CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

Bangkok Kamphaeng Saen East: Landfill Gas to Electricity Project

Version History:

Version number	Date completed	
1	14 March 2009	Submitted to DOE for starting validation
2	18 May 2009	Submitted to DOE as response to CDM.VAL2782 IN02
3	26 June 2009	Submitted to DOE as response to 2nd CDM.VAL2782 IN02
4	3 September 2009	Submitted to DOE as response to 3rd CDM.VAL2782 IN02
5	21 October 2009	Re-inclusion of SCC as project participant
6	23 December 2009	Submitted to DOE as response to 4th CDM.VAL2782 IN02
7	18 January 2010	Change of Methodology version
8	13 August 2010	Requesting registration incomplete
9	02 July 2012	Changes to the project design of a registered project activity

A.2. Description of the project activity:

Bangkok Kamphaeng Saen East: Landfill Gas to Electricity Project (hereinafter is referred as "The Project") will extract, capture and utilize landfill gas (LFG) to generate electricity. The LFG will be extracted and captured using Sindicatum Carbon Capital (ordered by Xentolar Holdings Limited, a project participant) proprietary LFG collection system and the electricity generated will be exported to the Thailand grid. Sources & gases included in the project boundary are methane emission from decomposition of waste at the landfill site & CO_2 from Thai grid emission factor.

The scenario existing prior to the start of the implementation of the project activity is atmospheric release of the landfill gas and existing and/or new grid connected power plants for the power generation. These scenarios are also the only remaining credible and plausible scenarios, and have been identified as the baseline scenario.

Under project activity, a full integrated LFG collection system will be installed and operated. The extracted gas will be utilized to generate electricity. When the yield of gas is insufficient to supply to the generators, or surplus LFG due to engine maintenance or other site factors, LFG will be sent to an enclosed ground flare where the gas will be flared thus minimise methane emissions and maximising carbon abatement. The emission reduction will be achieved by LFG utilization that otherwise would be released the atmosphere & Thai grid connected LFG electricity

This is expected to achieve emission reduction of 1,911,564 tCO2 over the first 7 years crediting period.

The project activity will bring a number of benefits to sustainable development, explained as follows:

1. Environmental benefits:
    - The project will significantly improve local air quality; and
    - The project will create global benefits through reduced impact upon climate change.

The project activity will also ensure that correct management of the landfill is carried out as to optimise landfill gas recovery.

2. Social impacts:
    - Improved air quality, through the reduction of odours, will have a marked impact upon the quality of life for the neighbouring communities
    - The utilisation of a renewable source of energy to generate electricity will contribute to Thailand's sustainable development.
    - Collection of the landfill gas will improve the safety aspects of the landfill, reducing the dangers of combustion and explosion of methane pockets.
    - Moreover, benefit from an additional source of revenue from sales of electricity and sales of CER, will provide reserve funds to secure the future and the continued provision of sanitary waste disposal

3. Economic impacts:
    - An additional source of revenue (CER), will help to secure the future and the continued provision of sanitary waste disposal.

4. Technology transfer:

    The project will introduce new technology to the landfill management sector in Thailand, demonstrating how improved gas capture techniques can improve the capture of methane, resulting in more power generation. The project will utilise Sindicatum Carbon Capital proprietary LFG collection technology currently installed at similar landfill sites in China. The Project will be the first landfill to use this technology on a Thailand landfill and may be replicated for other landfill in Thailand. Transfer of know-how will be performed directly by training or indirectly through the visibility of the project and its interest as a successful local environmental initiative

A.3. Project participants:

Name of Party Involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project

		participant (Yes/No)
The Kingdom of Thailand (host)	Bangkok Greenpower Co., Ltd.	No
UK (Annex I)	Xentolar Holdings Limited	No
UK (Annex I)	Sindicatum Carbon Capital Ltd.	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

The Kingdom of Thailand

A.4.1.2. Region/State/Province etc.:

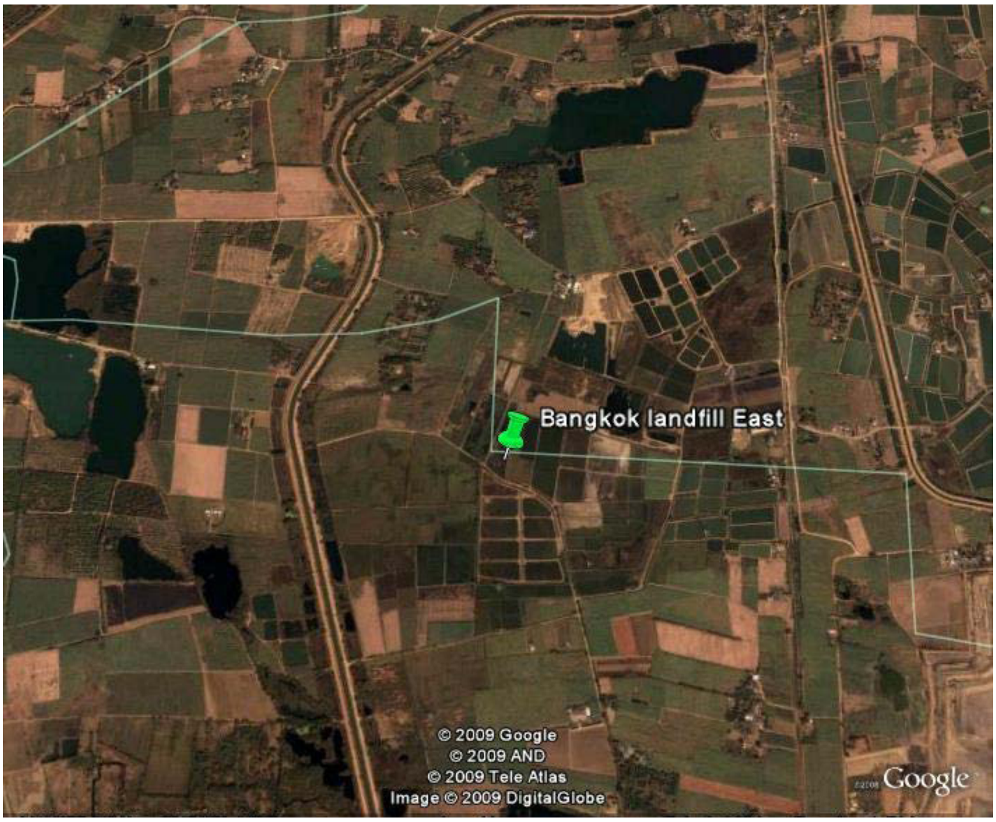
Province of Nakhon Pathom, District of Kamphaeng Saen

A.4.1.3. City/Town/Community etc.:

City of Kamphaeng Saen

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

This landfill is located at T. Sasimhum, A. Kamphaeng Saen, Nakhon Pathom, 73140.
Its geographic coordinates are 14° 3'50.62"N 99°56'50.96"E


Bangkok landfill East
© 2009 Google
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© 2009 Tele Atlas
Image © 2009 DigitalGlobe
Google

Figure 1 Project coordinate and location

A.4.2. Category(ies) of project activity:

Sectoral Scope 1 - Energy industries (renewable - / non-renewable sources)
Sectoral Scope 13 - Waste Handling and Disposal

A.4.3. Technology to be employed by the project activity:

As explained in the sustainable development aspect on technology transfer in section A2, the introduction of Sindicatum Carbon Capital proprietary LFG collection system (ordered by Xentolar Holdings Limited)to utilize LFG will directly transfer know-how of the project by training the local staff employed. Indirectly, it may bring new perspective in domestic waste handling in Thailand.

The scenario existing prior to the start of the implementation of the project activity is the atmospheric release of the landfill gas and existing and/or new grid connected power plants. Therefore, there is no list of equipments & systems in operation under this scenario. This existing scenario is also the only remaining credible and plausible scenario, and has been identified as the baseline scenario.

The scope of project activity as illustrated by figure 2, the project will extract, capture and utilize landfill gas (LFG) from Kamphaeng Saen East Landfill to generate electricity. The electricity generated will be exported to the Thailand grid. Whenever there is surplus LFG due to engine maintenance or other site factors, LFG will be sent to an enclosed ground flare where the gas will be flared thus minimise methane emissions and maximise carbon abatement.

The project activity will use Sindicatum Carbon Capital (SCC) state of the art proprietary LFG gas collection system that has been developed for Asian landfill sites. The design takes into account the different waste composition, climatic conditions and tipping practices of landfill sites in the Asian region when compared with more conventional systems and designs. The LFG system will form an integral part of the overall landfill operation and modifications will be made to the current tipping practice to enhance gas generation and recovery by improving surface water and leachate management. The performance of the LFG design will be continually assessed to ensure optimum LFG recovery, and where required modified to reflect actual site conditions and changes in waste composition and/or daily tipping rates.

Landfill gas collection system:

High density polyethylene (HDPE) horizontal collection pipes will be installed in the waste as an integral part of the tipping operation, these collection wells may be augmented by additional horizontal and vertical collection wells. The collection pipes will be connected via main carrier pipes to the LFG extraction plant and a negative pressure applied. The LFG, comprising approximately 50% methane and 50% carbon dioxide will be used for power generation with any surplus gas flared. SCC proprietary LFG system has been design to optimise LFG recovery and utilisation and optimise carbon abatement, and is designed to overcome inherent problems associated with LFG projects in similar conditions.

The recovered LFG will pass through the pre-treatment plant where moisture and particulates will be removed prior to the power generating engine. The specification of the pre treatment plant will be designed to ensure that the gas quality reaching the engines is in line with the manufacture requirements. A schematic layout of the pre treatment and utilisation plant is shown in Figure 2 below. Power generation units will be installed in line with electrical infrastructure capacity and also to match the LFG recovery profile, as more LFG is generated additional engines will be added to the project, sufficient flare capacity will be installed to ensure that any surplus LFG is flared if engine capacity is insufficient or during periods of maintenance or breakdown . The interface control and system management will be designed to allow real time adjustment of system performance thus optimising gas utilisation and carbon abatement.

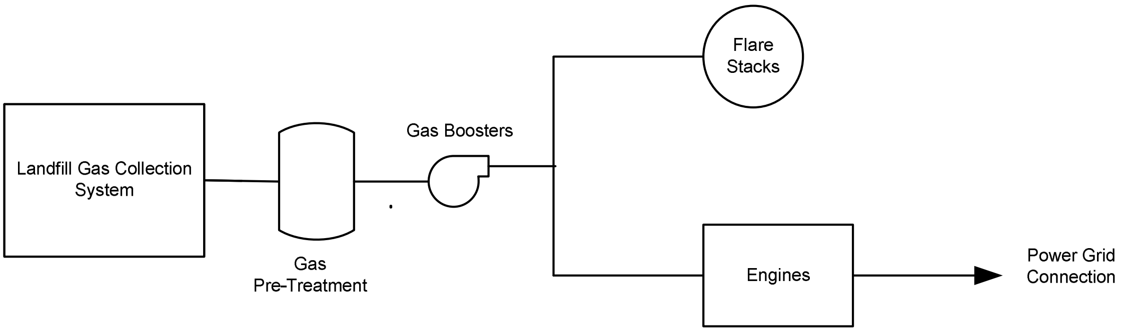

Figure 2 technical diagram of the project activity

LFG generator sets:

After the LFG has passed through the pre treatment plant the gas will be sent to spark ignition power generation units. The electricity produce will be distributed to the grid. For the *ex-ante* emission reduction calculation, it is assumed that all gas engine and generator sets have a capacity of 1.063 MW_e each.

The number of generator sets installed will vary during the life of the project depending on the quantity of gas available. The volume of gas is expected to increase during the first years of the project activity while waste tipping continues and it is expected that up to 11 generators can be installed if the expected increase in gas volume is confirmed, but a maximum of 15 generators could be installed as there is a maximum capacity of 16MW that can be exported with two grid connections. After waste tipping ceases, the quantity of gas available is expected to reduce, and generator sets may be decommissioned and sold.

The electrical power required for the operation of project equipment will normally be obtained from that generated on site. However, during periods when the generator sets are not operating (for example, during fault conditions or during planned maintenance) power to operate project equipment will be imported from the grid.

Flaring system

As described above there may be situations because of weather-induced variation in the gas flow rate or generator down-time where there is surplus LFG that can not be used for power generation, under these conditions the surplus gas will be destroyed by a ground flare. The design will allow real time interface between the engines and flares to optimise the destruction of LFG. Each flare considers the capacity to replace up to approximately 4 generator sets to flare the LFG in the case of troubleshooting & maintenance.

The flare installation used by this project meets all of the necessary conditions that are required by “Tool to determine project emissions from flaring gases containing methane” for continuous monitoring. The flaring system will be equipped with a monitoring system to measure the flow, the pressure, methane concentration and the temperature in order to comply with the tool.

The flaring system employed is closed flaring system. Below is summary of the technical specification of the system:

Table 1 Technical specification for the enclosed flare

Item	Data
Capacity (Nm^3/h)	3 x 2000
Flare temperature (°C)	500-1200
Methane combustion efficiency (%)	>98%

The lifetime of all of the equipment is expected to meet or exceed the period of the maximum total crediting period (3 x 7 years).

