective Action Requests (CAR) and 00 Clarification Request (CL) have been raised. All the CARs and CLs have been closed out successfully.

Hence, KBS requests the renewable of the crediting period of the project activity (VCS ID. 403) “Siam Cement Biomass Project”.

Abbreviations

CAR	Corrective Action Request
CDM	Clean Development Mechanism
CL	Clarification Request
CO ₂	Carbon dioxide
DOE	Designated Operational Entity
EB	Executive Board
EF	Emission Factor
ER	Emission Reduction
FAR	Forward Action Request
GHG	Greenhouse gas(es)
MP	Monitoring Plan
PA	Project Activity
PD	Project Description
PP	Project proponent
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard

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1 INTRODUCTION

1.1 Objective

South Pole Carbon Asset Management Ltd. has commissioned KBS to perform the validation of request to renew crediting period of the VCS project “Siam Cement Biomass Project” (Project ID. 403). The assessment was done with regard to the relevant requirements for VCS Version 3.7 /1/.

The purpose of validation is to ensure a thorough, independent assessment of registered VCS project activity submitted for renewal of crediting period against the applicable VCS requirements.

In particular, the validity of project's baseline and regularity surplus are validated in order to confirm the clause no. 3.8.5 of VCS Standard Version 3.7 for the “Renewal of Project Crediting Period” /1/. The validation is seen as necessary to provide assurance to stakeholders of the quality of the project and its intended generation of verified emission reduction (VER).

1.2 Scope and Criteria

The assessment was performed in accordance with the requirements of Verified Carbon Standard V3.7 and included an assessment, but not limited to, of following:

1. Demonstration of the regulatory surplus, in reference to the additionality of the project, in accordance with section 4.6.3 of the VCS Version 3.7.
2. Validity of the original baseline scenario reviewing the following:
 - a. Evaluation of impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario.
 - b. Assessment of GHG emissions associated with the original baseline scenario using the latest version of the CDM Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period /2/.
 - c. If original baseline scenario is no longer valid, whether the current baseline scenario is established in accordance with the VCS rules.
 - d. The project description, containing updated information with respect to the baseline, the estimated GHG emission reductions or removals and the monitoring plan, submitted for validation is based upon the latest approved version of the methodology or its replacement.
3. The updated project description is validated in accordance with the current VCS rules (V3.7).

1.3 Level of Assurance

☒ Reasonable level of assurance

☐ Limited level of assurance

1.4 Summary Description of the Project

The proposed project activity involves partial substitution of fossil fuels with alternative fuels and less carbon intensive fuels for combustion in the kiln processing in cement plants. Prior to the implementation of each project activity, the fossil fuel such as coal, coke, lignite, heavy fuel and diesel oil were consumed; no alternative fuels or less carbon intensive fuels were used. In the

absence of the proposed project activity, 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 project, 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 /3/.

The details of cements plants where the five GHG reduction projects located in five different manufacturing plants of SCG Cement Co., Ltd, in Thailand during the first crediting period are as follows:

Name of Participants	Name of the cement plant	Site location (Thailand)
The Siam Cement (Kaeng Khoi) Co., Ltd.	The Siam Cement (Kaeng Khoi)	Kaeng Khoi , Saraburi
The Siam Cement (Ta Luang) Co., Ltd.	The Siam Cement (Ta Luang)	Ta Luang, Saraburi
The Siam Cement (Ta Luang) Co., Ltd	The Siam Cement (Khao Wong)	Khao Wong, Saraburi
The Siam Cement (Lampang) Co., Ltd	The Siam Cement (Lampang)	Chaehome, Lampang
The Siam Cement (Thung Song) Co., Ltd	The Siam Cement (Thung Song)	Thung Song, Nakon Si Thammarat

The purpose of the project activity can be summarised as:

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

The 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 project 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.

The use of biomass residue in cement kilns was new and no cement plant in Thailand had introduced the system before the successful development of the knowledge, technology and system by SCG Cement Co.,Ltd. This group project falls under the category of first of its kind in Thailand. The Engineering Department of SCG Cement Co.,Ltd did the research and designed the system, and first implemented it at The Siam Cement (Kaeng Khoi) Co., Ltd. The knowledge and technology has been transferred to other sites such as Khao Wong site, Ta Lung site, Tung Song site and Lampang site. Although the main concept of the systems is the same, there are slight differences in technology used, depending on the type and quality of biomass residue around site location /8/.

Apart from the implementation of the project activity, it is also expected to provide;

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

The proposed project activity is expected to reduce 1,07,356 tCO₂e annually (on average) or total of 1,073,560 tCO₂e during 10 years of this second crediting period.

As compared to the registered project design, there are changes in the project design which have been mentioned as below. 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.

CAR 01 was raised in line with the requirement of Section 1.12.1 (project ownership) of the VCS-PD. In response to the raised CAR, PP submitted the “Emission Reduction Purchase Agreement” /9/ and “STS Operating License” /10/ as supporting document for demonstrating the project ownership. Hence the issue was subsequently closed.

None of the change impacts the baseline scenario, additionality of the project activity and the applicability of applied methodologies. The above project description was verified during the site visit and cross checked with the registered VCS documents of the first crediting period and found to be appropriate.

2 VALIDATION PROCESS

2.1 Method and Criteria

The validation process was carried out in line with the requirements of VCS Version 3. The Standard auditing techniques and KBS's CDM Procedures were also applied during the validation. The validation process included the following processes as described in the subsequent sub-sections.

The duration of validation is summarized as follows:

Validation Contract	21/09/2017
On site verification	02/10/2017 to 04/10/2017
Findings raised	16/10/2017
Draft Validation Report	19/12/2017
Final Validation Report	28/12/2017

2.2 Document Review

Desk review was performed of the revised PD /3/ against the registered and validated VCS PD /5/. The validation report /6/ and the previous verification reports /7/ were also reviewed to validate the renewal of crediting period in accordance with the VCS Standard Version 3.7. In addition, certain supportive documents, relating the project performance (like Technical description of project technology /8/, Single line diagram /11/, Measurements from Laboratory /12/, STS Operating license /10/, Operator log sheets /13/) were also reviewed.

The list of document reviewed is included in the Appendix 1: 'References'

2.3 Interviews

The site visit /14/ for this validation assessment was undertaken by the members of the assessment team. Summary of on-site activities are mentioned below;

Location	Thung Song, Nakon Si Thammarat, Thailand Khao Wong, Saraburi, Thailand Ta Luang, Saraburi, Thailand
Dates	02/10/2017 to 04/10/2017
Key points discussed	Name of persons interviewed, Designation, Organization
Project Document Project and Technology Description, Methodology Justification, Validity of Baseline, Monitoring Plan, Project Performance	Santosh K. Singh, Regional Director, South Pole Carbon Asset Management Ltd. Nattaya Lonawan, Project Manager, South Pole Carbon Asset Management Ltd. Kanitpoom Piboonnurak, Site Engineer, SCG Pipat Kussalerdjarjya, Laboratory section, SCG Oubonrat Kabounsang, Laboratory section, SCG Panuwat Naruebarn, Production section, SCG Sirinut Raya, Project Manager, South Pole Carbon Asset Management Ltd. Yulta Dobrolyubova, Expert, South Pole Carbon Asset Management Ltd. Pollaphat Pornpitakthum, Engineer, SCG Patiphan Kurustien, Engineer, SCG Attaporn Matae, Engineer, SCG

2.4 Site Inspections

A site visit is undertaken by members of validation team, involving but not limited to,

- An assessment of the implementation and operation of the VCS project activity as per the revised VCS PD;
- Interviews with relevant personnel to confirm that the operational and data collection procedures are implemented in accordance with the mentioned monitoring plan;
- A cross-check between information provided in the revised PD and data from other sources such as plant log books, inventories, purchase records or similar data sources;

- A check of the monitoring equipments including performance and observations of monitoring practices against the requirements of the registered VCS PD and the selected methodology.

2.5 Resolution of Findings

During the validation of the renewable of the crediting period, the following correction actions (CARs) and clarifications (CLs) have been raised and resolved after satisfactory response from the project participants.

Table 1. CL from this validation

No CL from this validation

CL ID	xx	Section no.		Date: DD/MM/YYYY
Description of CL				
Project participant response				Date: DD/MM/YYYY
Documentation provided by project participant				
DOE assessment				Date: DD/MM/YYYY

Table 2. CAR from this validation

CAR ID	01	Section no.	-	Date: 16/10/2107
Description of CAR				
PP need to submit the supportive document corresponding to the section “1.12.1 Project Ownership” under the VCS PD.				
Project participant response				Date: 03/11/2017
The Emission Reduction Purchasing Agreement (ERPA) and the operating license are submitted.				
Documentation provided by project participant				
- ERPA - Operating license of STS				

DOE assessment	Date: 19/12/2017
Validation team has checked the submitted documents /09/, /10/ and found OK. Hence this CAR is closed.	

