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

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

New England Landfill Gas to Energy Project
PDD Version Number 1
13 March 2009

A.2. Description of the project activity:

The New England Landfill Gas to Energy Project (hereafter, the "Project") developed by Ener-G Systems Msunduzi (Pty) Ltd (hereafter referred to as the "Project Developer") is a landfill gas (LFG) collection and utilisation project at the New England landfill site located on New England Road in Pietermaritzburg, South Africa (hereafter referred to as the "Host Country").

The objective of the project is to collect and destruct/utilise the landfill gas (LFG) generated at the New England Landfill site. The project activity will consist of two distinct stages. In the first stage, LFG will be captured and destroyed by using a LFG flare, while in the second stage the captured LFG will be fed to the LFG flare and a modular electricity generation plant. The purpose of LFG flaring is to dispose of the flammable constituents, particularly methane, safely and to control odour nuisance, health risks and adverse environmental impacts. Hence this will involve investing in a highly efficient gas collection system as well as flaring equipment. The generator will combust the methane in the LFG to produce electricity for export to a local power purchaser. Excess LFG, and all gas collected during periods when electricity is not produced, will be flared. The installed capacity is expected to be approximately 2MW.[1]

The New England landfill site is an active landfill site which has been operational since 1960. Approximately 3.5 million m^3 of solid waste is currently deposited on the site. The landfill site has an existing leachate control system on site, installed in 1998, and is planned to close in 2030.

Prior to the implementation of the project activity the LFG was being emitted into the atmosphere freely through a gas venting system resulting in GHG emissions. The Project involves the avoidance of methane emissions as well as the displacement of electricity from the South African coal-based grid, resulting in a consequent reduction in CO_2 emissions. In the baseline scenario, the LFG would have been released into the atmosphere resulting in GHG (CH_4) emissions in the atmosphere. The electricity would have been produced in the fossil fuel based South African grid resulting in CO_2 emissions.

The Project is estimated to reduce greenhouse gas emissions by 53,652 tCO_2e/ year on average over the first 7 year crediting period. These emission reductions will be constituted by methane emission reductions, through the capture and flaring of LFG in stage 1 as well as CO_2 emission reductions through the displacement of coal-based electricity from the grid by generation of electricity from captured landfill gas, in stage 2.

[1] The potential of the gas flow from the site may support a higher installed capacity (up to 4MW) in the future.

Moreover, the Project is helping the Host Country to fulfil its goals of promoting sustainable development, and will have several positive social and environmental impacts:

- First, the Project promotes the integration of infrastructure which will improve environmental conditions. 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 gas migration off-site.
- Second, many constituents of landfill gas are hazardous and pose a potentially significant risk to human health. The objective of LFG flaring is to dispose of the perilous constituents, particularly methane, safely and to control and reduce odour nuisance and health risks.
- Third, the Project minimises environmental damage through reduced methane emissions.
- Fourth, the Project provides a model for LFG management, a key element in improving landfill management practices throughout the Host Country.
- Fifth, the Project optimises the use of natural resources and will act as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity. Development in this area has been discouraged by the extremely low cost of electricity in South Africa (by international comparison)[2] and by promoting the use of this technology sustainable and diverse energy systems are promoted.
- Finally, the Project will attempt to increase employment opportunities in the area where the Project is located. It will attempt to provide for both short- and long-term employment opportunities for local people. Local contractors and labourers will be required for construction, and long-term staff will be contracted to operate and maintain the system.

A.3. Project participants:

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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)**
South Africa (host)	ENER·G Systems Msunduzi (PTY) LTD (private entity)	No
United Kingdom of Great Britain and Northern Ireland	EcoSecurities International Limited (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.

[2] Eskom Annual Report 2008, pg vi, extract from NUS Consulting Group International Electricity Supply and Cost Comparison, April 2008

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Republic of South Africa (the "Host Country")

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

Province of KwaZulu-Natal (KZN)

A.4.1.3. City/Town/Community etc:

Pietermaritzburg, in the Msunduzi Municipality.

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

The Project is located on NewEngland Road, Pietermaritzburg.