The emission sources and green house gases (GHGs) involved in the project activity as illustrated in figure 2 are:

1. CH_4 emission from decomposition of waste at the landfill site
2. CO_2 emission from grid electricity consumption

Baseline scenario has been identified as LFG2 (atmospheric release of the landfill gas) and P6 (existing and/or new grid connected power plants). Since there is no utilization of heat from LFG in the project activity, emission from cogen is not considered. The increasing price of fossil fuel has made the fossil fuel fired captive power plant is not preferable. Sources of renewable sources such as wind, hydro and biomass are not available at sufficient level; therefore renewable based captive power plant is also not preferable. Detailed process determination of baseline can be found at section B4.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

Renewable crediting period of 3 x 7 years is adopted by the project. It is expected that the project will generate emission reductions of approximately 1,911,564tCO2e over the first crediting period from 1 April 2010 to 31 March 2017.

Table 2 Ex ante emission reduction

Years	**Annual estimation of emission reduction in tCO_2e**
2010	220,949
2011	315,502
2012	326,881
2013	335,940
2014	291,757
2015	218,737
2016	169,816

2017	31,981
Total estimated reductions (tonnes of CO_2e)	1,911,564
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	273,081

A.4.5. Public funding of the project activity:

No public funding from Annex I countries is involved in the project activity

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

- ACM0001 "Consolidated baseline and monitoring methodology for landfill gas project activities" Version 11
- "Tool for the demonstration and assessment of additionality" Version 05.2
- "Tool to determine project emissions from flaring gases containing methane" Version 01
- "Tool to calculate the emission factor for an electricity system" Version 01.1
- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 04
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" Version 1.
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" Version 2

Detailed information regarding these methodologies and tools please refer to UNFCCC methodology website.

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

ACM0001 version 11 is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; and/or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy)
c) The captured gas is used to supply consumers through natural gas distribution network

The baseline scenario of the project activity is total atmospheric release of LFG. The project activity fulfils conditions a) and b) therefore ACM0001 version 11 is considered as the most applicable methodology. The methodology also covers the emissions reduction from the grid electricity displacement by the LFG electricity produced.

B.3. Description of the sources and gases included in the project boundary:

Project boundary

The Project boundary includes landfill gas capturing and delivering system, generator sets, enclosed flare and auxiliary facilities that are located inside the project site. The electricity generated by this project will be delivered to the Thai Power Grid.

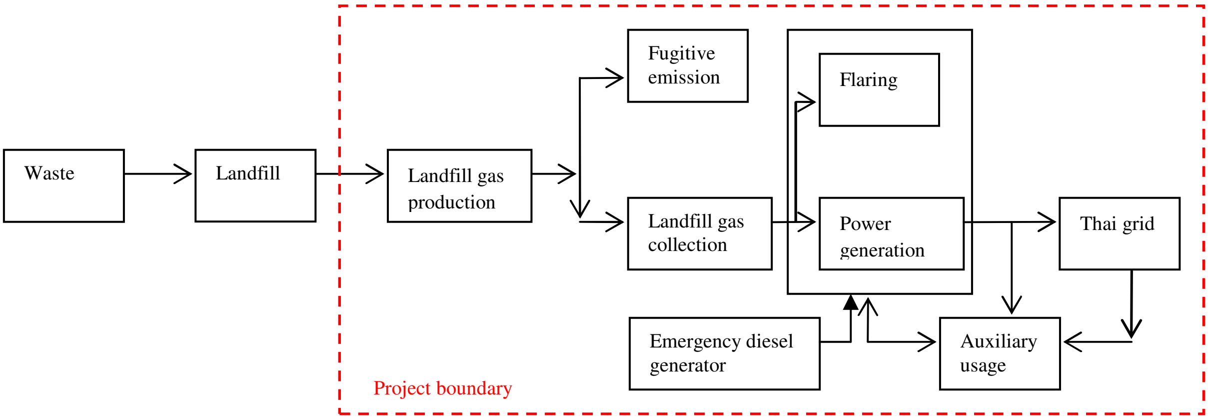

Figure 3 project boundary

The following project activities and emission sources are considered within the project boundary:

Table 3 Sources & gases included in project boundary

	Source	Gas	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
	Power supply from the Thai Power Grid	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from thermal energy generation	CO_2	No	Thermal energy is not included in the project activity.
		CH_4	No	Thermal energy is not included in the project activity.
		N_2O	No	Thermal energy is not included in the project activity.
Project activity	On-site fossil fuel consumption due to the project activity other than for electricity consumption	CO_2	Yes	Consumption of fossil fuel during period when there is no on-site generation and grid electricity (e.g. during connection of new engines).
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.

		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Yes	Consumption of grid electricity during periods when there is no on-site generation
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The baseline scenario has been identified through the "Tool for the demonstration & assessment of additionality version 05.2" and ACM0001 version 11.

Step 1: Identification of alternative scenarios.
Sub-step1a.Define alternatives for baseline scenarios:

In the absence of the project activity, the possible baseline alternatives for LFG treatment/disposal and for power generation might include the following:

1. Alternatives for LFG treatment/disposal
LFG 1. The project activity (i.e. capture of LFG and its flaring and/or its use) undertaken without being registered as a CDM project activity;

LFG 2. Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odor concerns.

LFG2 corresponds to the continuation of the current situation. Currently, there are no regulations for controlled capture and destruction of LFG in Thailand. The license declared by Tung Bua Sub-district Administrative Organisation, the local administrative in whose area the landfill is located, to the landfill operator does not regulate the LFG. Therefore, the release of the LFG directly into the atmosphere will continue in the foreseeable future.

2. Alternatives for power generation
Since project activity will use LFG for electricity generation, the plausible alternatives are shown below:

P1. Power generated from landfill gas undertaken without being registered as CDM project activity;
P2. Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3. Existing or construction of a new on-site or off-site renewable based cogeneration plant;

P4. Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
P5. Existing or construction of a new on-site or off-site renewable based captive power plant;
P6. Existing and/or new grid-connected power plants

As the project activity does not aim at producing heat for nearby industries or on-site use, existing or construction of a cogeneration plant is not part of the baseline scenario. Hence alternatives P2 and P3 are not taken into consideration in the present identification of baseline scenario.

Sub-step1b. Consistency with mandatory laws and regulations:

The Thailand legislation governing operation of a landfill is the Public Health Act B.E.2535. It states that local administrative body has the authority to establish its own regulations regarding issuance of the license to operate the landfill. For the Bangkok East project, Tung Bua Sub-district Administrative Organisation, the local administrative in whose area the landfill is located, currently has not set out any specific regulations relating to issuance of the license, including regulation or policy governing the release of LFG into the atmosphere.

In Thailand, national laws regulating electricity generation do not interfere with the construction of power plants, either producing electricity for internal use or providing power to the grid. National Energy Policy Council (NEPC) on 4th September 2006, prescribes the increasing quantity of power purchase from Very Small Power Producer for generating electricity of renewable energy and primary commercial energy in Cogeneration System[1] It will raise non-conventional renewable energy such as LFG utilization to produce electricity.

Hence alternatives P1, P4, P5 and P6 are in compliance with mandatory laws and regulations.

Step 2. Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.

There are no renewable energy resources (such as wind power, hydro-power and bio-mass power) that can be commercially developed in the region where this project is located. Fossil fuels are not available in abundance in Thailand & its price is increasing. Furthermore, there is no intention to utilize electricity produced as captive power plant. The electricity produced will be exported the Thailand grid. Therefore, alternative P4 and P5 will not be taken into consideration furthermore in the baseline scenario identification.

Alternatives LFG1, LFG2, P1 and P6 are feasible baseline scenarios of the project activity. The next step demonstrates that alternative LFG 1 & P1 faces significant barriers.

Step 3. Barrier analysis

The application of Step 3 of "Tool for the demonstration and assessment of additionality" Version 05.2 is described in Section B5. This analysis shows that scenarios LFG1 and P1, corresponding to the project without CDM revenue would be prevented by barriers relating to investment. The atmospheric release of LFG and refraining from activities at the electricity market do not require any further investment and

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[1] Provincial Electricity Authority, http://www.pea.co.th/vspp/vspp/Announce.pdf

therefore are not prevented by the same barriers described in Section B.5. Therefore, baseline scenario of this project is determined as follows.

Table 4 Baseline scenario

Scenario	Baseline		Description
	Landfill gas treatment	Power generation	
1	LFG 2 (Atmospheric release of the LFG)	P 6 (grid supply)	The atmospheric release of LFG is the current practice in Kamphaeng Saen East Landfill. Electricity is obtained from the Thailand Grid.

Step 4.

Based on the analysis above, LFG2 (atmospheric release of the landfill gas) and P6 (existing and/or new grid connected power plants) are the only remaining credible and plausible scenarios, LFG 2 and P6 have been identified as the baseline scenario.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The project has not started yet, and carbon finance has been considered prior to the investment decision with revenues from CERs essential for the financial viability of the project. Below is the chronology of events leading up to the financial closure of the project.

Date	Description	Amount transacted	Evidence
Apr-08	Feasibility study done by Royal Haskoning		
Jun-08	Sindicatum began involvement.	Nil	
Jul-08	Closing to start 3 month due diligence	50 mil THB (refundable if project does not go ahead)	Security Deposit Agreement, Fee receipt for bank guarantee.
Aug-08	Due Diligence	Nil	
Sep-08	Due Diligence	Nil	
Oct-08	Due Diligence	Nil	
Nov-08	SCC Board Internal Approval - Conditional approval with conditions for renegotiations		
Dec-08	Commercial negotiations	Nil	
Jan-09	Commercial negotiations	Nil	
Feb-09	Commercial negotiations	Nil	

14 Mar 09	Submission for validation	Nil	
24 Mar 09	Loan agreed with payments for CERs	confidential	Loan facility agreement & ERPA
30 Mar 09 (Project Start Date)	Financial close of Bangkok East	THB 85.000,000	Bank transfer for Gas rights payment

Additionality is demonstrated using the CDM *Tool for the demonstration and assessment of additionally* version 05.2 and the Guidelines for Objective Demonstration and Assessment of Barriers version 01. The implementation of step 1 is described in section B.4 above. Step 2 (investment analysis), is not applied since step 3 (barrier analysis) shows a clear conclusion. Step 4 (common practice analysis) is described as the last sequence of the additionality test.

Step 3. Barrier Analysis

In line with the *Guidelines for Objective Demonstration and Assessment of Barriers* (Version 01) published in Annex 13 to EB 50, the following section provides information on the nature of the companies involved in the ownership and operation of the project and baseline scenarios, their organization, ownership and financial status (following Guideline 1 of the *Guidelines for Objective Demonstration and Assessment of Barriers,* Version 01). The text then proceeds to identify and describe an investment barrier (following Guideline 6 of the *Guidelines for Objective Demonstration and Assessment of Barriers,* Version 01) with relevance to scenario LFG1 (the project activity conducted without CDM) and concludes by showing how the CDM overcomes this investment barrier.

The following companies are involved in the ownership and operation of the project and Baseline Scenarios:

COMPANIES TO WHICH THE BARRIER APPLIES

Wasaduphan Turakit Co. Ltd (“Wasaduphan”) owns the Kamphaeng Saen East Landfill. Wasaduphan’s sole business is the collection and disposal of waste in modern sanitary landfills. Wasaduphan and an associated company, Group 79[2], have been managing disposal of Bangkok’s waste at Kamphaeng Saen for over 20 years and possess a contract to do so placed by the Bangkok Municipal Authority (BMA) . Wasaduphan is privately owned by a Thai family and is organized around the ownership and operation of the Bangkok Kamphaeng Saen East Landfill site. Wasaduphan is not related to (ie it is not a parent or subsidiary of nor does it have any shareholders in common with) any of the other parties described herein.

Group 15 was formed by the descendants of the owners of Wasaduphan and Group 79 as a separate independent and unrelated company with different shareholders. It was established as a means to commercialize various opportunities arising from the operation of the Kamphaeng Saen landfills – including all of the non-core business opportunities that arise from Wasaduphan’s activities. Group 15 is privately owned and it is not related to any of the other parties described herein.

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[2] Note: Group 79 operates adjacent landfill that is being developed as another CDM project “Bangkok Kamphaeng Saen West Landfill site”.

COMPANIES INVOLVED TO ALLOW CDM TO OVERCOME THE BARRIER

GRT Ecosystems Company Ltd (GRTE) has been contracted to transfer Wasaduphan's gas and CER rights from Group 15 to the Project Companies listed below involved in building and operating a LFG to-energy project at the site. GRTE was established in March 2007. GRTE is privately owned, is operated as a single-purpose vehicle and is not related to any of the other parties described herein[3]
Bangkok Green Power Co. Ltd is a single-purpose company (the "Project Company") established to build and operate the LFG to-energy project. Bangkok Green Power Co Ltd is registered in Thailand and is a host country Project Participant. Bangkok Green Power will be the first company to receive gas and CER rights. Bangkok Green Power is owned 99.99% by Central Waste Water Developments Limited.

Central Waste Water developments Limited is a single purpose company established to own and capitalise Bangkok Green Power. Central is privately owned by individual shareholders and, other than its ownership of Bangkok Green Power, is not related to any of the parties described herein.

PS Natural Co Ltd are single-purpose company (the "Project Company" or together with Bangkok Green Power the "Project Companies") established to receive gas if there is more than sufficient gas for Bangkok Green Power. PS Natural Energy Co Ltd is registered in Thailand.
PS Natural Co Limited is privately owned and is not related to any of the other parties described herein. If sufficient gas is forthcoming it will be restructured with the addition of a new Parent to be the same as the structure of Bangkok Green Power and Central.

Sindicatum Carbon Capital Limited (SCC, www.carbon-capital.com) is a privately owned company registered in the UK. SCC is a principal developer of carbon projects. To ensure the effective implementation of these projects, SCC also employs relevant technical expertise and has developed its own proprietary "OBC"© technology for the efficient collection of landfill gas.

