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:

Biogas Technology Group Ras Al-Khaimah Landfill Gas to Energy Project
Document Version Number 7
Date completed: 12/02/2009

A.2. Description of the project activity:

The Biogas Technology Group Ras Al-Khaimah Landfill Gas to Energy Project (hereafter, the “Project”) developed by Biogas Technology Group Ltd (hereafter referred to as the “Project Developer”) is a landfill gas (LFG) collection and destruction project in Ras Al-Khaimah, one of the United Arab Emirates, hereafter referred to as the “Host Country”.

The Ras Al-Khaimah Landfill started its operations at the end of 2001, and its design allows at least a twenty years operation time. Since 2002, approximately 500,000 tonnes of Municipal Solid Waste have been deposited at the well engineered site, which is equipped with simple gas and leachate collection systems. Prior to going to the landfill, waste is sorted at a sorting facility, where the plastic, glass and aluminium are separated.

The objective of the Project is to replace the existing ineffective passive venting system (where the LFG is simply released into the atmosphere without any combustion) in order to collect and destroy the LFG generated at the Ras Al-Khaimah landfill. This will be achieved in two subsequent stages.

In the first project stage, the captured LFG will be combusted via a LFG flare. The purpose of LFG flaring is to safely dispose of the flammable constituents, particularly methane, safely and to control odour nuisance, health risks and adverse environmental impacts. This will involve investment in a highly efficient gas collection system, and the requisite flaring equipment.

In a second project stage, once generation of LFG is proven to be steady, both in terms of volume and quality, electricity generation equipment will be installed. This also implies that a power purchase agreement (PPA) has been secured, and all of the requisite permits have been obtained.
The generation equipment will combust the methane in the LFG to produce electricity. The anticipated installed capacity is expected to reach a maximum of 2 MW.
Excess LFG, and all gas collected during periods when electricity is not produced, will be flared.

The project activity therefore leads to greenhouse gas emission reductions in two different manners. First, by capturing and flaring LFG (project scenario), the Project avoids the uncontrolled release of methane into the atmosphere (baseline scenario). Second, by producing electricity from LFG the Project will lead to emission reductions attributable to a displacement of electricity, which would have been more carbon intensive.

The project activity is contributing to the Host Country’s sustainable development, as it will have several positive social and environmental impacts:

- The installed landfill gas collection and flaring system will prevent potentially explosive situations associated with the subsurface gas migration, as it represents an effective control system which minimises migration off-site.
- Many constituents of landfill gas are hazardous and pose potentially significant risks to human health. The objective of LFG flaring is to safely dispose of the perilous constituents, particularly methane, and to control and reduce odour nuisance and health risks.
- The Project guarantees sustainability in the environmental sector by minimising damage to or deterioration of the environment and by reducing global methane emissions. The Project therefore contributes to the effort of tackling global warming, by reducing this harmful greenhouse gas.
- If the Project does generate electricity, it will act as a clean technology demonstration project, by optimising the use of natural resources, and encouraging less dependence on grid-supplied electricity. It promotes and diversifies sustainable energy systems.
- The Project represents an investment in environmental funds, and increases employment opportunities in the area. It will provide local short- and long-term employment opportunities. Local contractors and labourers will be required for construction, and long-term staff will be needed to operate and maintain the system.

A.3. Project participants:

Table: 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 participant (Yes/No)
United Arab Emirates	Public Works and Services Department (PWSD), Government of Ras Al-Khaimah	No
United Kingdom of Great Britain And Northern Ireland	Biogas Technology Group Ltd. (private entity)	No
United Kingdom of Great Britain And Northern Ireland	Biogas Technology Ltd. (private entity)	No
United Kingdom of Great Britain and Northern Ireland	EcoSecurities Group PLC (private entity)	No

(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party (country) involved may or may not have provided its approval. At the time requesting registration, the approval by the Party (ies) involved is required.
Further contact information of project participants is provided in Annex 1

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

United Arab Emirates (the "Host Country")

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

Emirate: Ras Al-Khaimah

A.4.1.3. City/Town/Community etc:

Ras Al-Khaimah

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

The landfill is 24.5 km southwest of the entrance of Ras Al-Khaimah Creek, and 4.7 km inland. The access road is called "Al Itihad Road" and the area surrounding the landfill is known as "Al Jazeera Al Hamra".

The geographical coordinates of the landfill are 25^{o} 38' 20. 37" North and 55^{o} 47' 27.44" East.

The picture below shows a map of the Project location (Aerial view of the Ras Al-Khaimah landfill)

Map of the United Arab Emirates, highlighting the location of Ras Al-Khaimah

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

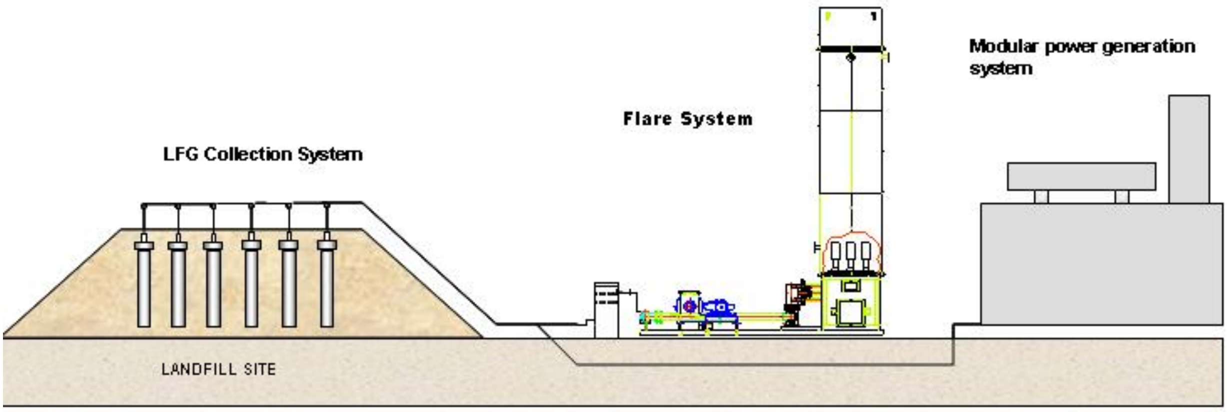
According to Annex A of the Kyoto Protocol, this Project fits under Sectoral Categories:

13. Waste Handling and Disposal.

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

The project activity involves the installation of an active landfill gas collection system, an enclosed flare system, and a modular electricity generation system. The average lifetime of the installed equipment is about twenty years.

The following diagram illustrates the main components involved in the project activity:



The Project Developer has over twenty years of practical experience in the design, installation and operation of LFG collection and flaring systems. This is a proven technology for landfill gas combustion, and has been widely demonstrated as reliable and environmentally safe.
The technology used in the project activity to collect, flare and utilise the LFG comes from the UK. The import and installation of the equipment in Ras Al-Khaimah, represents a transfer of technology.

Landfill Gas Collection System

The project activity involves the installation of an active LFG collection system using vertical gas wells drilled into the waste to extract the LFG. The gas collection pipe network consists of pipes that connect groups of gas wells to manifolds. These manifolds are connected to a main pipe and then to the main header pipe, which delivers the gas to the extraction plant and the flare. The system operates at pressure slightly lower than atmospheric, as blowers will draw the gas from the wells through the collection system and deliver it to the flare or the LFG power generation system.

Flare System

The project activity involves the installation of a modular enclosed gas flare consisting of pipe-work, valves, blower, stack with proprietary burners, instrumentation and control panel. The rated capacity for the flare is 1,000Nm^3/h,
For safety purposes, flare units are fitted with flame arresters protecting the blower and the field pipe work-from burner flame flashback. At high temperatures, proprietary Biogas Technology Group designed burners ensure full destruction of the combustible constituents found in LFG, in accordance with the UK Environment Agency guidelines.

Electricity Generation Technology

When the Project secures a Power Purchase Agreement enabling the sale of generated electricity, a modular reciprocating engine facility will be installed. Small modular reciprocating engine generator units make it possible to adapt the equipment to the site-specific gas volumes. The anticipated installed capacity is 2MW.
The packaged generation system consists of an outdoor acoustic containerised generating set. This comprises an engine/alternator set, connected to a subterranean electrical earthing blanket in compliance with electrical regulations.

The containers are fully leak proof, averting possible ground contamination with oil or battery acids, and can therefore be classified as environmentally compliant. The Project Developer would develop the electricity generation component of the project activity through its relationship with the ENER*G Group, whose subsidiary ENER*G Natural Power has extensive experience in the design, construction, and operation of generators using LFG.
The electricity generated by the project activity would be otherwise produced by the Grid (baseline), thus resulting in more carbon intensive emission.

Prior to the project activity, the landfill had a passive venting system, where the landfill gas was simply released into the atmosphere, through vertical pipes, thus resulting in methane emission into the atmosphere. This scenario represents the situation prior the project activity, and it is the baseline scenario. In the absence of the new gas collection system and flare installation, the landfill gas produced would have continued to be released (Baseline scenario); therefore emitting a significant amount of methane into the atmosphere. Thanks to the project, the LFG is captured and destroyed, resulting in methane emission reduction.

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

Table: Estimated emission reductions from the Project

Year	**Total Annual estimation of emission reductions in tonnes of CO_2e**
2009 (July-Dec)	12,080
2010	29,538
2011	34,179
2012	38,098
2013	42,036
2014	45,644
2015	49,891
2016 (Jan-June)	26,850
Total estimated reductions (tonnes of CO_2e)	278,316
Total number of crediting years	7 years (3*7)
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	39,759

A.4.5. Public funding of the project activity:

The Project will not receive any public funding from Parties included in Annex I of the UNFCCC.

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 version 8.1, adopted at EB39, "Consolidated baseline and monitoring methodology for landfill gas project activities[1]" will be used.

ACM0001 refers to the following tools:

- "Tool for the demonstration and assessment of additionality"; version 05.2, adopted at EB39.
- "Tool to determine project emissions from flaring gases containing methane"; version 01, adopted at EB28.
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption; version 01, adopted at EB39;
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"; version 02, adopted at EB41;
- "Combined tool to identify the baseline scenario and demonstrate additionality"; version 02.1, adopted at EB28;
- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"; version 04 adopted at EB 41[2]

For the second stage of the project, the electricity component (consumption and/or exportation), ACM0001 refers to the following tool to calculate the Grid emission factor:

- "Tool to calculate the emission factor for an electricity system"; version 01.1, adopted at EB35

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

The Project is anticipated to have two complementary activities:

- Methane collection and destruction:

The collection and destruction (through flaring) and/or utilization (through combustion in electricity generation units) of LFG, thus converting its methane content into CO_2, reducing its greenhouse gas effect; and

- Electricity displacement:

The generation and supply of electricity to the Grid and /or to a local power purchaser, thus displacing a certain amount of fossil fuels used for electricity generation from the grid.

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[1] http://cdm.unfccc.int/UserManagement/FileStorage/F533IMIDQ5RYD9I7V715HJFL8G0LH6

[2] This tool is referred to as "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". The name change occurred in EB41.

The Project therefore fulfils the conditions of option a) and b) of ACM0001 applicability criteria (i.e., captured LFG is flared and used to produce energy), and is consequently considered the most appropriate methodology for the proposed project activity. Option c) (the captured gas is used to supply consumers through natural gas distribution network) is not applicable for this project.
Since the baseline of the Project is electricity generated by plants connected to the grid, the approved "Tool to calculate the emission factor for an electricity system" can be applied to calculate the grid emission factor, as stated in ACM0001, version 08.1

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

According to ACM0001 baseline methodology, the project boundary is the site of the project activity where the gas will be captured and destroyed/used.
The methodology also states:

"If the electricity for project activity is sourced from grid or electricity generated by the LFG captured would have been generated by power generation sources connected to the grid, the project boundary shall include all the power generation sources connected to the grid to which the project activity is connected."

As the project is getting electricity from the Grid, the project boundary includes all the power generation sources connected to the grid to which the project activity is connected.

The activities and emission sources considered within the project boundaries are listed in the table below:

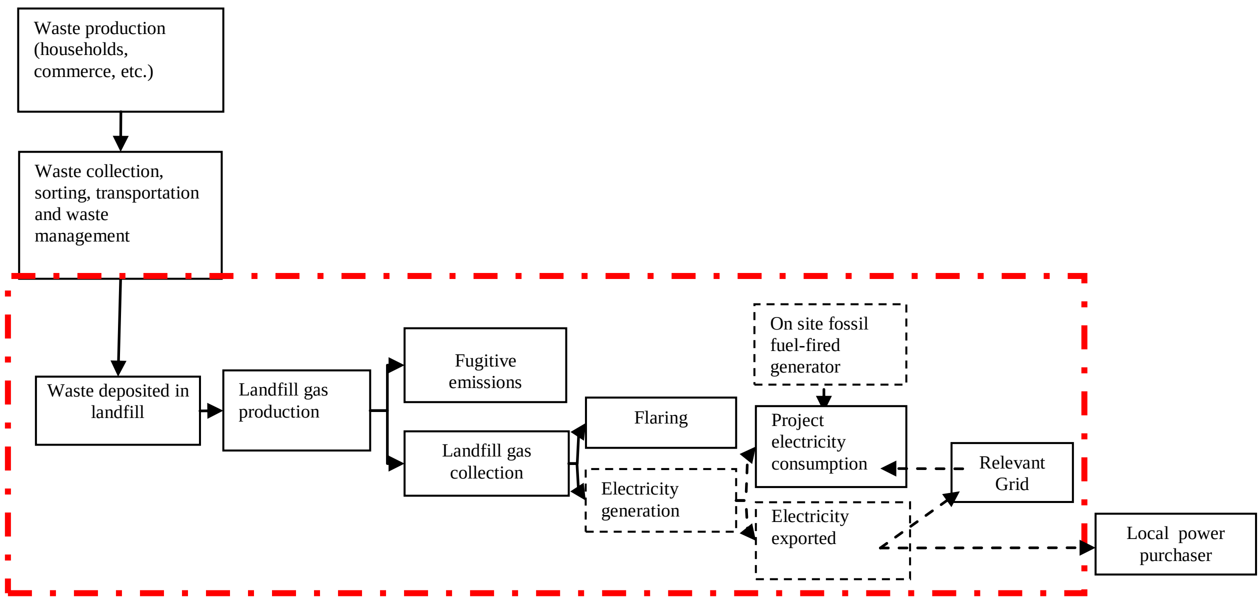
Table 1: Summary of gases and sources included in the project boundary, and justification/explanation where gases and sources are not included.