CAR ID	02	Section no.	-	Date: 16/10/2107
Description of CAR				
During the review of the VCS PD, verification team has found that PP has used old versions of the applicable methodological tools in the VCS PD. Also PP need to justify for all the applicability criteria's of the applied methodology under the section 2.2 of the VCS PD.				
Project participant response				Date: 03/11/2017
The VCS PD is revised as per the latest version of relevant methodologies and tools.				
Documentation provided by project participant				
VCS PD version 02				
DOE assessment				Date: 19/12/2017
Corrections have been done in the revised PDD /03/ and found OK. Hence this CAR is closed.				

Table 3. FAR from this validation

No FAR raised during this validation.

FAR ID	xx	Section No.		Date: DD/MM/YYYY
Description of FAR				
Project participant response				Date: DD/MM/YYYY
Documentation provided by project participant				
DOE assessment				Date: DD/MM/YYYY

2.5.1 Forward Action Requests

No FAR (Forward Action Request) is raised during this validation of the renewal crediting period.

3 VALIDATION FINDINGS

3.1 Project Details

Same as in the registered VCS PD except for the information which have been revised and mentioned below.

As compared to the registered project design, there are changes in the project design which have been mentioned as below. During the first crediting period, there were four sites from five sites of this bundle /7/, 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.

None of the change impacts the baseline scenario, additionality of the project activity and the applicability of the applied methodologies.

- Project crediting period: 2nd Crediting period, 10 years from 01/04/2016 to 31/03/2026.
- Project estimated GHG emission reductions or removals: 10,73,560 tCO₂e emission reductions credits for the 10 year crediting period and 1,07,356 tCO₂e emission reduction credits per year (on an average).

Validation team has checked the project description in the revised VCS PD /03/ from the on-site visit and also from the document review. Validation team confirms that the description in the project description is accurate, complete, and provides an understanding of the nature of project.

3.2 Application of Methodology

3.2.1 Title and Reference

The project uses the VCS board-approved consolidated baseline and monitoring methodologies:

- ACM0003: Large scale consolidated methodology – Partial substitution of fossil fuels in

cement or quicklime manufacture, version 08.0¹ /15/;

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 /16/;
- b) Upstream leakage emissions associated with fossil fuel use, version 02.0 /17/.
- c) Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion, version 03 /18/;
- d) Baseline , project and/or leakage emissions from electricity consumption and monitoring of electricity generation, version 03.0 /19/;
- e) Project and leakage emissions from transportation of freight, version 01.1.0 /20/.

During the validation, CAR 02 was raised as the older versions of applicable methodological tools were used in the VCS-PD. In response to the raised issue, PP has updated all the applicable methodological tools in the revised VCS PD.

3.2.2 Applicability

In accordance with the para 3.8.5 of the VCS standard V3.7 /01/ and Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1 /2/, the VCS PD has been updated using the latest version of the applied methodology i.e. *ACM0003: Large scale consolidated methodology – Partial substitution of fossil fuels in cement or quicklime manufacture, version 08.0 /15/* and applicable methodological tools. The project meets the applicable criteria of the latest version of the applied methodology and the applicable tool. Validation team has checked the PP's justification (In the revised VCS PD/03/) for the applicability criteria of the latest version of the applied methodology and found Ok.

The assessment of the project's compliance with each applicability condition of the applied methodology (ACM0003 version 08.0) is given below.

Applicability Criteria	Project Status	Validation team assessment
3. The methodology is applicable to project activities in the cement or quicklime industry where fossil fuel(s) used in an existing clinker or quicklime production facility are partially replaced by less carbon intensive fossil fuel(s) and/or alternative fuel(s).	The proposed project activities are the partially replacing of fossil fuels by biomass residues in cement plant. Therefore, the proposed project activity can fulfil this applicability condition.	The justification provided by the PP is acceptable to the validation team. The project involves replacement of carbon intensive fuels (such as coal, coke, lignite, heavy fuel and diesel oil) with the carbon neutral fuels (biomass residue) in the cement plant. The

¹ <https://cdm.unfccc.int/methodologies/DB/DPP1VND7USZ0IGEPcABT2DF8JCPGG3>

		validation team has checked the same through site visit /14/, previous registered VCS PD /5/ and document review. The same was also validated during the previous crediting period. Hence the applicability criterion has been met by the project activity.
4. The following conditions shall apply: a) A significant investment is required to enable the use of the alternative fuel(s) and/or the less carbon intensive fossil fuel(s); b) During the last three years prior to the start of the project activity, no alternative fuels have been used in the project plant; c) The CO₂ emissions reduction relates to CO₂ emissions generated from fuel combustion only and is unrelated to the CO₂ emissions from decarbonisation of raw materials (i.e. CaCO₃ and MgCO₃ bearing minerals); d) The methodology is applicable only for installed capacity (expressed in tonnes clinker/year or tonnes quicklime/year) that exists by the time of validation of the project activity.	a) The significant investment is required for new machinery installation, including storage, handling and transporting systems to enable the use of alternative fuels and/or the less carbon intensive fossil fuels. b) According to the fuel consumption data in WJ during the last three years period, before the start of the project activities, no alternative fuels and biomass were consumed. However a small amount of alternative fuels was used in the testing phase of the projects. c) The CO₂ emission reductions are only related to the CO₂ generated by fuel burning requirement and not by decarbonisation of raw material. d) The installed capacity has not changed at project site during the time of validation as described in section 1.1. Therefore, the proposed project activities can fulfil all above applicability criterions.	The justification provided by the PP with respect to the applicability criteria is acceptable to the validation team. The project involves usage of biomass and hence investment is required for new machinery installation, including storage, handling and transporting systems to enable the use of alternative fuels and/or the less carbon intensive fossil fuels. The fuel consumption data for the last three years period, before the start of the project activity has been checked during the on-site visit and confirmed that no alternative fuels and biomass were consumed. PP shall claim the CO₂ emission reductions only related to the CO₂ generated by fuel burning requirement and not by decarbonisation of raw material. The same was also discussed and

		confirmed during the site visit. The installed capacity has not changed at the project site by the time of validation of the project activity as checked from the on-site interview and from the documents review.
5. In case of project activities using biomass residues or renewable biomass, the following applicability conditions apply: a) The biomass is not chemically processed (e.g. esterification to produce biodiesel, production of alcohols from biomass, etc.) prior to combustion in the project plant but it may be processed mechanically or be dried at the project site. Moreover, any preparation of the biomass, occurring before use in the project activity, does not cause other significant GHG emissions (such as, for example, methane emissions from anaerobic treatment of waste water or from char coal production); b) The biomass used by the project facility is stored under aerobic conditions.	a) The biomass residues used in the project plant are not chemically processed prior to combustion in the project plant. b) All biomass residues used in the project plant are stored under aerobic condition and the storage time is less than one year. Therefore, the proposed project activities can fulfil both applicability criterions.	The justification provided by the PP is acceptable to the validation team. The biomass residues used in the project plant are not chemically processed prior to combustion in the project plant. The biomass residues used in the project plant are stored under aerobic conditions and the storage time is less than one year. The same has been checked from the on-site visit /14/, registered VCS PD /5/ and the document review. The same was also validated during the previous crediting period.
6. If the land area is severely degraded, land degradation can be demonstrated using one or more of the following indicators: a) Vegetation degradation, for example: (i) Crown cover of pre-existing trees has decreased in the recent past for reasons other than sustainable	This condition is not relevant to the project activities.	The condition is not relevant to the project activity as checked from the on-site visit /14/ during the validation.