International Sindicatum Climate Change Partnership (ISCCP) (http://www.carbon-financeonline.com/index.cfm?section=lead&action=view&id=12542).
The ISCCP, which is registered in the Cayman Islands, is specifically formed to invest in projects which exploit the newly developing environmental markets, carbon and the CDM being the principle market at present. SCC is 20% owner of the ISCCP. Information on the investment history of the fund, in the form of a monthly newsletter to the investors, is available to the DOE to show how much of the fund has been invested in CDM and carbon related projects to date. Most of this information may be corroborated from SCC's existing portfolio of CDM projects, either registered or under validation.

Xentolar Holdings Limited, which is registered in Cyprus, is a wholly owned subsidiary of ISCCP Investment Platform, Limited.

Xentolar Holdings Ltd ("XHL") and SCC Ltd are non-host Project Participants.

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[3] Note: GRTE is also contracted to transfer the gas and CER rights for an adjacent landfill that is being developed as a CDM project "Bangkok Kamphaeng Saen East Landfill site".

Sub-step 3a: Identify barriers that would prevent the implementation of the proposed CDM project activity

The Investment Barrier

The development of the project activity described in the PDD requires a capital investment of USD 14.3m. This investment is required under LFG1, i.e. the project activity implemented without CDM is - with minor differences for monitoring efforts – the same amount to be invested in the CDM activity. Applying the project without CDM is from an initial perspective an option which is available for the operator of the landfill, Wasaduphan.

Audited financial statements for Wasaduphan in respect of the financial year 2007 (confidential documents provided to the DOE) show that Wasaduphan had insufficient assets to develop such a project. The audited accounts show income and expenditure consistent with the operation of the landfills, but insufficient income or assets to develop a Landfill Gas (“LFG”) to-energy project directly. Furthermore, Wasaduphan would be unable to raise finance to facilitate such a project, as the land on which the landfill is constructed is the most significant asset of the company, and this is not available to be offered as security to raise further funds (confidential documents supporting this have been shown to the DOE).

Considering that the net assets of Wasaduphan are significantly below the total required funding for this project, and that Wasaduphan has no other assets that could be offered as security to raise funds it is clear that they lack sufficient capital to finance the investment in infrastructure and equipment required to construct the landfill gas to energy project described in this PDD. It therefore follows that they would need to source external, unsecured or non-recourse investment to develop this project.

Raising finance for such a project in Thailand is difficult due to several considerations:

1) In Thailand, there are no other projects that are operational and that are similar to the proposed project activity, taking into account a broadly similar technology, similar scale and that take place in a comparable environment with respect to regulatory framework and investment climate. The Journal of the Air and Waste Management Association vol. 58 (2008) page 634[4] states “However, LFG utilization in Thailand is currently at a very infant stage. Only one sanitary landfill where MSW from Bangkok is being deposited and is under the process of examining its gas recovery project”. This is the Kasetsart University research project funded by King Rama IX Chaipattana Foundation. The foundation allocates 1 million baht to support the research project. A small number of other LFG projects are currently being developed under the CDM, including the Bionersis project at Kamphaeng Saen (which is now registered, project number 2514) and the Active Synergy Project, under Validation and also at Kamphaeng Saen.
2) There is a shortage of technology providers because there is no domestic market for such equipment
3) There is a shortage of experienced developers, staff and labour to design, build, operate and manage such a project

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[4] Chiemchaisri, C and Chettiyappan, V: Greenhouse Gas Emission Potential of the Municipal Solid Waste Disposal Sites in Thailand, *J. Air & Waste Manage. Assoc.* **58**:629–635

Under these circumstances, it is not possible for a company such as Wasaduphan, with no experience in LFG capture and power generation, to raise un-secured or non-recourse finance. Potential lenders would not be able to obtain the comfort they would require about the ability of the project to repay an investment, and would therefore not agree to provide financing. Consequently Wasaduphan's only option would be to partner with other organizations which have the necessary expertise and access to finance.

These facts are further supported by the Clean Technology Investment Plan presented by the Government of Thailand at the recent World Banks Clean Technology Fund Trust Fund Committee meeting in December 2009 available at http://siteresources.worldbank.org/INTCC/Resources/thailand_ctf_investment_plan_111209.pdf. In particular, paragraphs 47, 60 and 111 support the conclusions that the renewable energy sector in Thailand faces a number of barriers including finance, technology and know-how.

These facts are presented as objective evidence supporting the conclusion that an investment barrier is the predominant barrier stopping the development of landfill gas to energy projects in Thailand.

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The investment barrier identified above, would not prevent the alternative scenario, LFG2, which is the release of LFG to the atmosphere and refraining from activities at the electricity market. This scenario requires no new equipment, construction, or additional skilled staff for operation, has been implemented already (i.e. is the existing scenario) and consequently requires no investment.

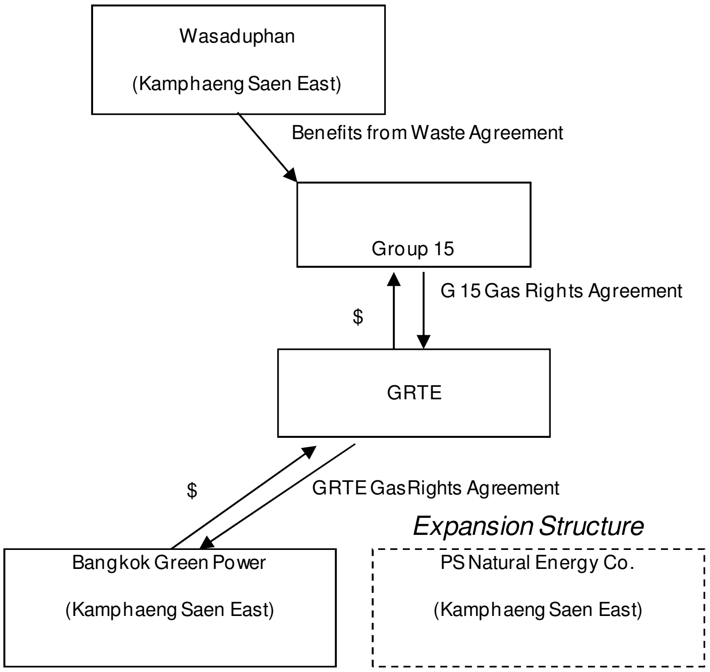
Overcoming the investment barrier

The existence of this investment barrier and the role of CDM in overcoming this barrier are confirmed by:

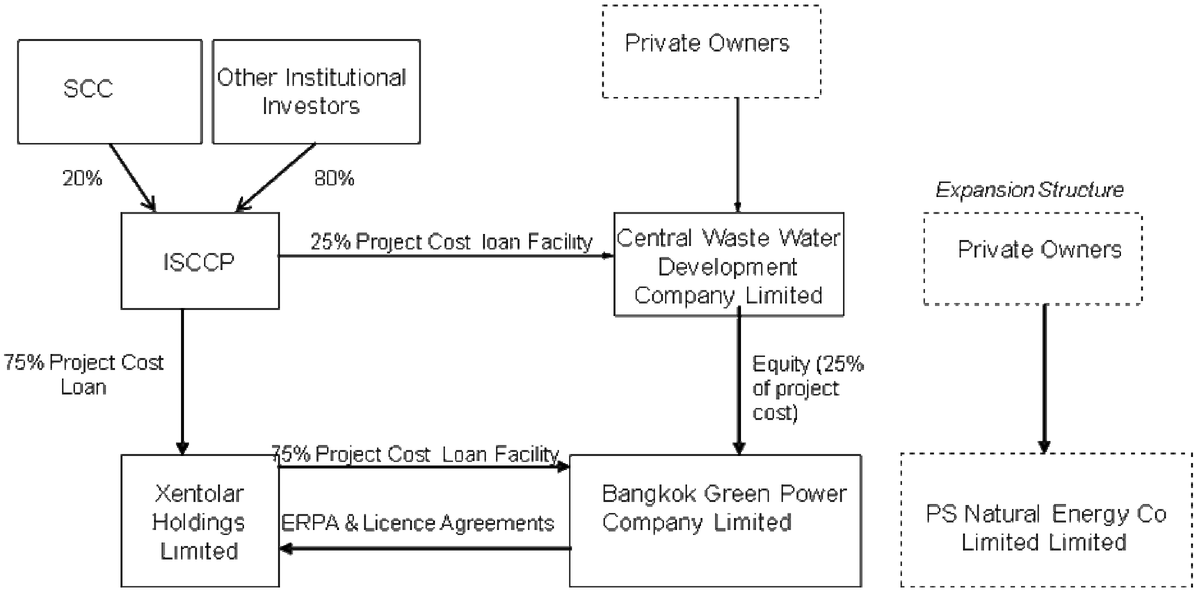
1) Wasaduphan subcontracting the rights to this non-core business to Group 15; and,
2) Group 15's selection of a partner to develop this project and
3) the financing structure which has been developed between the PPs to finance and implement this project activity.

The existence of the barrier required that a structure suitable for the provision of the necessary funds, and, expertise be developed, and also required that the rights necessary to collect and utilise the gas be adequately created and transferred to the Project Developer.

This resulted in the following Gas Rights and Financing structures between the parties identified above:



Chain of gas rights created to Overcome Investment Barrier



Ownership /financing Structure Created to Overcome The Investment Barrier

Group 15 received the Gas Rights from Group 79 who had no wish to involve itself in this non core business. Group 15 in turn, after seeking to identify a CDM developer themselves, contracted the Gas Rights to GRTE who had identified ISCCP as a potential CDM developer and assisted with the structuring of the investment using the Project Companies. All documents supporting the gas and CER rights have been provided to the DOE. The figure above explains the chain of gas rights.

ISCCP, through its wholly owned subsidiary XHL has loaned the project company (Bangkok Green Power Co. Ltd) 75% of the expected project costs (370 Million THB and €0.88 million). The remaining 25% of the project costs (€2.979 Million) have been loaned to the Parent Company ("Central Waste Water Development Company") by ISCCP Investment Platform Ltd.

The loans were divided in this way because, as has been demonstrated in the Investment Barrier, funds for this project had to come from outside Thailand. To repatriate these funds the project required registration with the Board of Investment in Thailand to be able to receive repayments without the deduction of irrecoverable taxation in Thailand. Bangkok Green Power is therefore registered with the Board of Investment (and PS Natural would be). One of the requirements for such registration by the Board of Investment is that only 75% of Bangkok Green Power's funding may be by way of Debt, hence the structure described above was required.

These loans are documented in the Bangkok Green Power Facility Agreement and Central Waste Water Development Company Facility Agreement respectively, were both signed on 24th March 2009, and are available to the DOE. If more gas becomes available , it will result in a additional loans being required to be made available to PS Natural Energy Co. Ltd and its (yet to be incorporated) parent.

ISCCP has experience in the design and implementation of LFG-to-energy projects. ISCCP employs SCC which in turn employs experienced staff and has developed its own proprietary technology for the efficient collection of LFG.

Both loans are repaid by an ERPA (i.e. the loan is repaid through CERs) between XHL and Bangkok Green Power, a copy of which is available to the DOE. In the event of expansion, further loans will be repaid via an ERPA with PS Natural Energy.

Wasaduphan's core business is Waste Disposal so on 8th August 2008 it contracted the rights for any Gas to Group 15 for the purposes of securing a CDM developer. Group 15 in turn, after seeking to identify a CDM developer themselves, contracted the Gas Rights to GRTE who had identified ISCCP as a potential CDM developer and assisted with the structuring of the investment using the Project Companies. All documents supporting the gas and CER rights have been provided to the DOE. The figure above explains the chain of gas rights.

Conclusion

In conclusion, an investment barrier exists in the landfill gas to energy sector in Thailand, which would not prevent the baseline/alternative scenario but would prevent the development and implementation of the project activity without CDM. The financing of the project was assured only due to the benefit of the CDM. This is evidenced by the contractual structure, which relies on CDM for the project to occur and has been drawn up to enable:

a) The rights to gas and CERs to be passed from the original owner to the Project Companies;
b) the lender to lend money for the development of the project by the Project Companies; and
c) the Project Companies to repay the money from the proceeds of the sale of energy and CERs.

These contracts therefore demonstrate that the loan approval by the lender explicitly takes the CDM registration into account. Therefore, both Sub-steps 3a and 3b are satisfied, and the project activity required CDM to overcome the identified barrier.

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

In Thailand, there are no other projects that are operational and that are similar to the proposed project activity, taking into account a broadly similar technology, similar scale and take place in a comparable environment with respect to regulatory framework and investment climate. The Journal of the Air and Waste Management vol. 58 page 634 states "However, LFG utilization in Thailand is currently at a very infant stage. Only one sanitary landfill where MSW from Bangkok is being deposited and is under the process of examining its gas recovery project"[5] which is the Kasetsart University research project funded by King Rama IX Chaipattana Foundation[6]. The foundation allocates 1 million baht to support the research project.

Sub-step 4b. Discuss any similar options that are occurring:

No similar privately financed activities are observed and being carried out in a comparable environment . The Kasetsart University research project to extract, capture and utilize the LFG is funded 1 million Bhat by King Rama IX Chaipattana Foundation. In conclusion similar projects can be developed only through the assistance of donor funding.

