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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Jaroensompong Corporation Rachathewa Landfill Gas to Energy Project (the Project or Project Activity)

Version 03

27/06/2007

A.2. Description of the project activity:

Solid waste management is one of the most pressing environmental concerns for cities and municipalities in Thailand today. In Bangkok, waste disposal sites are responsible for 36.5 % of the methane released into the atmosphere.[1] The Rachathewa landfill site is located 30km east of the Bangkok Metropolitan Area (BMA) and receives approximately 3,500 tons/day or 16,667 cubic meters/day of municipal solid waste (MSW). There are presently no regulatory or contractual requirements for landfill gas (LFG) collection/combustion in Thailand so landfill sites such as Rachathewa are emitting huge quantities of methane gas directly into the atmosphere.

The Project's developer, Jaroensompong Corporation, has installed a LFG collection system and 1MW electricity generator at the Rachathewa site. Recovered LFG will be utilized as a fuel source for the generator. Any gas in excess of the amount required for power generation will be flared. The generated electricity will be sold to the Metropolitan Electricity Authority (MEA) under a power purchase agreement. GHG emissions are expected to be reduced by approximately 470,000 tCO_2e over ten years through combustion of the collected methane and displacement of grid electricity produced by fossil fuel based plants.

The Project is consistent with the Thai energy policy that actively promotes renewable energy resources. At present, Thailand is heavily dependent on natural gas for energy production.[2] The Electricity Generation Authority of Thailand (EGAT) is actively seeking alternative energy sources because natural gas resources will be depleted in approximately 24 years.[3] Thai government is also hoping to become less dependent on oil and other fuel imports. Methane gas will potentially become a new, indigenous and renewable energy resource for the country.

The Project will be the first in Thailand to utilize LFG for electricity generation on a commercial basis and contributes to sustainable development of the country by mitigating uncontrolled GHG emission from the landfill, preventing on-site fires, controlling the release of volatile organic compounds, reducing

[1] Thailand's Initial National Communication under the United Nations Framework Convention on Climate Change, Office of Environmental Policy and Planning (OEPP), Ministry of Science, Technology and Environment (MOSTE), Bangkok, Thailand, 2000, p.46.

[2] Natural gas plants made up over 70% of the Thai Grid's generation during from 2002 to 2004 (See Annex 3).

[3] Information sourced from a Japanese publication "Tai no denryoku joho to teiden no kiki ni tsuite", published in 2002 by Japanese External Trade Organization (JETRO) Business Support Center, Bangkok.

undesirable odours, providing greater control of leachate drainage, and physically stabilizing the landfill site. The Project will bring the following additional economic, environmental and social benefits:

- A foreign manufacturer will transfer LFG generator related technology to Thailand. The company will supply the generator for the Project and, under the contract, be responsible for training staff in generator operation and maintenance.
- Upon being issued, a large portion of the CERs will be sold to companies and public entities in Japan. The demand for CERs and opportunity for landfill owners to access a supplementary income provides the incentive to install LFG collection equipment.
- The Project promotes more efficient use of local resources, which results in reduction of energy imports.
- Local inhabitants will benefit from the improvement of air quality due to lower methane and odour emissions from the landfill.
- The Project will promote practical experience in LFG collection and utilization. Local staff will be trained and acquire the skills required to operate LFG collection and utilization equipment.

Furthermore, it is noteworthy that solid waste management project is given high priority vis-à-vis CDM project development in Thailand's Climate Change Strategy.

A.3. Project participants:

Name of Party involved(*) ((host) indicates a host Party)	Private and/ or Public entity(ies) Project participants(*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participants (Yes/ No)
Thailand (host)	**Jaroensompong Corporation (private entity)**	No
Japan	**Clean Energy Finance Committee, Mitsubishi UFJ Securities (Private entity)**	No

Jaroensompong Corporation is the project developer and owner. The company is an affiliate of Pairojsompongpanich Ltd, the operator of the Rachathewa landfill site. Pairojsompongpanich Ltd has been engaged in infrastructure development projects for the last 10 years. The main completed projects include construction of roads, hospital and university facilities, and waste management projects in the BMA. Pairojsompongpanich's expertise in waste management includes transportation of municipal solid waste and renovation of waste treatment plants. The company is responsible for the transportation of 3,500 tons/day of MSW to the Rachathewa landfill site.

The Clean Energy Finance Committee, Mitsubishi UFJ Securities (MUS) provides consulting services to promote Clean Development Mechanism (CDM) and Joint Implementation (JI) projects. In addition to being a project participant, Mitsubishi UFJ Securities is the CDM Advisor to the Project and the contact for the Project activity.

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.:

Samuthprakarn

A.4.1.3. City/Town/Community etc:

Rachathewa Bangplee

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

The Project will be located at the Rachathewa landfill area, about 30 km east of BMA. The area in the vicinity of the landfill is primarily industrial, with numerous heavy industrial compounds and some agricultural and residential establishments.

The Rachathewa landfill site occupies some 40 hectares and includes ancillary facilities necessary to support its operations. It also includes a buffer zone around the disposal area. The landfill site has been separated into two sites.

Site 1

Operations commenced on Site 1 in December 1999. The site was capped and closed in November 2001. The area contains approximately 2.5 million tons of newly disposed solid waste and 2.2 million tons of old solid waste relocated from the On-Nuch landfill site, the former neighbouring landfill site. Waste was disposed off in an 8 hectare area that is located at the west end of the landfill area. The base of the site is located 18 meters below ground level.

Methane gas generated from this site is directly attributable to strong odours and other adverse impacts that affect the vicinity of the landfill.

Site 2

Site 2 commenced operations in December 2001 and was closed in December 2006. It is estimated that this disposal site will contain approximately 6 million tons of solid waste by the end of 2006. Waste is disposed off in a 21 hectare area that is located at the east end of the landfill area. The base of the area is located 18 meters below ground level.

The CDM project activity for which this PDD is prepared plans only to recover and utilize LFG from Site 1. Therefore, only landfill site 1 is included in the project boundary. However, it is possible that Jaroensompong formulates a separate CDM project activity for Site 2 in the future.