harvesting activities; b) Soil degradation, for example: (i) Soil erosion has increased in the recent past; (ii) Soil organic matter content has decreased in the recent past; c) Anthropogenic influences, for example: (i) There is a recent history of loss of soil and vegetation due to anthropogenic actions; and (ii) Demonstration that there exist anthropogenic actions/activities that prevent possible occurrence of natural regeneration.		
7. The methodology is not applicable to project activities that implement efficiency measures in production of clinker or quicklime, such as changing the configuration/number of pre-heaters.	The project will not implement any efficiency measures in clinker production. Therefore, the proposed project activities can fulfil this applicability condition.	The project activity will not implement any efficiency measures in clinker production as the same was checked from the on-site visit /14/. Hence this applicability criterion has been fulfilled by the project activity.
8. Finally, this methodology is only applicable if F2 (the continuation of the current fuel mix) or F3 (a different fossil fuel mix portfolio) results to be the most plausible baseline scenario for the use of fuels in the cement or quicklime plant and if one or several of the following scenarios, as explained in the "Procedure for the selection of the most plausible baseline scenario and demonstration of additionality", result to be the	As per the description of baseline scenario provided in section 2.4 , the most plausible baseline scenarios of this project activities are summarized as below; - the option F2 or F3 for the use of fuels in cement plant ; - the option W1 or W3 for using wastes originating from fossil sources ;	The PP has identified the most plausible baseline scenario from the alternative scenarios identified in line with the applied methodology in Section 2.4 of the VCS PD /3/. The justification provided by the PP is acceptable to the validation team. The identified baseline scenarios are: 1. The option F2 or F3 for

most plausible baseline scenario for the use of alternative fuels: a) For the fate of any wastes originating from fossil sources: scenarios W1 and/or W3; b) For the fate of any biomass residues: scenarios B1, B2 and/or B3; c) For the fate of any renewable biomass: scenario R1.	the option B3 for using of biomass residues. Therefore, the proposed project activities can fulfil this applicability condition.	the use of fuels in cement plant; 2.. The option W1 or W3 for using wastes originating from fossil sources; 3. The option B3 for using of biomass residues. The above identified baseline scenario have been validated in the below sections of the validation report. Therefore, the proposed project activities fulfil this applicability condition.
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During the validation, CAR 02 was raised as all the applicability criteria's of the applied methodology were not discussed under Section 2.2 of the VCS PD. In response to raised issue, PP has justified all the applicability criteria of the applied methodology in the VCS PD.

3.2.3 Project Boundary

As per the para 17 of the applied methodology ACM0003 (version 08), the physical project boundary covers all production processes related to clinker or quicklime production, including:

- (a) The pre-heaters, if applicable, where the heat of exhaust gas is used to heat the inputs for clinker production;
- (b) The pre-calciner, if applicable, where fuels are fired for the pre-calcination of the inputs for clinker production;
- (c) The kiln tube, where fuels are fired and where the calcinations process of the inputs for clinker production takes place;
- (d) The pre-heater or pre-heating zone, if applicable, where the heat of exhaust gas is used to heat the inputs for quicklime production;
- (e) The calcination kiln where fuels are fired and where the calcination process of the inputs for quicklime production takes place;
- (f) On-site storage and on-site transportation and drying of alternative fuels (if alternative fuels are used in the project activity);
- (g) The vehicles used for transportation of alternative fuels to the project site;
- (h) Where biomass residues are used, the project boundary includes the sites where the biomass residues would be dumped, left to decay or burnt in the absence of the project activity;
- (i) Where renewable biomass is used in the project plant, the project boundary also includes the sites where the renewable biomass is cultivated.

The components of the project boundary mentioned in the VCS PD /03/ were found to be in compliance with applicable paragraph of the applied methodology. The validation team conducted the on-site inspection to confirm the appropriateness of the identified project boundary. The validation team confirmed during the site visit /14/ that all GHG sources required by the methodology have been included within the project boundary. It was assessed by physical inspection that no emission sources related to project activity will cause any deviation from the applicability of the methodology or accuracy of the emission reductions. The following emission sources included or excluded from the project boundary have been found to be correct for the project activity.

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

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

The validation team was able to assess that complete information regarding the project boundary has been provided in VCS PD /03/ and could be validated from the line diagram /11/.

The validation team confirms that all identified boundary, selected emissions sources are justified for the project activity. It could be confirmed that there are no emissions expected due to implementation of the project activity, contributing more than 1% of the overall expected average annual emission reductions, which are not addressed by the applied methodology.

3.2.4 Baseline Scenario

The revised VCS PD (version 02.1, dated 06/12/2017) /03/ applying the latest version of the applied methodology ACM0003: Large scale consolidated methodology – Partial substitution of fossil fuels in cement or quicklime manufacture, version 08.0 /15/ and applicable methodological tools, found in line with paragraph 3.8.5 (2) of VCS standard V3.7/01/.

The baseline scenario is identified and additionality is assessed using the most recent approved version of the “Combined tool to identify the baseline scenario and demonstrate additionality”. The first step in specifying the baseline is to identify realistic and credible alternatives available to project participants that provide outputs or service comparable with the proposed grouped project. In this case the baseline scenario has considered only three segments, including fuel mix for cement manufacturing, alternative fuels, biomass residues. The renewable biomass will not be considered in this case because there is no site using renewable biomass from a new dedicated plantation in the project plants which was also confirmed during the site visit. The following alternatives have been identified for the project activity in line with the requirements of tool and applied methodology.

In line with the Step 1a of the tool, the alternatives to be analysed for the fuel mix for cement or quicklime manufacturing may include the following:

Alternative Scenario	Description	Justification	Validation team assessment
F1	The proposed project activity not undertaken as a CDM project	Once project activity started, there were no implementation of CDM and other GHG	The project has been taken up as a VCS project activity since the start of

Alternative Scenario	Description	Justification	Validation team assessment
	activity.	reduction programs in Thailand.	the project activity. The same was confirmed during the site visit /14/ and cross checked with the previous registered VCS PD /5/ and through the document review. Further the project activity faces barriers which have been described under Section 2.5 of the VCS PD, hence it is unlikely that the project would have been taken up without the VCS benefits. The project has already been registered and issued under VCS during the first crediting period. Hence the alternative is not applicable to the project activity.
F2	Continuation of current practice, i.e., a scenario in which the company continues cement production using the existing technology, materials and fuel mix.	The cement manufacturing industry in Thailand is mainly using coal. In the absence of the project activity the usage of lignite and other carbon intensive fuels in cost effective way would have continued without involving any major capital investments.	The coal is mainly consumed in the cement manufacturing industry in Thailand. The continuation of the current practice involving the uses of existing technology, materials and fuel mix do not require any capital investments and the same was also confirmed during the site visit and through the document review /14//25/. Hence this alternative scenario is applicable to the project activity.
F3	The continuation of using only fossil fuels and no alternative fuels; however, with a different fuel mix portfolio, taking into	The cement manufacturing industry in Thailand is mainly using coal. In this regard, continuing utilization of fossil fuels is most likely to happen in the absence of the project	The coal is mainly consumed in the cement manufacturing industry in Thailand, hence the continuing utilization of fossil fuels is most likely to

Alternative Scenario	Description	Justification	Validation team assessment
	account relative prices of fuels available. The scenario(s) may be based on one fuel or a different mix of fuels.	activity. In Thailand formal permission from government is required to start alternative fuel usage in cement manufacturing. This requires a significant amount of effort on part of project proponent. Then in the absence of the project activities the usage of lignite and other carbon intensive fuels in a cost effective way would have continued.	happen in the absence of the project activity. However a different fuel mix portfolio, taking into account relative prices of fuels is also a valid alternative scenario. The same was discussed and confirmed during the site visit /14/ and cross checked with the document review. Hence this is a credible alternative baseline scenario.
F4	The current used fuels are partially substituted with alternative fuels and/or less carbon intensive fossil fuels other than those used in the CDM project activity and/or any other fuel types, without using the CDM. If relevant, develop different scenarios with different mixes of alternative fuels or less carbon intensive fuels and varying degrees of fuel-switch from traditional to alternative fuels or less carbon intensive fuels.	The project activity scenario is characterized by a substantial use of alternative fuels such as wastes originating from fossil sources, biomass residues (excluding renewable biomass from a dedicated plantation). The project activity was the first of its kind in Thailand. Implementation of fuel mix, even in different proportions would involve serious investment on the part of project proponents which is not a possible baseline scenario.	The project activity involves substantial use of alternative fuels such as wastes originating from fossil sources, biomass residues (excluding renewable biomass from a dedicated plantation). The project activity was the first of its kind in Thailand when it was taken up, which has been validated from the document review and confirmed during the site visit /14/. The implementation of fuel mix, even in different proportions would involve serious investment on the part of project proponents and hence it has not been considered as a possible baseline scenario. The same was also validated during the previous crediting period. Hence the alternative baseline scenario is not applicable to the project activity.
F5	The construction and operation of a new	SCG Cement Co., Ltd has no plan to construct the new	The construction and operation of a new plant is

Alternative Scenario	Description	Justification	Validation team assessment
	cement plant.	cement plant in Thailand.	not a feasible scenario as it involves investment and the project proponent has no plans for the same as discussed during the site visit /14/. Hence this is not a feasible alternative scenario.