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The proposed project activity is therefore additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline scenario

According to methodology ACM0001 Version 11, baseline emissions in year y are calculated as follows:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,,y} * CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y}$$

Where:

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[5] Chiemchaisri, C and Chettiyappan, V: Greenhouse Gas Emission Potential of the Municipal Solid Waste Disposal Sites in Thailand, *J. Air & Waste Manage. Assoc.* **58**:629–635

[6] http://www.phtnet.org/news51/view-news.asp?nID=521 cited in http://www.thairath.co.th/news.php?section=agriculture&content=101801

BE_y = Baseline emission in year y(tCO_2e)

$MD_{project,y}$ = The amount of methane that would have been destroyed/combusted during year y (tCH_4) in project scenario

$MD_{BL,y}$ = The amount of methane that would have been destroyed/combusted during year y in the absence of the project due to regulatory and/or contractual requirement(tCH_4)

GWP_{CH4} = Global Warming Potential value for methane for the first commitment period is 21(tCO_2e/tCH_4)

$EL_{LFG,y}$ = Net quantity of electricity produced using LFG,which in the absence of this project activity would have been produced by power plants connected to the Thailand Grid during year y(MWh)

$CEF_{elec,BL,y}$ = CO_2 emission factor of the Thailand Grid(tCO_2e/MWh)

$ET_{LFG,y}$ = The quantity of thermal energy produced utilizing the landfill gas, which in the absence of project activity would have been produced from onsite/offsite fossil fuel fried boiler, during the year y (TJ)

$CEF_{ther,BL,y}$ = CO_2 emission intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation (t CO_2/TJ)

In this project there will be no thermal energy utilization from LFG: $\mathbf{ET_{LFG,y} = 0}$

Determination of $MD_{BL,y}$

There are no contractual or regulatory requirements that specify LFG to be destroyed. The Thailand legislation governing operation of a landfill is the Public Health Act B.E.2535. It states that local administrative body has the authority to establish its own regulations regarding issuance of the license to operate the landfill. For the Bangkok East project, Tung Bua Sub-district Administrative Organisation, the local administrative in whose area the landfill is located, currently has not set out any specific regulations relating to issuance of the license.

Therefore, the existing practice in Kamphaeng Saen Landfill East of the atmospheric release of LFG through ventilation system would have been continued in the absence of project activity. LFG is assumed to be channeled through simple piping system to avoid gas pressure build up and breaking the retaining wall. Therefore, $MD_{BL,y}$ is assumed as 0% of $MD_{project,y}$.

Determination of $MD_{project,y}$

$MD_{project,y}$ will be determined *ex post* by metering the actual quantity of methane captured and destroyed once the project is operational. The methane would have been destroyed by flaring & fuelled to gas engine to produce electricity only. Thermal & feeding to the natural gas distribution network is not under project scenario.

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y}$$

Where:

$MD_{flared,y}$ = Quantity of methane destroyed by flaring during year y(tCH_4);

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity during year y(tCH_4).

Determination of $MD_{flared,y}$

Methane destruction through flaring shall be measured as follows:

$$MD_{flared,y} = LFG_{flare,y} * \omega_{CH4,y} * D_{CH4} - PE_{flare,y} / GWP_{CH4}$$

Where:

$LFG_{flare,y}$ = Quantity of landfill gas fed to the flare during year y(m^3);

$\omega_{CH4,y}$ = Average methane fraction of the landfill gas as measured during year y and expressed as a fraction (m^3CH_4/m^3LFG);

D_{CH4} = Methane density (tCH_4/m^3CH_4);

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y(tCO_2e), determined following the procedure described in the *"Tool to determine project emissions from flaring gases containing methane"*. The calculation is shown below:

Determination of $MD_{flared,y}$, the density of methane (D_{CH4}) and $LFG_{flare,y}$ are assumed at standard temperature and pressure (0 degree Celsius and 1.013 bar). The density of methane (D_{CH4}) is 0.0007168 tCH_4 /m^3 CH_4 at standard temperature & pressure

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} x (1 - \eta_{flare,h}) x GWP_{CH4} / 1000$$

Where:

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO_2e);

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour h($kgCH_4/h$);

$\eta_{\text{flare, h}}$ = Flare efficiency in hour h(%), IPCC default value 90% is taken;

GWP_{CH4} = Global warming potential of methane valid for the first commitment period(21tCO$_2$e/tCH$_4$).

The calculation for $TM_{RG,h}$ & $\eta_{\text{flare, h}}$ is shown below:

The determination of $\eta_{\text{flare, h}}$

The default value of flare efficiency taken is as follow:

- 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 °C for more than 20 minutes during the hour *h,*
- 50%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour *h,* but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h,*
- 90%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

For the ex-ante estimation of emission reductions the flare efficiency is assumed to be 90%

The determination of $TM_{RG,h}$

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas $(FV_{RG,h})$,the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal and dry or wet basis).

It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas or LFG sent to the flaring system) to the same reference condition that may be dry or wet basis. If the residual gas moisture is significant (temperature greater than 60^0 C), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample gas analysis). Under project scenario, the temperature of the LFG sent to the flaring system will be below 60^{0}C.

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

Variable	SI unit	description
$TM_{RG,h}$	kg/h	Mass flow rate of methane in residual gas in the hour h
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal condition in

		hour h
$fv_{CH4,RG,h}$		Volumetric fraction of methane in the residual gas on dry basis in hour h
$P_{CH4,n}$	kg/m^3	Density of methane at normal condition (0.7168)

Determination of $MD_{electricity,y}$

Methane destruction through electricity generation shall be measured as follows:

$$MD_{electricity,y} = LFG_{electricity,y} * \omega_{CH4,y} * D_{CH4}$$

Where:

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity(tCH_4);

$LFG_{electricity,y}$ = Quantity of landfill gas fed into electricity generator (m^3).

Determination of $MD_{electricity,y}$, the density of methane (D_{CH4}) and $LFG_{electricity,y}$ are assumed at standard temperature and pressure (0 degree Celsius and 1.013 bar). The density of methane (D_{CH4}) is 0.0007168 tCH_4 /m^3 CH_4 at standard temperature & pressure

Project emissions

$PE_y = PE_{EC,y} + PE_{FC,j.y}$

Where:

$PE_{EC,y}$ = Emission from consumption of electricity in project case

$PE_{FC,j.y}$ = Emission from consumption of heat in the project case

Although $PE_{FC,j,y}$ does not normally need to be accounted for as there is no thermal generation by the project activity. In the case where fossil fuel is used in the project activity, CO_2 emission from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, $PE_{FC,j,y}$ is determined using the procedure described in Methodological " Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" Version 02, follows.

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \qquad (9)$$

Where:

$PE_{FC,j,y}$ = Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr);

$FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process *j* during the year *y* (mass or volume unit/yr);

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)

i = Are the fuel types combusted in process *j* during the year *y*

The CO_2 emission coefficient $COEF_{i,y}$ can be calculated using one of the following two Options, depending on the availability of data on the fossil fuel type i, as follows:

Option A: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i, using the following approach:

If *FCi,j,y* is measured in a mass unit: $COEF_{i,y} = w_{C,i,y} \times 44/12$ ***(10)***

If *FCi,j,y* is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$ ***(11)***

Where:

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)

$Wc_{i,y}$ = Is the weighted average net calorific value of the fuel type *i* in year *y* (tC/mass unit of the fuel)

$\rho_{i,y}$ = Is the weighted average density of fuel type i in year y (mass unit/volume unit of the fuel)

i = Are the fuel types combusted in process *j* during the year *y*

Option B: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type *i*, as follows:

$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$ ***(12)***

Where:

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)

$NCV_{i,y}$ = Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit)

$EF_{CO2,i,y}$ = Is the weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)

i = Are the fuel types combusted in process *j* during the year *y*

Project emissions arise from consumption of grid electricity ($PE_{EC,y}$) during periods when there is no on-site generation. $PE_{EC,y}$ is determined using the procedure described in Methodological "Tool to calculate baseline, project and/or leakage emissions from energy consumption" Version 1.

$$PE_{EC,y} = EC_{P,y} \times EF_{EL,y} \times \left(1 + TDL_y\right)$$

Where

$EC_{P,y}$ = Electricity imported from the grid and used in the project in year y (MWh/yr)

$EF_{EL,y}$ = CO_2 emission factor of the Thailand Grid in year y (tCO_2e/MWh)

TDL_y = Average technical transmission and distribution losses for providing electricity to the project in year y (fraction)

$EC_{P,y}$ is estimated by assuming that a power requirement equals to the parasitic losses when power is being generated is replaced by power imported from the grid on 1 day per month in each year.

Leakage

No leakage effects need to be accounted under ACM0001 version 11.

Emission reduction

$ER_y = BE_y - PE_y$

Where:

ER_y = Emission reductions in year y(tCO_2e/yr)

BE_y = Baseline emissions in year y(tCO_2e/yr)

PE_y = Project emissions in year y(tCO_2e/yr)

B.6.2. Data and parameters that are available at validation:

Data/parameter	regulatory requirements to capture and flare landfill gas
Data unit	
Description	regulatory requirements to capture and flare landfill gas
Source of data used	Current version of Thailand government regulation on municipal solid waste and landfill
value applied	*n/a*
Justification of the choice of data or description of measurement method and procedures actually applied	-
Any comment:	The information recorded annually, is used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Changes to regulation will be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$).

Data/parameter	GWP_{CH4}
Data unit	$tCO2e/tCH_4$

Description	Global warming potential of CH4
Source of data used	Decisions under UNFCCC and the Kyoto Protocol
value applied	21
Justification of the choice of data or description of measurement method and procedures actually applied	As per ACM0001 version 11
Any comment:	Shall be updated according to any future COP/MOP decisions

Data/parameter	D_{CH4}
Data unit	tCH_4/m^3CH_4
Description	Methane density
Source of data used	
value applied	0.0007168 tCH_4/m^3CH_4
Justification of the choice of data or description of measurement method and procedures actually applied	As per ACM0001 version 11
Any comment:	At standard temperature and pressure (0^0 C and 1.013 bar)

Data/parameter	$BE_{CH4,SWDS,y}$
Data unit	tCO_2e
Description	Methane generation from the landfill in the absence of the project activity at year *y*
Source of data used	Calculated as per the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04
value applied	As per “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04
Justification of the choice of data or description of measurement method and procedures actually applied	As per “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04
Any comment:	Used for ex ante estimation of the amount of methane that would have been destroyed/combusted during the year

Data/parameter	Φ
Data unit	-
Description	Model correction factor to account for model uncertainties
Source of data used	Oonk et al. (1994)
Value applied	0.9
Justification of the choice of data or description of measurement method and procedures actually applied	As per “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04
Any comment:	Oonk et al. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model result

Data / Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	0.1
Justification of the choice of data or description of measurement method and procedures actually applied	As per “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04
Any comment:	The value applied for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost.

Data / Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data used	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	0.5
Justification of the choice of data or description of measurement method and procedures actually applied	As per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 04
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic condition in SWDS. A default value of 0.5 is recommended by IPCC

Data / Parameter	DOC_f
Data unit	-
Description	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	0.5
Justification of the choice of data or description of measurement method and procedures actually applied	As per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 04
Any comment:	

Data / Parameter	MCF
Data unit	-
Description	Methane correction factor
Source of data used	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	1.0
Justification of the choice of data or description of measurement method and procedures actually applied	As per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 04, Kamphaeng Saen Bangkok landfill has controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and includes the following: (i) cover material; (ii) mechanical compacting; and (iii) levelling of the waste.

Any comment	The value applied for anaerobic managed solid waste disposal sites

<table>
<tr><td>**Data / Parameter**</td><td>DOC_j</td></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon (by weight) in the waste type j</td></tr>
<tr><td>Source of data used</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from volume 5, table 2.4 and 2.5)</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Waste type j</th><th>DOC_j (%wet waste)</th></tr>
<tr><td>Wood & wood product</td><td>43</td></tr>
<tr><td>Pulp, paper & cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverage & tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textile</td><td>24</td></tr>
<tr><td>Garden, yard & park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Justification of the choice of data or description of measurement method and procedures actually applied</td><td>As per “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04</td></tr>
<tr><td>Any comment</td><td></td></tr>
</table>

<table>
<tr><td>**Data / Parameter**</td><td>k_j</td></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data used</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from volume 5, table 3.3)</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th colspan="2">Waste type j</th><th>Tropical (MAT>20^0C) dry (MAP>1000mm)</th></tr>
<tr><td>Slowl y degra</td><td>Pulp, paper, cardboard (other than sludge), textile</td><td>0.07</td></tr>
</table>
</td></tr>
</table>

		Moderately degrading	Other (non-food) organic putrescible garden & park waste	0.17	
		Rapidly degrading	Food, food waste, sewerage sludge, beverage & tobacco	0.40	
Justification of the choice of data or description of measurement method and procedures actually applied	As per “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” Version 04				
Any comment	Climatic condition reference: http://www.tmd.go.th/en/archive/rainfall.php				

Data / Parameter	$CEF_{elec,BL,y}$
Data unit	tCO_2/MWh
Description	Grid emission factor of electricity
Source of data used	Thai grid emission factor calculation
Value applied	0.57420
Justification of the choice of data or description of measurement method and procedures actually applied	As per “Tool to calculate the emission factor for an electricity system” Version 01.1
Any comment:	

B.6.3. Ex-ante calculation of emission reductions:

1. *Ex-ante* estimate of methane destroyed by power generation and flaring

ACM0001 version 11 requires project participants to provide an *ex-ante* estimate of emission reductions, by predicting the future GHG emissions of the landfill. The *ex-ante* estimate of the amount of methane that would have been vented during the year, in tonnes of methane will be calculated according to “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4”. The calculation formula is shown below:

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4}$$

where

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f).GWP_{CH4}. \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot .DOC_{f.} \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j(y-x)} \cdot (1 - e^{-k_j})$$

$MD_{project,y}$ = Methane destroyed by the project during the year y (t CO_2)

$BE_{CH4,SWDS,y}$ = Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e).