	Source	Gas	Included?	Justification/Explanation
Baseline	Emission from decomposition of waste at the landfill site	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.
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	Yes	Electricity consumed from the grid in the baseline scenario.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emission from thermal energy generation	CO_2	No	No thermal energy generation is planned in the project activity.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.

Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	Applicable in case an on site fossil fuel generator is used as a back up.
		CH_4	No	Excluded for simplification. This emission source is assumed to be negligible.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.
	Emissions from on-site electricity use	CO_2	Yes	Important emission source. Applicable for the electricity consumption from the Grid or in case an on site fossil fuel generator (used as a back up in case of Grid failure).
		CH_4	No	Excluded for simplification. This emission source is assumed to be negligible.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.
	LFG destruction (flaring)	CO_2	No	The combustion products of, methane are CO_2 and H_2O. The CO_2 released during the combustion process was originally fixed via biomass so that the life cycle CO2 emissions of LFG are zero.
		CH_4	Yes	As the Project uses a 90% default value for flare efficiency, the remaining 10% is accounted for as project emissions and are therefore deducted from the total emission reduction.

A flow diagram of the project boundary is presented in figure 1 below. The flow diagram comprises all possible elements of the LFG collection systems and the equipment for electricity generation.

Figure 1: Flow chart of project boundary (red line indicates project boundary and the black dotted line refers to the potential second phase of the project)



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

The baseline scenarios are identified and listed in section B.5.

In the particular case of the proposed project activity, the baseline scenario was defined as the result of both the additionality assessment of the "Tool for the demonstration and assessment of additionality" (version 05.2 adopted at EB39) and the approved ACM0001 vers08.1 methodology.
The baseline scenario is the combined:

- LFG2: The atmospheric release of the landfill gas. There is no active gas collection system but only a passive venting system in place at RAK landfill.
- P6. Existing and/or new grid-connected power plants.

As the former landfill operator is not collecting neither burning the gas produced in the landfill in the baseline scenario, the adjustment factor (AF) applied to this project is set at 0%.

This value can further be justified based on the fact that the regulatory requirements do not indicate any specific amount of gas collection and destruction or utilisation and that in practice, no LFG is actually combusted.

(For detailed information on this assessment, please refer to Section B.5).

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 additionality):

The determination of project scenario additionality is performed using the methodological "Tool for the demonstration and assessment of additionality" (version 05.2 adopted at EB39), which follows the subsequent steps:

The project activity was conceived as a CDM activity and considered carbon revenues since its conception. The Project Developer conducted the first site visit to the RAK landfill in April 2007 and PWSD agreed that the project could be developed under the CDM and invited Biogas to make an offer in May 2007, including developing the Project under the CDM. Furthermore, CDM revenue was seriously considered in the decision to proceed with the project activity upon contract signature between the Project Developer and PWSD on 1st August 2007[3].

The Project schedule is summarized in Table below:

Events	Date	Comments
First CDM consideration	April 2007	First landfill site visit by Biogas
Other CDM Consideration	May 2007	PWSD Letter inviting Ceres Associates[4] to discuss CDM with Biogas
Project activity start date	August 2007	Contract signed between Biogas and PWSD
Construction start date	October 2007	Flare being built by Biogas Ltd, in Sawtry (UK)
Shipping date	January 2008	Flare shipped to Ras Al-Khaimah
Validation start date	February 2008	International Stakeholder Consultation
Commissioning date	February 2008	Flare Operation start date
EIA approved	June 2008	Approval of the project by EPDA
Host Nation LOA request	July 2008	First request for Non Annex I LOA

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

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

According to ACM0001 version 08.1, the following alternatives have to be included:

<u>LFG 1:</u> The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity.

<u>LFG 2</u>: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.
The latter represents the business as usual scenario, where the gas is simply venting through the atmosphere, without any combustion.

As the Project may include electricity generation in the future, realistic and credible alternatives may include, inter alia:

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[3] The document will be made available to the DOE on request.

[4] Ceres Associates are subcontracted by PWSD to manage the landfill operations from waste sorting to disposal including landfill gas collection and flaring using Biogas Ltd. equipment

- P1. Power generated from landfill gas undertaken without being registered as a 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.

Renewable sources other than LFG are not economically feasible for the project site; therefore options P3 and P5 may be discarded. Similarly, since heat* is not considered as part of the proposed project activity (for the reason mentioned hereafter), fossil-fuel fired cogeneration plants are not a viable alternative. Therefore P2 is also discarded.

As a Grid connection already exists on the landfill site, construction of a new on site fossil fuel fired captive power plant is not as economically competitive as purchasing power from the grid.
Furthermore, the power needs at the landfill site are minimal and therefore do not justify the construction of a new fossil fuel fired captive power plant. Therefore, P4 may also be discarded.

Therefore, the only remaining options for consideration as plausible baseline alternatives for power generation in the absence of the project activity are then:

- LFG 2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.
- P1. Power generated from landfill gas undertaken without being registered as CDM project activity. This represents the project activity and corresponds to LFG 1.
- P6. Power plants connected to the grid.

*Baseline alternatives for heat generation were not considered in this assessment; given isolation of the project site and the lack of local off-takers. The costs associated with developing a pipeline to supply off-takers further from the project site would be too high to justify an investment in thermal energy production. Indeed, potential off-takers are situated at least 3Km from the project site, which makes this alternative not economically feasible. Furthermore, as the biogas is not pure methane, it requires purification before its use, which also involves significant cost.
Therefore, alternatives for heat generation have not been considered.

Sub-step 1b. Enforcement of applicable laws and regulations:

LFG 1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity, complies with all the applicable laws and regulations.

LFG 2: Atmospheric release of the landfill gas represents the BAU scenario, and complies with UAE’s local and national laws. Indeed, neither the RAK cleanliness law nor the federal law of the UAE mentions practices for landfill gas management and use.

P1: Power generation without registration as a CDM project activity, complies with all the applicable laws and regulations.

LFG1: Same as P1

P6: Power plants connected to the grid, complies with all the applicable laws and regulations.
In summary, all possible scenarios described above would comply with national and local regulations as there are no laws/regulations concerning the use of the landfill gas, neither in the Emirate of Ras Al-Khaimah nor in the United Arab Emirates.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the additionality Tool, if the alternatives to the CDM project activity do not include investments of comparable scale to the project, then Option III must be used.
The Tool also states that he simple cost analysis can only be used in case the CDM project activity and the alternatives identified in Step 1 generate no financial or economic benefits other than CDM related income. As the project will potentially have revenue from electricity sell, applying the simple cost analysis is not a suitable option.
In this case, the most likely alternative to the project is not to install flaring and generation equipment at the site. Therefore, since no investments of a similar scale to the Project are involved, benchmark analysis is applied.

Sub-step 2b: Option III - Apply benchmark analysis

The likelihood of development of the Project without being registered as a CDM (P1 or LFG 1), as opposed to the continuation of current activities (atmospheric release of biogas) will be determined by comparing the Project IRR to benchmark rates of return available to investors in the Host Country.

According to the "Tool for the demonstration and assessment of additionality", version 05.2, a relevant benchmark for a project's IRR can be derived from government bond rates increased by a suitable risk premium (to reflect private investment and / or project type). Two sources have been used to establish a suitable benchmark:

- According to Bloomberg[5], an acknowledged specialist in providing financial data and investment information, the government bond in UAE (also known as the risk free rate) is 4.21 %.
    - Risk premiums generally reflect circumstances related both to the individual country where the investment is taking place and the technology in question. As per Bloomberg, the country risk for the UAE is currently 5.85%.
    - A reliable risk premium related to landfill gas projects (i.e. technology risk) could not be identified due to a lack of public information in this sector. However, it is well known that landfill gas projects throughout the world have encountered difficulties in delivering

[5] The printout attached in Annex 3 of the PDD (outlining premium risk in UAE) is obtained through our internal Bloomberg Tool. The information source is a service from a financial expert (Bloomberg) and it is called 'Bloomberg professional service: http://about.bloomberg.com/professional/data.html.
The information provided by this service is publicly available data (everyone who wants can buy this expert information). EcoSecurities is interested in providing accurate and relevant as well as economic reasonable benchmarks for investments, and therefore has a subscription to this service.

their respective projected CERs, and till now, no LFG project in UAE has been developed under the CDM. This suggests that a realistic risk premium for this type of project would be higher than the 5.85% premium indicated by the country risk.

Therefore, a realistic benchmark IRR for this type of project should at least be equal or even greater than the base investment threshold (UAE government bonds) plus a risk premium, which given the actual figures referenced above is greater than 10.06% (4.21% + 5.85%). A benchmark of 10% was deemed to be appropriate for the proposed project activity.

Sub-step 2c: Calculation and comparison of financial indicators

Table 2 below illustrates the result of the financial analysis for the project activity, considering a twenty-one year period. As shown, the project IRR (without CDM revenue) is negative, hence lower than the chosen benchmark.

Table 2: Financial results of the project (LFG 1 or P1) with and without carbon finance, considering a twenty-one year period are presented below. The NPV incorporates a 10% discount rate, which is the chosen Benchmark. The electricity price is set at 50 US$/MWh, which reflects the actual buying price[6] (for both industrial and residential use) for electricity in Ras Al-Khaimah.

	Without CDM	**With CDM**
Net Present Value (US$)	-3,666,678	658,865
IRR	Negative IRR	12.7%
Discount rate (the chosen benchmark)	10%	

Input/Assumption	**Value**	**Comments**
Electricity price (US$ / kWh)	0.05	Electricity tariff in Ras Al-Khaimah
Income Tax	0%	No Income Tax in UAE http://www.ameinfo.com/145047.html
VAT	0%	No VTA in the UAE http://www.ameinfo.com/156063.html
O&M Cost (over 21 years)	$11,946,575	Figures provided by Biogas Technology Group Ltd
Investment Cost (over 21 years)	$4,881,676	Figures provided by Biogas Technology Group Ltd

Detailed information on the financial analysis carried out can be found in Annex 3.

Sub-step 2d: Sensitivity analysis

A sensitivity analysis was conducted by altering the following parameters:

- Increase in project revenue;
- Reduction in project capital expenditures (CAPEX) and operational and maintenance costs.

These parameters were selected, as they are considered the most likely to change over time. Furthermore, we chose to vary those parameters by a range of +10% and –10% (as per EB 39 recommendation on Sensitivity analysis) as it was deemed appropriate in the context of the specific project circumstances.

[6] Electricity invoice for both residential and industrial can be made available to the DOE on request.

Therefore, financial analyses were performed altering each of these parameters by 10% (either an increase in revenue or a reduction in cost), and assessing the impact on the project IRR would be (see Table 3 below). The project IRR remains lower than the benchmark IRR even in the case where these parameters change in favour of the Project.

Table 3: Sensitivity analysis

Scenario	**% change**	**IRR (%)**	**NPV $US**
Original		Negative IRR	-3,666,678
Increase in project revenue	+10%	-8.8%	-2,927,330
Reduction in project costs	-10%	-8.2%	-2,599,686

Note: NPV uses 10% discount rate. Calculations consider a twenty-one year period.

In order for the project IRR to reach the 10% Benchmark, the project revenue should increase by 75%, which is very unlikely to happen. Indeed, in the previous years, the electricity tariff in Ras Al-Khaimah hasn't increased and remained at 0.05 US$ / kWh (20 fils per kWh).
Using the same approach, in order for the project IRR to reach the 10% Benchmark, the project costs should decrease by 43%, which sounds very unrealistic.

In conclusion, the project IRR is not substantial enough to warrant investment in the Project even with an increase in revenue, or a decrease in project costs. The installation of a landfill gas to energy project is therefore not viable without consideration of carbon finance, and more specifically without the revenue obtained under the CDM. The project activity without CDM (scenario P1 or LFG1) does not generate an IRR comparable with standard investment behaviour in the Host Country, which makes the project clearly additional.

Conclusion:

Based on the above analysis, P1 (LFG1) can be discarded from the possible baseline scenarios.
Hence, LFG2 (atmospheric release of the landfill gas) and P6 (electricity obtained from the Grid) are the only remaining credible and plausible scenarios, and have been identified as the baseline scenario.

We do not apply Step 3 (Barrier analysis), since Step 2 (Investment analysis) shows a clear conclusion.

Step 4. Common Practice Analysis

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

The United Arab Emirates consists of 7 separate states (Emirates): Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al Qaiwain, Fujairah and Ras Al Khaimah. Although waste management policies differ between the various emirates, the common practice has been carried out on a nationwide basis in order to be conservative, and considering that Ras Al Khaimah as an emirate has a relatively small population on its own. In order to compare landfills of a similar scale to the project activity, landfills covering all major cities in the host country have been identified. The following table lists all cities in the host country with a population over 30,000. These are considered to be cities of similar or larger population size as compared to Ras Al Khaimah, where the project activity is located (population 113,374), in order to ensure that all landfills of comparable scale in the host country are considered in the analysis. Cities smaller than 30,000 were not considered since the volume of waste generated would not be comparable with that of Ras Al Khaimah; and furthermore, data was not available.