The validation team has also referred to the publications provided by World Business Council for Sustainable Development (WBCSD) for Cement Sustainability Initiative (www.wbcscement.org) /24/. It has been found that most cement kilns use coal and petroleum coke as primary fuels, and to a lesser extent natural gas and fuel oil. As these fuels burn they provide energy, and some leave fuel ash containing silica and alumina compounds (and other trace elements). These combine with the raw materials in the kiln, contributing to the structure of the clinker and forming part of the final product².

The use of biomass globally has been checked as part of the validation process. In 2006, the use of alternative fuels on global level was 7% in relation to the total fuel energy consumption for cement manufacturing. Almost 3% was covered by biomass and the remaining 90% was provided by conventional fuels, mainly coal³. In 2014, the use of alternative fuels on global level as 16% of total fuel energy demand for cement manufacturing. Almost 6% of the 16% was covered by biomass and the remaining 84% was provided by conventional fuels, mainly coal⁴ /24/.

Hence the alternatives F2 or F3 are the most plausible baseline scenario for the fuel mix for cement manufacturing.

The project proponent has also discussed the options where wastes originating from fossil sources may be used as the alternative fuel. The different alternative scenarios have been discussed as follows:

Alternative Scenario	Description	Justification	Validation team assessment
W1	Incineration of the waste in a waste incinerator without utilizing the energy from the incineration.	In the absence of the project activity, most wastes have gone to the incinerator without utilizing the energy from the	The wastes would have been transferred to the incinerator without utilizing the energy from incineration in the

² Section 2.2 , page 7 of https://www.wbcscement.org/pdf/CSI%20Guidelines%20for%20Co-Processing%20Fuels%20and%20Raw%20Materials%20in%20Cement%20Manufacturing_v2.pdf

³ Section 2.3.1 , page14 of 99 - <https://www.wbcscement.org/pdf/technology/Technology%20papers.pdf>

⁴ Section 2.3 , page 15/190 - https://www.wbcscement.org/pdf/technology/CSI_ECRA_Technology_Papers_2017.pdf

Alternative Scenario	Description	Justification	Validation team assessment
		incineration.	absence of the project activity which was also confirmed during the site visit /14/. Hence this is a credible alternative scenario.
W2	Incineration of the waste in a waste incinerator with use of the energy (e.g. for heat and/or electricity generation)	Wastes used at project are not used for energy purpose.	The alternative of using wastes for incinerating with use of energy (e.g. for heat and/or electricity generation) is not feasible option as the wastes used at the project site is not use for any energy purpose. The same has been confirmed during the site visit /14/ and through the document review. The same was also validated during the previous crediting period. Hence the alternative baseline scenario is not applicable to the project activity.
W3	Disposal of the waste at a managed or unmanaged landfill.	Some of the waste has been disposed at landfill in the absence of the project activity	This is a credible alternative as some of the waste would have been disposed-of at the landfill in the absence of the project activity. The same was discussed during the site visit /14/ and found to be an alternative.
W4	The use of the waste at other facilities, e.g. other cement plants or power plants, as a feedstock or for the generation of energy.	When project started, there were no cement plants and power plants using waste as fuels to generate energy.	There were no cement plants and power plants using waste as fuels to generate energy at the time when the project was taken up. The same has also been confirmed through the documents review and based on discussions during the site visit /14/. Hence this is not a credible

Alternative Scenario	Description	Justification	Validation team assessment
			alternative scenario.
W5	The recycling or reutilization of the waste.	All wastes to be used at the project plant cannot be recycled or reutilized.	The wastes generated at the project plant cannot be recycled or reutilized which was confirmed during the site visit /14/. Hence this is not a credible alternative scenario.
W6	The proposed project activity, not undertaken as a CDM project activity, i.e. the use of the waste in the project plant.	The proposed project activity is not undertaken as a CDM project activity.	The project activity has been taken as a VCS project activity since the start of the project activity. The same was confirmed during the site visit /14/ and cross checked with the previous registered VCS PD /5/ and the document review. The project has already been registered and issued under VCS during the first crediting period. Further the project activity faces barriers which have been described under Section 2.5 of the VCS PD, hence it is unlikely that the project would have been taken up without the VCS benefits. Hence the alternative is not applicable to the project activity.

The alternatives W1 or W3 have been identified as the most plausible alternative scenarios and found Ok by the assessment team.

The PP has also discussed the possible alternative scenario when the biomass residue may be used an alternative fuel. The various alternatives have been analyzed as follows:

Alternative Scenario	Description	Justification	Validation team assessment
B1	The biomass residues	In the absence of the project	As per the practice

Alternative Scenario	Description	Justification	Validation team assessment
	are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.	activities, the biomass residues are not dumped or left to decay under aerobic conditions. Most of them were burnt in an uncontrolled manner without utilizing them for energy purpose and some of them were left on the ground, in mainly aerobic conditions.	followed at the project region, the biomass residues are not dumped or left to decay under aerobic conditions but burnt in an uncontrolled manner without utilizing them for energy purpose and some of them left on the ground, in mainly aerobic conditions. The same was also checked and confirmed during the site visit /14/, Hence the alternative scenario is not applicable to the project activity.
B2	The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.	Biomass residues may be left to decay under anaerobic condition, however for a conservative estimate of baseline emissions this is not taken into account.	The biomass residues may be left to decay under anaerobic conditions; however the project proponent has not taken it into account which is acceptable since this result in a conservative estimate of baseline emissions. Hence this is not a credible alternative scenario.
B3	The biomass residues are burnt in an uncontrolled manner without utilizing them for energy purposes.	Most of the biomass used in project plants is burnt in an uncontrolled manner without utilizing them for energy purposes.	The practice of burning the biomass in an uncontrolled manner without utilizing them for energy purposes is a practice followed in the project region which was also observed during the site visit /14/ and cross checked with the previous registered VCS PD /5/. Hence this is a credible alternative scenario.
B4	The biomass residues are sold to other	Moreover, some biomass residue has been consumed	As per the general practice in the project

Alternative Scenario	Description	Justification	Validation team assessment
	consumers in the market and used by these consumers, such as for heat and/or electricity generation, for the generation of bio-fuels, as feedstock in processes (e.g. the pulp and paper industry), as fertilizer, etc.	by power plants in the area. The remaining biomass residue is left to decay in fields or burnt in open fields.	region the biomass residue is left to decay in the field or burned in open fields, while only small fraction has been consumed by the power plants in the area. The same was also cross checked with the document review. Hence this is not credible alternative scenario.
B5	The biomass residues are used for other purposes at the project site, such as for heat and/or electricity generation, for the generation of bio-fuels, as feedstock in processes. (e.g. the pulp and paper industry), as fertilizer, etc.	Biomass residues are used for other purposes at the project site. The biomass residues are used only for substitution of fossil fuels.	The biomass residues are only utilized for the substitution of fossil fuels and not for other purpose which was also observed during the site visit. Hence this is not an alternative scenario.
B6	The proposed project activity, not undertaken as a CDM project activity, i.e. the use of the biomass residue in the project plant.	The proposed project activity is not undertaken as a CDM project activity.	The project activity has been taken as a VCS project activity since the start of the project activity. The same was confirmed during the site visit and cross checked with the previous registered VCS PD /5/ and the document review. The project has already been registered and issued under VCS during the first crediting period. Further the project activity faces barriers which have been described under Section 2.5 of the VCS PD, hence it is unlikely that the project would have been taken up without the VCS benefits. Hence

Alternative Scenario	Description	Justification	Validation team assessment
			the alternative is not applicable to the project activity.

Hence the option B3 has been found to be the most credible alternative scenario in term of using biomass residues for substitution of fossil fuels.

The renewable biomass will not be considered in this case because there is no site using renewable biomass from a new dedicated plantation in the project plants. Hence the identified alternative scenarios are F2, F3, W1, W3 and B3.