φ = Model correction factor to account for model uncertainties (0.9 is used).

f = Fraction of methane captured at SWDS and flared or combusted

GWP_{CH4} = Global Warming Potential of methane, valid for the relevant commitment period

OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste). Clay is used for covering the waste in this project. 0.1 is used

F = Fraction of methane in the SWDS gas (volume fraction). 0.5 is used by this project.

DOC_f = Fraction of degradable organic carbon (DOC) that can decompose. IPCC default value 0.5 is used.

MCF = Methane correction factor. The landfill of this project is an anaerobic managed solid waste disposal site. 1.0 is used

$W_{j,x}$ = Amount of organic waste type j prevented from disposal in the SWDS in the year x (tonnes)

DOC_j = Fraction of degradable organic carbon (by weight) in the waste type j, determined in accordance to “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4”.

k_j = Decay rate for waste type j which will be determined in accordance to “methane emissions avoided from disposal of waste at a solid waste disposal site version 4”.

j = Waste type category

x = Year during the crediting period: x runs from the first year after the start of the operation of the landfill (x=1) to the year y for which avoided emissions are calculated (x=y).

y = Year for which methane emissions are calculated.

The amount of annual waste tipping (Wj,x) for the Kampheng Saen East Landfill is expected to be 320,322 tonnes/year to 755,007 tonnes/year. The landfill is expected to operate for the total 3x7 crediting period. The waste characterization sampling conducted by project participant at 28th of August 2008 shows up to 62.4% of organic matter on wet basis.

Table 5 fraction of waste organic composition

Organic composition of wood	3.0%
Organic composition of paper	4.6%
Organic composition of food	44.2%
Organic composition of textile	6.6%
Organic composition of garden	4.0%

The climate of Bangkok falls into tropical zone, with mean annual temperature (MAT) of >20℃ and >1000 mm of mean annual precipitation (MAP) [7]. Referring to "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", fraction of degradable organic carbon (DOC_j) and decay rate (k_j) for different type of waste are shown in table 6 below.

Table 6 DOC & k value

Waste type j	**DOC_i (% wet)**	**k_j (tropical MAT>20C & MAP>1000mm)**
Wood and wood products	43%	0.035
Pulp, paper and cardboard	40%	0.07
Food waste	15%	0.40
Textile waste	24%	0.07
Garden, yard and park waste	20%	0.17

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[7] http://www.tmd.go.th/en/archive/rainfall.php

Because advanced LFG collection technology will be applied, the fraction of methane captured (f) is assumed 80%**.** The non-continuous monitoring & enclosed flare will apply; therefore the flare efficiency (η) is 90%. Methane captured will be consumed by the generators any excess gas it will be fed to the flare to achieve maximum destruction.

Table 7 Emission reduction by destruction of CH_4 in power generation & flaring

Year	***emission reduction by power generation and flaring (tonne CO_{2e}/year)***
2010	220,997
2011	315,574
2012	326,966
2013	336,025
2014	291,835
2015	218,785
2016	169,855
2017	31,987

2. *Ex ante* CO_2 reduction from electricity exported to the grid

The *ex-ante* estimate of the amount of CO_2 from electricity that would have been exported during the year, in t CO_2/MWh will be done with the following equation:

$$BE_{elec,\,y} = EL_{lfg,y} * CEF_{elec,\,BL,y}$$

$BE_{elec,\,y}$	=	Baseline Emission from electricity that would have been exported during the year, in tCO_2
CEF_{grid}	=	Grid emission factor in tCO_2/MWh (Thai Grid)
$EL_{LFG,y}$	=	Electricity generated by the landfill gas during the year y MWh

The electricity generated by the LFG generator set. Taken 100% load at power output of a 1.063 MW single generator set requires 266 m^3/hour CH_4. The operational hour is 7200 hours/year and the generator set efficiency is 40%. The parameters above are subject to change for *ex post* emission reduction calculation since different selection of generator set might apply. The project will export the electricity produced to the Thai Grid, with the emission factor of 0.57420 ton CO_2/MWh. The figure is calculated according to "Tool to calculate the emission factor for an electricity system" The calculation is described in annex 3.

Table 8 *Ex- ante* CO_2 reduction from electricity exported to the grid

Year	***tCO_2***
2010	25,050
2011	37,542
2012	37,575
2013	37,575
2014	33,400
2015	25,050
2016	20,318
2017	3,131

3. Leakage

No leakage effects need to be accounted under this methodology

4. *Ex-ante* estimate of project emission (PE_y)

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

Where:

$PE_{EC,y}$ = emission from consumption of electricity in the project case (t CO_2/year)
$PE_{FC,y}$ = emission from consumption of heat in the project case (t CO_2/year)

Emissions from the consumption of electricity arise when there is no on-site generation, for example during fault conditions and planned maintenance, and grid power is imported to supply on-site demand. The emissions arising from this consumption are estimated by assuming that the on-site demand is equal to the auxiliary power consumed when the generators are operating and that import occurs for 1 day per month.

Table 9 *ex-ante* project emission from consumption of grid electricity

Year	**Project emission from consumption of grid electricity *(tonne CO_2/year)***

2010	48
2011	72
2012	72
2013	72
2014	64
2015	48
2016	39
2017	6

In cases where grid electricity is also not available and power required for example during connection of new engines, emissions will arise through the use of an emergency diesel generator will be used. This will only be in exceptional circumstances and for a very short period of time. In such a case, the fossil fuel consumption will be monitored according to the monitoring plan in section B.7.1 and calculated according to the equation in B.6.1. This event may only happen for a at most a few days during the whole crediting period and is estimated as 3 days during which additional engines may be added using around 5,000 litres/day of diesel resulting in the following ex-ante estimate.

Year	**Project emission from diesel consumption of onsite generator** ***(tonne CO_2/year)***
2010	0
2011	0
2012	14
2013	14
2014	14
2015	0
2016	0
2017	0

Since the project does not consume any heat, there will be no emission from heat consumption in the project case.

5. *Ex-ante* estimate of baseline methane destruction ($MD_{BL,y}$)

As the atmospheric release of LFG would have been continued in the absence of project, $MD_{BL,y}$ = 0% x $MD_{project,y}$ = 0

6. *Ex ante* estimate of emission reduction

Emission reduction is calculated as follows:

$$ER_y = BE_y - PE_y - L$$

Where:

ER_y = Emission reduction in year y (t CO_2/year)

BE_y = Baseline emission in year y (t CO_2/year)

PE_y = Project emission in year y (t CO_2/year)

L = Project leakage in year y (t CO_2/year)

Since *L* are determined as 0 (zero) due to the explanation above, therefore:

$$ER_y = BE_y - PE_y$$

Where:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP + BE_{elec,y}$$

and

$$MD_{BL,y} = 0\% \text{ x } MD_{project,y}$$

B.6.4 Summary of the ex-ante estimation of emission reductions:

year	Estimate of project activity emissions (tonnes of CO_2e)	Estimate of baseline emissions (tonnes of CO_2e)	Estimate of leakage (tonnes of CO_2e)	Estimate of overall emission reductions (tonnes of CO_2e)
2010	48	220,997	0	220,949
2011	72	315,574	0	315,502
2012	86	326,966	0	326,881
2013	86	336,025	0	335,940
2014	77	291,835	0	291,757
2015	48	218,785	0	218,737

2016	39	169,855	0	169,816
2017	6	31,987	0	31,981
Total (tonnes of CO_2e)	460	1,912,024	0	1,911,564

Renewable crediting period (7 years x 3) is adopted by the Project. It is expected that the project activities will generate total emission reductions of 273,081 tCO_2e per year over the first 7-year crediting period from 1 April 2010 to 31 March 2017.

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$LFG_{total,y}$
Data unit:	m^3
Description:	Total amount of landfill gas captured at Normal Temperature and Pressure
Source of data to be used:	Flow meter readings
Value of data applied for the purpose of calculating emission reduction in section B.5:	Year | $LFG_{total,y}$ 2010 | 13,182,851 2011 | 18,603,462 2012 | 19,440,072 2013 | 20,108,534 2014 | 17,368,459 2015 | 13,019,655 2016 | 9,999,236 2017 | 1,969,807 Values are based on the quantity of gas predicted using the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 04 and assuming that the fraction of landfill gas captured and destroyed by flaring and combustion is 0.8.
Description of measurement methods and procedures to be applied:	Measured by a flow meter. The same basis (dry or wet) is considered for this measurement and the measurement of the methane fraction in landfill gas ($\omega_{CH4,y}$). Data to be aggregated monthly and yearly. Monitoring frequency is continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions). The flow reading meter is mounted at LFG pipe work between the gas treatment package and the generator sets / flares
QA/QC procedures to be applied:	Data will be backed up and archived, where it will be stored for the longer of two years longer than the crediting period or two years after the last issuance of CERs. Flow meters will be calibrated according to the manufacturer's specifications. Calibrations will be carried out by the manufacturer or a suitably qualified external company. Calibration and maintenance records will be retained. On site staff will receive training in CDM monitoring and the maintenance requirements of the flow meters.
Any comment:	The sum of the LFG quantities fed to the flare and the power plant would be compared hourly with the LFG_{total}. The least value would be used for calculation of $MD_{Project,y}$. . The proposed flow meter for LFG monitoring will work on the differential pressure measurement principle with associated differential pressure gauge having an accuracy of ± 0.5%

Data / Parameter:	$LFG_{flare,y}$
Data unit:	m^3
Description:	Amount of landfill gas flared at Normal Temperature and Pressure
Source of data to be used:	Flow meter on the inlet to each flare
Value of data applied for the purpose of calculating emission reduction in section B.5:	Year — $LFG_{flare,y}$ 2010 — 1,691,651 2011 — 1,381,685 2012 — 2,203,272 2013 — 2,871,734 2014 — 2,046,859 2015 — 1,528,455 2016 — 678,596 2017 — 533,407 Values are based on the assumption that gas that is collected is sent either to the installed gas engines or to the flare with priority given to the gas engines.
Description of measurement methods and procedures to be applied:	Measured by a flow meter. The same basis (dry or wet) is considered for this measurement and the measurement of the methane fraction in landfill gas ($\omega_{CH4,y}$). Data to be aggregated monthly and yearly. Monitoring frequency is continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions)
QA/QC procedures to be applied:	Data will be backed up and archived, where it will be stored for the longer of two years longer than the crediting period or two years after the last issuance of CERs. Flow meters will be calibrated according to the manufacturer's specifications. Calibrations will be carried out by the manufacturer or a suitably qualified external company. Calibration and maintenance records will be retained. On site staff will receive training in CDM monitoring and the maintenance requirements of the flow meters.
Any comment:	Total flow to the flares will be checked by mass balance calculation with total LFG flow and generator consumption. The least value would be used for calculation. . The proposed flow meter for LFG monitoring will work on the differential pressure measurement principle with associated differential pressure gauge having an accuracy of ± 0.5%

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	m^3
Description:	Amount of landfill gas combusted in power plant at Normal Temperature and Pressure
Source of data to be used:	Flow meter on the inlet to each generator

<table>
<tr><td>Value of data applied for the purpose of calculating emission reduction in section B.5:</td><td><table><tr><th>Year</th><th>$LFG_{electricity,y}$</th></tr><tr><td>2010</td><td>11,491,200</td></tr><tr><td>2011</td><td>17,221,776</td></tr><tr><td>2012</td><td>17,236,800</td></tr><tr><td>2013</td><td>17,236,800</td></tr><tr><td>2014</td><td>15,321,600</td></tr><tr><td>2015</td><td>11,491,200</td></tr><tr><td>2016</td><td>9,320,640</td></tr><tr><td>2017</td><td>1,436,400</td></tr></table>Values are based on the assumption that gas that is collected is sent either to the installed gas engines or to the flare with priority given to the gas engines.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Measured by a flow meter. The same basis (dry or wet) is considered for this measurement and the measurement of the methane fraction in landfill gas ($\omega_{CH4,y}$). Data to be aggregated monthly and yearly.
Monitoring frequency is continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions)</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>Data will be backed up and archived, where it will be stored for the longer of two years longer than the crediting period or two years after the last issuance of CERs.
Flow meters will be calibrated according to the manufacturer’s specifications. Calibration and maintenance records will be retained.
On site staff will receive training in CDM monitoring and the maintenance requirements of the flow meters.</td></tr>
<tr><td>Any comment:</td><td>Total flow to the generators will be checked by mass balance calculation with total LFG flow and flare consumption. The least value would be used for calculation. . The proposed flow meter for LFG monitoring will work on the differential pressure measurement principle with associated differential pressure gauge having an accuracy of ± 0.5%</td></tr>
</table>

<table>
<tr><td>**Data / Parameter:**</td><td>$PE_{flare,y}$</td></tr>
<tr><td>Data unit:</td><td>tCO_{2e}</td></tr>
<tr><td>Description:</td><td>Project emissions from flaring of the residual gas stream in year y</td></tr>
<tr><td>Source of data to be used:</td><td>As per the “Tool to determine project emissions from flaring gases containing Methane”</td></tr>
<tr><td>Value of data applied for the purpose of calculating emission reduction in section B.5:</td><td><table><tr><th>Year</th><th>$PE_{flare,y}$</th></tr><tr><td>2010</td><td>2,547</td></tr><tr><td>2011</td><td>2,080</td></tr><tr><td>2012</td><td>3,317</td></tr><tr><td>2013</td><td>4,324</td></tr><tr><td>2014</td><td>3,082</td></tr><tr><td>2015</td><td>2,301</td></tr><tr><td>2016</td><td>1,022</td></tr><tr><td>2017</td><td>803</td></tr></table></td></tr>
</table>