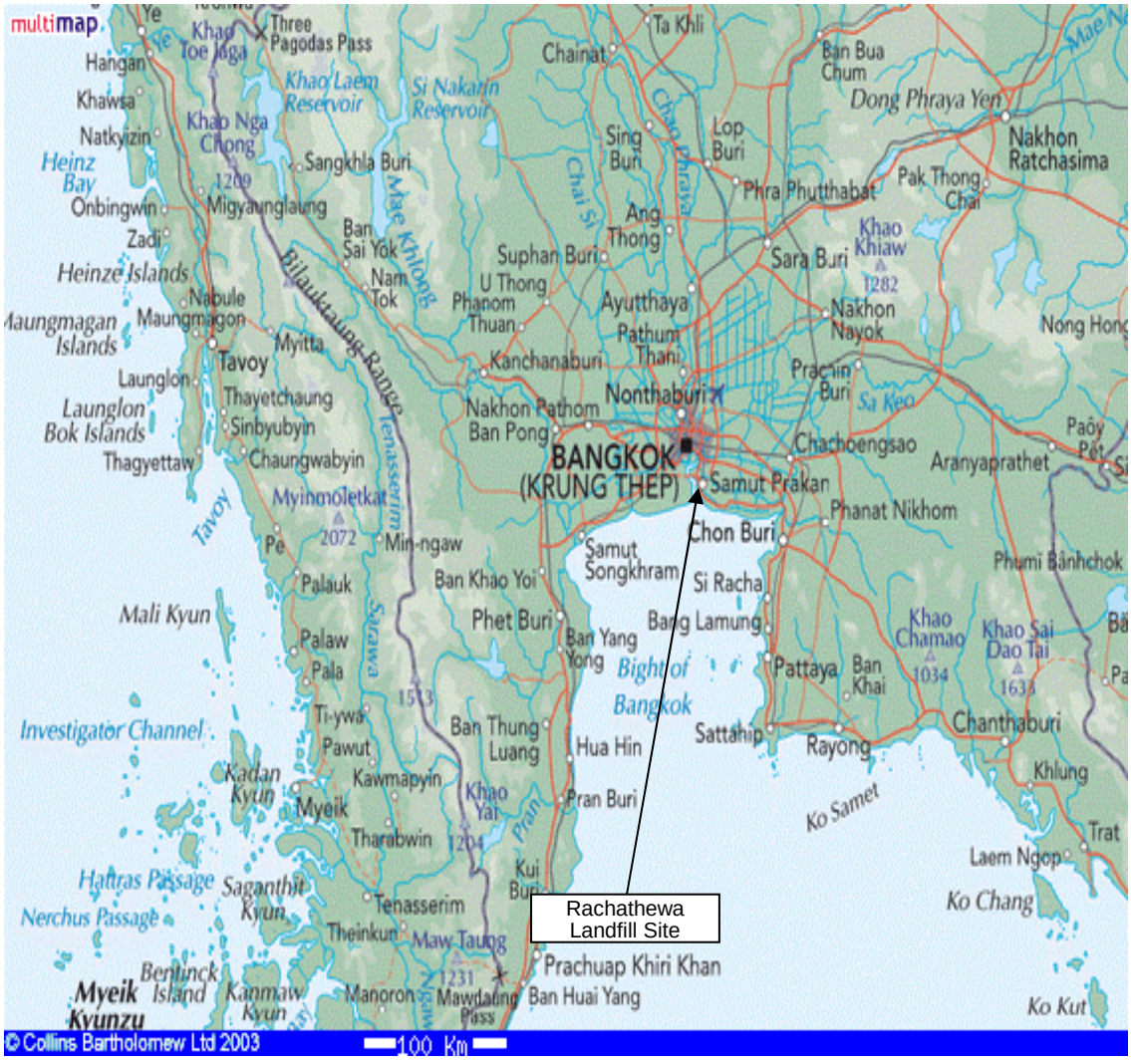


Figure 1. Location of the site for the project activity.

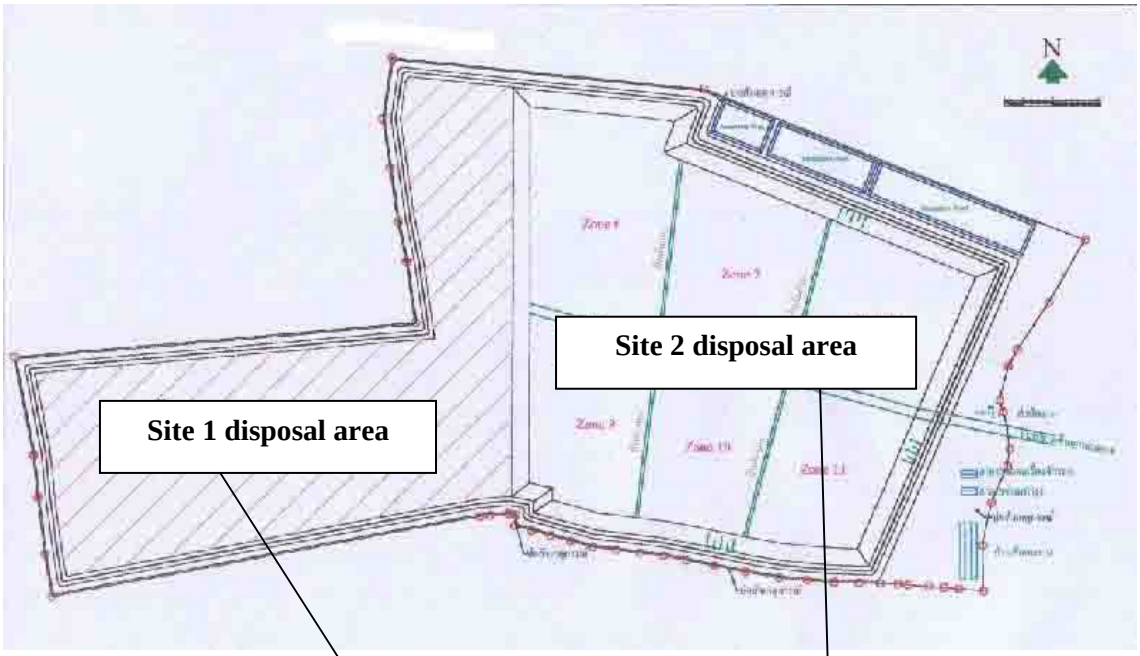


Figure 2a: Topographic map and a recent photo of the Rachathewa landfill site

Figure 2b: Overview of the Rachathewa landfill sites

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

The categories applicable to this Project are:

Sectoral scope 13: Waste handling and Disposal

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

LFG collection system

Jaroensompong Corporation has utilized its waste management experience to design a LFG collection system for the Project based on horizontal lines and wells. Rather than the traditional vertical system for the closed landfill site, the company concluded that the horizontal design technology is more appropriate for the characteristics of Thai MSW and country's climatic conditions. The MSW contains high moisture. During the long rainy season, there is a continuous influx of rainwater into the landfill site. The wells of a vertical system would be prone to flooding under such conditions.

The Project will only utilize LFG from Site 1. A total of 10 horizontal collectors have been installed at Site 1. LFG is recovered at the outer edges and at the center of the landfill. The collectors include a system for drainage and collection of leachate at the outer edges of the landfill. They are constructed using PVC and HDPE piping to allow for settlement, and the collectors are placed approximately 30 meters apart.

The horizontal collectors and other points are connected by laterals to a main header system. This is the area where LFG gas is drawn to under a vacuum created by the blower.

Condensate is removed from the system using a process which begins from the recovery system. Here, sloping laterals and headers are used to provide drainage into condensate traps, knockout collectors, and tanks. The condensate is then drained back into the landfill.

LFG utilization system

Jaroensompong Corporation has installed a power plant with a capacity of 1MW.

Corrosive elements and contaminants are removed from the LFG using a system composed of an inlet scrubber, filter and gas holder.

Jaroensompong Corporation conducted a two-year pilot project to examine the potential of commercial LFG collection/utilization for electricity generation. The pilot project utilized two old engines that had been modified from diesel to gas. The information gathered from the pilot project provided the basis for the final design of the Project.

Flaring system

The Project will install a flaring system to burn excess LFG that is not used in power generation. An open flare system is selected over an enclosed flare system because it is a less expensive approach for flaring.

The Project will utilize advanced foreign technology for electricity generation. As the first landfill site to use this state of the art technology in Thailand, the Project represents an important case for technology transfer.

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

It is estimated that the Project will generate 471,851 tCO_2e of emission reductions over a 10-year period with an average of 47,851 tCO_2e/yr.

Years	Annual estimation of emission reductions in tonnes of CO_2e
2008	71,503
2009	63,844
2010	57,252
2011	51,578
2012	46,695
2013	42,492
2014	38,874
2015	35,760
2016	33,080
2017	30,773
Total estimated reductions (tonnes of CO_2e)	471,851
Total number of crediting years	10 years
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	47,185

A.4.5. Public funding of the project activity:

The financial plans for the Project Activity do not involve any public funding from annex I countries.