For the renewal of crediting period, as per the Section 3.8.5 (2) of the VCS Standard (version 3.7), *The validity of the original baseline scenario shall be demonstrated, or where invalid a new baseline scenario shall be determined, when renewing the project crediting period, as follows:*

Assessment as per VCS standard	Justification	Validation team confirmation
(a) The validity of the original baseline scenario shall be assessed. Such assessment shall include an evaluation of the impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario.	Refer to section 1.11 of this PD, <i>The proposed project activity is in compliance with all local laws and regulations.</i> Therefore, there is no impact to the original baseline of project activity.	The justification provided by the PP is Ok. The validation team has reviewed many relevant rules, regulations, policies and reports published Thailand Government bodies including "Energy Policy and Planning Office, Ministry of Energy", "Department of Renewable Energy Development and Energy Efficiency, Ministry of Energy", "Department of Alternative Energy Development and Efficiency, Ministry of Energy", "Energy Policy and Planning Office, Ministry of Energy", "Policy and Strategy Management Office, Office of the Permanent Secretary, Ministry of Energy", Government of Thailand and "GIZ" /25/, as per which, there is no impact on the current baseline. The government bodies being already aware of the project activity as the

Assessment as per VCS standard	Justification	Validation team confirmation
		formal permission has already been sought along-with EIA clearances /13/ as well as the attachment to the operating license (which is renewed in every five years) as operating conditions. Therefore compliance to all regulations can be ensured by the validity of operating license /10/ valid for 5 years from 31/12/2012. There is no policy regarding the use of fossil or biomass as fuels in cement plant. Hence the project is in compliance with all the local laws and regulations /24/25/. Hence the current national/sectoral policies /24//25//26/ do not impact the current baseline identified during the 1st crediting period. Hence there is no impact on the original baseline and the same is accepted to the validation team.
(b) Where it is determined that the original baseline is still valid, the GHG emissions associated with the original baseline scenario shall be reassessed using the latest version of the CDM Tool to assess the validity of the original/current baseline and to update the baseline at the renewable of a crediting period.	The assessment is provided in Table 10 of VCS PD.	The GHG emissions associated with the original baseline scenario has been reassessed using the latest version of the CDM Tool to assess the validity of the original/current baseline and to update the baseline at the renewable of a crediting period in the Table 10 of the VCS PD which has been found correct. Validation opinion for the same is given in the below tables. Hence the requirement has been met by

Assessment as per VCS standard	Justification	Validation team confirmation
		the project activity.
(c) Where it is determined that the original baseline scenario is no longer valid, the current baseline scenario shall be established in accordance with the VCS rules.	According to assessment result presented in Table 10 of VCS PD, the original baseline scenario is still valid. This section is not applicable.	PP has demonstrated in Section 10 of the VCS PD that original baseline scenario is still valid and hence there is no requirement for determining a new baseline scenario. Validation team has already checked the validity of the original baseline in the point (a) of this table. Hence this requirement is not applicable to the project activity.
(d) The project description, containing updated information with respect to the baseline, the estimated GHG emission reductions or removals and the monitoring plan, shall be submitted for validation.	The project description is updated and revised according to the latest approved version of ACM0003 including the relevant tools to the applied methodologies.	Validation team has checked the updated project description, GHG emission reductions or removals and the monitoring plan and found OK. Hence this is acceptable to the validation team.

The validation team has assessed the validity of the original baseline scenario, including information about any new relevant national and/or sectoral policies and their effect on the baseline scenario and the reassessment of GHG emissions associated with the original baseline scenario as per the requirement of CDM Tool “*Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1*” as given below. It is confirmed that the original baseline scenario is still valid for the next crediting period.

Validity of original baseline scenario

Assessment as per CDM tool	Justification	Validation team confirmation
<i>Step 1:</i> Assess the validity of the current baseline for the next crediting period		
<i>Step 1.1:</i> Assess compliance of the current baseline with relevant mandatory national	The project complies with the national policies as the justification is provided in the	The justification provided by the PP is Ok. The validation team has reviewed many

and/or sectoral policies	previous section.	relevant rules, regulations, policies and reports published Thailand Government bodies including “Energy Policy and Planning Office, Ministry of Energy”, “Department of Renewable Energy Development and Energy Efficiency, Ministry of Energy”, “Department of Alternative Energy Development and Efficiency, Ministry of Energy”, “Energy Policy and Planning Office, Ministry of Energy”, “Policy and Strategy Management Office, Office of the Permanent Secretary, Ministry of Energy”, Government of Thailand and “GIZ” /25/26/, as per which, there is no impact on the current baseline. The government bodies being already aware of the project activity as the formal permission has already been sought along-with EIA clearances /13/ as well as the attachment to the operating license as operating conditions. Therefore compliance to all regulations can be ensured by the validity of operating license /10/. There is no policy regarding the use of fossil or biomass as fuels in cement plant. Hence the project is in compliance with all the local laws and regulations. Hence the current national/sectoral policies /24//25//26/ do not impact the current baseline identified during the 1st crediting period.
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		Hence there is no impact on the original baseline and the same is accepted to the validation team.
<i>Step 1.2: Assess the impact of circumstances</i>	There is no change in the circumstance that would impact the continuation using of fossil fuels for clinker production as a baseline scenario of the project.	There is no change in the national/sectoral rules and regulations related to the continuation of fossil fuel use for the clinker production as the baseline scenario of the project activity. Validation team has checked the same from the on-site interview /14/, review of the websites/regulations /24/, /25/.
<i>Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.</i>	The identified baseline scenario at the first validation of this project was the continuous using of the fossil fuels at cement kilns without any investment. The use of fossil fuels in cement production is the standard and traditional practice for cement production in Thailand. F: As per reference from the <i>Guidelines for Co-Processing Fuels and Raw Materials in Cement Manufacturing</i> published by World Business Council for Sustainable Development (WBCSD) for cement⁵, <i>Most cement kilns today use coal and petroleum coke as primary fuels, and to a lesser extent natural gas and</i>	The baseline scenario as identified during the first crediting period was the continuous usage of fossil fuels in cement plant. The usage of fossil fuels in the cement production plant is a standard practice in the project region in Thailand. The validation team has assessed in the above sections of the report that there is no change in the national/sectoral rules and regulations /24/25/ related to the continuation of the baseline scenario. Various references/sources /24/25/ have been referred to further confirm on the continuation baseline

⁵ https://www.wbcsdcement.org/pdf/CSI%20Guidelines%20for%20Co-Processing%20Fuels%20and%20Raw%20Materials%20in%20Cement%20Manufacturing_v2.pdf

	<i>fuel oil.</i> W: From the reference of <i>Solid Waste Management in Thailand</i>⁶ ; 36% of waste generated has been disposed by appropriate sanitary system which are incinerator and landfill systems , 43% of waste generated has been disposed by improper methods. B: Referring to the latest information of biomass potential data reported by Department of Alternative Energy Development and Efficiency⁷ , the biomass generation in 2016 is 134,134,102.21 tonnes while only 71,289,681.68 tonnes or 53% were utilized. The rest biomass residues were left as scrap or burnt on ground. Moreover , the technical lifetime of baseline system which is the lifetime of the cement kiln , also exceeds the crediting period for which renewal is requested. Therefore , the scenario to continue the using of current baseline equipment(s) is still applicable for this crediting period.	scenario as per which the use of coal in cement kilns is a standard practice in cement industry. The technical lifetime of the cement kiln is also more than the lifetime of the crediting period for which renewal is requested. Therefore, the scenario to continue the using of current baseline equipment(s) is still applicable for this crediting period.
Step 1.4: Assessment of the validity of the data and	All data and parameters that were determined at the start of	Validation team has checked the revised VCS PD /03/ and

⁶ <https://hls-esc.org/documents/8hlsesc/Thematic%20C1/Thematic%20%20C1%20-%20Thailand%20-%20Solid%20Waste%20Management%20in%20Thailand,%20Policy%20and%20Implementation%20by%20Dr.%20Wijarn%20Simachaya.pdf>

⁷ http://biomass.dede.go.th/biomass_web/index.html

parameters	the crediting period are updated accordingly.	found that the all the data and parameters are updated accordingly and found Ok.
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The justification provided above shows that the selected baseline scenario in the 1st crediting period is still valid for subsequent crediting period for which the renewal is requested. Also, all data and parameters have been updated to use for the renewed crediting period.

3.2.5 **Additionality**

As per the reference from VCS standard (version 3.7), section 3.8.5: Renewal of Project Crediting Period, 1) *a full reassessment of additionality is not required when renewing the project crediting period. However, regulatory surplus shall be demonstrated in accordance with Section 4.6.3 and the project description shall be updated accordingly.* The additionality of the project was assessed for the regulatory surplus.

The paragraph 4.6.3 of VCS standard states as follows:

Step 1 (Regulatory Surplus): *The project shall not be mandated by any law, statute or other regulatory framework. For UNFCCC non-Annex I countries, laws, statutes, regulatory frameworks or policies implemented⁸ since 11 November 2001 that give comparative advantage to less emissions intensive technologies or activities relative to more emissions-intensive technologies or activities need not be taken into account. For all countries, laws, statutes, regulatory frameworks or policies implemented since 11 December 1997 that give comparative advantage to more emissions intensive technologies or activities relative to less emissions-intensive technologies or activities shall not be taken into account.*

The validation team has referred various relevant rules, regulations, policies and reports published Thailand Government bodies including “Energy Policy and Planning Office, Ministry of Energy”, “Department of Renewable Energy Development and Energy Efficiency, Ministry of Energy”, “Department of Alternative Energy Development and Efficiency, Ministry of Energy”, “Energy Policy and Planning Office, Ministry of Energy”, “Policy and Strategy Management Office, Office of the Permanent Secretary, Ministry of Energy”, Government of Thailand and “GIZ” /25/ and found that there is no current regulatory requirement for using the less-carbon alternative fuels in cement production in Thailand.