The geographic coordinates of the site are: 29º 36'22.92''S and 30º 25' 08.84''E

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

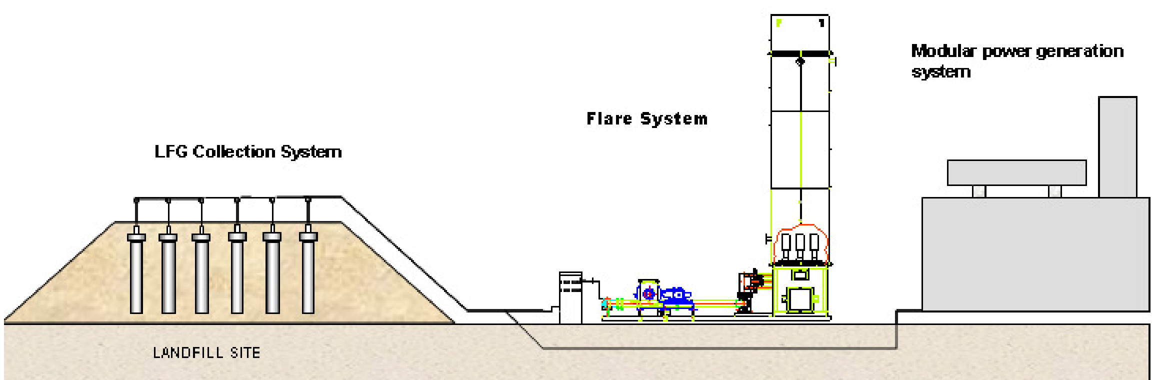
According to Annex A of the Kyoto Protocol, this Project fits in following Category:

Sectoral Scope 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 subsequently, a modular electricity generation system.

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



This is a proven technology for landfill gas combustion, and has been widely demonstrated as reliable and environmentally safe and sound.

Technology transfer is involved in the project through the introduction and demonstration of a new and modern technology for capture, destruction/ utilization of LFG and implementation of a detailed training program for maintenance and operation of the project equipments. The technology used in the project activity to collect, flare and utilise the LFG is designed in the UK.

Landfill Gas Collection System

The project activity involves the installation of an active LFG collection system using vertical and/or horizontal gas wells drilled into the landfill 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. 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[3].

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. These generators are designed by the ENER·G Group in Manchester, UK and supplied to ENER·G Systems Msunduzi (PTY) LTD.

Prior to the implementation of the project activity the LFG was being released into the atmosphere freely from the New England landfill without any capturing/utilization, resulting in GHG emissions. The Project involves the avoidance of methane emissions as well as the displacement of electricity from the South African coal-based grid, resulting in a consequent reduction in CO_2 emissions using the technology as explained above. In the baseline scenario, the LFG would have been emitted into the atmosphere resulting in GHG (CH_4) emissions in the atmosphere. The electricity would have been produced in the fossil fuel based South African grid resulting in CO_2 emissions.

The major sources and gases included in the project boundary are as follows:

[3] UK Environment Agency, 2002: Guidance on Landfill Gas Flaring. Biogas Technology Limited, Low Emission Ground Flare Systems Brochure.

Emission Sources and Greenhouse gases involved in the project Boundary		Gas
Baseline	Emission from decomposition of waste at the landfill site	CH_4
	Emissions from fossil fuel based grid electricity consumption	CO_2
Project Activity	On-site fossil fuel and electricity consumption due to the project activity	CO_2

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

The project will reduce global greenhouse gas emissions by:

a) Destroying methane from the New England landfill, and;
b) Displacing coal-based grid electricity by the combustion of the methane gas to produce electricity.

A 7 year renewable crediting period, renewable twice every 7 years has been selected for the project activity.

Table A4.4.1 - estimated emissions reductions from the project

Years	Estimation of annual emission reductions in tonnes of CO_2e
2010 (Jul - Dec)	20,914
2011	44,454
2012	49,834
2013	52,562
2014	55,212
2015	57,555
2016	62,539
2017 (Jan – Jun)	32,493
Total estimated reductions (tonnes of CO_2)	375,564
Total number of crediting years	7 years (3*7)
Annual average over the crediting period of estimated reductions (tonnes of CO_2)	53,652

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:

The large scale methodology ACM0001 Version 10, adopted at EB45, "Consolidated baseline and monitoring methodology for landfill gas project activities" has been used in the project activity.

Furthermore, the project makes use of the following tools, which are referred to in ACM0001, ver 10:

- "Tool for the demonstration and assessment of additionality"; Version 5.2, adopted at EB39.
- "Tool to determine project emissions from flaring gases containing methane"; Version 1, adopted at EB28.
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"; Version 01, adopted at EB 39.
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"; Version 2, adopted at EB 41
- "Combined tool to identify the baseline scenario and demonstrate additionality"; Version 2.2, adopted at EB28.
- "Tool to determine methane emissions avoided from disposing waste at a solid waste disposal site"; Version 04, adopted at EB 41.
- "Tool to calculate the emission factor for an electricity system"; Version 1.1, adopted at EB 35.