City	Emirate	Population
Dubai	Dubai	1,354,980
Sharjah	Sharjah	685,000
Abu Dhabi	Abu Dhabi	630,000
Al Ain	Abu Dhabi	350,000
Ajman	Ajman	202,244
Ras Al Khaimah	Ras Al Khaimah	113,374
Fujairah	Fujairah	74,330
Khor Fakkan	Sharjah	45,000
Umm Al Qaywayn	Umm Al Qaywayn	33,361

Source: http://www.citypopulation.de/UAE.html

Having defined the population centres to be considered, we now consider the landfills in each city, and the landfill gas management practices (if any) at each site. The following table lists all the landfills receiving waste for the above mentioned cities in the host country, and the status of landfill gas collection, venting, flaring, or use at each landfill.

Table 4: Major landfills in the UAE (landfills covering all cities with population greater than 30,000 people) other than the project activity:

Landfill Name	Location	Waste Deposition Rate (tonnes/day)	Current Status
Dubai landfills	Dubai, Dubai emirate	9,721 tonnes/day	No collection system
Sharjah old and new landfills	Sharjah, Sharjah emirate	8,500-10,000 tonnes/day	Some passive venting; aerobic treatment system being implemented under CDM but no LFG collection or use
Al Dhafra landfill (Abu Dhabi)	Al Dhafra, Abu-Dhabi emirate	2,500 tonnes/day[7]	No collection system
Al Ain landfill	Abu Dhabi Emirate	360 tonnes/day	No collection system
Al Hail landfill, Fujairah	Al Hail, Fujairah Emirate	250 tons/day	No collection system
Umm Al Quwain landfill	Umm El-Quwain emirate	150 tonnes/day	No collection system

From the table it is clear that landfill gas capture and flaring or use has not been practiced at any other major landfill in the host country (and given that this list covers all cities of any significant size in the host country, it can be concluded that landfill gas capture and use or flaring has not been practiced at any location in the UAE).This is further substantiated below:

[7] US Department of Commerce Report (2006) 'United Arab Emirates Municipal Solid Waste Management'

At the Dubai landfills, written communication from Tadweer, the company managing the landfills, confirms that no LFG collection system exists[8].

At the Sharjah landfills, the old Sharjah landfill is being closed down, and is currently undertaking a CDM project to rehabilitate the site, including "Smell Well" aerobic management of the waste[9,10]. The CDM submission (PDD and new methodology) confirms that no LFG collection exists on the landfill. This is further confirmed by expert opinion from Ms. Tania Fram, Chief Commercial Officer, Emirates Environmental Technology (the company managing the remediation project), who confirms that although waste at the new landfill is being managed into lined cells, the quantity of gas generated is very small and no LFG collection exists[11]. Furthermore, recent articles highlight the lack of adequate waste management at the Sharjah landfills[12].

For Abu Dhabi, all waste is sent to Al Dhafra landfill, where management does not include any gas collection and use/flaring system[13] as confirmed in writing by Mr Mohamad Hashim, Public Health Administration (solid waste privatization project), Municipality of Abu Dhabi[14]. The State of the Environment Report published by the Abu Dhabi Environment Agency also confirms that no LFG collection and use/flaring exists in Abu Dhabi emirate: "Methane is 20 times more potent as a GHG than carbon dioxide (CO_2). It can be captured and used as a source of energy, but this is not the case in Abu Dhabi landfills"[15].

At Al Ain (located in Abu Dhabi emirate), waste is dumped in an uncontrolled manner at Zakher landfill[16]. An expert opinion from the Chief Commercial Officer of Emirates Environmental technology, a leading waste management company bidding for the contract to manage the waste at Zakher landfill in Al Ain (EET already manages waste from Sharjah) confirmed that there is no LFG management system in

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[8] Email, November 8, 2007 - Lina Chaaban, EnviroCare Manager, Tadweer waster recovery facility.

[9] CDM PDD and methodology submission http://cdm.unfccc.int/methodologies/PAmethodologies/publicview.html?meth_ref=NM0283

[10] Abu Dhabi Environment Agency, UAE Environment News 'Dh210m landfill move under way': http://www.ead.ae/en/?T=4&ID=1131

[11] Meeting with Ms. Tania Fram, Chief commercial officer, Emirates Environmental Technology, November 25, 2007.

[12] The National Newspaper 'Crisis looms in Sharjah' September 08 2008 http://www.thenational.ae/article/20080908/NATIONAL/823454948

[13] US Department of Commerce Report (2006) 'United Arab Emirates Municipal Solid Waste Management'

[14] Email, November 11, 2007 - Mohamad Hashim, Public Health Administration (solid waste privatization project) - Municipality of Abu Dhabi. Smilkova, M. Abu Dhabi UAE Landfill Al Dharfa Lanfill Gas measurements , Sept 2006 - IUT Czech spol s.r.o

[15] Abu Dhabi Environment Agency (2007) 'State of The Environment Abu Dhabi' http://www.soe.ae/Abu_Themespage.aspx?m=237

[16] Abu Dhabi Environment Agency, UAE Environment News 'Dh210m landfill move under way': http://www.ead.ae/en/?T=4&ID=1131

place[17]. The aforementioned State of the Environment Report from the Abu Dhabi Environment Agency also confirms that no LFG collection and use/flaring exists in Abu Dhabi emirate.

At Fujairah, all waste is sent to the landfill at Al Hail, where there is no current or proposed LFG management system, as confirmed by expert opinion from the Head of Environment Protection & Development Department of Fujairah Municipal Government[18].

At Umm El-Quwain, which in any case is a relatively small landfill, there is no waste management at the landfill, according to an investigation by Middle East Business Magazine The Kipp report[19]. It has been further confirmed by expert opinion from Mr Amer Mahmoud, manager of the Ras Al Khaimah Landfill that no LFG collection exists[20].

It is also important to note that the UAE faces extreme climate conditions (hot and dry) and hence landfill gas production is limited. This indicates why collection and use of LFG is unattractive, and why corresponding laws for LFG management have not been established yet.

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

There are no similar options occurring in the host country. In 2004, Sharjah’s municipality contracted the remediation of the old Sharjah landfill and construction of a new landfill to Emirates Environmental Technology Company (EET). But this project cannot be considered similar to the project activity since it involves aerobic treatment of the waste, not landfill gas collection and flaring or use. This project consists of excavation, mechanical sorting, and 2 “Smell Well” Systems. This remediation, aimed at creating an aerobic environment in the existing waste to avoid further methane production, is currently under construction, and is being developed under the CDM, with a PDD and new methodology having been submitted.

Since the project is the first of its kind in the host country, this substantiates the conclusion that the project activity is additional.

B.6 Emission reductions:

B.6.1. Explanation of methodology choices:

Baseline emissions:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \qquad (1)$$

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[17] Meeting with Ms. Tania Fram, Chief commercial officer, Emirates Environmental Technology, November 25, 2007.

[18] Email dated 08 Nov 2007. from Eng. Ali Mohamed Kassim, Head of Environment Proection & Development Department, Municipality of Fujairah.

[19] The Kipp Report (2008) ‘Dumping raw sewage and scavenging for recyclables on mountains of waste’: http://www.kippreport.com/kipp/2008/06/05/dumping-raw-sewage-and-scavenging-for-recyclables-on-mountains-of-waste/?bnr=1

[20] Phone call with Mr Amer Mahmoud, RAK Landfill manager - November 26, 2007

As the proposed project activity does not include a thermal energy component, all following equations[21] will exclude this component for simplification:

$$BE_y = (MD_{project,y} – MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} \qquad (1^*)$$

Where:

BE_y	tCO_2e	Baseline emissions in year *y*;
$MD_{project,y}$[22]	tCH_4	Methane destroyed/combusted by the project activity during a year *y*;
$MD_{BL,y}$	tCH4	The amount of methane that would have been destroyed/combusted the year in the absence of the project due to regulatory and/or contractual requirement;
GWP_{CH4}	tCO2 e/tCH4	Global Warming Potential value for methane for the first commitment period;
$EL_{LFG,y}$	MWh	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an onsite/off-site fossil fuel based captive power generation, during year *y*;
$CEF_{elecy,BL,y}$	tCO_2e/MWh	CO_2 emissions intensity of the baseline source of electricity displaced.

1. Methane destroyed by the project activity ($MD_{project,y}$):

a) Sum of the quantities fed to the flare(s) and the power plant(s):

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} \qquad (8^*)$$

Where:

$MD_{project,y}$:	tCH_4	Amount of methane that would have been destroyed during year *y*, in the project scenario;
$MD_{flared,y}$:	tCH_4	Quantity of methane destroyed by flaring during year *y*;
$MD_{electricity,y}$:	tCH_4	Quantity of methane destroyed by generation of electricity during year *y*.

The quantity of methane destroyed by flaring is calculated using the following equation:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) – (PE_{flare,y} / GWP_{CH4}) \qquad (9)$$

Where:

$MD_{flared,y}$:	tCH_4	Quantity of methane destroyed by flaring during year *y*;
$LFG_{flare,y}$:	Nm^3LFG	Quantity of landfill gas fed to the flare(s) during the year *y*;
$w_{CH4,y}$:	Nm^3CH_4/Nm^3LFG	Average methane fraction of the landfill gas as measured[23] during a year *y*;
D_{CH4}:	tCH_4/Nm^3CH_4	Methane density[24];
$PE_{flare,y}$:	tCO_2e	Project emissions from flaring of the residual gas stream in year *y* determined following the procedure described in the *"Tool to*

[21] All equations which are modified and/or simplified are marked with a (*).

[22] $MD_{project,y}$ will be calculated in two ways: Once as the sum of quantities fed to the flare(s) and the power plant(s) (equation (8*)), and once as the total quantity of methane generated (equation (13)). The lowest value of the two will be adopted as $MD_{project,y}$.

[23] Methane fraction of the landfill gas to be measured on wet basis.

[24] At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4 / m^3CH_4.

		determine project emissions from flaring gases containing methane";
GWP_{CH4}:	tCO_2e/tCH_4	Global Warming Potential of methane valid for the first commitment period.

Once the Project will include the second project component, electricity generation from the captured LFG, the quantity of methane destroyed through combustion in the electricity generation engines will be calculated using the following equation:

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4} \quad (10)$$

Where:

$MD_{electricity,y}$:	tCH_4	Quantity of methane destroyed by generation of electricity during year *y*;
$LFG_{electricity,y}$:	Nm^3LFG	Quantity of landfill gas fed into the electricity generator during year *y*;
$w_{CH4,y}$:	Nm^3CH_4/Nm^3LFG	Average methane fraction of the landfill gas as measured during year *y*;
D_{CH4}:	tCH_4/Nm^3LFG	Methane density.

As the sum of quantities fed to the flare(s) and to the power plant(s) must be compared annually with the total quantity of methane generated, in order to adopt the lowest value of the two as $MD_{project,y}$, the following estimation must be carried out with the additional equation from the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*.

b) Ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year ($MD_{project,y}$)

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4} \quad (13)$$

$BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year y (tCO2e), calculated as per the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site[25]"*.

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

Where:

Parameter	**Unit**	**Default**	**Description**
$BE_{CH4,SWDS,y}$	tCO_2e		Methane generation from the landfill in the absence of the project activity at year *y*;
φ	-	0.9	model correction factor to account for model uncertainties
f	-	0	Fraction of methane captured at the SWDS[26] and flared,

[25] This tool is referred to as "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". The name change occurred in EB41.

			combusted or used in another manner;
GWP_{CH4}	$tCO_2e/t\ CH_4$	21	Global Warming Potential of methane, valid for the relevant commitment period;
OX	-	0.1	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste);
F	volume fraction	0.5	Fraction of methane in the SWDS gas;
DOC_f	-	0.5	Fraction of degradable organic carbon that can decompose;
MCF	-	1.0	Methane correction factor;
$W_{j,x}$	tons		amount of organic waste type *j* prevented from disposal in the SWDS in the year *x*;
DOC_j	weight fraction		Fraction of degradable organic carbon in the waste type *j*;
k_j	-	-	Decay rate for the waste type *j*;
j	-	-	Waste type category (index);
x	-	-	Year since the landfill started receiving wastes, runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y);
y	-	-	Year for which methane emissions are calculated.

Above specified default values were taken from the ***"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site***[27]***"***. Where the tool provides different values to chose from, the following choices were made:

- OX: 0.1 because the landfill is covered with a mix of sand and clay.
- MCF: 1.0 because the landfill is considered as an anaerobic managed solid waste disposal sites as described in the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*.
- DOC_j: values are chosen assuming that the waste is wet (no drying process before being landfilled). Please find the values for the different waste types listed in Section B.6.2.
- k_j :values are chosen considering that the climate is tropical (Mean Annual Temperature > 20ºC) and dry (Mean Annual Precipitation < 1000mm), which is the case in Ras Al-Khaimah[28].

Once $BE_{CH4,SWDS,y}$ is calculated according to the Tool, a collection efficiency is applied to this value in order to reflect the fact that not all methane generated is actually captured by the collection system.
The collection efficiency value should consider the physical conditions of this landfill (properly managed with lining) as well as the capping material (mix of clay and sand) used to cover the waste, but those parameters are already addressed by the formula used to calculate $BE_{CH4,SWDS,y}$. Therefore, according to Biogas Technology Group Ltd expertise, a 70% collection efficiency is a reasonable factor to use, as it reflects only the efficiency of the system itself (pipes, blower, etc...).