The government bodies being already aware of the project activity as the formal permission has already been sought along-with EIA clearances /13/ as well as the attachment to the operating license as operating conditions. Therefore compliance to all regulations can be ensured by the validity of operating license /10/.

There is no new policy regarding the use of fossil or biomass as fuels in cement plant.

⁸ Implemented in the context of this paragraph means enacted or introduced, consistent with use of the term under the CDM rules on so-called Type E+ and Type E- policies.

Therefore, the proposed project activity is voluntary as it is not being implemented to respond to laws or regulations. Validation team has also checked the national and sectoral policies applicable to project activity from the review of documents and the assessment team is in the opinion that the project continues to be voluntary.

3.2.6 Quantification of GHG Emission Reductions and Removals

The emission reductions in the project activity have been generated due to the use of 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. The methodology *ACM0003 (version 08.0): Partial substitution of fossil fuels in cement or quicklime manufacture* has been applied for the estimation of emission reductions.

Baseline Emissions: The baseline emissions have been calculated in line with the para 41 of the applied methodology (ACM0003, version 08.0) as follows:

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

Where:

BE_y	=	Baseline emissions in year y (t CO ₂)
$BE_{FF,y}$	=	Baseline emission from fossil fuels displaced by alternative fuels or less carbon intensive fossil fuels in year y (t CO ₂)
$BE_{CH4,biomass,y}$	=	Baseline methane emissions avoided during the year y from preventing disposal or uncontrolled burning of biomass residues (t CO ₂ e)

As per the para 42 of the applied methodology, the baseline emissions are determined in the following steps:

- Step 1. Estimate the project specific fuel penalty;
- Step 2. Calculate baseline emissions from the fossil fuels displaced by the alternative or less carbon intensive fuel(s);
- 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) shall be determined as follows:

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

Where:

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

The specific energy consumption in the project shall be 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:

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

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:

$$SEC_{clinker,BL} = \frac{\frac{HG_x}{P_{clinker,x}} + \frac{HG_{x-1}}{P_{clinker,x-1}} + \frac{HG_{x-2}}{P_{clinker,x-2}}}{3}$$

with

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

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

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

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

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

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:

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

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 CO ₂ /GJ)
$FC_{i,x}$	=	Quantity of fossil fuel type i used in the project plant in year x (t)
NCV_i	=	Net calorific value of the fossil fuel type i (GJ/t)
$EF_{CO_2,FF,i}$	=	CO ₂ emission factor for fossil fuel type i (t CO ₂ /GJ)
x	=	Year prior to the start of the project activity
i	=	Fossil fuel types used in the project plant in the last three years prior to the start of the project activity

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

$$EF_{CO_2,BL,y} = \frac{\sum_i FC_{PJ,i,y} \times NCV_{i,y} \times EF_{CO_2,FF,i,y}}{\sum_i FC_{PJ,i,y} \times NCV_{i,y}}$$

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 CO ₂ /GJ)
$FC_{PJ,i,y}$	=	Quantity of fossil fuel type i fired in the project plant in year y (t)

- $NCV_{i,y}$ = Net calorific value of the fossil fuel type i in year y (GJ/t)
- $EF_{CO_2,FF,i,y}$ = Carbon dioxide emission factor for fossil fuel type i in year y (t CO₂/GJ)
- i = Fossil fuel types used in the project plant in year y that are not less carbon intensive fossil fuel types

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

$$EF_{CO_2,BL,y} = \frac{\sum_i FC_{BL,F3,i,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{\sum_i FC_{BL,F3,i,y} \times NCV_{i,y}}$$

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:

$$BE_{CH_4,biomass,y} = BE_{CH_4,B1/B3,y} + BE_{CH_4,B2,y}$$

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:

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

Where:

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

To determine the CH₄ emission factor, project participants may undertake measurements or use referenced default values. In the absence of more accurate information, the value of 0.0027 t CH₄ per tonne of biomass as default value for the product of NCV_k and $EF_{burning,CH4,k,y}$ ⁹ may be used.

The uncertainty of the CH₄ emission factor is in many cases relatively high. In order to reflect this and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor shall be applied to the CH₄ emission factor. The level of the conservativeness factor depends on the uncertainty range of the estimate for the CH₄ emission factor. The appropriate conservativeness factor from table below shall be chosen and multiplied with the estimate for the CH₄ emission factor.

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

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 ($PE_{BC,y}$):

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

Where:

- PE_y = Project emissions during the year y (t CO₂e)
- $PE_{k,y}$ = Project emissions from combustion of alternative fuels and/or less carbon intensive fossil fuels in the project plant in year y (t CO₂)
- $PE_{FC,y}$ = Project emissions from additional fossil fuel combustion as a result of the project activity in year y (t CO₂)
- $PE_{EC,y}$ = Project emissions from additional electricity consumption as a result of the project activity in year y (t CO₂)

⁹ 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

- $PE_{T,y}$ = CO₂ emissions during the year y due to transport of alternative fuels to the project plant (t CO₂)
- $PE_{BC,y}$ = Project emissions from the cultivation of renewable biomass at the dedicated plantation in year y (t CO₂e)

Project emissions are calculated in the following steps:

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

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

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

$$PE_{k,y} = \sum_k FC_{PJ,k,y} \times NCV_{k,y} \times EF_{CO_2,k,y}$$

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 CO₂)
- $FC_{PJ,k,y}$ = Quantity of alternative fuel or less carbon intensive fossil fuel type k used in the project plant in year y (t)
- $EF_{CO_2,k,y}$ = Carbon dioxide emissions factor for alternative or less carbon intensive fossil fuels type k in year y (t CO₂/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;

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:

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

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

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

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

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

- 2) CO₂ emissions from on-site electricity consumption ($PE_{EC,y}$) should be calculated using the latest approved version of the “Baseline, project and/or leakage emissions from electricity

consumption and monitoring of electricity generation” , version 03.0 /19/. 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 TGO¹⁰ /22/. The data used for national grid emission calculation is provided by Energy Regulatory Commission or ERC. The $EF_{grid,CM,y}$ from latest available version of the grid emissions study will be used. The use of emission factor as published by TGO has been found appropriate by the validation team.

The result of grid emission factor for general project reported by the “*Thailand Grid Emission Factor for GHG Reduction Project/Activity*”, published by TGO on 28/09/2017 /22/ is shown in table below;

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

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

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM}$$

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. The calculations are correct and the arrived value of emission factor has been found appropriate.

¹⁰http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf

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

Where:

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

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

Project participants shall determine CO₂ emissions resulting from transportation of alternative fuels to the project plant. In many cases transportation is undertaken by vehicles. Project participants shall calculate these project emissions following the methodological tool ‘Project and leakage emissions from transportation of freight’, version 01.1.0 /20/.

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.

$$PE_{TR,m} = \sum_f D_{f,m} \times FR_{f,m} \times EF_{CO2,f} \times 10^{-6}$$

Where:

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

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

The project does not involve the cultivation of biomass at the dedicated plantation. Thus, the project emissions from this source can be neglected. The same was discussed and checked during the site visit of the project activity.

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. The choice of option is found appropriate by the assessment team since 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:

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

where:

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

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

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

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

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

Net GHG Emission Reductions and Removals

Emission reductions have been calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

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

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

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

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

The emission reductions /4/ based on the above equations have been estimated as follows:

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

The calculation of emission reductions has been updated as per the requirement of the latest version of the applied methodology and the applicable methodological tools. The validation team has assessed the calculations of the project emissions, baseline emissions and leakage and emission reductions. It has been confirmed that the calculation for emission reductions are in accordance with the applied methodology (ACM0003 version 08). The formulae used in the calculations of the emission reductions are correct and have been transparently documented in the VCS PD and Excel spreadsheet.

3.2.7 Methodology Deviations

The project involves one deviation that the parameter “Production of clinker” ($P_{\text{clinker},y}$) is not monitored by the weight feeder. 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.

The PP has undertaken this deviation in the parameter due to reason that the amount of clinker production cannot be directly measured because of its high temperature. The amount is calculated through the raw meal which is directly measured by weight feeder and the clinker factor is used for calculating the clinker production.