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:

The approved baseline and monitoring methodology applied to the Project Activity is:

"Consolidated baseline methodology for landfill gas project activities (ACM0001-version 05)"

The methodology referred to calculate the grid emission factor is:

"Grid connected renewable electricity generation (AMS I.D. version 11)"

The tool used for demonstration and assessment of the additionality of the Project Activity is:

"Tool for the demonstration and assessment of additionality (version 03)"

The tool used for the determination of project emissions from flaring gases is:

"Methodological Tool to determine project emissions from flaring gases containing methane"

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

ACM0001-version 05 is applicable to the following situations in regards to LFG activities:

a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy from other sources.

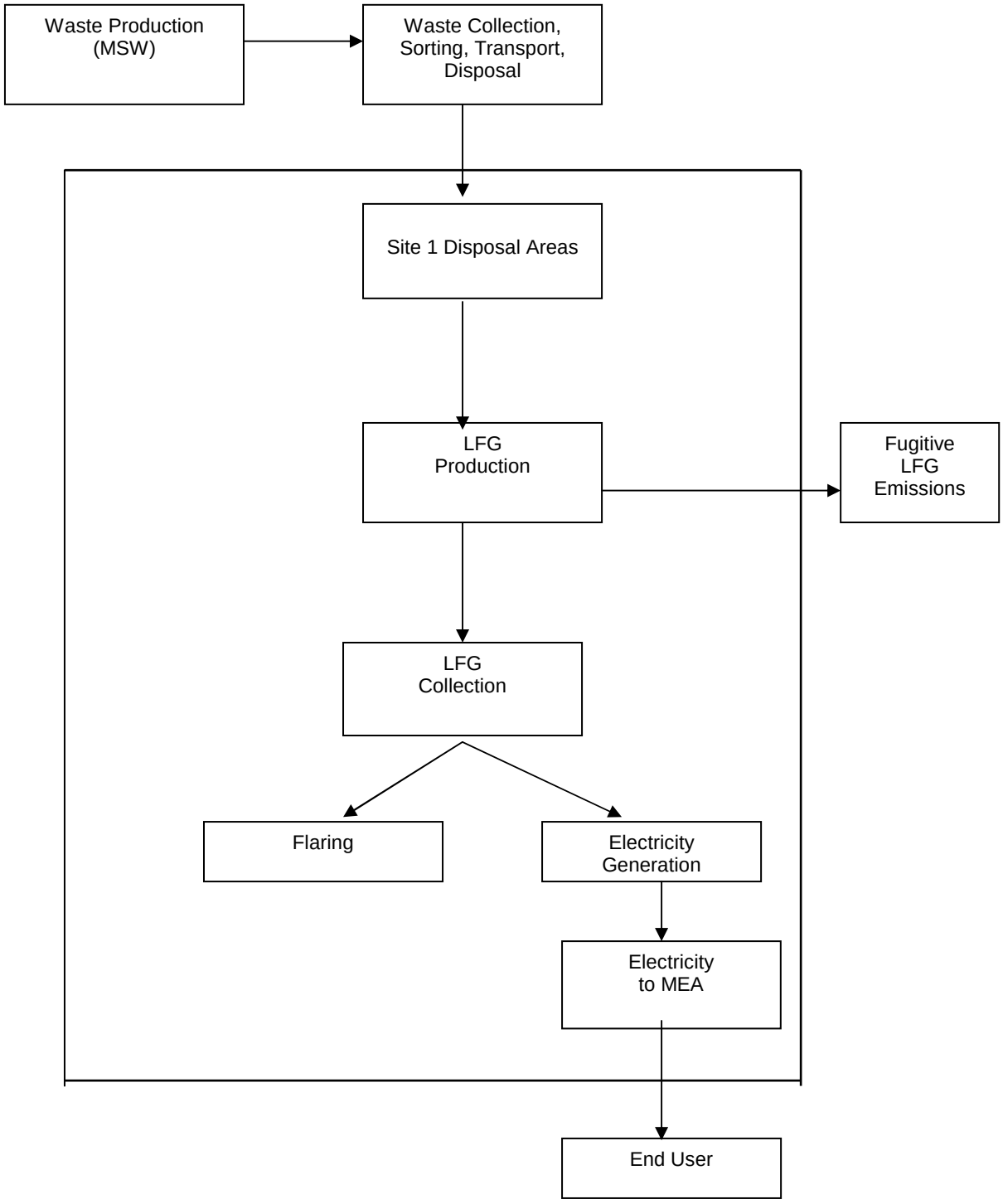
The Project corresponds to situation a) and c) above. Therefore, ACM0001 is applicable to the Project. Since there are no regulatory/contractual requirements in Thailand at present and this is the first project in Thailand to capture/destroy LFG, the baseline scenario is the total atmospheric release of LFG. The Project will collect/combust LFG and result in additional GHG reductions.

ACM0001 stipulates that in the case of c), a baseline methodology for electricity displaced shall be provided. It further indicates that "simplified modalities and procedures for CDM small-scale project activities" is applicable to projects where the installed generated capacity is less than 15 MW. The small-scale methodology I.D. (version 11) "Grid connected renewable electricity generation" is applicable to the Project due to the fact that electricity is exported to the grid and the installed capacity of the generator is only 1 MW.

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

The spatial extent of the project boundary is the Rachathewa landfill site. The boundary includes LFG collection at Site 1, flaring, electricity generation and electricity transmission to MEA.

Figure 3 – Project Boundary



Emission sources and gases included in or excluded from the project boundary are listed in the below table:

Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from electricity consumption	CO_2	Included	Electricity is exported to the Thai grid and displaces mainly fossil fuel fired generation from existing and new plant additions
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Emissions from decomposition of waste at the landfill site	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not counted.
		CH_4	Included	Main source of emissions in the baseline.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption due to the project activity	CO_2	Included	The project will only utilize LFG and not use any fossil fuels. However, this will be monitored and project emissions determined if fossil fuels are in fact consumed.
		CH_4	Excluded	Amount is negligible so excluded for the reason of simplification.
		N_2O	Excluded	Amount is negligible so excluded for the reason of simplification.
	Emissions from on-site electricity use	CO_2	Included	The project may import a small amount of electricity from the grid for start-ups.
		CH_4	Excluded	Amount is negligible so excluded for the reason of simplification.
		N_2O	Excluded	Amount is negligible so excluded for the reason of simplification.

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

Since there are no enforced regulatory or contractual requirements for LFG collection/combustion in Thailand, commercial landfill sites emit 100% of produced LFG directly into the atmosphere. As shown below, the selected baseline scenario for the Project is the total atmospheric release of methane gas with an adjustment factor of 0. Emission reductions will be claimed for burning the collected methane gas to generate electricity, flaring the collected excess methane gas not used by the engine and displacing fossil-fuel-based electricity generation from the grid.

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): >>

Prohibitive barriers that the Project activity faces are clearly identified using the "tool for the demonstration and assessment of additionality (version 03)". The following steps from the additionality tool will be completed below;

STEP 1 – Identification of alternatives to the project activity consistent with current laws and regulations
STEP 3 – Barrier analysis
STEP 4 – Common Practice Analysis

As per "Specific guideline for completing the Project Design Document (CDM-PDD)", it is required to provide evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity if the starting date of the project activity is before the date of validation.

For the Project Activity, it is not required to provide such evidence since the date of validation of the Project Activity is May 2004, which is before the starting date of Project Activity, August 2004.

STEP 1 – Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a - Define alternatives to the project activity:

Scenario A
Continuation of the current practices of not collecting or utilizing LFG from waste disposal sites. Uncontrolled LFG emissions occur from the landfill until the organic component of the MSW is completely decomposed.