2. Amount of methane that would have been destroyed/combusted in the absence of the Project due to regulatory and/or contractual requirements (**$MD_{BL,y}$**)

[26] Solid Waste Disposal Site, as defined in the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.

[27] This tool is referred to as *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. The name change occurred in EB41.

[28] http://www.uaemet.gov.ae/upload/fileshow.php?target=uae_climate

An adjustment factor (AF) is used to determine the $MD_{BL,y}$ as regulatory or contractual requirements do not specify $MD_{BL,y}$, and in fact no methane is destroyed/combusted in the absence of the project activity.

For the amount of methane destroyed in the baseline scenario, the following equation is used:

$$MD_{BL,y} = MD_{project,y} * AF \qquad (2)$$

Where:

$MD_{BL,y}$:	tCH_4	Amount of methane that would have been destroyed/combusted during year *y* in the absence of the project due to regulatory and/or contractual requirements;
$MD_{project,y}$:	tCH_4	Amount of methane that would have been destroyed/combusted during year *y* in the project scenario;
AF:	%	Adjustment factor in percentage.

The adjustment factor AF was set at 0%. This value is justified based on the fact that the regulatory requirements do not indicate any specific amount of gas collection and destruction or utilisation and that in practice, no LFG is actually flared. The former landfill operator is not collecting neither burning the gas generated in the landfill. $MD_{BL,y}$ therefore equals zero.

3. Determination of $CEF_{elec,BL,y}$

As the baseline is electricity generated by plants connected to the grid, the emissions factor $CEF_{elec,BL,y}$, for the relevant grid will be calculated according to the requirements of the *"Tool to calculate the emission factor for an electricity system"*, once the Project generates electricity.

Project emissions:

1. Project emissions from flaring:

Project emissions from flaring will be calculated and monitored according to the procedures described in the "*Tool to determine project emissions from flaring gases containing methane*", using the 90% default value[29] for the methane destruction efficiency of the flare.

According to the description in the *"Tool to determine project emissions from flaring gases containing methane"* the project emissions from flaring gases are calculated as follows:

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

Where:

$PE_{flare,y}$:	tCO_2e	Project emissions from flaring of the residual gas stream in a year *y*;
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*;
$\eta_{flare,h}$	-	Flare efficiency in hour *h;*

[29] A 90% default value will be used for the project activity as long as the entire equipment for continuous measurement of the methane destruction efficiency of the flare is not installed. At the moment of submitting the PDD, only a continuous monitoring of the parameter T_{flare} is contemplated. As and when the entire equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the actual flare efficiency will be monitored continuously *ex-post*, and the default value will no longer be used. Details of the additional parameters to be monitored in the event of using continuous monitoring of the flare efficiency are described in Annex 4. Additional equations will be based on the "*Tool to determine project emissions from flaring gases containing methane*".

The mass flow rate of methane in the residual gas is calculated as follows:

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

Where:

$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*;
$FV_{RG,h}$	Nm^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h;*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h*;
$\rho_{CH4,n}$	kg/Nm^3	Density of methane at normal conditions (0.7168).

2. Project emissions from electricity consumption:

$PE_y = PE_{EC,y} + PE_{FC,y}$ (16)

As there is no thermal energy component for this project activity, the simplified equation will be used:

$$PE_y = PE_{EC,y} \qquad (16^*)$$

Where:

PE_y	tCO_2/yr	Project emissions in year *y*;
$PE_{EC,y}$	tCO_2/yr	Emission from consumption of electricity in the project case. The project emissions from electricity consumption $PE_{EC,y}$ will be calculated following the latest version of *"Tool to calculate baseline, project and/or leakage project emissions from electricity consumption"*.

The *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* provides procedures to calculate project emissions from electricity consumption.
Case A: Electricity consumption from the grid is applicable for the project activity, using the following formula:

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,CM,y} * (1 + TDL_y)$$

Where:

Parameter	**Unit**	**Default (or estimated)**	**Description**
$PE_{EC,y}$	tCO_2/yr		Project emissions from electricity consumption by the project activity during the year *y*;
$EC_{PJ,y}$	MWh	263[30]	Quantity of electricity consumed by the project activity during the year *y*;
$EF_{grid,y}$	tCO_2/Mh	1.3	Emission factor for the grid in year *y*;
TDL_y	-	20%	Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site.

[30] Estimated average annual electricity consumption by the Project. Please refer to Annex 3.

The default value for $EF_{grid,y}$ will only be applied as long as the Project does not generate electricity from the captured LFG.
As and when the project faces the second stage[31], and relevant data to calculate the grid emission factor will be publicly available, $EF_{grid,y}$ will be calculated in accordance to the *"Tool to calculate project emissions from electricity consumption"*.
The default value for TDL_y was chosen, as recent, accurate and reliable data about grid-related transmission and distribution losses within the Host Country were not available at the time of PDD submission.
The value of 263 MWh/year for $EC_{PJ,y}$ is an estimated value for ex ante emission reduction calculation.

Also, in the event that a diesel generator is used as a back up of the Grid for electricity consumption, the following equation from the *Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* (Option B2) will apply:

$$PE_{EC,y} = EC_{PJ,y} * 1.3\ tCO_2/MWh$$

Leakage emissions:

No leakage effects need to be accounted under this methodology.

Emission reductions:

The following formula was modified in order to clearly differentiate between project emissions from flaring ($PE_{flare,y}$) and electricity consumption ($PE_{EC,y}$). Project emissions from flaring are already included in the calculation of $MD_{flare.y}$ (equation (9)), and thus in $MD_{project}$ and BE_y. Hence, they have not to be deducted once more in the overall emission reduction calculation in equation (17*).

$$ER_y = BE_y - PE_{EC,y} \qquad (17^*)$$

Where:

ER_y	tCO_2e/yr	Emission reductions in year *y*;
BE_y	tCO_2e/yr	Baseline emissions in year *y*;
$PE_{EC,y}$	tCO_2e/yr	Project emissions from electricity consumption in year *y*.

All *ex-ante* calculations to obtain the emission reduction from the project activity are listed in Section B.6.3.

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

Data / Parameter:	**Regulatory requirements relating to landfill gas projects**
Data unit:	-
Description:	Regulatory requirements relating to landfill gas projects
Source of data used:	National legislation and mandatory regulations
Value applied:	0%
Justification of the	The information will be recorded annually, to use it for changes to the

[31] As the changes in the CEF are expected to be significant until the start of the second project component, a *ex-post* calculation of the CEF at given time represents a more accurate approach.

choice of data or description of measurement methods and procedures actually applied:	adjustment factor (AF) or directly to MDreg,y at renewal of the credit period.
Any comment:	Further information in Section B.6.3.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of methane
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:	**D_{CH4}**
Data unit:	tCH_4/m^3CH_4
Description:	Methane Density
Source of data used:	
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied:	At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4.
Any comment:	

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[32]"*.
Value applied:	
Justification of the choice of data or description of measurement methods	As per the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"

[32] This tool is referred to as *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. The name change occurred in EB41.

and procedures actually applied:	
Any comment:	Used for *ex-ante* estimation of the amount of methane that would have been destroyed/combusted during the year

Data / Parameter:	DOCj
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*.
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value applied:	The following values for the different waste types *j* are applied: (see table below)
Justification of the choice of data or description of measurement methods and procedures actually applied:	In accordance with *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*[33]*"*
Any comments	The values applied are for wet waste, as there is no drying process of the waste

Waste type *j*	**DOC_j (% wet waste)**
Wood and wood products	43
Pulp, paper and cardboard (other than sludge)	40
Food, food waste, beverages and tobacco (other than sludge)	15
Textiles	24
Garden, yard and park waste	20
Glass, plastic, metal, other inert waste	0

Data / Parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type *j*.
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value applied:	The following values for the different waste types *j* are applied:

[33] This tool is referred to as *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. The name change occurred in EB41.

Waste type j		Tropical (MAT > 20ºC) Dry (MAP < 1000 mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.045
	Wood,wood products and straw	0.025
Moderatley degrading	Other (non-food) organic putrescible garden and park waste	0.065
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.085

Justification of the choice of data or description of measurement methods and procedures actually applied:	In accordance with *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*[34]*"*
Any comments	The values applied are for tropical (MAT> 20°C) and dry (MAP < 1000m) conditions (http://www.uaemet.gov.ae/upload/fileshow.php?target=uae_climate)

Data / Parameter:	E_{DS}
Data unit:	%
Description:	Efficiency of the degassing system which will be installed in the project activity
Source of data used:	Project Developer
Value applied:	**70%**
Justification of the choice of data or description of measurement methods and procedures actually applied:	The 70 % is a reasonable factor to differentiate between LFG generated (from the pure application of the methodology) and LFG collected. This collection efficiency takes into account the efficiency of the system itself, therefore losses of gas through the gas collection system.
Any comments	

Data / Parameter:	$\mathbf{EF_{grid,CM,y}}$
Data unit:	tCO_2/MWh
Description:	Emission factor for the grid in year *y*
Source of data used:	*"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*
Value applied:	1.3
Justification of the choice of data or description of	Conservative default value as per *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.

[34] This tool is referred to as *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. The name change occurred in EB41.

measurement methods and procedures actually applied:	
Any comment:	The default value will only be applied as long as the Project does not generate electricity from the captured LFG, and hence no displacement of grid electritiy is taking place in the project activity. As and when the second faces the second project stage, and relevant data to calculate the grid emission factor will be publicly available, $EF_{grid,y}$ will be calculated in accordance to the "Tool to calculate the emission factor for an electricity system" .$CEF_{elec,BL,y}$ will then equal $EF_{grid,CM,y}$, and default values for both parameters will no longer be used for the Project.

Data / Parameter:	**TDL_y**
Data unit:	-
Description:	Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site.
Source of data used:	*"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*
Value applied:	20%
Justification of the choice of data or description of measurement methods and procedures actually applied:	Default value as per *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, as recent, accurate and reliable data was not publicly available within the Host Country at the time of PDD submission.
Any comment:	

Data / Parameter:	**$\eta_{flare,h}$**
Data unit:	-
Description:	Flare efficiency in the hour *h*
Source of data used:	*"Tool to determine project emissions from flaring gases containing methane".*
Value applied:	90%
Justification of the choice of data or description of measurement methods and procedures actually applied:	Default value as per *"Tool to determine project emissions from flaring gases containing methane".* *(See Footnote15.)*
Any comment:	As and when the entire equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the actual flare efficiency will be monitored continuously *ex-post*, and the default value will no longer be used. For details refer to Section B.6.3.

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

Baseline emission

$$BE_y = (MD_{project,y} – MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} \qquad (1^*)$$

1. $MD_{project,y}$

a) Estimated amount of methane destroyed by the project activity - Sum of quantities fed to the flare(s) and power plant(s):

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} \qquad (8^*)$$

Table 1[35]:

	$MD_{flare,y}$ (tCH_4)	$MD_{electricity,y}$ (tCH_4)	$MD_{project,y}$ (tCH_4)
2009 (July-Dec)	585	0	585
2010	559	867	1,426
2011	260	1,387	1,647
2012	273	1,561	1,834
2013	287	1,734	2,021
2014	459	1,734	2,193
2015	315	2,081	2,395
2016 (Jan-June)	161	1,127	1,288
Total	2,899	10,490	13,390

Where the quantity of methane destroyed by flaring was calculated using the following equation:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) – (PE_{flare,y} / GWP_{CH4}) \qquad (9)$$

Table 2:

	$LFG_{flare,y}$ (m^3)	**$PE_{flare,y}$** ($t\ CO_2$)	**$MD_{flared,y}$** ($t\ CH_4$)
2009 (July-Dec)	1,813,553	1,365	585
2010	1,733,382	1,305	559
2011	805,903	607	260
2012	846,835	637	273
2013	890,664	670	287
2014	1,423,225	1,071	459
2015	975,222	734	315
2016 (Jan-June)	500,007	376	161
Total	8,988,791	6,765	2,899
Default values: $w_{CH4,y}$ = 50%; D_{CH4} = 0.0007168; GWP_{CH4} = 21			

[35] The values for $MD_{flare,y}$ and $MD_{electricity}$ in Table 1 are derived from a retransformation from the FOD model (tCO_2e retransformed into LFG flow in Nm^3/hr) as per the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”

And the quantity of methane destroyed through combustion in the electricity generation engines is estimated using the following equation:

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4} \qquad (10)$$

Table 3:

	$LFG_{electricity,y}$ (m^3)	$MD_{electricity,y}$ (t CH_4)
2009 (July-Dec)	0	0
2010	2,419,014	867
2011	3,870,423	1,387
2012	4,354,225	1,561
2013	4,838,028	1,734
2014	4,838,028	1,734
2015	5,805,634	2,081
2016 (Jan-June)	3,144,718	1,127
Total	29,270,070	10,490
Default values: $w_{CH4,y}$ = 50%; D_{CH4} = 0.0007168		

b) *Ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year* ($MD_{project,y}$)

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4} \qquad (13)$$

Table 4:

	$BE_{CH4,SWDS,y}$ (t CO_2)	**$MD_{project,y}$** (t CH_4)
2009 (July-Dec)	13,650	650
2010	31,253	1,488
2011	35,196	1,676
2012	39,145	1,864
2013	43,116	2,053
2014	47,125	2,244
2015	51,035	2,430
2016 (Jan-June)	54,863	2,613
Total	315,383	15,018
Default values: $w_{CH4,y}$ = 50%; D_{CH4} = 0.0007168; E_{DS}: Degassing efficiency :70% (The degassing efficiency is already applied to the $BE_{CH4,SWDS,y}$ values in this table)		

The comparison of $MD_{project,y}$ from Table 1 and Table 4 show, that $MD_{project,y}$ from Table 1 gives lower values, as it includes the project emissions from flaring. $MD_{project,y}$ values from Table 1 will be adopted for the *ex-ante* estimations.