- The amount of raw meal is continuously monitored by the weight feeder and the data is recorded on daily basis.
- The clinker factor is from the result of LOI (Lost of Ignition), % ash, % dust loss and moisture content from internal laboratory.
- The amount clinker produced in the stock checking report is from the truck scale and the available stock of clinker in the cement factory.
- The calculated amount of clinker produced is cross-checked and adjusted with the stock checking information on monthly basis to ensure the accuracy of the figures presented in the Work Journal /13/.

The deviation undertaken for this parameter is due the practical issue of difficulty in measuring the clinker production due to its high temperature. Further this deviation has already been applied during previous verifications /7/ which have been confirmed through the VCS website. The deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario. Hence the deviation for the parameter has been accepted by the validation team.

3.2.8 Monitoring Plan

The project applies the monitoring methodology as per the large scale consolidated methodology: ACM0003 - Partial substitution of fossil fuels in cement or quicklime manufacture, version 08.0 and applicable methodological tools. The methodology is an approved CDM methodology. The baseline and project emission parameters that are monitored are available in the Section 4 of the

VCS-PD. The Validation team has verified the list of parameters and confirms that these are in line with the requirements of the applied methodology.

Monitoring Parameters:

1. Quantity of alternative fuel or less carbon intensive fossil fuel of type k ($FC_{PJ,k,y}$), fossil fuel of type i ($FC_{PJ,i,y}$) used in the project plant: The quantity of solid fossil fuels and biomass fuels is continuously monitored by weight feeder equipment. The data from all inline measuring equipment is connected to Distributed Control System (DCS) at the control room. The data recording from DCS is carried out by cell operator on daily basis. The fuel oil volume is continuously monitored by flow meter /13/. 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 have been summarized in Work Journal (WJ) /13/ by engineer. The data is recorded continuously and aggregated at least annually. The monitoring procedure for the parameter has been confirmed during the site visit and cross checked through the document review.

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 ISO 9001 requirements. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of baseline and project emissions.

2. Weighted average CO₂ emission factor for alternative or less carbon intensive fuels of type k ($EF_{CO_2,k,y}$) and for fossil fuel of type i ($EF_{CO_2,FF,i}$): The applied methodology provides various options (as sources) from where the data may be sourced. The data for the parameter has been sourced from various options as follows:
 - a. Fossil fuels: For the fossil fuel, the option (d) has been chosen as per which the 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 /23/ on National GHG Inventories shall be used.
 - b. Alternative Fuels: For the alternative fuels, the option (c) has been chosen as per which the regional or national default values shall be used. The emission factor shall be sourced from the CO₂ Accounting and Reporting Standard for the Cement Industry, provided by World Business Council for Sustainable Development /24/. The $EF_{CO_2,k,y}$ is zero for the following alternative fuels:
 - Wastes originating from fossil sources where W1 has been identified as the most plausible baseline scenario;
 - Biomass residues;
 - Renewable biomass

The monitoring procedure for the parameter has been confirmed during the site visit and through the document review. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of baseline and project emissions.

3. Weighted average net calorific value of the alternative or less carbon intensive fuel types k (NCV_{k,y}) and fossil fuel types i (NCV_{i,y}): The applied methodology provides various sources of data (as options) for the parameter from where the data may be sourced. The net calorific value of the most of the fossil fuel and biomass shall be tested by internal laboratory in line with the option (b). The results are saved in QIS (Quality Information System) by lab analyst. In case of HFO, the heating value is provided by the supplier, hence the option (a) shall be used in this case. In case both the options (a) and (b) is not available the national default heating values shall be considered as per the option (c) provided by the methodology. The monitoring procedure for the parameter has been confirmed during the site visit and through the document review. The national or international methods shall be used for the measurement of option (a) and (b). The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of baseline and project emissions.
4. Production of clinker (P_{clinker,y}): The methodology deviation has been sought for this parameter in Section 2.6 of the VCS-PD and the same has been validated in Section 3.2.7 of the validation report. 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 data is recorded/calculated and reported on monthly basis. The documentation and calibration is controlled and managed in accordance with ISO 9001 requirements. The requirement for the deviation in monitoring procedure was confirmed during the site visit and found acceptable. The monitoring equipment is calibrated according to calibration plan and/or shutdown plan of kiln. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of baseline emissions.
5. 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 (EF_{CO2,BL,y}): The emission factor shall be calculated as the lowest of the following CO₂ emission factors:
 - a. The weighted average annual CO₂ emission factor for the fossil fuel(s) consumed and monitored ex ante during the most recent three years before the start of the project activity;
 - b. The weighted average annual CO₂ emission factor of the fossil fuel(s) consumed in the project plant in year y that are not less carbon intensive fossil fuels;
 - c. If F2 has been determined as the most likely baseline scenario: the weighted average annual CO₂ emission factor for the fossil fuel(s) that would have been consumed according to fuel mix determined in the "Procedure for the selection of the most plausible baseline scenario and demonstration of additionality" above.

The data shall be monitored continuously, aggregated at least annually. The monitoring procedure for the parameter has been confirmed during the site visit and based on the document review. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of baseline emissions.

6. Quantity of fossil fuel type i fired in the project plant while project alternative or less carbon intensive fuel or biomass was used: (FC_{PJ,i,k,y}): The quantity of fossil fuel shall be measured using the mass or volume meters, crossed with operation logs showing when alternative or less carbon intensive fuel was used. The consistency of metered fuel consumption quantities should be cross-

checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the project, the metered fuel consumption quantities shall also be cross-checked with available purchase invoices from the financial records. The measurement shall be recorded in the log books. The above procedure of monitoring was discussed and checked during the site visit. The monitoring equipment is calibrated according to calibration plan /12/ and/or shutdown plan of kiln. The documentation and calibration is controlled and managed in accordance with ISO 9001 requirements. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of baseline emissions.

7. Combined margin emission factor for the grid ($EF_{grid,CM,y}$): The value for the factor shall be sourced from the latest national value reported by Thailand Greenhouse Gas Management Organization¹¹ /22/. The value shall be updated during the verification periods. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of project emissions.
8. Average technical transmission and distribution losses for providing electricity to source ($TDL_{i,y}$): The value of the parameter shall be sourced from the latest available of National data, World Bank indicator 'Electric power transmission and distribution loss (%of output)' for Thailand¹² /22/. The frequency of monitoring shall be annual and in the absence of data from the relevant year, most recent figures should be used, but not older than 5 years. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of project emissions.
9. Quantity of electricity consumed by the project electricity consumption source ($EC_{PJ,i,y}$): The quantity of electricity shall be measured through the electricity meters installed at the electricity consumption sources. The measurement shall be direct measurement or calculated based on measurements from more than one electricity meters. The measurement shall be continuous measurement and at least monthly recording. The monitoring procedure for the parameter has been confirmed during the site visit and based on the document review. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of project emissions.
10. Specific fuel consumption ($FC_{i,i,y}$): The data shall be sourced from the data used for ex-ante estimation in the previous crediting period. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of project emissions.
11. Weighted average net calorific value of fuel ($NCV_{i,y}$): The net calorific values shall be sourced based on the option (c) which is "regional or national default values". The reference from reports of Department Alternative Energy Development and Efficiency /25/ shall be used. The appropriateness of the values shall be reviewed annually. The measurement procedures are in

¹¹http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf

¹²<https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?locations=TH&page=6>

line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of project emissions.

12. Weighted average CO₂ emission factor of fuel (EF_{CO₂,i,y}): The value of emission factor shall be sourced through the option (d) of the applied methodology. The option (d) is 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 /23/ on National GHG Inventories is selected for this case. The future revisions shall be taken into account. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The data shall be used for the calculation of project emissions.

The above monitoring parameters will give an opportunity for real measurements of achieved emission reductions. The details of the data to be collected, the frequency of data recording, format and storage type have been clearly described in the VCS-PD. The algorithms and formulae used are clearly presented and the calculations are without errors. The monitoring plan provided detailed information related to the collection and archiving of all relevant data needed to estimate or measure emissions occurring from GHG sources, sinks and reservoirs. The responsibility and authority for measurement, measurement and monitoring frequency, data collection and management system, quality assurance and quality control, data storage and back-up, reporting and registration activities have been discussed during the site visit and found to be in line with the description as provided in the VCS-PD

The monitoring plan was also validated against the requirements of the latest version applied methodology ACM0003: Large scale consolidated methodology – Partial substitution of fossil fuels in cement or quicklime manufacture, version 08.0 and applicable methodological tools and found in compliance.

3.3 Non-Permanence Risk Analysis

Not Applicable to the project activity.

4 SAFEGUARDS

4.1 No Net Harm

The project activity has no potential negative environment and social-economic impacts. Assessment team confirms it based on the on-site visit, document review and local & sectoral expertise.