Scenario B: **The proposed Project**
Installation of facilities for LFG collection, electricity generation and flaring of any excess LFG. The Company operates these facilities and sells the (net) produced electricity to the Thai grid.

Scenario C
Collection of LFG and its disposal by flaring, without utilization in an electricity generator.

Scenario D
Composting facilities are installed for MSW at the landfill site.

Scenario E
Construction and operation of a waste incineration facility at the landfill site

Sub-step 1b – Consistency with mandatory laws and regulations :

All the alternatives stated above are in compliance with applicable laws and regulatory requirements in Thailand. It is unlikely that regulations will change in a way that would render the scenarios non-compliant. However, as stipulated in the monitoring plan, laws and regulations in regards to LFG collection/combustion will be monitored on an annual basis.

STEP 3 – Barrier Analysis

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

The implementation of the Project Activity is prevented by the following barriers.

Barriers due to prevailing practice

The Project Activity is the first commercial LFG collection/ utilization project in Thailand. According to the information from Energy Policy and Planning Office (EPPO) and the report from World Bank[4], no LFG is used for power generation except for the Project Activity. At present, since there are no regulations for LFG collection/ utilization in Thailand, LFG generated from landfill sites are emitted to the atmosphere without gas collecting/ utilization system.

Jaroensompong Corporation faces formidable barriers for this reason. It started its construction only after site visit by a DOE for validation was completed in June 2004 and it became confident that additional revenue from the registration of the Project as a CDM project activity could mitigate the serious risks associated with the implementation of the Project Activity.

Investment barriers

Jaroensompong Corporation initially planed to finance 50% of the required capital for the Project Activity by bank loan. However, as the first LFG collection/ utilization project in Thailand, perceived risks were too high for local banks. As a result, local banks declined to lend for the Project Activity. This forced Jaroensompong Corporation to change its business plan to finance the required capital with 100%

[4] Information from EPPO: http://www.eppo.go.th/power/data/data-website-thai.xls

Thailand Environment Monitor 2003, World Bank

(http://www.worldbank.or.th/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/THAILANDEXTN/0,,contentMDK:20206649~menuPK:333323~pagePK:141137~piPK:217854~theSitePK:333296,00.html)

equity under the judgement that the Project Activity would gain additional revenue from the registration as a CDM activity.

Technological barriers

The Project Activity faces high technological risks due to the lack of available technology and experience. Since there is no precedence for LFG collection in Thailand, the Project Activity encountered difficulties in choosing a proper gas collecting system that suits the waste characteristics and climate condition of Thailand. As a result of an intensive study, Jaroensompong Corporation chose to install a horizontal gas collection system instead of the vertical system which is the standard approach for closed landfill sites such as the one where the Project will be carried out. However, the technology applied is not proven in Thailand. The difficulty is aggravated by the fact that Rachathewa landfill contains newly deposited solid waste and old solid waste relocated from the On-Nuch landfill site.[5] Decomposition of the old waste at the far western site will be more advanced than decomposition of the new waste at the front site. This puts greater weight on the pipes at the front of the site compared to the pipes at the far end of the site. This difference in the weight could bend the pipes, resulting in the development of cracks and disruption of the pipe's layout. This means the risk of technological failure is far greater for the Project site than for other landfill sites.

Another technical barrier is the lack of experience stemming from the fact that the Project is the first of its kind in the country. Though the staffs are intensively trained for the operation and maintenance regarding the Project Activity, if malfunctioning or underperformance happens due to the problems mentioned above or other reasons, lack of experience in operating and maintaining the technology applied can cause additional risk to Jaroensompong Corporation.

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

Scenarios C, D and E face similar investment and/or technology barriers as the Project Activity does. However, it is clear that the barriers mentioned above would not prevent scenario A, which is the baseline scenario - continuation of total atmospheric release of methane gases, which is prevailing practice in Thailand. Therefore both Sub-steps 3a and 3b are satisfied.

The risks identified are insurmountable without the additional revenue from the registration of the Project Activity as a CDM project activity. This prompted Jaroensompong Corporation to look to CDM assistance to improve the viability of the Project and reduce its risks. Discussions with CDM professionals, both in Thailand and abroad, convinced the developer that the Project had good prospects for CDM status, particularly after AM0010 was approved. The estimated amount of CERs before the end of the first commitment period is approximately 290,000 CERs, which can be converted into monetary value of USD 2.9 million under the assumption of 10 USD/CER. The revenue is high enough for Jaroensompong Corporation to take high risks originating from 100% equity investments as well as above mentioned technological barriers. It was only with this expectation of additional revenue from CERs that Jaroensompong Corporation became comfortable about proceeding with the Project.

STEP 4 – Common Practice Analysis

[5] Please refer to the Section A.4.1.4.

Sub-step 4a – Analyse other activities similar to the proposed project activity

The Project is the first commercial LFG to electricity operation in Thailand. There are no regulations requiring LFG to be collected/destroyed, so no other commercial LFG projects have been implemented in Thailand. Project developers are generally reluctant to invest in this untested technology because the high risks do not justify the low returns.

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

There are no other similar activities being carried out in Thailand at present.

Since all steps are satisfied, the proposed Project Activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Emission Reduction

The greenhouse gas emission reduction achieved by the Project Activity during a given year "y" (ER_y) are estimated as follows:

$$ER_y = (MD_{project,y} – MD_{reg,y}) * GWP_{CH4} + EL_y * CEF_{,electricity,y} - ET_y * CEF_{thermal,y}$$

where:

$ER_{,y}$	emission reductions, in tonnes of CO_2 equivalents (tCO_2e)
$MD_{,project,y}$	the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4)
$MD_{reg,y}$	the amount of methane that would have been destroyed/combusted during the year in the absence of the project, in tonnes of methane (tCH_4)
GWP_{CH4}	the Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4
EL_y	net quantity of electricity exported during year y, in megawatt hours (MWh).
$CEF_{electricity,y}$	CO2 emissions intensity of the electricity displaced, $intCO_2$/MWh. This will be estimated using AMS I.D.
$ET_{,y}$	incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y, in TJ
$CEF_{thermal,y}$	CO_2 emission intensity of the fuel used to generate thermal/mechanical energy, in tCO_2e/yr

$$El_y = EL_{EX,LGFG} – EL_{IMP}$$

where:

$EL_{EX,LGFG}$ net quantity of electricity exported during year y, produced using landfill gas, in megawatt hours (MWh)

EL_{IMP} net incremental electricity imported, defined as difference of project imports less any imports of electricity in the baseline, to meet the project requirement, in MWh

$MD_{reg,y} = MD_{project,y} * AF$

where:

AF Adjustment factor

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

$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) – (PE_{flare,y} / GWP_{CH4})$

where:

$MD_{flare,y}$ quantity of methane destroyed by flaring

$LFG_{flare,y}$ quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3)

$w_{CH4,y}$ average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3CH_4/m^3LFG)

D_{CH4} methane density expressed in tonnes of methane per cubic meter of methane (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 "Methodological Tool to determine project emissions from flaring gases containing methane"

As mentioned in the section A.4.3, an open flaring system is selected to burn excess LFG. As per the guideline in the "Methodological Tool to determine project emissions from flaring gases containing methane", following equations are used to calculate project emissions from flaring of the residual gas ($PE_{flare,y}$)

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

where:

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

$\eta_{flare,h}$ Flare efficiency in hour h

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

where:

$FV_{RG,h}$ Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (m^3/h) (monitored)
$fv_{CH4,RG,h}$ Volumetric fraction of methane in the residual gas on dry basis in hour h (monitored)
$\rho_{CH4,n}$ Density of methane at normal conditions (0.716 kg/m^3)

Flare efficiency ($\eta_{flare,h}$)

0%, if the flame is not detected for more than 20 minutes during the hour h
50%, if the flare is detected for more than 20 minutes during the hour h

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

where:

$MD_{electricity,y}$ quantity of methane destroyed by the generation of electricity
$LFG_{electricity,y}$ quantity of landfill gas fed into electricity generator

$MD_{thermal,y} = LFG_{thermal,y} * w_{CH4,y} * D_{CH4}$

where:

$MD_{thermal,y}$ quantity of methane destroyed for the generation of thermal energy
$LFG_{thermal,y}$ quantity of landfill gas fed into the boiler

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

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	-

Data / Parameter:	**AF**
Data unit:	%
Description:	Adjustment factor
Source of data used:	
Value applied:	0 %

Justification of the choice of data or description of measurement methods and procedures actually applied :	There are no enforced regulatory or contractual requirements for LFG collection/utilization in Thailand.
Any comment:	-

Data / Parameter:	**EF_{grid}**
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor of the grid
Source of data used:	EGAT, EPPO
Value applied:	0.51 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data choice and calculation method as per AMS I.D. Calculated based on the data for the year 2001, 2002 and 2003 which are the most recent data available at the time of the validation.
Any comment:	None

Data / Parameter:	**EF_{OM}**
Data unit:	tCO_2/MWh
Description:	CO_2 Operating Margin emission factor of the grid
Source of data used:	EGAT, EPPO
Value applied:	0.60 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data choice and calculation method as per AMS I.D.
Any comment:	None

Data / Parameter:	**EF_{BM}**
Data unit:	tCO_2/MWh
Description:	CO_2 Build Margin emission factor of the grid
Source of data used:	EGAT, EPPO
Value applied:	0.42 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data choice and calculation method as per AMS I.D.

Any comment:	None

B.6.3 Ex-ante calculation of emission reductions:

Following the instructions outlined in the ACM0001, *ex ante* emission reduction estimates for methane gas are projected for reference purposes only. The emission reductions will be determined on an *ex post* basis by measuring data that is stipulated in the monitoring plan.

ACM0001 stipulates that an Adjustment Factor (AF) for regulatory or contractual requirements shall be used and justified, taking into account the context of the Project. The AF has been set at 0% due to the fact that there are no enforced regulatory or contractual requirements for LFG collection/utilization in Thailand.

As mentioned in the section B.6.1, open flaring system is selected to burn excess LFG. As per the guideline in the "Methodological Tool to determine project emissions from flaring gases containing methane", default value of flare efficiency (50% or 0% depending on the results of monitoring of flare) will be used. For *ex ante* project emission calculation, 50% of flare efficiency will be used.

For *ex ante* emission reductions calculation, data for 2008 is used[6]:

$ER_y = (MD_{project,y} – MD_{reg,y}) * GWP_{CH4} + EL_y * CEF_{,electricity,y} - ET_y * CEF_{thermal,y}$
$= (3{,}230.76 – 0) * 21 + 7171.5 * 0.51 – 0$
$= 71{,}503$ (tCO_2/yr)

$El_y = EL_{EX,LGFG} – EL_{IMP}$
$= 7200$ (MWh/yr) – 28.5 (MWh/yr)
$= 7171.5$ (MWh/yr)

$MD_{reg,y} = MD_{project,y} * AF$
$= 3{,}230.76$ (tCH_4/yr) * 0
$= 0$ (tCH_4/yr)

$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y}$
$= 2{,}004.51$ (tCH_4/yr) + 1,226.25 (tCH_4/yr) + 0 (tCH_4/yr)
$= 3{,}230.76$ (tCH_4/yr)

$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) – (PE_{flare,y} / GWP_{CH4})$
$= (9{,}699{,}145\ (m^3CH_4/yr)*0.576*0.0007168(tCH_4/m^3CH_4))–(42{,}001\ (tCO_2/yr)/21(tCO_2/CH_4))$
$= 2{,}004.51$ (tCH_4/yr)

[6] Annex 3 provides the results of *ex-ante* emission reductions calculation for all years.

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$$
$$= \sum_{h=1}^{8760} 456.63 \times (1 - 0.5) \times \frac{21}{1000}$$
$$= 42{,}001 (tCO_2 / yr)$$

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4.RG,h} \times \rho_{CH4,n}$$
= 1,107.21 (m^3LFG/h) * 0.576 (m^3CH_4/m^3LFG)* 0.716 (kg/m^3)
= 456.63 ($kgCH_4$/h)

$MD_{electricity,y}$ = $LFG_{electricity}$ * $w_{CH4,y}$ * D_{CH4}
= 2,970,003 (m^3CH_4/yr) * 0.576 * 0.0007168 (tCH_4/m^3CH_4)
= 1,226.25 (tCH_4/yr)

$MD_{thermal,y}$ = $LFG_{thermal,y}$ * $w_{CH4,y}$ * D_{CH4}
= 0 (m^3CH_4/yr) * 0.576 * 0.0007168 (tCH_4/m^3CH_4)
= 0 (tCH_4/yr)

Baseline data for LFG estimation, grid CEF, etc., can be found in Annex 3.

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

Year	Estimation of project activity emissions# (tCO_2e)	Estimation of baseline emission reductions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of emission reductions (tCO_2e)
2008	0	71,503	0	71,503
2009	0	63,844	0	63,844
2010	0	57,252	0	57,252
2011	0	51,578	0	51,578
2012	0	46,695	0	46,695
2013	0	42,492	0	42,492
2014	0	38,874	0	38,874
2015	0	35,760	0	35,760
2016	0	33,080	0	33,080
2017	0	30,773	0	30,773
TOTAL	0	471,851	0	471,851

Note – a small amount of project emissions could occur due to import of electricity for start ups but this has already been deducted from emission reductions in B.6.3.

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
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	12,669,148 m^3 (estimate for 2008)
Description of measurement methods and procedures to be applied:	Measured continuously using a flow meter. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	-

Data / Parameter:	$LFG_{flare,y}$
Data unit:	m^3
Description:	Amount of landfill gas flared
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	9,699,145 m^3 (estimate for 2008)
Description of measurement methods and procedures to be applied:	Measured continuously using a flow meter. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	-

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	m^3
Description:	Amount of landfill gas combusted in power plant
Source of data to be used:	On-site measurements
Value of data applied for the purpose of	2,970,003 m^3 (estimate for 2008)

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured continuously using a flow meter. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	-

Data / Parameter:	**$PE_{flare,y}$**
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data to be used:	On-site measurements / calculation
Value of data applied for the purpose of calculating expected emission reductions in section B.5	42,001 tCO_2e (estimate for 2008)
Description of measurement methods and procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) will be monitored as per the "Tool to determine project emissions from flaring gases containing Methane"
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$fv_{i,h}$**
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h where i = CH_4, CO, CO_2, O_2, H_2, N_2
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$fv_{CH4,h}$ ($w_{CH4,y}$) = 0.576 $fv_{CO,h}$ = 0 $fv_{CO2,h}$ = 0 $fv_{O2,h}$ = 0 $fv_{H2,h}$ = 0 $fv_{N2,h}$ = 0.426
Description of measurement methods and procedures to be applied:	Measured continuously using a continuous gas analyser. Values to be averaged hourly. The same bases (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceed 60℃.
QA/QC procedures to	Analysers will be periodically calibrated according to the manufacturer's

be applied:	recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	These values will be used for the calculation of project emissions from flaring of residual gas stream in year y ($PE_{flare, y}$). $fv_{CH4,h}$ is equivalent to the variable $w_{CH4,y}$ described in the monitoring methodology and also used for the emission reductions calculation. In case only methane content of the residual gas is measure, the remaining part will be considered as N_2 as per the guideline in the tool.