The methane actually destroyed by the project activity is determined *ex-post* by monitoring the quantity of methane flared and/or used to generate electricity.

2. $MD_{BL,y}$

For the amount of methane destroyed in the baseline scenario, we use the following equation:

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

As the AF was set a 0% as explained in Section B.6.1, $MD_{BLt,y}$ equals zero for the first commitment period.

3. Electricity displacement: $EL_{LFG,y} \cdot CEF_{elec,BL,y}$

For the purpose of the ex-ante emission reduction calculation, a default value of 0 is applied for $CEF_{elec,BL,y}$.
As and when the Project faces the second stage (Electricity generation), and relevant data to calculate the grid emission factor are publicly available, $CEF_{elec,BL,y}$ will be calculated in accordance to the "Tool to calculate the emission factor for an electricity system" and the default value (0) will no longer be used.

	EL LFG,*y* (MWh)	EL LFG,*y* * $CEF_{elec,BL,y}$ (t CO2)
2009 (July-Dec)	0	0
2010	4,000	0
2011	6,400	0
2012	7,200	0
2013	8,000	0
2014	8,000	0
2015	9,600	0
2016 (Jan-June)	5,200	0
Total	48,400	0

Project emissions:

1. Project emissions from flaring

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

with:

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

Table 5:

	$FV_{RG,h}$	$TM_{RG,h}$	$PE_{flare,y}$
2009 (July-Dec)	207	74	682
2010	198	71	1,305
2011	92	33	607
2012	97	35	637
2013	102	36	670
2014	162	58	1,071
2015	111	114	2,100

2016 (Jan-June)	57	367	3,376
Total	1,176	422	7,754
Default values: $fv_{CH4,RG,h}$ = 50%; $\rho_{CH4,n}$ = 0.7168; $\eta_{flare,h}$ = 90%; GWP_{CH4} = 21			

These project emissions are already included in the calculation of $MD_{project.y}$ (equation (8*)), and thus in BE_y. Hence, they have not to be deducted once more in the overall emission reduction calculation in equation (17*).

2. Project emissions from electricity consumption

$$PE_y = PE_{EC,y} \qquad (16^*)$$

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1 + TDL_y)$$

$$PE_{EC,y} = EC_{PJ,y} * 1.3 * (1 + 0.20) = PE_y$$ [36]

Table 6:

	$EC_{PJ,y}$ (MWh)	**$PE_{EC,y}$ (tCO_2)**
2009 (July-Dec)	131	205
2010	263	410
2011	263	410
2012	263	410
2013	263	410
2014	263	410
2015	263	410
2016 (Jan-June)	131	205
Total	1,840	2,870

Emission reduction

The greenhouse gas emission reductions achieved by the project activity during a given year *y* (ER_y) are calculated using a modified equation (based on the formula above), as Project Emissions from flaring ($PE_{flare,y}$) need to be deducted, too:

$$ER_y = BE_y - PE_{EC,y} \qquad (17^*)$$

	BE_y ($tC0_2$)	$PE_{EC,y}$ (tCO_2)	ER_y (tCO_2)
2009 (July-Dec)	12,285	205	12,080
2010	29,948	410	29,538
2011	34,589	410	34,179
2012	38,508	410	38,098

[36] With default values as defined in the *"Tool to calculate the emission factor for an electricity system"*.

2013	42,446	410	42,036
2014	46,054	410	45,644
2015	50,301	410	49,891
2016 (Jan-June)	27,055	205	26,850
Total	281,186	2,870	278,316

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

Table: Total Emission Reductions over the first crediting period

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
2009 (July-Dec)	205	12,285	0	12,080
2010	410	29,948	0	29,538
2011	410	34,589	0	34,179
2012	410	38,508	0	38,098
2013	410	42,446	0	42,036
2014	410	46,054	0	45,644
2015	410	50,301	0	49,891
2016 (Jan-June)	205	27,055	0	26,850
Total (tonnes of CO2e)	2,870	281,186	0	278,316

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:	Nm^3
Description:	Total amount of landfill gas captured at Normal Temperature and Pressure
Source of data to be used:	Project Developer

Value of data applied for the purpose of calculating expected emission reductions in section B.5	5,465,552 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Under normal operational conditions data will be measured with a flow meter and monitored continuously by the Project Developer. If for any reasons the continuously monitored data for $LFG_{total,y}$ shall not be available, the Project Developer will take periodical measurements of $LFG_{total,y}$ at a 95% confidence level, using calibrated equipment (please see justification with reference to ACM0001, v8.1 in the comment). 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. The flow meter will be maintained and calibrated regularly in line with manufacturer requirements. This will ensure that the accuracy of the measurement instrument is maintained. The accuracy ±1.5 % of reading plus ±0.5 % of full scale
Any comment:	As long as the Project is not generating electricity from the captured LFG, $LFG_{total,y}$ will equal $LFG_{flared,y}$. The flow meter will express gas flow in normalized cubic meters, therefore no separate monitoring of pressure (P) and temperature (T) of LFG is necessary to determine density. ACM0001, v8.1 states that "*The fraction of methane in the landfill gas (wCH4,y) should be measured with a continuous analyzer or, alternatively, with periodical measurements, at a 95% confidence level , […] and accordingly the amount of land fill gas from* $LFG_{total,y}$, $LFG_{flare,y}$, *LFGelectricity,y*, $LF_{PL,y}$ *and* $LFG_{thermal,y}$ *shall be monitored in the same frequency.*

Data / Parameter:	$\mathbf{LFG_{flared,y}}$
Data unit:	Nm^3
Description:	Amount of LFG flared at Normal Temperature and Pressure
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,284,113 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Under normal operational conditions data will be measured with a flow meter and monitored continuously by the Project Developer. If for any reasons the continuously monitored data for $LFG_{flared,y}$ shall not be available, the Project Developer will take periodical measurements of $LFG_{flared,y}$ at a 95% confidence level, using calibrated equipment (please see justification with reference to ACM0001, v8.1 in the comment). 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.

	The flow meter will be maintained and calibrated regularly in line with manufacturer requirements. This will ensure that the accuracy of the measurement instrument is maintained. The accuracy ±1.5 % of reading plus ±0.5 % of full scale
Any comment:	The flow meter will express gas flow in normalized cubic meters, therefore no separate monitoring of pressure (P) and temperature (T) of LFG is necessary to determine density. **$LFG_{flared,y}$** is considered to be equivalent to the variable $FV_{RG,h}$ (volumetric flow rate of the residual gas) as described in the "*Tool to determine project emissions from flaring gases containing methane*" to determine the project emissions from the flaring process. ACM0001, v8.1 states that "*The fraction of methane in the landfill gas (wCH4,y) should be measured with a continuous analyzer or, alternatively, with periodical measurements, at a 95% confidence level , […] and accordingly the amount of land fill gas from $LFG_{total,y}$, $LFG_{flare,y}$, $LFG_{electricity,y}$, $LF_{PL,y}$ and $LFG_{thermal,y}$ shall be monitored in the same frequency*.

Data / Parameter:	**$LFG_{electricity,y}$**
Data unit:	Nm^3
Description:	Amount of LFG combusted in power plant at Normal Temperature and Pressure
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4,181,439 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Under normal operational conditions data will be measured with a flow meter and monitored continuously by the Project Developer. If for any reasons the continuously monitored data for $LFG_{flared,y}$ shall not be available, the Project Developer will take periodical measurements of $LFG_{electricity,y}$ at a 95% confidence level, using calibrated equipment (please see justification with reference to ACM0001, v8.1 in the comment). 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. The flow meter will be maintained and calibrated regularly in line with manufacturer requirements. This will ensure that the accuracy of the measurement instrument is maintained. The accuracy ±1.5 % of reading plus ±0.5 % of full scale
Any comment:	As long as the Project is not generating electricity from the captured LFG, $LFG_{electricity,y}$ will not be monitored. The flow meter will express gas flow in normalized cubic meters, therefore no separate monitoring of pressure (P) and temperature (T) of LFG is necessary to determine density. ACM0001, v8.1 states that "*The fraction of methane in the landfill gas (wCH4,y) should be measured with a continuous analyzer or, alternatively, with periodical measurements, at a 95% confidence level , […] and accordingly the*

	amount of land fill gas from $LFG_{total,y}$, $LFG_{flare,y}$, $LFG_{electricity,y}$, $LF_{PL,y}$ and $LFG_{thermal,y}$ shall be monitored in the same frequency.

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:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	966 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Calculated 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:	

Data / Parameter:	**w_{CH4}**
Data unit:	m^3CH_4 / m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Parameter is measured by using certified equipment
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50%
Description of measurement methods and procedures to be applied:	Under normal operational conditions the methane content will preferably be measured continuously with a fixed gas analyser by the Project Developer. If for any reasons the continuously monitored data for w_{CH4} from the fixed gas analysers shall not be available, the Project Developer will alternatively take periodical measurements of w_{CH4} at a 95% confidence level, using calibrated portable gas analyser(s) (please see justification with reference to ACM0001, v8.1 in the comment).
QA/QC procedures to be applied:	The analyser(s) should be subject to a regular maintenance and calibration according to manufacturer’s recommendation to ensure accuracy. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Any comment:	ACM0001, v8.1 states *“The fraction of methane in the landfill gas (wCH4,y) should be measured with a continuous analyzer or, alternatively, with periodical measurements, at a 95% confidence level , using calibrated portable gas meters*

	[…].” In accordance with the *“Tool to determine project emissions from flaring gases containing methane”* only the methane content of the landfill gas is measured and the remaining part is considered as N_2. Further $\mathbf{w_{CH4}}$ is considered to be equivalent to the variable $fv_{CH4,h}$ (Volumetric fraction of the component CH_4 in the landfill gas in the hour *h*) as described in the “*Tool to determine project emissions from flaring gases containing methane*”.

Data / Parameter:	$\mathbf{T_{flare}}$
Data unit:	˚C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Project Developer
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:	Continuous measurement of the temperature in the exhaust gas with a type N thermocouple as described in the “*Tool to determine project emissions from flaring gases containing methane*”. A temperature above 500^0C indicates that a significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	The thermocouple will be replaced or calibrated every year.
Any comment:	Required to determine adequate operation and operating hours of the flare.

Data / Parameter:	$\mathbf{EL_{LFG}}$
Data unit:	MWh
Description:	Net amount of electricity generated using LFG.
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	6,914 (annual average)
Description of measurement methods and procedures to be applied:	Electricity will be monitored continuously using an electricity meter.
QA/QC procedures to be applied:	Electricity meter will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier to ensure accuracy.
Any comment:	Required to estimate the emission reductions from electricity generation from LFG.

Data / Parameter:	$\mathbf{CEF_{elec,BL,y}}$

Data unit:	tCO_2/MWh
Description:	Carbon emission factor of electricity.
Source of data to be used:	Project Developer
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:	The $CEF_{elec,,BL,y}$ will be calculated once the project generates electricity. It will be calculated according to the equations from the *"Tool to calculate the emission factor for an electricity system"*, based on fuel consumption and electricity generation data for plants connected to the grid.
QA/QC procedures to be applied:	As per the *"Tool to calculate the emission factor for an electricity system"*.
Any comment:	The default value is only applied for *ex-ante* emission reduction calculation. As and when the Project faces the second project stage, and relevant data to calculate the grid emission factor will be publicly available, $EF_{grid,y}$ will be calculated in accordance to the "Tool to calculate the emission factor for an electricity system". $CEF_{elec,BL,y}$ will then equal $EF_{grid,y}$, and default values for both parameters will no longer be used for the Project.

Data / Parameter:	**$EC_{PJ,y}$**
Data unit:	MWh
Description:	Onsite consumption of electricity provided by the grid and/or captive power plant(s) and attributable to the project activity during the year *y*
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	263 (*ex-ante* estimate from Project Developer)
Description of measurement methods and procedures to be applied:	Electricity will be monitored using an electricity meter. Data will be aggregated at least annually.
QA/QC procedures to be applied:	Electricity meter will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier to ensure accuracy. Cross-check measurement results with invoices for purchased electricity if relevant.
Any comment:	Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity.

Data / Parameter:	**$EF_{grid,CM,y}$**
Data unit:	tCO_2/MWh
Description:	Emission factor for the grid in year *y*

Source of data to be used:	Conservative default value from the *“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”*.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1.3
Description of measurement methods and procedures to be applied:	N/A
QA/QC procedures to be applied:	N/A
Any comment:	A conservative default value of 1.3 tCO_2/MWh, as per the *“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”* will be used as long as the Project does not generate electricity. Once the project generates electricity, $\mathbf{EF_{grid,CM,y}}$ will be calculated as per the “Tool to calculate the emission factor for an electricity system” and is considered to be equivalent to $\mathbf{CEF_{elec,BL,y}}$.