4.2 Environmental Impact

Project has received the EIA clearance already /13/. Validation team has checked the EIA clearance /13/ of the project activity and also the operating license /10/. Same as in the registered VCS PD /05/.

4.3 Local Stakeholder Consultation

Same as in the registered VCS PD /05/.

4.4 Public Comments

This is not a new project activity hence this section is not applicable.

5 VALIDATION CONCLUSION

The project activity “Siam Cement Biomass Project” VCS Registry no. 403 as described in project document version 02.1 dated 06/12/2017 meets the requirements of the renewal of the crediting period as stated in the para 3.8.5 of VCS Standard V3.7 /01/ and Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period, version 3.0.1 /01/. The applied methodology is also the latest ACM0003: Large scale consolidated methodology – “Partial substitution of fossil fuels in cement or quicklime manufacture, version 08.0” /15/ in accordance with the procedure for renewal. The project activity meets all the criteria and the conditions to generate verified emission reductions (VERs) for the requested crediting period i.e. 01/04/2016 to 31/03/2026.

Validation team confirms that project complies with the validation criteria for projects set out in VCS Version 3, and includes any qualifications or limitations. Further the project is likely to achieve estimated GHG emission reduction or removals.

Location: Faridabad
Date: 28/12/2017



Authorized Signatory: Kaushal Goyal
Designation: Managing Director
KBS Certification Services Pvt. Ltd.

APPENDIX 1: REFERENCE DOCUMENTS

S. No	Document Name
/1/	- VCS web site: www.v-c-s.org, http://v-c-s.org/program-documents - VCS Standard Version 3.7 - VCS Program Guide Version 3.7
/2/	- CDM Validation and Verification Standard for project activities version 01 - CDM Project Standard for project activities version 01 - Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1
/3/	/2.1/ VCS – PD Version 01, dated 03/11/2017
	/2.2/ VCS – PD Version 02.1, dated 06/12/2017
/4/	Emission Reduction Calculations sheet dated 03/11/2017
/5/	VCS Registered PD for project: “Siam Cement Biomass Project”, Version 2 dated 24/09/2009
/6/	Validation report for the project “Siam Cement Biomass Project”, Dated 03/11/2009
/7/	Previous Verification Reports
/8/	Technical description of the project technology installed along with the monitoring equipments
/9/	Emission Reduction Purchase Agreement between “The Siam Cement (Thung Song) Co., Ltd. and South Pole Carbon Asset Management Ltd. dated 27/08/2009.
/10/	STS Operating License for the Cement Plant valid from 31/12/2012 for 5 years.
/11/	Single line diagram
/12/	Calibration records of all the monitoring equipments: - Daily data for Weigh feeder for raw meal data - Weight scale - Fuel Oil volume meter totalizer - Electricity meter installed at the project sites - NCV measurement equipments
/13/	- Operator Log sheets - Letter from Khao Wong supplier regarding diesel oil usage for biomass handling - Work journal for the monitoring parameters - Work instructions for the operator - EIA clearances for the project activity
/14/	Site visit for the project activity - Audit plan sent to the PP for the site inspection. - Attendance sheet
/15/	Large scale consolidated methodology: ACM0003 - Partial substitution of fossil fuels in cement or quicklime manufacture, version 08.0
/16/	Combined tool to identify the baseline scenario and demonstrate additionality”, version 07.0
/17/	Upstream leakage emissions associated with fossil fuel use”, Version 02.0
/18/	Tool to calculate project or leakage CO ₂ emissions from fossil fuel combustion”, version 03;
/19/	Baseline , project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, version 03.0;
/20/	“Project and leakage emissions from transportation of freight”, version 01.1.0.
/21/	“Tool to calculate the emission factor for an electricity system”, Version 05
/22/	Thailand Grid Emission Factor for GHG Reduction Project/Activity” , published by TGO on 28/09/2017

	http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559 - Finalised.pdf
/23/	2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.
/24/	• http://www.aecen.org/sites/default/files/country_report_thailand.pdf • http://webeng.mnre.go.th/ewt_news.php?nid=5 • http://www.aecen.org/ • http://www.environnet.in.th/en/archives/1832 • http://www2.eppo.go.th/power/PDP2015/PDP2015_Eng.pdf • https://www.wbcscement.org/pdf/CSI%20Guidelines%20for%20Co-Processing%20Fuels%20and%20Raw%20Materials%20in%20Cement%20Manufacturing_v2.pdf • https://www.wbcscement.org/pdf/technology/Technology%20papers.pdf • https://www.wbcscement.org/pdf/technology/CSI_ECRA_Technology_Papers_2017.pdf • http://wbcscement.org/index.php/key-issues/climate-protection/co2-accounting-and-reporting • http://biomass.dede.go.th/biomass_web/index.html • https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?locations=TH&page=6 • www.wbcscement.org
/25/	• “Thailand Power Development Plan” (2015-2036) dated June 30, 2015 by “Energy Policy and Planning Office, Ministry of Energy” • “Thailand Energy Report 2015” dated 13/05/2016, by “Energy Policy and Planning Office”, “Ministry of Energy”. • A Report on “Thailand: Renewable Energy Policy Update” dated 20/05/2015, facilitated by GIZ. • A Report on “Alternative Energy Development Plan” (AEDP2015) dated September 2015, by “Department of Renewable Energy Development and Energy Efficiency, Ministry of Energy” • A Report on “Research and Development in the field of Energy Conservation and Renewable Energy in Thailand” by “Department of Alternative Energy Development and Efficiency, Ministry of Energy”, Thailand • “Thailand Energy Situation 2015 Report” dated March 2016 by “Energy Policy and Planning Office, Ministry of Energy”. • “Thailand National Energy Policy and Development Plan” • “Thailand 20-year Energy Efficiency Development Plan” (2011-2030) by “Ministry of Energy”. • A Report on “Energy in Thailand: Facts & Figures 2014” by “Department of Alternative Energy Development and Efficiency, Ministry of Energy”. • A Report on “Thailand Energy Outlook 2016” by “Policy and Strategy Management Office, Office of the Permanent Secretary, Ministry of Energy”. • A Report on “Thailand Renewable Energy Policy Update dated 01/2017 facilitated by GIZ. • A Report “Renewable Energy Outlook Thailand” by “International Renewable Energy Agency (IRENA)” and “Department of Alternative Energy Development and Efficiency, Ministry of Energy”. • Transportation regulation of Thailand for the maximum load allowed per truck
/26/	• http://weben.dede.go.th/webmax/content/thailand-needs-promote-energy-waste • https://www.wbcscement.org/pdf/technology/CSI_ECRA_Technology_Papers_2017.pdf

APPENDIX 2: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS

Personnel Name:		Chetan Swaroop Sharma	
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	TA 1.2: Energy generation from renewable energy sources		
Energy Demand	TA 3.1. Energy demand		
Waste handling and disposal	TA 13.1. Solid waste and wastewater TA 13.2. Manure		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	01/05/2017		

Personnel Name:		Anil Kumar Pandey	
Qualified to work as:			
Team Leader	☐	Technical Expert	☒
Validator/Verifier	☐	Financial Expert	☐
Technical Reviewer	☐	Local Expert (India)	☐
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy Industries (Manufacturing Industries)	TA 4.1: Cement		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	10/07/2017		

Personnel Name:		SIAM PHOOLCHAROEN	
Qualified to work as:			
Team Leader	☐	Technical Expert	☐
Validator/Verifier	☐	Financial Expert	☐

Technical Reviewer	☐	Local Expert (Thailand)	☒
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
NA	NA		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	11/11/2016		

Personnel Name:	Rohit Badaya		
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.2: Energy generation from renewable energy sources		
	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
Energy demand	TA 3.1. Energy Demand		
Waste Handling and Disposal	TA 13.1 Waste Handling and Disposal		
	TA 13.2 Manure		
Approval date:	16/10/2017		

Personnel Name:	M.P. Kanal		
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☐
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	TA 1.2: Energy generation from renewable energy sources		
Energy demand	TA 3.1. Energy Demand		
Waste Handling and Disposal	TA 13.1 Waste Handling and Disposal		

Agriculture	TA 15.1 Agriculture
Approved by (Manager C & T)	Sanjay Kandari
Approval date:	02/08/2017

Personnel Name:		Rajpal Singh Shekhawat	
Qualified to work as:			
Team Leader	☐	Technical Expert	☒
Validator/Verifier	☐	Financial Expert	☐
Technical Reviewer	☐	Local Expert	☐
Area(s) of Technical Expertise			
Sectoral Scope		Technical Area	
4: Manufacturing Industries		TA 4.1: Cement Sector	
Approved by (Manager C & T)		Gagandeep Kakkar	
Approval date:		31/12/2014	