Description of measurement methods and procedures to be applied:	As per the "Tool to determine project emissions from flaring gases containing Methane"
QA/QC procedures to be applied:	As per the "Tool to determine project emissions from flaring gases containing methane"
Any comment:	Regular maintenance should ensure optimal operation of flares. The enclosed flare shall be operated and maintained as per the specifications prescribed by the manufacturer

Data / Parameter:	$\omega_{CH4,y}$
Data unit:	m^3CH_4 /m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Measured by gas quality analyzer
Value of data applied for the purpose of calculating emission reduction in section B.5:	0.5
Description of measurement methods and procedures to be applied:	Methane concentration will be measured continuously (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions) by certified instrumentation mounted in the LFG pipe work between the LFG treatment package and the generator sets/flares. The same basis (dry or wet) is considered for this measurement and the measurement of the LFG flow. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Data will be backed up and archived where it will be stored for the longer of two years longer than the crediting period or two years after the last issuance of CERs. Analysers will be calibrated according to the manufacturer's specifications & subject to a regular maintenance in accordance to manufacturer's recommendation
Any comment:	

Data / Parameter:	*T*
Data unit:	°C
Description:	Temperature of the landfill gas
Source of data to be used:	Measured by temperature probe in LFG pipe work between the gas treatment package and the generator sets / flares.
Value of data applied for the purpose of calculating emission reduction in section B.5:	0°C
Description of measurement methods and procedures to be applied:	Measured continuously to determine the density of CH_4 (D_{CH4}). No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in

	normalised cubic meters (Nm3)
QA/QC procedures to be applied:	Data will be backed up and archived where it will be stored for the longer of two years longer than the crediting period or two years after the last issuance of CERs. Measuring instruments will subject to a regular maintenance and testing regime in accordance in accordance with manufacturers' recommendations..
Any comment:	

Data / Parameter:	*P*
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be used:	transmitter mounted in the LFG pipe work between the gas treatment package and the generator sets / flares.
Value of data applied for the purpose of calculating emission reduction in section B.5:	101,300 Pa
Description of measurement methods and procedures to be applied:	Measured continuously to determine the density of CH_4 (D_{CH4}). No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalised cubic meters (Nm3).
QA/QC procedures to be applied:	The pressure transmitter will be calibrated according to manufacturers' instructions and the data will be recorded and archived for two years after the end of the crediting period or two years after the last issuance of CERs. The measuring instrument is a subject of regular maintenance in accordance to the manufacturer's specification.
Any comment:	

<table>
<tr><th>Data / Parameter:</th><th>EL_{LFG}</th></tr>
<tr><td>Data unit:</td><td>MWh</td></tr>
<tr><td>Description:</td><td>Net quantity of electricity produced / exported using LFG.</td></tr>
<tr><td>Source of data to be used:</td><td>Electricity meter</td></tr>
<tr><td>Value of data applied for the purpose of calculating emission reduction in section B.5:</td><td><table><tr><th>Year</th><th>EL_{LFG}</th></tr><tr><td>2010</td><td>45,922</td></tr><tr><td>2011</td><td>68,822</td></tr><tr><td>2012</td><td>68,882</td></tr><tr><td>2013</td><td>68,882</td></tr><tr><td>2014</td><td>61,229</td></tr><tr><td>2015</td><td>45,922</td></tr><tr><td>2016</td><td>37,248</td></tr><tr><td>2017</td><td>5,740</td></tr></table>
Values are based on the assumed quantity of gas destroyed in the gas engines</td></tr>
</table>

	and the generator performance specified by the manufacturer together with an assumed 5% parasitic loss.
Description of measurement methods and procedures to be applied:	Continuously measured by electricity meter on sub-station connecting system to the grid
QA/QC procedures to be applied:	The electricity meters will meet the relevant Thailand standards for fiscal calibration purposes. They will be maintained and calibrated according to manufacturer's instructions or the relevant regulations. Data will be archived for 2 years after the crediting period or two years after the last issuance of CERs. The data can be corroborated against financial data from the export of power to the grid.
Any comment:	The specification of electricity meter is to be determined by the power grid company at the time of grid connection

Data / Parameter:	EL_{import}
Data unit:	MWh
Description:	Net amount of electricity imported from the grid for auxiliary use
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating emission reduction in section B.5:	Year | EL_{LFG} 2010 | 75 2011 | 113 2012 | 113 2013 | 113 2014 | 101 2015 | 75 2016 | 61 2017 | 9 Values are based on the assumptions that a) the power requirement for internal project uses during complete shutdowns is equal to the parasitic losses during normal operation; b) complete shutdowns occur for 1 day per month (12 days per year). assumed 5% parasitic loss; and c) power for internal project uses during complete shutdowns is obtained from the grid..
Description of measurement methods and procedures to be applied:	Continuously measured by electricity meter on sub-station connecting system to the grid
QA/QC procedures to be applied:	The electricity meters will meet the relevant Thailand standards for fiscal calibration purposes. They will be maintained and calibrated according to manufacturer's instructions or the relevant regulations. Data will be archived for 2 years after the crediting period or two years after the last issuance of CERs. The data can be corroborated against financial data from the import of power to the grid.
Any comment:	The specification of electricity meter is to be determined by the power grid company at the time of grid connection

Data / Parameter:	Operation of the energy plant
Data unit:	Hours
Description:	Operation of the energy plant
Source of data to be used:	Measured with an individual run meter connected to each generator set
Value of data applied for the purpose of calculating emission reduction in section B.5:	7200 hours/year/generator set
Description of measurement methods and procedures to be applied:	Data will be measured by the project developer. Data is monitored annually to ensure methane destruction is claimed for methane used in electricity plant when it is operational
QA/QC procedures to be applied:	The run meter will be calibrated according to the manufacturer's specifications & subject to a regular maintenance in accordance to manufacturer's recommendation
Any comment	

Data / Parameter:	Regulatory requirements relating to landfill gas projects
Data unit:	
Description:	Regulatory requirements relating to landfill gas projects may effect the value of AF or $MD_{reg,y}$
Source of data to be used:	National legislation and mandatory regulations
Value of data applied for the purpose of calculating emission reduction in section B.5:	N/A
Description of measurement methods and procedures to be applied:	Although the methodology only requires recording at the renewal of the crediting period, the information related to all relevant policies and circumstances will be collected and recorded annually. Information will be kept during crediting period and two years after.
QA/QC procedures to be applied:	
Any comment:	The information, though recorded annually, is used for changes in the adjustment factor (AF)

The following variables are required to determine flare efficiency using the tool to determine project emission from flaring gases containing methane. For *ex-ante* estimates, fixed flare efficiency is assumed, so estimates of following data are not required.

$PE_{flare,y}$ (Project Emissions from flaring the residual gas stream in the year y) need to be calculated from the following parameters that will be monitored, according to “Tool to determine project emissions from flaring gases containing methane”

Data / Parameter:	$FV_{RG,h}$
Data unit:	m^3/h
Description:	volumetric flow rate of the residual gas in dry basis (or wet basis if the temperature is below 60^0C) at normal conditions in the hour h
Source of data to be used:	On-site measurement using a flow meter.
Value of data applied for the purpose of calculating emission reduction in section B.5:	N/A
Description of measurement methods and procedures to be applied:	The same basis (dry or wet) is considered for this measurement and the measurement of the volumetric fraction of CH_4 in residual gas ($fv_{CH4,RG,h,}$) when the residual gas temperature exceeds 60^0C It will be measured continuously. This parameter and volumetric fraction of CH_4 in residual gas ($fv_{CH4,RG,h,}$) may be measured under wet conditions if the temperature is below 60^0C (see. AM_CLA_0092 and CLA_TOOL_0003). Values to be averaged hourly or at a shorter time interval. The flow meter is mounted in the LFG pipe work between the gas treatment package and the generator sets / flares.
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation.
Any comment:	

Data / Parameter:	$fv_{CH4,RG,h,}$
Data unit:	-
Description:	Volumetric fraction of CH_4 in the residual gas on dry basis (or wet basis if the temperature is below 60^0C) in the hour *h*
Source of data to be used:	Measurements by project participants using a continuous gas analyzer
Value of data applied for the purpose of calculating emission reduction in section B.5:	N/A
Description of measurement methods and procedures to be applied:	The same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60^0C. This parameter and volumetric flow rate of residual gas ($FV_{RG,h}$) may be measured under wet conditions if the temperature is below 60^0C (see. AM_CLA_0092 and CLA_TOOL_0003). It will be measured continuously. Values to be averaged hourly or at a shorter time interval. The gas analyzer is mounted in the LFG pipe work between the gas treatment package and the generator sets / flares.
QA/QC procedures to be applied:	Analyzers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be

	performed by comparison with a standard certified gas.
Any comment:	As simplified approach, methane content is the only measurement and consider the remaining part as N_2

Data / Parameter:	T_{flare}
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating emission reduction in section B.5:	N/A
Description of measurement methods and procedures to be applied:	Continuous measurement will be performed at the exhaust gas stream in the flare. A temperature above 500 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated according to the manufacturer's specifications & subject to a regular maintenance in accordance to manufacturer's recommendation
Any comment:	An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.

$PE_{EC,y}$ (Project Emission from consumption of grid electricity during period when there is no on-site generation) is determined using the procedure described in Methodological "Tool to calculate baseline, project and/or leakage emissions from energy consumption" Version 1. The following parameter is required to monitor according to the tool.

Data / Parameter:	$TDL_{j,y}$
Data unit:	--
Description:	Average technical transmission and distribution losses for providing electricity to source *j*
Source of data to be used:	Electricity Annual Report by DEDE Department Ministry of Energy, Thailand
Value of data applied for the purpose of calculating emission reduction in section B.5:	10.36%
Description of measurement methods and procedures to be applied:	The monitoring will be performed annually. Most recent, accurate and reliable data available within the host country which will be applied.
QA/QC procedures to be applied:	
Any comment:	In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years

Data / Parameter:	$EC_{PJ,j,y}$
Data unit:	MWh
Description:	Net amount of grid electricity consumed by the project in year y
Source of data to be used:	Measurement on electricity meter
Value of data applied for the purpose of calculating emission reduction in section B.5:	Year | EL_{LFG} 2010 | 75 2011 | 113 2012 | 113 2013 | 113 2014 | 101 2015 | 75 2016 | 61 2017 | 9 Values are based on the assumptions that a) the power requirement for internal project uses during complete shutdowns is equal to the parasitic losses during normal operation; b) complete shutdowns occur for 1 day per month (12 days per year). assumed 5% parasitic loss; and c) power for internal project uses during complete shutdowns is obtained from the grid.
Description of measurement methods and procedures to be applied:	Continuously monitored by electricity meter mounted at LFG treatment package
QA/QC procedures to be applied:	The electricity meters will meet the relevant Thailand standards for fiscal calibration purposes. They will be maintained and calibrated according to manufacturer's instructions or the relevant regulations. Data will be archived for 2 years after the crediting period or two years after the last issuance of CERs. The data can be corroborated against financial data from the import of power to the grid.
Any comment:	

$PE_{FC,j,y}$ (Project Emission from consumption of fossil fuel during the period when emergency or temporary) is determined using the procedure described in Methodological " Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" Version 02, The following parameter is required to monitor according to the tool.