Data / Parameter:	$\mathbf{FC_{i,m,y}}$, $\mathbf{FC_{i,y}}$, $\mathbf{FC_{i,j,y}}$, $\mathbf{FC_{i,k,y}}$, $\mathbf{FC_{i,n,y}}$ **and** $\mathbf{FC_{i,n,h}}$
Data unit:	Mass or volume unit
Description:	Amount of fossil fuel type *i* consumed by power plant / unit *m*, *j*, *k* or *n* (or in the project electricity system in case of $FC_{i,y}$) in year *y* or hour *h*
Source of data to be used:	Utility or government records or official publications
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Simple OM, simple adjusted OM, average OM: Annually during the crediting period for the relevant year, • Dispatch data OM: If available, hourly, otherwise annually for the year *y* in which the project activity is displacing grid electricity or, if available, hourly • BM: annually *ex-post*
QA/QC procedures to be applied:	
Any comment:	Applicable in the following cases: • Calculation of power *unit* emission factors ($EF_{EL,m,y}$, $EF_{EL,j,y}$, $EF_{EL,k,y}$ and $EF_{EL,n,y}$), in cases where fuel consumption data for the power unit is available; • Calculation of the simple OM, the simple adjusted OM and the average OM in cases where fuel consumption data is available for all power plants / units, • Calculation of the hourly emission factor of plants in the top of the dispatch where hourly fuel consumption data is available,

	The adequate parameter FC will be monitored depending on the type of data available (therefore depending on which method is used) at the time the project starts generating electricity.

Data / Parameter:	**NCVi,y**
Data unit:	GJ / mass or volume unit
Description:	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data to be used:	<table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>Values provided by the fuel supplier of the power plants in invoices</td><td>If data is collected from power plant operators (e.g. utilities)</td></tr><tr><td>Regional or national average default values</td><td>If values are reliable and documented in regional or national energy statistics / energy balances</td></tr><tr><td>IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td></td></tr></table>
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:	Simple OM, simple adjusted OM, average OM: annually during the crediting period for the relevant year • Dispatch data OM: Annually for the year *y* in which the project activity is displacing grid electricity or, if available, hourly • BM: annually *ex-post*
QA/QC procedures to be applied:	
Any comment:	Applicable in the following cases: • Calculation of power *unit* emission factors ($EF_{EL,m,y}$, $EF_{EL,j,y}$, $EF_{EL,k,y}$ and $EF_{EL,n,y}$), in cases where fuel consumption data for the power unit is available; • Calculation of the simple OM, the simple adjusted OM and the average OM in cases where fuel consumption data is available for all power plants / units • Calculation of the hourly emission factor of plants in the top of the dispatch where hourly fuel consumption data is available The gross calorific value (GCV) of the fuel can be used, if gross calorific values are provided by the data sources used.

Data / Parameter:	**$EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil 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** Values provided by the fuel supplier of the power plants in invoices / If data is collected from power plant operators (e.g. utilities) Regional or national average default values / If values are reliable and documented in regional or national energy statistics / energy balances IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories /
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:	• Simple OM, simple adjusted OM, average OM: annually during the crediting period for the relevant year • Dispatch data OM: Annually for the year *y* in which the project activity is displacing grid electricity or, if available, hourly • BM: For the first crediting period, annually *ex-post*. For the second and third crediting period, only once *ex-ante* at the start of the second crediting period.
QA/QC procedures to be applied:	
Any comment:	The adequate EF parameter will be monitored depending on the method used. The method used depends on the data available at the time the project starts generating electricity.

Data / Parameter:	**EGm,y, EGy, EGj,y, EGk,y and EGn,h**
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant / unit *m, j, k* or *n* (or in the project electricity system in case of *EGy*) in year *y* or hour *h*
Source of data to be 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:	Simple OM, simple adjusted OM, average OM: annually during the crediting period for the relevant year, • Dispatch data OM: Hourly • BM: For the first crediting period: annually *ex-post*,. For the second and third crediting period, only once *ex-ante* at the start of the second crediting period.

QA/QC procedures to be applied:	
Any comment:	The adequate parameter EG will be monitored depending on the type of data available (therefore depending on which method is used) at the time the project starts generating electricity.

Data / Parameter:	**EGPJ,h**
Data unit:	MWh
Description:	Electricity displaced by the project activity in hour *h* of year *y*
Source of data to be used:	As specified by the underlying methodology
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:	As specified by the underlying methodology
QA/QC procedures to be applied:	As specified by the underlying methodology
Any comment:	Only applicable for the dispatch data OM. This parameter will not be monitored if the dispatch data OM method is not used (ie if the information for using this method is not available).

Data / Parameter:	$\eta_{m,y}$
Data unit:	-
Description:	Average net energy conversion efficiency of power unit m in year y
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Use either: • Documented manufacturer's specifications (if the efficiency of the plant is not significantly increased through retrofits or rehabilitations); or • Data from the utility, the dispatch center or official records if it can be deemed reliable; or • The default values provided by the "Tool to calculate the emission factor for an electricity system"
Description of measurement methods and procedures to be applied:	Once for the crediting period
QA/QC procedures to	If the data used is significantly lower than the default value of the applicable

be applied:	technology, project proponents should assess the reliability of the values, and provide appropriate justification
Any comment:	This parameter will only be monitored if required by the method used. The method used depends to the data available at the time the project starts generating electricity.

Data / Parameter:	**TDLy**
Data unit:	-
Description:	Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site.
Source of data to be used:	Default value as per *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, as recent, accurate and reliable data was not publicly available within the Host Country at the time of PDD submission.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20%
Description of measurement methods and procedures to be applied:	N/A
QA/QC procedures to be applied:	N/A
Any comment:	The 20% default value will only be used if no accurate and reliable data is obtained during the crediting period. As soon as data for average technical transmission and distribution losses is obtained, the default value will be replaced by the real value.

Data / Parameter:	**Operation of the energy plant**
Data unit:	hours
Description:	Operation of the energy plant in a year *y*
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8000
Description of measurement methods and procedures to be	Data will be recorded annually by the Project Developer to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

applied:	
QA/QC procedures to be applied:	Equipment will be maintained in line with manufacturer's recommendations to assure high quality output.
Any comment:	

Data / Parameter:	$\mathbf{PE_{EC,y}}$
Data unit:	tCO_2
Description:	Project emissions from electricity consumption by the project activity during the year *y*
Source of data to be used:	Calculated as per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	410 (Annual average over the first crediting period)
Measurement procedures (if any):	As per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.
QA/QC procedures to be applied:	As per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.
Any comment:	

Data / Parameter:	**Other Flare operation parameters**
Data unit:	-
Description:	This should include all data and parameters that are required to monitor whether the flare operates within the range of operating conditions according to the manufacturer's specifications including a flame detector in case of open flares.
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour".
Measurement procedures (if any):	Continuously
QA/QC procedures to be applied:	
Any comment:	Only applicable in case of use of a default value

B.7.2. Description of the monitoring plan:

The Monitoring Plan for this Project has been developed to ensure that from the start, the Project is well organised in terms of the collection and archiving of complete and reliable data.

Data collection and record keeping arrangements

Monitored data required by the methodology ACM0001 (version 8.1 adopted at EB39) will be measured & collected as detailed in section B.7.1 above.
Data collected on site will be compiled in an electronic format which will be sent to EcoSecurities on a regular basis. All data required for verification and issuance will be backed-up and kept for at least two years after the end of the crediting period or the last issuance of CERs of this project, whichever occurs later.

Data Quality Control and Quality Assurance
All data collected on site will be checked internally before being compiled in an electronic format to assure it is complete and of an appropriate quality.

EcoSecurities will perform a regular final check of the data and analyse project performance prior to any verification. Moreover, regular internal audits will be conducted to assure that the Project is in compliance with CDM requirements.
Procedures will be developed to deal with possible monitoring data adjustments and uncertainties as well as emergencies.

Maintenance and Calibration of monitoring equipment
All equipment will be maintained and calibrated in line with manufacturer's recommendations. This will assure that the equipment operates at the stated level of accuracy.

Staff training
Training is conducted on site at regular intervals to ensure that staff is capable to perform their designated tasks at high standards. This will include CDM specific training to warrant that they understand the importance of complete and accurate data and records for CDM monitoring.

CDM monitoring organisation and management
Prior to the start of the crediting period, the organisation of the monitoring team will be finalised. Clear roles and responsibilities will be assigned to all staff involved in the CDM project.
The Project Developer will have designated CDM Monitoring staff on site who will be responsible for monitoring emissions reductions of the project activity. All staff involved in the collection of data and records will be coordinated by either Managers on site or staff based in the Project Developer's headquarters in the UK.

Further information on the delegation of responsibilities can be found in Annex 4.

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):

Date of completion: 15 Dec 2007

Person/entity determining the baseline:

Marc Halgand
EcoSecurities Group Plc- UK
40/41 Park End Street
Oxford OX1 1JD

United Kingdom
Phone: +44 (0) 1865 202 635
e-mail: marc.halgand@ecosecurities.com

EcoSecurities Group Plc is participating in the project as the Carbon Advisor and is listed in part A3 of PDD, and Annex 1 of this document as a project participant.

Detailed baseline and monitoring information are attached to Annex 3 and 4.

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:

01/08/2007 (Date on which the contract between PWSD, Government of Ras Al-Khaimah and Biogas was signed, considered as the project start date)

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

Approximately 20 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:

The crediting period will start on 01/07/2009, or on the date of registration of the CDM project activity, whichever is later.

C.2.1.2. Length of the first crediting period:

7 (seven) 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 project will actively collect and destroy LFG, thereby improving overall landfill management and reducing adverse global and local environmental effects of uncontrolled releases of landfill gas.
Whilst the main global environmental concern over gaseous emissions of methane, is the fact that it is a potent greenhouse gas, and thus contributes importantly to global warming, emissions of LFG can also have significant health and safety implications at the local level. For example:

- Risk of explosions and/or fires either within the landfill or outside its boundaries, although the majority of LFG emissions are quickly diluted in the atmosphere;
- Asphyxiation and/or toxic effects to humans from concentrated emissions of LFG;
- Local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation due to over 150 trace component contained in landfill gas.

Through both the installation of a well-designed LFG collection and a destruction/utilisation system and its proper operation, LFG will be captured and combusted in a controlled way, thereby removing safety risks from the surrounding community, reducing the risks of toxic effects on the local community and the local environment as well as reducing the emissions of a potent greenhouse gas.

It is worth noting that the Project Developer will install a flare and electricity generation units which comply with stringent UK emission standards, thereby minimising the environmental impact from this particular source and suggesting that these emissions are significantly less harmful than the continued uncontrolled release of LFG. The Project will significantly reduce odour and greenhouse gas emissions.

Thus, the project activity can be referred as environmentally ameliorative, and the installation of the LFG collection and combustion system is part of a broader effort by the landfill operator to continue to improve waste management practices.

In UAE nevertheless, it is a legal requirement that a professional body conducts the Environmental Impact Assessment which needs to be submitted to the RAK- Environment Protection & Development Authority for approval. Hence a consultant started the preliminary assessment for the Ras Al-Khaimah landfill site in December 2007, and the report has been submitted to RAK Environment Protection & Development Authority (EPDA) and had been approved on 23rd June 2008.

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:

Not applicable.

SECTION E. Stakeholders' comments:

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

To inform comprehensively about the proposed project activity, and in order to fulfil the CDM requirement, EcoSecurities conducted a stakeholder consultation program during the month of December 2007.

The program consisted of sending letters to the direct Stakeholders such as the landfill employees, the Municipality of RAK (waste section employees) and RAKIA (Ras Al-Khaimah Investment Authority). The landfill site being very isolated, there are no other direct stakeholders.

Stakeholder	Contact Person	Title	Telephone number	Fax number	City	E-mail
Landfill employees	Mr. Aamir Mehmood	Landfill Manager	050-7791857	07-2270035	Ras Al-Khaimah	kkaamir1@yahoo.com
Landfill environmental consultant	Dr. Shaheed Khader	Environmental Specialist	07-2362720	07-2362721	Ras Al-Khaimah	drshaheedkhader@hotmail.com
Services section - Municipality of Ras Al-Khaimah	Mr. Mohammed Attar	Manager Services Section	07-2285000	07-2270035	Ras Al-Khaimah	
Ras Al-Khaimah Investment Authority - RAKIA	Mr. Raman A. Iyer	General Manager	07-2446533	07-2447697	Ras Al-Khaimah	

All interested and affected parties were given 14 days to respond and comment the letter sent on the 12th of December.

Further, two meetings to discuss the Project were held on the 16th of December: with the Ras Al-Khaimah landfill employees at the landfill site, and with the services section of the municipality of RAK at the Material Recovery Facility.