Data / Parameter:	**$FV_{RG,h}$**
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal condition in the hour h
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,107.21 m^3/h (estimate for 2008)
Description of measurement methods and procedures to be applied:	Measured continuously using a flow meter. Values to be averaged hourly. The same bases (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas ($fv_{i,h}$) when the residual gas temperature exceed 60℃.
QA/QC procedures to be applied:	Flow meters will be periodically calibrated according to the manufacturer's recommendation.
Any comment:	These values will be used for the calculation of project emissions from flaring of residual gas stream in year y ($PE_{flare, y}$).

Data / Parameter:	**Flare operation parameter**
Data unit:	min/h
Description:	Minutes that flare is detected during the hour h
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	60 min/h
Description of measurement methods and procedures to be applied:	Measured continuously using a flame detector.
QA/QC procedures to be applied:	
Any comment:	These values will be used for the calculation of project emissions from flaring of

	residual gas stream in year y ($PE_{flare, y}$). If is more than 20 min/h during the hour h, 50% of flare efficiency will be applied for the hour h, otherwise 0% will be applied.

Data / Parameter:	$w_{CH4,y}$
Data unit:	m^3CH_4/m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.576
Description of measurement methods and procedures to be applied:	Before the open flare system is installed, this parameter will be measured periodically using a portable gas analyser. After installation of the open flare system, this parameter will be measured continuously using a continuous gas. analyser.
QA/QC procedures to be applied:	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	The monitored parameter is also used for $fv_{CH4,h}$ in case this parameter is measured continuously using continuous gas analyser.

Data / Parameter:	**T**
Data unit:	Temperature of the landfill gas
Description:	℃
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured periodically to determine the density of methane (D_{CH4}) using a thermocouple.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**p**
Data unit:	Pressure of the landfill gas
Description:	Pa
Source of data to be	On-site measurements

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured periodically to determine the density of methane (D_{CH4}) using a pressure transmitter.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$EL_{EX,LFG}$**
Data unit:	MWh
Description:	Total amount of electricity exported out of the project boundary
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7,200 MWh/yr
Description of measurement methods and procedures to be applied:	Measured continuously using an electricity meter.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. Amount of electricity exported will be double checked with receipt of sale.
Any comment:	-

Data / Parameter:	**EL_{IMP}**
Data unit:	MWh
Description:	Total amount of electricity imported to meet project requirement
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	28.5 MWh/yr
Description of measurement methods and procedures to be	Measured continuously using an electricity meter.

applied:	
QA/QC procedures to be applied:	-
Any comment:	The records of any electricity imported in the baseline too should be recorded at the start of the project

Data / Parameter:	**ET_y**
Data unit:	TJ
Description:	Thermal energy used in landfill during project
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	If fossil fuel is used, the quantity of fossil fuel used will be measured using weight or volume meters.
QA/QC procedures to be applied:	-
Any comment:	It is not expected any thermal energy will be used for the Project Activity. However, this variable will be monitored.

Data / Parameter:	**$CEF_{thermal,y}$**
Data unit:	tCO_2/TJ
Description:	CO_2 emission intensity of the thermal energy
Source of data to be used:	Calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	If fossil fuel is used, CO2 emission intensity of the thermal energy will be calculated with local data of NCV and/or IPCC default values.
QA/QC procedures to be applied:	-
Any comment:	

Data / Parameter:	**-**
Data unit:	-
Description:	Regulatory requirements relating to landfill gas projects

Source of data to be used:	Local/national data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	The information will be recorded annually.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	-
Data unit:	hours
Description:	Operation of the energy plant
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Recorded annually
QA/QC procedures to be applied:	-
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational

B.7.2 Description of the monitoring plan:

The monitoring methodology clearly describes how to identify and collect necessary data. All data collected as part of monitoring plan should be archived electronically and be kept at least 2 years after the end of the crediting period.

Figure 2 below outlines the operational and management structure that Jaroensompong Corporation has implemented to monitor emission reductions generated by the Project activity. Jaroensompong Corporation has formed an operational and management team, which will be responsible for monitoring of all the parameters aforementioned. This team composes of a general manager and a group of operators. A group of operators, who are under the supervision of the general manager, are assigned for monitoring of different parameters on a timely basis as well as recording and archiving data in an orderly manner.

Monitoring reports are forwarded to and reviewed by the general manager on a monthly basis in order to ensure the Project follows the requirements of the monitoring plan.

The performance of the Project will be reviewed and analyzed by the consultants on a regular basis.

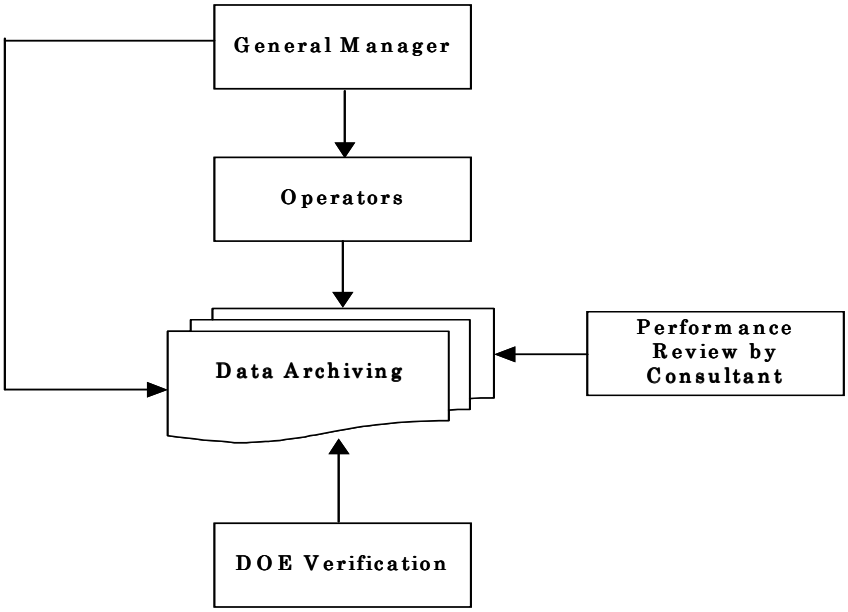


Figure 2. Operational and management structure for monitoring the project activity.

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 baseline study was completed on the 12/01/2007 by:

Clean Energy Finance Committee
Mitsubishi UFJ Securities (MUS)
26th Floor, Marunouchi Building,
2-4-1 Marunouchi, Chiyoda-ku
Tokyo, 100-6317, Japan

Tel: +81-3-6213-6860
Fax: +81-3-6213-6175
E-mail: hatano-junji@sc.mufg.jp

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:

01/08/2004

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

The expected minimum operation lifetime of the Project is 15 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:

Not applicable.

C.2.1.2. Length of the first crediting period:

Not applicable.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

07/01/2008 or the date of registration, whichever is later

C.2.2.2. Length:

Ten (10) years

SECTION D. Environmental impacts

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

Based on the information obtained from the Office of Environmental Policy and Planning (OEPP), an Environmental Impact Assessment (EIA) is not required for LFG collection and utilization projects that have a capacity of less than 10MW.