Data / Parameter:	$FC_{i,j,y}$
Data unit:	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description:	Quantity of fuel type i combusted in process j during the year y
Source of data to be used:	Onsite measurements by project participants
Value of data applied for the purpose of calculating	5,000 litres per day (once in 2012, 2013, and 2014)

emission reduction in section B.6:	
Description of measurement methods and procedures to be applied:	In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed. It will have a book or record sheet of control for fuel consumed recording (on a daily basis or per shift).
Monitoring frequency	Continuously
QA/QC procedures to be applied:	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$w_{C,i,y}$</td></tr>
<tr><td>Data unit:</td><td>tC/mass unit of the fuel</td></tr>
<tr><td>Description:</td><td>Weighted average mass fraction of carbon in fuel type i in year y</td></tr>
<tr><td>Source of data to be used:</td><td>The following data sources may be used if the relevant condition apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data sources</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Value of data applied for the purpose of calculating emission reduction in section B.6:</td><td>N/A as Option A not used for the purpose of calculating emission reduction in section B.6</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>The mass fraction of carbon should be obtained for each fuel delivery from which average annual values should be calculated</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>Verify if the values under a) and b) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in b) should have ISO17025 accreditation or justify that they can comply with similar quality standards.</td></tr>
<tr><td>Any comment:</td><td>Applicable where Option A is used</td></tr>
</table>

Data / Parameter:	$\rho_{i,y}$
Data unit:	Mass unit/volume unit
Description:	Weighted average density of fuel type i in year y
Source of data to be used:	The following data sources may be used if the relevant conditions apply:

<table>
<tr><td></td><td>
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoice</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available</td></tr>
</table>
</td></tr>
<tr><td>Value of data applied for the purpose of calculating emission reduction in section B.6:</td><td>N/A as Option A not used for the purpose of calculating emission reduction in section B.6, see $FC_{i,j,y}$</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>The density of the fuel should be obtained for each delivery, from which weighted average annual values should be calculated</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td></td></tr>
<tr><td>Any comment:</td><td>Applicable where Option A is used and where $FC_{i.j.y}$ is measured in a volume unit. Preferably the same data source should be used for $w_{C,i,y}$ and $\rho_{i,y}$.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{i,y}$</td></tr>
<tr><td>Data unit:</td><td>GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)</td></tr>
<tr><td>Description:</td><td>Weighted average net calorific value of fuel type i in year y</td></tr>
<tr><td>Source of data to be used:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoice</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A)</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainly at a 95% confidence interval as</td><td>If a) is not available</td></tr>
</table>
</td></tr>
</table>

	provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG inventories
Value of data applied for the purpose of calculating emission reduction in section B.6:	0.03642 GJ/litre (Reference to Summary Report – the Study of Emission factor for an electricity generation of Thailand in Year 2010.
Description of measurement methods and procedures to be applied:	For a) and b): Measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	For a) and b): The NCV should be obtained for each delivery, from which weighted average annual values should be calculated For c): Review appropriateness of the values annually For d): Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures to be applied:	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standard
Any comment:	Applicable where Option B is used

Data / Parameter:	$EF_{CO2,i,y}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of fuel type i in year *y*
Source of data to be used:	The following data sources may be used if the relevant conditions apply:

Data source	Conditions for using the data source
a) Values provided by the fuel supplier in invoice	This is the preferred source
b) Measurements by the project participants	If a) is not available
c) Regional or national default values	If a) is not available
d) IPCC default values at the upper limit of the uncertainly at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on	If a) is not available

	National GHG inventories
Value of data applied for the purpose of calculating emission reduction in section B.6:	0.07480 tCO_2/GJ Refer to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 by Intergovernmental Panel on Climate Change.
Description of measurement methods and procedures to be applied:	For a) and b): Measurements should be undertaken in line with national or international fuel standards
QA/QC procedures to be applied:	Applicable where option B is used. For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, Options b), c) or d) should be used.
Any comment:	

B.7.2. Description of the monitoring plan:

A monitoring plan will be implemented to ensure that the approved monitoring methodology is correctly implemented in order to enable the accurate and transparent determination of avoided emissions. The plan will incorporate the QA/QC procedures described in 7.1 above. Since the proposed project involves flaring and electricity generation, referring to ACM0001 version 11, the monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed in the flare(s) and the electricity generating unit(s) to determine the quantities as shown in Figure 2. The monitoring plan provides for continuous measurement of the quantity and quality of LFG. The main variables determined are the quantity of methane actually captured MDproject,y, quantity of methane flared ($MD_{flared,y}$), the quantity of methane used to generate electricity ($MD_{electricity,y}$) and the quantity of methane generated ($MD_{total,y}$). The methodology also measures the energy generated by use of LFG ($EL_{LFG,y}$).

The schematic monitoring system is shown in Figure 5 below.

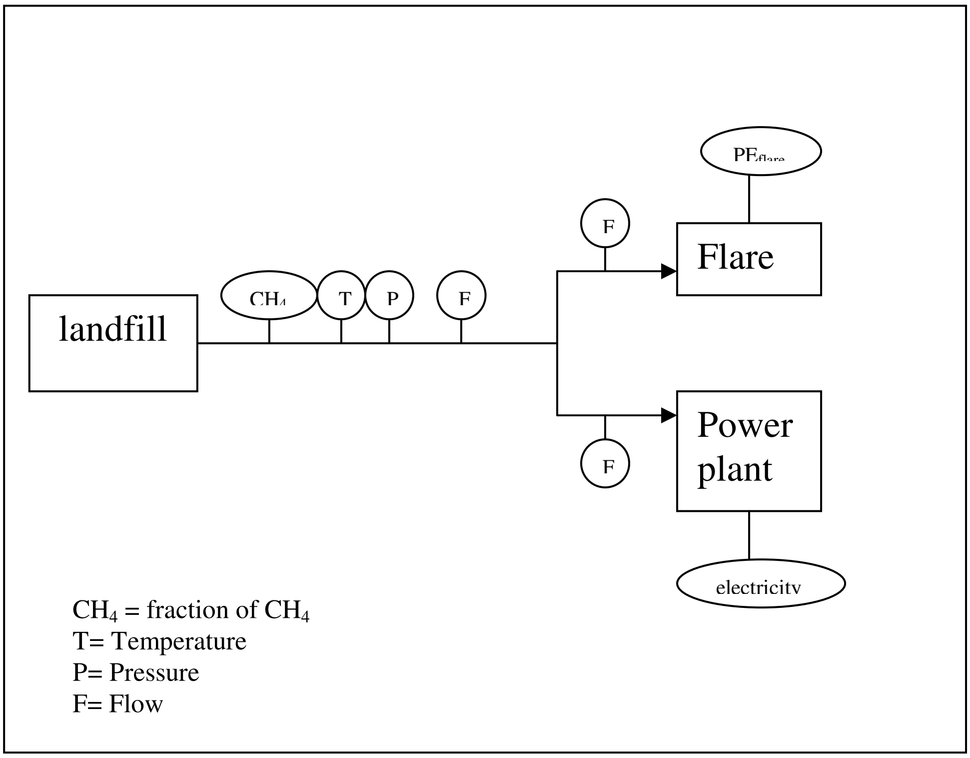


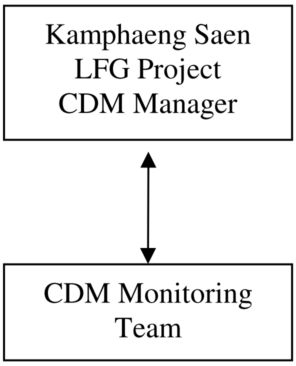
Figure 4 Schematic of monitoring system

Parameters to be monitored

The variables to be monitored were all listed and described in Section B.7.1.

Management structure for the implementation of monitoring plan

A specific CDM department will be established by the project owner and a CDM manager will be appointed to oversee that activities are carried out according to the monitoring plan. The organizational structure for the CDM department is shown below.



Responsibility and CDM management: A CDM manager will be appointed at the landfill with responsibility for monitoring all project related activities and organising training. Competency requirements for the all positions will be defined and applied.

All calculations will be checked and signed off by the CDM manager who will also be responsible for preparing and checking documents required for verification.

A CDM monitoring team (reporting to the CDM manager) will have day to day responsibilities for checking instrumentation, record keeping, data handling and data processing, filing, reporting, organising repair and maintenance of monitoring equipment and ensuring the monitoring plan is adhered to as indicated in the approved PDD. The monitoring staff will receive technical training and refresher training as well as safety training to minimise exposure to workplace hazards.
A management level link will be established to ensure effective co-operation between landfill staff and CDM monitoring staff.

All relevant information, notes of meetings, data files, maintenance records, defect reports, hard copy and computerised records of monitoring will be kept at a designated location and arranged in an orderly and transparent manner to facilitate audit as and when required.

Responsibilities, procedures, methods, equipment types and specifications are described in detail in a site-specific CDM monitoring manual.

Data collection and management

- On-line monitoring

All key meters required to determine GHG emissions and emission reductions will be monitored from a central control point which will record meter readings at a pre-determined interval as specified in the CDM monitoring manual. These data will be used to continually update total emission reductions as long as the generating plants are in operation.

- Manual data recording system

The CDM Manager will implement a manual data recording system to act as a back-up for the on-line monitoring system. This will involve completion of a log sheet that records flow meter readings. Spot readings of other values (methane concentration, temperature and pressure) will also be recorded periodically and at the times when flow meter readings are taken.

- Regulatory requirements related to landfill gas projects

Although the methodology only requires recording at the renewal of the crediting period, the information related to all relevant policies and circumstances will be collected and recorded annually. Information will be kept during crediting period and two years after.

- Data archiving

The on-line monitoring system will automatically and periodically (eg. weekly) archive data in a safe manner. Electronic documents will be saved for backup, with written documents and back-ups safely kept. Calibration data should be saved electronically. All information related to monitoring such as meeting minutes, data documents, maintenance records, accident reports, hard copies as well as computer records, should be kept in order at designated locations to ensure examination process transparent and highly effective. These data will be stored until 2 years after the end of the crediting period.

Maintenance and calibration of meters

All meters will be purchased and maintained as specified in the CDM monitoring manual according to manufacturer specifications. All key meters will be subject to a quality control regime that will include regular maintenance and calibration. Calibrations will be carried out by the manufacturer or a suitably qualified external company. A record will be maintained showing the location and unique identification number of each meter, the calibration status of that meter (when last calibrated, when next due for calibration) and who performs the calibration service. Calibration certificates will be retained for all meters until two years after the end of the crediting period.

Mass flow of methane supplied to the engines will be corroborated by comparison with the sum of the gross engine power outputs, the relationship being a function of engine efficiency which can be considered a constant under the proposed maintenance regime.

Treatment of missing or corrupted data

When data in the on-line system are corrupted or missing whilst the generators are operating (as shown, for example, by electricity output) the missing data can be estimated by taking the lower value of the parameter one hour before the error and one hour after the system restart. If there is evidence that neither of these values is representative, use the average value of the parameter from the previous 24 hours.

The error will be recorded in the log sheet and the occurrence of the error will be investigated and rectified as soon as possible. If the on-line system is compromised for more than 24 hours, data will be manually recorded. Manually recorded data table will be backup data for methane destruction amount and other key parameters. Any deficiencies in methane flow monitoring data will be rectified by calculation from power generation data.

Non essential data

The on-line monitoring system will also record "non-essential" data. Such data is termed non-essential because it is not directly listed in the CDM Monitoring Methodology, but it will constitute a means of corroborating the on-line system. Non-essential data may include measurements of net and gross output from individual generators, certificated conversion efficiency, waste deposition and any other data considered relevant to the project activity.

Document Control

The CDM Manager will implement a document control system that ensures that the current versions of necessary documents are available at the point of use.

Preparation of monitoring report

A monitoring report will be prepared by CDM department at periodic intervals (at least once per year). The monitoring report will serve as basis for verification by a DOE. The content of the monitoring report should include as minimum information concerning the project activity, monitoring data, calculation of emission reductions and records on maintenance and calibration of monitoring meters.

Audit function and management review

The CDM Manager will arrange for an independent internal audit of the management system periodically and at least once per year. The auditor will not be involved in the daily operation of the landfill and if necessary, may be sourced from a third party. The auditor will assess the implementation of the monitoring procedure and the preparation of the monitoring report. Audit findings, and steps taken to address findings will be recorded and reviewed in a Management Review meeting (convened at least annually) at which time the effectiveness of these procedures will be reviewed and necessary changes implemented.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

The application of the baseline study and monitoring methodology of the project was completed on 16/01/2010. The contact person shall be Mr. Gareth Phillips, Chief Climate Change Officer, Sindicatum Carbon Capital: gareth.phillips@carbon-capital.com

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

30/03/2009 based on the bank transfer for gas rights payment

C.1.2. Expected operational lifetime of the project activity:

21 years

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

10/04/2010 or date of registration, whichever is later

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The analysis of the project’s environmental impacts has been performed. Following the host country regulation, the Initial Environmental Examination (IEE) is required for the specific electricity project with the capacity less than 10 MW. The processes that have been performed to conduct IEE are as follows:

1. Investigation of the study area
2. Characterization of the environmental aspects.
3. Identification of the environmental principal change
4. Evaluation and prediction of short and long term impacts
5. Recommendation of short and long term mitigation measures

The project has been analyzed based on 13 (thirteen) aspects for both construction and operation phase, as follows

1. Topography/geology
2. Air quality
3. Noise
4. Hydrology

5. Water Quality
6. Aquatic Ecology
7. Terrestrial Ecology
8. Land Use
9. Transportation
10. Public Utilities
11. Socio-Economic
12. Public Health & Safety
13. Cultural, Heritage, Aesthetic and Tourism

There are no significant impacts identified for all the environmental aspects mentioned above. Low impact may occur from noise during the construction phase. At the working area where there is high level of noise source, such as at the genset house, health and safety equipment is strictly required to be used by operators. The impact on air quality is also considered insignificant but a monitoring program will confirm the compliance with the host country regulation on air quality[8]. To some extend, local workers will be hired and community development will be established in order to contribute positively on socioeconomic life of the local communities. Safety & Public Health regulation will be strictly applied to mitigate the low impact of construction stage.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Following the host country regulation, the Initial Environmental Examination (IEE) has been carried ou. The conclusions are summarised in Section D.1, above.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

A public consultation event was held on December 19th, 2008 at Sub district Administration Organization: Tungbua, Kampheang Sean district, close to the project site. The event was organized by Bangkok Green Power Co., Ltd; PS Natural Energy Co., Ltd and Xentolar Holdings Limited (SCC).

<u>AIMS OF THE EVENT</u>

To allow the stakeholders to express their concerns regarding the project.

<u>Invitation process and compilation of comments.</u>

The invitation was distributed by project participants. The invitation is distributed to all relevant stakeholders that were identified as representatives of the government, local officials, NGOs, academic institutions, members of the local community living in the project area and others. Public announcement in Thai was advertised in the local newspaper named Ban Muang Biweekly year 7 number 95 .

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[8] Ministry of National Resources and Environment, Pollution Control Department
http://www.pcd.go.th/info_serv/en_reg_std_airsnd.html

There are 118 stakeholders who attended the consultation. Project participants described the project in a manner that allows the stakeholder to understand. A special animation of project description was presented for this purpose. During the event, the attendees were given the opportunity to raise their concern by filling up the questionnaire. Opportunity to raise their concern orally was given during question and answer session. In conjunction with the compilation of the oral comments, the result of questionnaire was also compiled. Both are available in section E.2 below.