Table: List of attendants to the stakeholder consultation meetings

EcoSecurities Middle East DMCC
P.O.Box : 214837
Dubai, U.A.E.
Date : Dec 16 2007

لائحة المشاركين في اللقاء التشاوري حول مشروع استخراج الغاز من مرمى رأس الخيمة: لقاء موظفي مرمى رأس الخيمة

List of Participants in the Stakeholder Consultation meeting for Ras Al Khaimah landfill gas extraction project: landfill employee meeting

Date & Location: Ras Al Khaimah Landfill – December 16, 2007

Signature التوقيع	Position المنصب	Name الإسم	
[illegible]	Controller	Maqsood Chishti	1
M. [illegible]	Operator	Muhammad Iqbal	2
AYUB KHAN	— " —	Ayub Khan	3
MD: ZOHIR	— " —	Muhammad Zaheer	4
[illegible]	— " —	Mushtaq Khan	5
ROSTOOM ALI	Labourer	Rustam	6
[illegible]	Driver	Naseeb Khan	7
MD AZAD ALI	Labourer	Azad Ali	8
[illegible]	Operator	M. Ismail	9
[illegible]	Labourer	M. Idrees	10
Rehman	— " —	Abdul Rehman	11
MD. ARIF HOSSAIN	— " —	M. Arif Hussain	12
MD SALIK AHMED	— " —	M. Salik Ahmad	13
[illegible]	— " —	M. Sagheer Mian	14
ATTER	— " —	Atiq-ur-Rehman	15
[illegible]	Driver	Izat Khan	16
J. [illegible]	Operator	Jilani Kamal	17

لائحة المشاركين في اللقاء التشاوري حول مشروع استخراج الغاز من مرمى رأس الخيمة: لقاء موظفي مرمى رأس الخيمة

List of Participants in the Stakeholder Consultation meeting for Ras Al Khaimah landfill gas extraction project: landfill employee meeting

Date & Location: Ras Al Khaimah Landfill – December 16, 2007

Signature التوقيع	Position المنصب	Name الإسم	
	Labourer	Ghulam Shabir	18
	Landfill Coordinator	Nadeem Ali	19
	Plumber	Sharif Abdul Razaq	20
	Driver	Momin Khan	21
	Gate Incharge	Arshad Ali	22
	Laborer	Nizam-ud-din	23
	Gate Incharge	Javaid	24
	Driver	Noor-ur-Rehman	25

EcoSecurities Middle East DMCC
P.O.Box: 21483
Dubai, U.A.E.
Date Dec 16, 2007

لائحة المشاركين في اللقاء التشاوري حول مشروع استخراج الغاز من مرمى رأس الخيمة: لقاء موظفي قسم الخدمات في بلدية رأس الخيمة

List of Participants in the Stakeholder Consultation meeting for Ras Al Khaimah landfill gas extraction project: services section employees – municipality of Ras Al Khaimah

Date & Location: Material Recovery Facility ~~Municipality of~~ Ras Al Khaimah – December 16, 2007

Signature التوقيع	Position المنصب	Name الإسم
	Manager, Services Sections, DWSD, RAK	Mr. Mohd. Ather
	Manager, commercial waste operations, RAK	Mr Mohd. Farooq
	operations waste collection	Mr. Mohidunni
	Coordinator, RAK MRF.	Mr. Rashid

E.2. Summary of comments received:

The only response to the stakeholder consultation letters was from RAKIA, who did not have any concerns about the proposed CDM activity but was interested in the quantity of biogas produced and its potential export to the nearest facility (around 2kms from the landfill) for steam production or for district cooling.

EcoSecurities responded to RAKIA that this option is not economically feasible for the project developer because it entails additional investments in pipelines and landfill gas purification (See enclosed letter from RAKIA, and clarification response from EcoSecurities).

During the stakeholders' consultation meetings, the only questions raised were from the employees in relation to the impact of the Project on their health and safety. During the meeting, both PWSD and EcoSecurities representatives clarified to the employees that gas extraction and flaring will take place on cell 1, which is now closed and the employees are not working on it.

Therefore, the employees will not be working close to the landfill extraction installation and equipment. Furthermore, the system itself will only be burning gas with no other reactions. By burning methane, smells will be reduced, and fires will be controlled because methane will no longer be concentrating under pressure in the landfill.

To date no other formal comments have been received from stakeholders.

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

As indicated in Section E.2 above, there have been no formal comments raised during the stakeholder consultation.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Host Country Participant:

Organization:	Public Works and Services Department (PWSD), Government of Ras Al-Khaimah
Street/P.O.Box:	PO Box 1661
Building:	
City:	
State/Region:	Ras Al-Khaimah
Postfix/ZIP:	
Country:	United Arab Emirates.
Telephone:	971-7-228 5688
FAX:	971-7-227 0035
E-Mail:	rakpwsd@emirates.net.ae
URL:	Public Works and Services Deparment, Government of Ras Al-Khaimah
Represented by:	
Title:	Director General
Salutation:	Mr.
Last Name:	Sakkal
Middle Name:	
First Name:	Michel
Department:	
Mobile:	
Direct FAX:	As above
Direct tel:	As above
Personal E-Mail:	As above

Project Developer:

Organization:	Biogas Technology Group Ltd
Street/P.O.Box:	PO Box 119, Martello Court
Building:	Admiral Park
City:	St Peter Port
State/Region:	
Postfix/ZIP:	GY1 3HB
Country:	Guernsey, Channel Islands
Telephone:	+44 1481 751 000
FAX:	+44 1481 751 001
E-Mail:	guernsey@biogastechnologygroup.com
URL:	
Represented by:	
Title:	Carbon Emissions Administrator
Salutation:	Mrs
Last Name:	Highton
Middle Name:	
First Name:	Bridget
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	cdm@biogastechnologygroup.com

Organization:	Biogas Technology Ltd.
Street/P.O.Box:	6 Brookside Industrial Estate, Glatton Road
Building:	-
City:	Sawtry
State/Region:	Cambridgeshire
Postfix/ZIP:	PE28 5SB
Country:	United Kingdom
Telephone:	+44 (0) 1487 831 701
FAX:	+44 (0) 1487 830 962
E-Mail:	
URL:	www.biogas.co.uk
Represented by:	
Title:	Managing Director
Salutation:	Mr.
Last Name:	Gadsby
Middle Name:	
First Name:	Ian
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	cdm@biogastechnologygroup.com

Project Annex 1 participant:

Organization:	EcoSecurities Group PLC.
Street/P.O.Box:	40 Dawson Street
Building:	
City:	Dublin
State/Region:	
Postfix/ZIP:	2
Country:	Ireland
Telephone:	+353 1613 9814
FAX:	+353 1672 4716
E-Mail:	ireland@ecosecurities.com
URL:	www.ecosecurities.com
Represented by:	
Title:	Treasurer
Salutation:	Mr.
Last Name:	Meegan
Middle Name:	
First Name:	Conor
Mobile:	
Direct FAX:	
Direct tel:	as above
Personal E-Mail:	cdm@ecosecurities.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This Project will not receive any public funding.

Annex 3

BASELINE INFORMATION

LANDFILL CALCULATION PARAMETERS		
Parameter	Units	**Ras Al-Khaimah Landfill**
	Landfill data	
Year landfill started operation		2001
Waste in place at the beginning of Project	tonnes	500,000
Density of waste	tonnes/m^3	1.0
Area of site (cell #1)	ha	4.6
Average daily waste rate	tonnes/day	300
Date gas collection project starts		03-Feb-2007
	Operational data	
Gas collection efficiency	%	70%
Ex-ante default flare efficiency	%	90%
	General data	
Methane content of landfill gas	%	50%
GWP CH_4	tCO_2 / tCH_4	21
Density of Methane	tCH_4/m^3	0.0007168
	Baseline data	
Proportion of methane flared in Baseline (AF)	%	0%

	Baseline emission BE y								
	ACM001 vers078& Tool methane avoidance	**Units**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
	Baseline emission BE CH4,SWDS,y	tCO_2e	27,299	31,253	35,196	39,145	43,116	47,125	51,035
	MD project,y= BE/GWP CH4	tCH4	1,300	1,488	1,676	1,864	2,053	2,244	2,430
$LFG_{total,y}$	LFG volume collected per year	m3/year	3,627,107	4,152,396	4,676,325	5,201,060	5,728,692	6,261,253	6,780,856
LFG elec	Total LFG volume to be combusted in power generation	m3/year	0	2,419,014	3,870,423	4,354,225	4,838,028	4,838,028	5,805,634
LFG flare	Total LFG volume to be flared	m3/year	3,627,107	1,733,382	805,903	846,835	890,664	1,423,225	975,222
MD electricity	Methane combusted in power generation	tCH4	0	867	1,387	1,561	1,734	1,734	2,081
$TM_{RG,h}$	Methane mass flow rate in the residual gas	kg / h	148	71	33	35	36	58	40
$PE_{flare,y}$	Project Emissions from flaring	tCO2e	2,730	1,305	607	637	670	1,071	734
MD flare	Methane destroyed by the flare	tCH4	1,170	559	260	273	287	459	315
MD project	**MD project,y = MD flared + MD electricity**	**tCH4**	**1,170**	**1,426**	**1,647**	**1,834**	**2,021**	**2,193**	**2,395**
MD BL,y	**Baseline Emission Reductions**	tCH4	0	0	0	0	0	0	0
	Emission reductions from methane destruction								
	(MD project,y - MD reg,y)* GWP CH4	tCO_2e	24,569	29,948	34,589	38,508	42,446	46,054	50,301
	Emission reductions from Grid displacement								
	Installed capacity	MW	0.00	0.50	0.80	0.90	1.00	1.00	1.20
$EL_{LFG,y}$	**Electricity generation**	MWh/year	0	3,653	5,845	6,575	7,306	7,306	8,767
	EL LFG,y *CEF elec, BL,y	tCO2e	0	0	0	0	0	0	0
	Baseline emissions								
BE y	**Baseline emissions**	tCO2e	24,569	29,948	34,589	38,508	42,446	46,054	50,301

$$PE_y = PE_{EC,y}$$ and $$\mathrm{PE}_{\mathrm{EC,y}} = \mathrm{EC}_{\mathrm{PJ,y}} * \mathrm{EF}_{\mathrm{grid,y}} * (1 + \mathrm{TDL}_{\mathrm{y}})$$

	Project emission PE y								
	ACM001 vers08 & Tool to calculate project emissions fro	**Units**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
EC PJ,y	**Electricity consumption**	MWh/year	263	263	263	263	263	263	263
PE y	**Project emissions**	tCO2e	410	410	410	410	410	410	410

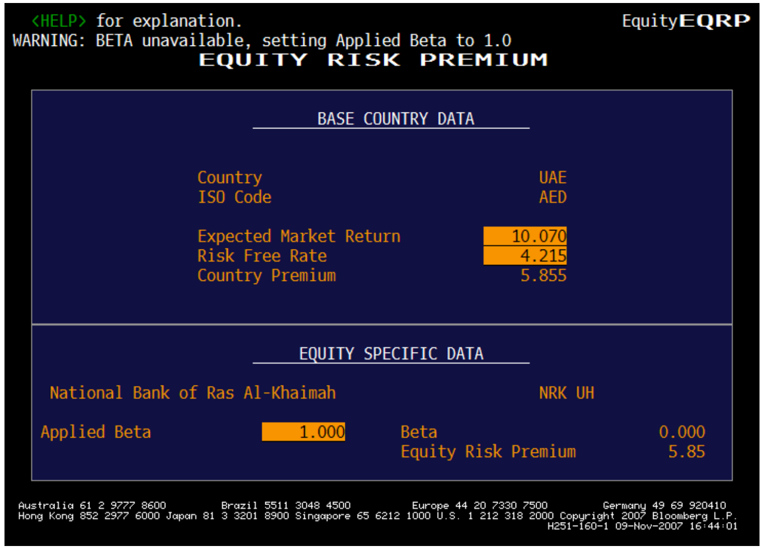
$$ER_y = BE_y - PE_y$$

	Emission reduction ER y								
	ACM0001 vers08	**Units**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
ER y	**Emission reduction**	tCO2e	24,159	29,538	34,179	38,098	42,036	45,644	49,891

Investment Analysis

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Investment																						
Power generation equipment				$867,576					$867,576													
Gas collection system		$413,439		$330,751			$330,751			$330,751				$330,751				$330,751				
Flaring system		$413,901																				
Compound civil works and electrical interconnection		$153,049	$512,381																			
Total investment	$0	$980,388	$512,381	$1,198,327	$0	$0	$330,751	$0	$867,576	$330,751	$0	$0	$0	$330,751	$0	$0	$0	$330,751	$0	$0	$0	$0
Operation and admin costs																						
O&M fee for power generation equipment	0	0	67,643	153,686	153,686	192,107	221,329	221,329	259,750	259,750	259,750	307,371	307,371	345,793	375,015	384,214	413,436	413,436	413,436	451,858	451,858	451,858
Management and operation cost - electricity (ENER*G)	0	0	24,512	55,691	55,691	69,614	80,203	80,203	94,126	94,126	94,126	111,383	111,383	125,305	135,895	139,228	149,817	149,817	149,817	163,740	163,740	163,740
O&M of gas collection and flare	0	94,304	85,617	87,560	89,562	91,624	93,747	95,934	98,187	100,508	102,898	105,359	107,895	110,506	113,196	115,965	118,817	121,754	124,780	127,896	131,106	134,413
Project support costs	0	74,910	74,910	74,910	59,910	59,910	74,910	59,910	74,910	74,910	59,910	59,910	59,910	74,910	59,910	59,910	59,910	74,910	59,910	59,910	59,910	59,910
Total annual project costs	0	169,214	252,683	371,847	358,849	413,255	470,189	457,377	526,974	529,294	516,684	584,023	586,559	656,515	684,016	699,317	741,980	759,918	747,943	803,404	806,614	809,920
Average projects costs per MWh			79.0	51.1	49.4	45.5	44.9	43.7	42.9	43.1	42.0	40.2	40.3	40.1	38.6	38.5	37.9	38.9	38.2	37.6	37.7	37.9
Depreciation																						
Depreciation of equipment installed in 2008	-	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685	46,685
Depreciation of equipment installed in 2010	-	-	-	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037	90,037
Depreciation of equipment installed in 2013	-	-	-	-	-	-	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672	20,672
Depreciation of equipment installed in 2015	-	-	-	-	-	-	-	-	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970	61,970
Depreciation of equipment installed in 2016	-	-	-	-	-	-	-	-	-	25,442	25,442	25,442	25,442	25,442	25,442	25,442	25,442	25,442	25,442	25,442	25,442	25,442
Depreciation of equipment installed in 2020	-	-	-	-	-	-	-	-	-	-	-	-	-	36,750	36,750	36,750	36,750	36,750	36,750	36,750	36,750	36,750
Depreciation of equipment installed in 2024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66,150	66,150	66,150	66,150	66,150
Total depreciation costs	-	46,685	46,685	136,722	136,722	136,722	157,394	157,394	219,364	244,806	244,806	244,806	244,806	281,557	281,557	281,557	281,557	347,707	347,707	347,707	347,707	347,707