An EIA was also not required for the development of the landfill site. The Pollution Control Department of MOSTE (MOSTE PCD) is responsible for approving solid and hazardous waste management facilities. This approval process does not have any requirements or constraints relating to the development of the landfill site. Prior to the development of the site, the landfill owner was required to obtain an Initial Environmental Examination (IEE). A consultant that was approved by the MOSTE PCD, prepared the IEE.

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:

No significant negative environmental impacts are expected to result from the Project. On the other hand, by collecting and combusting LFG, the Project will contribute greatly to reducing anthropogenic GHG emissions that were previously released into the atmosphere. The collection of LFG will also help to prevent on-site fires, as well as reduce undesirable odors, improve leachate drainage, reduce emissions of volatile organic compounds (VOC) and other hazardous air pollutants (HAP).

SECTION E. Stakeholders' comments

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

As part of the process to gather stakeholders' comments in regards to the Project, Jaroensompong Corporation held a public consultation meeting on 2 April 2004.

The participants of the meeting included 23 leaders from 15 organizations representing local administrative officials, neighboring villages, manufacturing plants, a school and scavengers. A list of the representatives is included in Appendix 7.

Using a slide presentation, the company explained the below details in regards to the Project. After the presentation, the participants were invited to ask questions and give their opinions.

Contents of the Presentation

1) Introduction of each participant
2) Purposes of the meeting
3) Company profile
4) Location of the Project
5) Purposes and process of the Project
6) Environmental and social impacts
7) Contact details of the staff in charge of the Project

E.2. Summary of the comments received:

The participants of the meeting expressed their support for the Project. Their main interests were focused on the environmental and social impacts of the Project. The participants were told about the training program for Staff and were particularly interested in the social value. Jaroensompong Corporation explained that occupational safety would be of the utmost importance and training would focus on correct operation and maintenance procedures for gas collection equipment and the generator. Training of staff in correct gas and equipment monitoring should prevent accidents but just in case, emergency procedures are also taught. Furthermore, the Project will employ 20 people, and only have a positive effect on the environment by reducing pollution from the landfill.

It became clear that most of the participants did not have a deep knowledge of the Project prior to listening to the presentation.

There were no negative comments in regards to the Project and all participants were satisfied that there would be no adverse environmental or social impacts generated by the Project.

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

At the meeting, Jaroensompong Corporation expressed willingness to keep the community informed and involved in the Project. Participants were told that visitors are welcome to view the site on the condition that they make a booking in advance.

Lastly, participants were encourage that the Project would provide a practical means of education, and attract academics and students who are looking to learn more about LFG collection/utilization.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Jaroensompong Corporation
Street/P.O.Box:	142 Moo 14 Kingkaew Rd., Rachathewa
Building:	
City:	Bangplee
State/Region:	Samutprakarn
Postfix/ZIP:	10540
Country:	Thailand
Telephone:	(66-2)-738-4457
FAX:	(66-2)-738-4457
E-Mail:	pairojsompong@hotmail.com
URL:	
Represented by:	
Title:	Managing Director
Salutation:	Mr.
Last Name:	Jaroenpoj
Middle Name:	
First Name:	Pairoj
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	Mitsubishi UFJ Securities Co., Ltd.
Street/P.O.Box:	2-4-1 Marunouchi
Building:	Marunouchi Building
City:	Chiyoda-ku,
State/Region:	Tokyo
Postfix/ZIP:	100-6317
Country:	Japan
Telephone:	+81 3 6213 6860
FAX:	+81 3 6213 6175
E-Mail:	hatano-junji@sc.mufg.jp
URL:	http://www.sc.mufg.jp/english/e_cefc/inedx.html
Represented by:	
Title:	Chairman
Salutation:	Mr
Last Name:	Hatano
Middle Name:	
First Name:	Junji
Department:	Clean Energy Finance Committee

Mobile:	NA
Direct FAX:	+81 3 6213 6860
Direct tel:	+81 3 6213 6175
Personal E-Mail:	hatano-junji@sc.mufg.jp

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The financial plans for the Project do not involve any public funding from Annex I countries.

Annex 3

BASELINE INFORMATION

As in other Southeast Asian countries, solid waste in Thailand is high in moisture and organic content. These characteristics lead to high leachate and a low calorific value. Collected mostly from residential areas and some commercial establishments, the organic content of MSW entering the Rachathewa landfill site is estimated to be 60-80%. (see Table1). The Rachathewa landfill site, as well as other landfills and dumpsites in Thailand, generate landfill gas at a comparably rapid rate. Similar to an enhanced bioreactor, the conditions in the landfill are optimal for the rapid biodegradation of organic waste. The microorganisms involved in the biodegradation process produce methane gas as a by-product.

Table 1 – The Composition of MSW at Rachathewa Landfill Site[7]

Type	MSW composition (%)		
	Analysis 1	**Analysis 2**	**Analysis 3**
Vegetable, food waste	46.52	36.03	40.11
Paper	12.97	20.77	13.01
Leather	-	-	-
Wood	20.46	14.00	8.14
Sub-total: organic waste	*79.95*	*71.00*	*61.26*
Plastic	17.24	27.41	30.43
Rubber	-	1.15	0.9
Glass	0.85	-	4.61
Metal	-	0.64	-
Stone, gravel	-	-	2.80
Other	1.96	-	-
Total	**100**	**100**	**100**

[7] Results from analysis carried out in 2001 by Jaroensompong.

Estimation of LFG production and collection

First Order Decay (FOD) model recommended in the 2006 IPCC Guidelines for National Greenhouse Gas Inventoriesis used to estimate LFG production. Only newly deposited solid wastes are considered in the calculation.

CH4 Emission from SWDS

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{\ x,T} - R_T \right] \cdot (1 - OX_T)$$

where:

CH_4 Emissions	CH4 emitted in year Y, Gg
T	Inventory year
x	waste category or type/material
R_T	recovered CH_4 in year T, Gg
OX_T	oxidation factor in year T, (fraction)

CH_4 generated = DDOCm $decomp_T$ * F * 16/12

where:

DDOCm $decomp_T$	DDOCm (mass of decomposable DOC) decomposed in year T, Gg
F	fraction of CH_4, by volume, in generated landfill gas (fraction)
16/12	molecular weight ratio CH_4/C (ratio)

DDOCm $decomp_T$ = DDOCma $_{T-1}$ * (1- e^{-k})
$DDOCma_T$ = $DDOCmd_T$ + ($DDOCma_{T-1}$ * e^{-k})

where:

$DDOCma_T$	DDOCm accumulated in the SWDS at the end of year T. Gg
$DDOCma_{T-1}$	DDOCm accumulated in the SWDS at the end of year T-1. Gg
$DDOCmd_T$	DDOCm deposited into the SWDS in year T, Gg
k	reaction constant

DDOCm = W * DOC * DOC_f * MCF

where:

DDOCm	mass of decomposable DOC deposited, Gg
W	mass of waste deposited, Gg
DOC	degradable organic carbon in the year of deposition, fraction (Gg C/Gg waste)
DOC_f	fraction of DOC that can decompose (fraction)

MCF CH_4 correction fraction for anaerobic decomposition in the year of deposition (fraction)

Data used for the above calculation and other baseline data are as follows:

Variable	Value	Source
R_T	0	Project developer, no LFG is recovered in the baseline scenario.
OX_T	0.1	IPCC default value for managed covered with CH_4 oxidising material
k	0.15	Project developer, the most appropriate value of k is 0.15 considering the moisture content of the municipal solid waste,
W	1,277.5	Project developer, average annual waste acceptance is 1,277,600 tonnes.
DOC	0.1874	Calculated using the data in table 1, annex 3 and IPCC default DOC content values
DOC_f	0.5	IPCC default value
MCF	1	IPCC default value for managed-anaerobic landfill site
LFG collection efficiency	0.6	The US EPA estimates that the methane collection efficiency of the landfills ranges from 60 to 85%. Taking the low limit leads to a conservative calculation. The use of this value for the Project Activity was confirmed by the feasibility study.
Fraction of methane in landfill gas	0.578	Project developer, from laboratory analysis
Opening year	December 1999	Project developer
Closed year	November 2001	Project developer

Predicted LFG collection/combustion data

Year	(A) LFG emission (m^3/yr)	(B) LFG collected (m^3/year)	(C) LFG used by the Plant (m^3/year)	(D) LFG flared (m^3/year) (B) - (C)
2008	21,115,246	12,669,148	2,970,003	9,699,145
2009	18,174,061	10,904,436	2,970,003	7,934,433
2010	15,642,559	9,385,535	2,970,003	6,415,532
2011	13,463,675	8,078,205	2,970,003	5,108,202
2012	11,588,293	6,952,976	2,970,003	3,982,973
2013	9,974,136	5,984,482	2,970,003	3,014,479
2014	8,584,818	5,150,891	2,970,003	2,180,888
2015	7,389,022	4,433,413	2,970,003	1,463,410
2016	6,359,790	3,815,874	2,970,003	845,741
2017	5,473,922	3,284,353	2,970,003	314,350
Total	**117,765,521**	**70,659,313**	**29,700,030**	**40,959,283**

Calculation of the Thai CEF

According to the Baseline Methodology, calculations can be conducted as outlined in the small scale methodology "Renewable electricity generation for a gird (I.D.)" if the Project has an installed capacity of less than 15 MW. Among the two options described in the AMS I.D, option (a), a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedure prescribed in the approve methodology ACM0002, is chosen. Thai CEF calculation is based on the most recent data available at the time of PDD submission and is calculated *ex ante*.

Data for Simple OM calculation

Among the options for OM calculation, simple OM calculation is chosen since the dispatch data is not available and low-cost/must run resources constitute less than 50% of total grid generation. For simple OM calculation, aggregated generation and fuel consumption data is used since more disaggregated data is not available.

Table 1: EGAT's grid generation and fuel consumption data for 2001-2003[8]

Type of fuel		2001	2002	2003
Hydroelectric	GWh (low-cost/must-run)	6,311	6,481	7,742
	GWh (Imported from Laos)	2,885	2,807	2,438
Natural Gas	GWh	70,280	76,689	83,500
	MMSCFD	1,681	1,632	1,895
Heavy Oil	GWh	3,146	2,062	2,150
	Mlitres	783	521	533
Diesel Oil	GWh	155	258	45
	Mlitres	46	67	12
Lignite	GWh	17,307	16,890	17,134
	Mtons	15.24	15.2	16.22
Imported Coal	GWh	2,475	2,541	2,526
	Mtons	0.99	1.054	1.084
Renewable Energy	GWh (low-cost/must-run)	597	648	1,103
EGAT-TNB	GWh (Imported from Malaysia)	9	13	105
Total	GWh	**103,165**	**108,389**	**116,743**

Source: Power Development Plans for 2002 – 2004, EGAT

[8] Power Development Plans for 2002 – 2004, EGAT

Data for BM calculation

Table 2: Generation and fuel consumption data for recently built plants[9]

Plant name	Commissioning Date	Fuel type	Capacity (MW)	Generation (GWh)	Efficiency (Btu/kWh)	Fuel Consumption (TJ)	CO_2 emission (tCO_2)
EPEC	25-Mar-03	Natural Gas	350.0	1,922	7,083	14,363	805,764
Grow	31-Jan-03	Natural Gas	713.0	4,298	6,850	31,062	1,742,578
Ratchaburi	18-Apr-02, 1-Nov-02	Natural Gas	2,175.0	12,315	7,262	94,355	5,293,316
SPP (collective)	after 28-Oct-00	Renewable	192.0	1,236	-	0	0
SPP (collective)	after 28-Oct-00	Natural Gas	210.0	1,352	-	9,386	526,555
Ratchaburi	22-Oct-00	Natural Gas	1,512.0	3,451	10,110	36,810	2,065,041
Total			-	24,574[10]	-	185,977	10,433,254

Source: Department of Alternative Energy Development and Efficiency (www.dede.go.th/dede)
Energy Policy and Planning Office (www.eppo.go.th)

Table 3: Other variables

Variable	Value	Reference
Net calorific value	(TJ/kt) Natural gas = 48.00 Heavy oil = 40.40 (residual fuel oil) Diesel oil = 43.00 Lignite = 11.90 Imported Coal = 26.70 (anthracite)	2006 IPCC Guideline for National Greenhouse Gas Inventories, Volume 2 Table 1.2
CO_2 emission factor	(tCO_2/TJ) Natural gas = 56.1 Heavy oil = 77.4 (residual fuel oil) Diesel oil = 74.1 Lignite = 101.0 Imported Coal = 98.3 (anthracite)	2006 IPCC Guideline for National Greenhouse Gas Inventories, Volume 2 Table 1-4

(1) Natural gas plants include single and combined cycle.
(2) The natural gas data is based on "dry" value.
(3) Specific gravity of natural gas is typically around 0.6. The density of natural gas is calculated by multiplying density of air (1.29kg/m^3) by 0.6. The result is 0.774kg/m^3.
(4) Densities used for heavy oil and diesel oil are 0.89 kg/m^3 and 0.85 kg/ m^3 respectively.

[9] Department of Alternative Energy Development and Efficiency, www.dede.go.th/dede/ (last accessed February 2006) and Energy Policy and Planning Office, www.eppo.go.th/ (last accessed February 2006)

[10] The total generation was 116,743 GWh for 2003, the latest year for which data is publicly available. 20% of 116,743 GWh is 23,349 GWh.

(5) CEF values for fossil fuels were taken from Table 1.4 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
(6) EGAT-TNB: This is the electricity, which Thailand imports from Malaysia. In order to maintain a conservative approach, it is assumed to have a CEF of zero.
(7) Fuel consumption data for imported coal was not recorded in the EGAT Power Development Plan (PDP). The fuel consumption data was back-calculated by using the same thermal efficiency as that for lignite plants (31.8%).

Operating Margin

2001	0.62
2002	0.57
2003	0.60
Average OM =	**0.60**

Build Margin

BM =	**0.42**

Combined Margin

CM =	0.51

Annex 4

MONITORING INFORMATION

The monitoring plan is a document used as a standard by staff that are assigned to collect and archive relevant data necessary for determining the baseline and measuring project emissions. It must be utilized in a complete and accurate manner until the end of the 10-year crediting period (with archiving only ending 2 years after the end of the crediting period). Its effective use will facilitate accurate and consistent monitoring of the project's CERs.

Monitoring staff

Jaroensompong will form and operational and management team, which will be responsible for monitoring/ acquisition and recording for CDM purposes. This team composes of a general manager and a group of operators. Operators will be trained in the operation of all monitoring equipment and all readings will be taken under the supervision of management. Quality control and assurance procedures are to be undertaken for data monitored as outlined in the monitoring plan. A database will be maintained to record all relevant data as outlined in the monitoring plan.

Monitoring equipment

All monitoring equipment will be installed by experts using standard methods. Once installed, this equipment will be calibrated to the highest standards by Project staff. Any irregularities or problems with equipment will be reported to management and rectified as soon as possible.

Items to be monitored and archived

Data is to be collected and archived as directed in section B.7 of this CDM-PDD

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