Figure 5 stakeholder consultation event

E.2. Summary of the comments received:

During stakeholder consultation, detailed information about the project and its benefits were presented. The event provided a forum for all stakeholders to raise questions, concern and any other issues related to the project including sharing opinions. The landfill and brief of existing wastewater treatment, was presented by the project engineer. Xentolar Holdings Limited presented the CDM aspect of the project. The technology supplier presented the landfill collecting gas system and gas engine technology**.** The advantages and key features of the technology employed at Kampheang Saen to collect & utilize GHG to produce electricity were highlighted. The impact of the new technology to the community and global environment at large were also discussed.

The summary of the comment received is presented below:

- *How to solve the problem of rotten egg gas?*

This project can reduce the rotten egg gas because rotten egg gas is a part of landfill gas which will be utilized (burned) for the project. When the project burns landfill gas, it will be destroyed too.

- *How much of electricity does the project generate?*

Landfill was separated in two parts called east site and west site. The east and west site accept solid waste 2,000 tons/day and 3,000 tons/day. The project will generate less than 10 MW per site according to calculation and experience. The project was separate into 4 companies in order to join in the VSPP project (Very Small Power Producer). Each company will generate 8 MW but in the start time, it will generate 5 MW.

- *Has the project estimated the amount of methane from the landfill? Is this amount enough for the project?*

This project has estimated the amount of methane. In generating 1 MW, it will utilize 500 m3 at the concentration of 50-55% methane so the amount is enough for the project.

- *Where is the landfill that accepts solid waste 5,000 tons/day?*

The landfill is located in the entrance of Wat Paireunrom, Tungbua Sub district.

- *Where is the solid waste sent from?*

Bangkok, Kasetsart University (Kamphaeng Sean Campus) and Kamphaeng Sean District.

- *Has the methane of landfill been finished? How will the owner manage the power plant when the methane is finished?*

In the operating landfill, landfill always produces methane. Normally, the methane will be utilized around 3 months after waste is buried. If methane is not utilized, it will release to the atmosphere. The end time of the landfill gas will be faster. When the landfill gas is finished, the power plant will be move to the other sites.

- *What is the advantage and disadvantage from the project which is located in Tungbua Sub district?*

1. The project will give advantage to the locality because it will employ local people. Employment will bring about income to this area. It will form Community Department Fund. It will deduct from the selling electricity to this fund. For local tax, 10% deduction of tax that the companies pay will be returned to the local community.
2. Energy from the project is clean energy. It will decrease the construction of power plant that used fossil fuel.
3. The project will reduce the odor of the landfill because the landfill gas is utilized to generate electricity.
4. After the landfill gas is finished, the solid waste will be dug to make compost.
5. The project is not concerned in secondary pollutant (Dioxin) from burning fuel and coal.

☐ *Will the project make vibration, noise, heat wave and magnetic wave?*

In the operating time, it will set up a small office in the container. The officer will work in this area 24 hours. The small office will be designed as Department of Labor Standard. Moreover, the container is like a buffer to protect the heat and noise from the engine. If the heat releases, the painted color of the container will be swell. Anyway, noise at the distance 1 meter from the container is estimated at 45-50 dB, which is less than the roadside. For magnetic wave, the project will use general generator.

E.3. Report on how due account was taken of any comments received:

Beside the direct oral comments as described above at section E2, questionnaires were distributed to all participants in the event. The summary is shown below.

Summary of the project	**Agree**	**Disagree**	**No vote**
Environmental impact (The project will not provide the environmental impact)	604	32	4
%	94.38%	5.00%	0.63%
Social and public health (The project will not provide the social and public health impact)	796	30	6
%	95.67%	3.61%	0.72%
Overall	45	1	18
%	70.31%	1.56%	28.13%

From the result above, most of the participants understand that the project will have no negative impact on environment, social and public health.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There will be no public funding, under any form, for the proposed CDM project. It will be exclusively supported by private capital that is being raised from investment funds.

Annex 3

BASELINE INFORMATION

DETERMINATION OF GRID EMISSION FACTOR IN THAILAND CEF$_{elec,BL}$

The methodological Tool to calculate the emission factor for an electricity system is applied to determine the CO2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the “operating margin” (OM) and “build margin” (BM) as well as the “combined margin” (CM).

Therefore, we apply the baseline methodology procedure according to the tool:

STEP 1 Identify the relevant electric power system
STEP 2 Select an operating margin (OM) method
STEP 3 Calculate the operating margin emission factor according to the selected method
STEP 4 Identify the cohort of power units to be included in the build margin (BM)
STEP 5 Calculate the build margin emission factor
STEP 6 Calculate the combined margin (CM) emissions factor

STEP 1 Identify the relevant electric power system

The relevant project electricity system and connected electricity system is identified as the national grid. On the one hand, the Thai DNA has not published any delineation of the project electricity system connected electricity system. On the other hand, we did not identify any significant transmission constraints according to criteria set in the Tool to calculate the emission factor for an electricity system. Hence we use the default definition of the relevant electric power.

Step 2 Select an operating margin (OM) method.

Identify the relevant electric power system. According to the Tool to calculate the emission factor for an electricity system, the calculation of the operating margin emission factor $EM_{grid,OM,y}$ is based on one of the following methods:

a) Simple OM, or
b) Simple adjusted OM, or
c) Dispatch data analysis OM, or
d) Average OM

The simple OM method (option a) can be applied as low-cost/must-run resources constitute less than 50% of total grid generation in Thailand, in average of the five most recent years. Tables below presents the national grid generation by sources in Thailand for the 2003-2007 period (five most recent years for which data is available):

Year	Hydro (GWh)	Others including geothermal ,solar cell and wind turbine	Total low-cost/must-run resources (GWh)	Total national grid generation (GWh)	Generation from SPP and VSPP (GWh)	Total Grid generation in Thailand (GWh)	% of low-cost resources in total grid generation	EG m,y (GWh)	Imports (GWh)	EG m,y (GWh)
2003	7,299	2	7,301	103,561	13,422	116,983	6.24%	109,682	2479	112,161
2004	6,040	2	6,042	112,213	13,514	125,727	4.81%	119,685	3388	123,073
2005	5,798	2	5,800	118,495	13,514	132,009	4.39%	126,209	4419	130,628
2006	8,125	3	8,128	125,011	13,731	138,742	5.86%	130,614	5995	136,609
2007	8,114	3	8,117	128,819	14,559	143,378	5.66%	135,261	4491	139,752
Average 5 most recent years for which data is available							**5.39%**			

Source: Electricity Annual Report 2007 by DEDE Department Ministry of Energy, Thailand, Available on website: http://www.dede.go.th/dede/fileadmin/upload/cc/EleThai110951.pdf

Low-cost/must-run resources represents only 5.39% of total grid emission in Thailand, hence the simple OM method can be applied.

A 3-year generation-weighted average (2005-2007) is chosen, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

Step 3 Calculate the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO2 emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system, not including low-cost / must-run power plants / units. It will be calculated according to Option A, i.e. based on data on fuel consumption and net electricity generation of each power plant / unit, as fuel consumption data for each power plant in Thailand is available. Hence, the simple OM emission factor is calculated as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO_2,i,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)

$FC_{i,m,y}$ = Amount of fossil fuel type i consumed by power plant/unit m in year y (mass or volume unit)

$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)

$EF_{CO_2,i,y}$ = CO_2 emission factor of fossil fuel type i in year y (tCO2/GJ)

$EG_{m,y}$ = Net electricity generated and delivered to the grid by power plant/unit m in year y (MWh)

m = All power plants/units serving the grid in year y except low cost/must-run power plants/units

i = All fossil fuel types combusted in power plant/unit m in year y

y = Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in step 2.

The fuel consumption and Net Calorific Value data is taken from Electricity Annual Report 2007 by DEDE Department Ministry of Energy, Thailand, Available on website: http://www.dede.go.th/dede/fileadmin/upload/cc/EleThai110951.pdf

The amount of natural gas was reported incorrectly by DEDE when including gas consumption by private owned electricity generators in the amount consumed by public owned utilities in the year 2006. The mistake has been confirmed by DEDE and the correct value (764,215 MMScf) rather than the published value (857,103 MMScf) has been used in this PDD to calculate the grid factor. The use of the corrected value results in a slightly lower grid factor than the published value results and is hence conservative.

Data available for carbon emission factor of fossil fuel type EFCO2i,y: 2006 IPCC Guidelines for National Greenhouse Gas Inventories default values:

Fuel type	$EF_{CO_2,i,y}$ (tCO2/TJ)
Fuel oil	77.4
Diesel oil	74.1
Coal and lignite	101
Natural gas	56.1

Year	Fuel	EGAT & IPP	SPP	$FC_{i,m,y}$	$NCV_{i,y}$	$EF_{co2,i,y}$	Total	$EG_{m,y}$	$EF_{grid,OM,y}$
		unit	unit	unit	TJ/unit	tCO_2/TJ	tCO_2	GWh	tCO_2/MWh
2005	Fuel oil million liters)	1,996	17	2,013	39.77	77.4	6,195,092		
	Diesel oil (million liters)	83	0	83	36.42	74.1	225,165		
	Coal and Lignite (Gg)	16,571	917	17,488	10.47	101	18,492,833		
	Natural gas (MMscf)	764,118	94841	858,959	1.03	56.1	49,633,228		
	Total						**74,546,368**	**130,628**	**0.5707**
2006	Fuel oil (million liters)	2,030	8	2,038	39.77	77.4	6,273,906		
	Diesel oil	41	0	41	36.42	74.1	111,824		

	(million liters)								
	Coal and Lignite (Gg)	17,166	916	18,082	10.47	101	19,121,102		
	Natural gas (MMscf)	764,215 (Corrected value)	92888	857,103	1.03	56.1	49,525,983		
	Total						**75,032,815**	**136,609**	**0.5493**
2007	Fuel oil (million liters)	936	7	943	39.77	77.4	2,902,664		
	Diesel oil (million liters)	23	1	24	36.42	74.1	65,441		
	Coal and Lignite (Gg)	19,650	899	20,549	10.47	101	21,729,774		
	Natural gas (MMscf)	783,137	94725	877,862	1.03	56.1	50,725,500		
	Total						**75,423,379**	**139,752**	**0.5397**
								EF grid,OM, (tCO2/MWh)	**0.5532**

Step 4 Identify the cohort of power units to be included in the build margin

According to the Tool to calculate the emission factor for an electricity system, the sample group of power units m used to calculate the build margin consists of either:
(a) The set of five power units that have been built most recently, or
(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The identified power plants that have been built the most recently and comprised more than 20% of the system generation in Thailand in 2007 are listed in the following table.

The ex-ante option is chosen. BM is calculated according to the most recent data available on units already built for sample group m at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

Name of Power plant commercial	Operation date	Generation in 2007
		(GWh)
Ratchaburi	Apr-02	13,818
Glow	Jan-03	5,271
EPEC	Mar-03	2,649
Krabi	Aug-03	1,015
BLCP	Oct-06	10,218
Total		**32,971**

Total grid generation in 2007	**135,261 GWh**
% of the set of power plants m	**24.38%**

Source: Electricity Annual Report 2007 by DEDE Department Ministry of Energy, Thailand, Available on website: http://www.dede.go.th/dede/fileadmin/upload/cc/EleThai110951.pdf

Step 5 Calculate the build margin emission factor

The build margin emission factor BM is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)

$EG_{m,y}$ = Net electricity generated and delivered to the grid by power unit m in year y (MWh)

$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/GJ)

m = Power units included in the build margin

y = Most recent year for which power generation data is available

Name of Power plant commercial	Operation date	Generation in 2007	Type of fuel	Efficiency	Conversion	Energy	$EF_{co2,i,y}$	Emission	$EF_{EL,m,y}$
		(GWh)		(BTU/ kWh)	Joules/ BTU	(TJ)	(tCO$_2$/ TJ)	tCO$_2$	(tCO$_2$ /MWh)
Ratchaburi	Apr-02	13,818	Natural gas	7,050	1,055	102,769	56.1	5,765,337	0.417
Glow	Jan-03	5,271	Natural gas	6,909	1,055	38,418	56.1	2,155,255	0.409
EPEC	Mar-03	2,649	Natural gas	6,831	1,055	19,089	56.1	1,070,919	0.404
Krabi	Aug-03	1,015	Fuel oil	8,895	1,055	9,524	77.4	737,192	0.726
BLCP	Oct-06	10,218	Coal	9,089	1,055	97,974	101	9,895,345	0.968
	Total m	**32,971**						**$EF_{grid,BM,y}$ (tCO$_2$/MWh)**	**0.595**

STEP 6

The combined margin emission factor CM is calculated as follows:

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

Where:

$EF_{grid,OM,y}$ = Operating margin CO$_2$ emission factor in year y (tCO$_2$/MWh)

$EF_{grid,BM,y}$ = Build margin CO$_2$ emission factor in year y (tCO$_2$/MWh)

w_{OM} = Weighting of operating margin emission factor (%)

w_{BM} = Weighting of build margin emission factor (%)

$EF_{grid,OM,y}$	**w_{OM}**	**$E_{Fgrid,BM,y}$**	**wBM**	**$EF_{grid,CM,y}$**
(tCO$_2$/MWh)		**(tCO$_2$/MWh)**		**(tCO$_2$/MWh)**
0.5532	50%	0.5952	50%	**0.57420**

Annex 4

MONITORING INFORMATION

Detailed information is in Section B.7.