Printout from internal database outlining country risk premium for UAE



Financial Analysis for the first crediting period:

	A	B	C	D	E	F	G	H	I	J	K
1		**Financial Analysis without CDM:**									
2		Tariff (US$/MWh)	US$ / MWh	50							
4		VAT on electricity	%	0%							
5		Depreciacion	%	10%							
6		Income Tax	%	0%							
7											
8		**CASH FLOW WITHOUT CDM**			1	2	3	4	5	6	7
9				***2008***	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10		Projected Emission Reductions (tCO_2)	tCO_2	*0*	*24,159*	*29,538*	*34,179*	*38,098*	*42,036*	*45,644*	*49,891*
11											
12		**REVENUE**									
13		**Electricity Generation**									
14		Evolution of Power Tariff	US$ / MWh	*$50.000*	*$50.000*	*$50.000*	*$50.000*	*$50.000*	*$50.000*	*$50.000*	*$50.000*
15		Annual Electricity Generation	MWh	0	0	4,000	6,400	7,200	8,000	8,000	9,600
16		Gross Electricity Revenue (US$)		$0	$0	$200,000	$320,000	$360,000	$400,000	$400,000	$480,000
17		VAT on electricity	US$	*$0*	$0	$0	$0	$0	$0	$0	$0
18		**Electricity Revenue**	US$	***$0***	**$0**	**$200,000**	**$320,000**	**$360,000**	**$400,000**	**$400,000**	**$480,000**
19											
20		**INVESTMENT & COSTS**									
21		**a) Capital Cost**									
22		Flaring systems (Shipped and commissioned)	US$	*$413,901*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*
23		Gas collection system and civil works	US$	*$413,439*	*$0*	*$330,751*	*$0*	*$0*	*$330,751*	*$0*	*$0*
24		**Subtotal: Investment gas collection & flaring**	US$	*$827,340*	**$0**	**$330,751**	**$0**	**$0**	**$330,751**	**$0**	**$0**
25		Electrical Generating Equipment	US$	*$0*	*$0*	*$867,576*	*$0*	*$0*	*$0*	*$0*	*$867,576*
26		Connection to Grid & Civils	US$	*$153,049*	*$512,381*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*
27		**Subtotal: Investment Energy Generation**	US$	*$153,049*	**$512,381**	**$867,576**	**$0**	**$0**	**$0**	**$0**	**$867,576**
28		**TOTAL INVESTMENT**	US$	*$980,388*	$512,381	$1,198,327	$0	$0	$330,751	$0	$867,576
29		**b) O&M Cost**									
30		Operation and Project Support - Gas Collection & Flaring	US$	*$169,214*	*$160,527*	*$162,470*	*$149,472*	*$151,534*	*$168,657*	*$155,844*	*$173,097*
31		Operation and Project Support - Electricity Generation	US$	*$0*	*$92,155*	*$209,377*	*$209,377*	*$261,721*	*$301,532*	*$301,532*	*$353,877*
32		**TOTAL O&M and PROJECT SUPPORT COST**	US$	***$169,214***	**$252,683**	**$371,847**	**$358,849**	**$413,255**	**$470,189**	**$457,377**	**$526,974**
34		**TOTAL INVESTMENT & OPERATIONAL COST**	US$	***$1,149,603***	**$765,063**	**$1,570,174**	**$358,849**	**$413,255**	**$800,941**	**$457,377**	**$1,394,549**
35		Depreciacion	US$	*$46,685*	*$46,685*	*$136,722*	*$136,722*	*$136,722*	*$157,394*	*$157,394*	*$219,364*
36		Gross profit before tax	US$	*-215,899*	-$299,368	-$308,570	-$175,571	-$189,977	-$227,584	-$214,771	-$266,338
37		Cummulative (for carryforward tax)	US$	*-215,899*	-$515,267	-$823,837	-$999,408	-$1,189,385	-$1,416,969	-$1,631,740	-$1,898,078
38		Income Tax	US$	*$0*	$0	$0	$0	$0	$0	$0	$0
39		Net Profit	US$	*-$215,899*	-$299,368	-$308,570	-$175,571	-$189,977	-$227,584	-$214,771	-$266,338
40		**Cashflow without CDM**	US$	***-$1,149,603***	**-$765,063**	**-$1,370,174**	**-$38,849**	**-$53,255**	**-$400,941**	**-$57,377**	**-$914,549**
41		Cummulativ	US$	*-$1,149,603*	-$1,914,666	-$3,284,840	-$3,323,689	-$3,376,944	-$3,777,885	-$3,835,261	-$4,749,810
42			**21 years**								
43			**without CDM**								
44		Net Present Value (US$)	-3,666,678								
45		IRR	#DIV/0!								
46		Discount Rate	10%								

Input data for the Electricity Generation component of the Project Activity

Input data	
PROJECT DATA	
Date Project starts operating (year)	**2008**
Potential capacity (MW)	**2.00**
Estimated on-line availability of equipment (%)	**91%**
Operating period (h/yr)	**8,000**
BASELINE DATA	
Country	**UAE**
CEF country (t CO2e/MWh)	**TBD**
Crediting period (years)	**21**
FINANCIAL PARAMETERS	
Electricity tariff (US cents/KWh)	**5**
Rate of increase of base tariff (%/yr)	**0**
Income tax	**0%**
VAT on electricity	**0%**
Discount rate	**10.0%**
Depreciation	**10.0%**
Price of carbon (US$/tCO2)	**10.00**

Annex 4

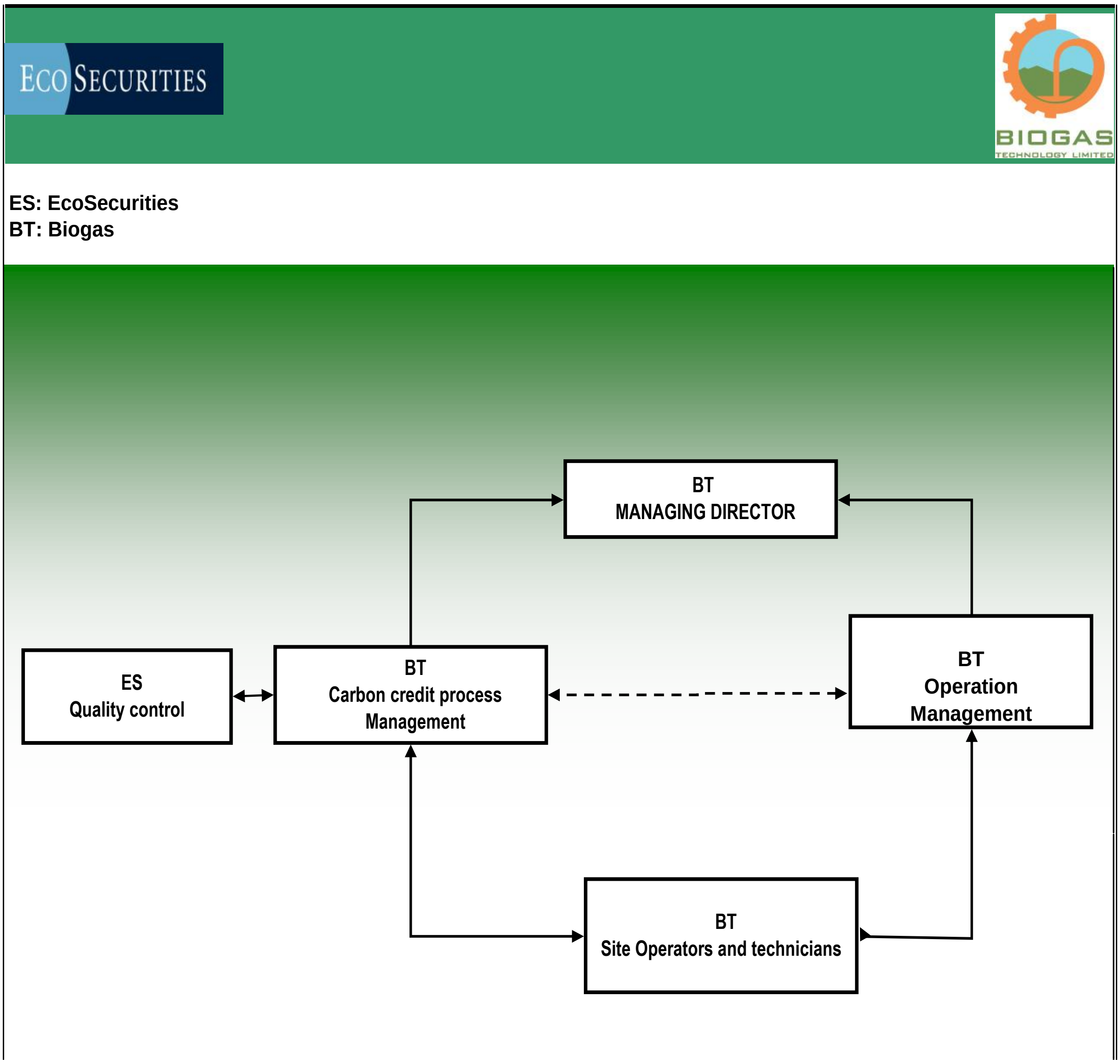
MONITORING INFORMATION

Table: CDM Monitoring System Procedures

Procedure name	Description	Scope
CDM Staff training	This procedure outlines the steps to ensure that staff receives adequate training to collect and archive complete and accurate data necessary for CDM monitoring.	This procedure should be followed by all staff on site prior to performing any monitoring duties for the CDM project.
CDM data and record keeping arrangements / day-to-day record handling	This procedure provides details of the site data and record keeping arrangements. The arrangements ensure that complete and accurate records are retained within the quality control system. Data and records will be stored and archived according to this procedure.	All data and records should be managed following this procedure. All staff is responsible for ensuring that any data or records are dealt with according to this procedure.
CDM data quality control and quality assurance	Data and records will be checked prior to being stored and archived. Data from the project will be checked to identify possible errors or omissions. All records will be checked for completeness on a regular basis.	The staff is responsible for ensuring the collection and archiving of complete and accurate data and records.
Internal audits	This procedure will outline the process of internal audits, where the performance of the project will be assessed. It will also provide details on the follow-up of forward actions arising after third party verification.	This procedure should be followed by all CDM staff involved in internal audits.
Equipment failure	This procedure details the process of data collection in the case that a problem with any meter occurs.	This procedure should be established by the project developer.
Equipment calibration	This procedure details the process of organising and managing the calibration process. The procedure	The calibration of the meters will be conducted by a suitable company according to the relevant

	includes details of how a suitable company or organisation is commissioned to undertake the calibration to the relevant standards.	standards. The Project Developer is responsible for organising the calibration and ensuring that records are retained.

The above procedures will be documented as part of the monitoring support material. The procedures may be contained in a single document (e.g. a monitoring manual) for CDM monitoring rather than separate procedures.



Equipment information

Equipment	Manufacturer	Calibration		Responsability for calibration	Uncertainity of equipment
		External Calibration	Internal Calibration		
Flowmeter	Endreess and Hauser	3 to 5 Years	N/A	Project Developer	±1.5 % of reading plus ±0.5 % of full scale
Thermocouple bottom Thermocouple top	Thermocouple Instruments	Replacement Every Year	N/A	Project Developer	± 0.75%
Fixed Gas Analyzer (Hi- Tech Panel)	Hi-Tech	3 Year Oxigen Card & 5 Years Gas Cards	Monthly	Project Developer	1% fsd
Portable Gas Analyzer	Geotechnical Instruments	6 Month	Weekly	Project Developer	CH_4 ±3.0% CO_2 ±3.0% O_2 ±1.0%

Notes:
(A) The equipments can be stored and its calibration time starts when the equipment started.
(B) The calibration time starts once the equipment starts operation

Note: The fixed gas analyser is the main system to monitor the landfill gas methane content, in a continuous way. The portable gas analyser is used to carry out the gas field balancing or is used to record periodic data when the main monitoring system is not working under notmal operational conditions, and continuously monitored data is not available.

Data/Parameters to monitor in case of using continuous monitoring of the flare efficiency

As and when the entire equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the flare efficiency will be monitored continuously *ex-post*, and the default value will no longer be used. According to the *"tool to determine project emissions from flaring gases containing methane"* the following additional parameters will be monitored to determine the flare efficiency, and the emission reductions will be calculated using the formulas as per the mentioned Tool.

Data / Parameter:	$\mathbf{t_{O2,h}}$
Data unit:	
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Source of data to be used:	Project Developer
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:	Volumetric fraction of O_2 will be measured continuously with in situ analyzers The sample is taken with a high temperature probe and will be conducted through filtration and conditioning system to ensure optimized functioning of the analyzer. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height).
QA/QC procedures to be applied:	The analysers should be subject to a regular maintenance and calibration according to manufacturer's recommendation to ensure accuracy. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	

Data / Parameter:	$\mathbf{fv_{CH4,FG,h}}$
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h*
Source of data to be used:	Project Developer
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:	Concentration of CH_4 in the exhaust gas will be measured continuously with in situ analyzers The sample is taken with a high temperature probe and will be conducted through filtration and conditioning system to ensure dry basis and optimized functioning of the analyzer. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height).
QA/QC procedures to be applied:	The analysers should be subject to a regular maintenance and calibration according to manufacturer's recommendation to ensure accuracy. A zero check and a typical value check will be performed by comparison with a standard certified gas.

Any comment:	Measurements will be undertaken in ppmv. This will be converted in accordance with the Tool.