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, as follows:

(1) 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

(2) Electricity displacement:

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

When the project goes ahead into activity (2), the baseline of the Project will be the generation of electricity by plants connected to the grid, and therefore the approved "Tool to calculate the emission factor for an electricity system" (Version 1.1, adopted at EB 35) will be applied to calculate the grid emission factor, as stated in ACM0001.

The project activity meets the applicability criteria of the methodology ACM 0001, ver 10 as follows:

Applicability of Methodology	Project Activity
This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as: (a) The captured gas is flared; and/or (b) The captured gas is used to produce energy (e.g. electricity/thermal energy). Emission reductions can be claimed for thermal energy generation, only if the LFG displaces use of fossil fuel either in a boiler or in an air heater. For claiming emission reductions for other thermal energy equipment (e.g. kiln), project proponents may submit a revision to this methodology; (c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodology AM0053.	The project is a landfill gas capture project in New England landfill. The baseline scenario is release of LFG in atmosphere without any capture. In the project activity the captured gas shall be used for the following: (a) The project would start with activity (1) (b) It shall subsequently proceed with activity (2) The supply of captured gas through natural gas distribution pipes to users is not envisaged in the project activity.

All applicability conditions of the other tools are also met, specifically from the:

"Tool to determine project emission from flaring gases containing methane" (Version 1, adopted at EB 28)

- The residual gas stream (LFG) to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen, and;
- The residual gas steam to be flared is obtained from the decomposition of organic material from the New England landfill.

"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 04, adopted at EB 41.

- The project activity where the solid waste disposal site where the waste would be dumped can be clearly identified as New England Landfill, and;
- The project does not consider hazardous wastes, and thus fulfils all the conditions of this tool.

"*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*; Version 02, adopted at EB 41.

- If and when the Project burns diesel (in the on-site diesel generator) the CO_2 emissions from the fossil fuel combustion will be based on the quantity of the fuel combusted and its properties.

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

According to ACM0001, ver 10, 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."

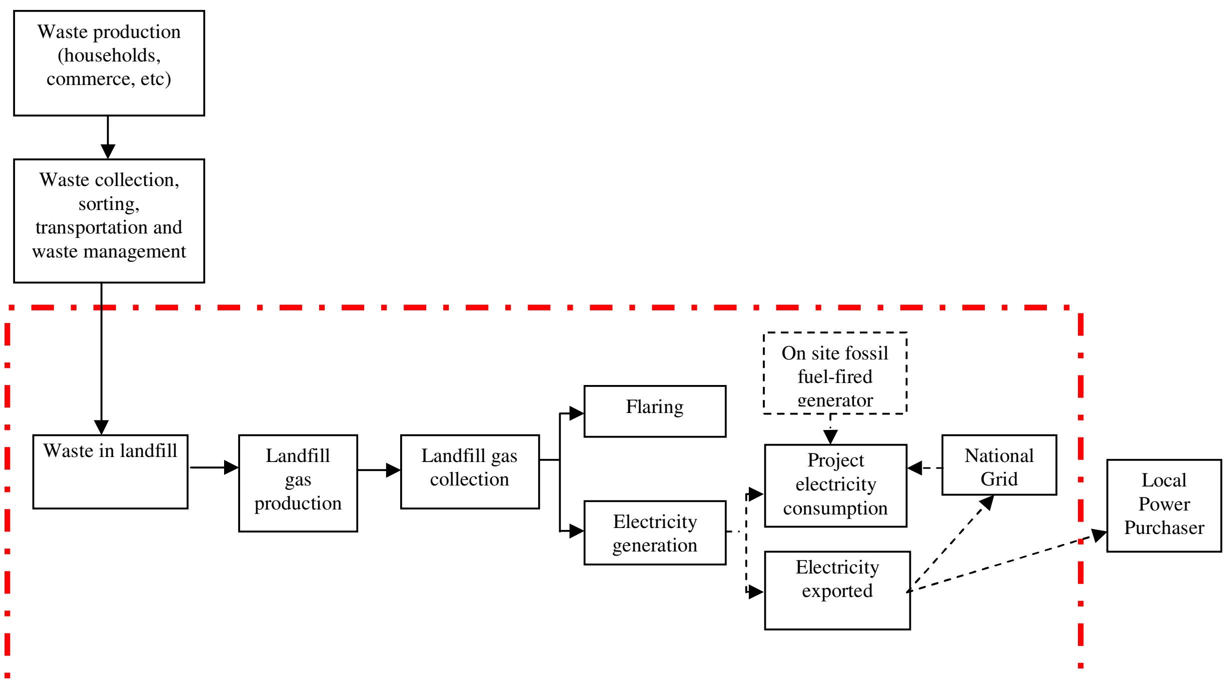
The following activities and emission sources are considered within the project boundaries:

Table B3.1: **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 CH4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO2 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	No	No fossil fuel consumption will take place other than for back-up electricity generation.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Yes	This is applicable for on-site electricity use. The project emissions due to grid electricity usage or fossil fuel consumption, if any, in fossil fuel based electricity generators shall be monitored and considered accordingly for determination of

	Source	Gas	Included?	Justification/Explanation
				project emissions.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

A full flow diagram of the project setup is presented in the figure below. The flow diagram comprises all possible elements of the LFG collection systems and the equipment for electricity generation. The Project boundary is delineated by the broken red line. If and when the project activity includes electricity generation the project boundary will be extended to include a power purchaser, including the allowance of the power purchaser possibly being the national grid.



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

The most plausible baseline scenario is release of LFG in atmosphere and generation of electricity in the fossil fuel based grid. As per ACM0001, ver10, the baseline scenario applicable to the project is as below:

Component	Baseline Option	Baseline Description

Landfill Gas	LFG2	The atmospheric release of the landfill gas. There is no active gas collection system but only a passive venting system in place at New England Landfill.
Power	P6	Existing grid-connected power plants. The project site is currently supplied by the grid.

There was no system existing at the landfill site to capture the LFG gas followed by its susbsequent destruction, neither the regulatory requirements specified within the Landfill Permit for the site[4] require any landfill gas to be collected or flared at the site. As the landfill operator is not collecting and utilising the gas produced in the landfill in the baseline scenario, $MD_{BL,y}$ applied to this project is set at 0%.

In the particular case of the proposed project activity, the baseline scenario was defined as the result of the additionality assessment of the "Tool for the demonstration and assessment of additionality" (version 5.2 adopted at EB39). (For detailed information on this assessment, please refer to Section B.5). Refer section B.5 for detailed analysis of baseline scenarios identification and selection.

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

The determination of project scenario additionality is done according to ACM 0001, ver 10 (which refers to the CDM consolidated "Tool for the demonstration and assessment of additionality", hereafter referred to as "Additionality tool"), which follows the subsequent steps:

Step 1. Identification of alternatives scenarios

Step 1 of the Additionality Tool is used, together with the additional guidance of ACM0001.

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

- **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.

- **LFG 2**: Atmospheric release of the landfill gas, which represents the business as usual scenario.

LFG1 cannot be the most plausible baseline scenario as it is not the most attractive course of action in the absence of project activity as explained in the investment analysis below.

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

- **P1.** Power generated from landfill gas undertaken without being registered as a CDM project activity;

[4] Department of Water Affairs and Forestry, 1998: Permit Number 16/2/7/U203/D3/Z1/P64 New England Road Landfill Site.

- **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 cogeneration plants are not a viable alternative and thus P2 and P3 can be 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 than purchasing power from the grid, so that P4 and P5 may also be discarded.

The only alternatives remaining for power generation are therefore P1 and P6.

The only remaining options for plausible baselines alternatives for project activity are then:

- **LFG 2:** Atmospheric release of the landfill gas, which represents the business as usual scenario.
- **P1:** Power generated from landfill gas undertaken without being registered as CDM project activity which represents the project activity. **P1** also corresponds to **LFG 1**.
- **P6:** Power plants connected to the grid.

Heat generation is not considered in the absence of the project activity; given 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. Therefore, alternatives for heat generation are not considered.

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

LFG 2: Atmospheric release of the landfill gas represents the business as usual scenario, and complies with South Africa's local and national laws. While there exists a draft 'Minimum Requirements for Waste Disposal by Landfill' (published in 2005 and constituting the most recent legislation on landfill site management available in South Africa) they do not categorically specify that it is a mandatory requirement to actively capture, flare or destroy landfill gas at every landfill in South Africa. The draft requirements provide guidelines to ensure safety on site (i.e. reducing the risk of explosions) by limiting landfill gas accumulation via passive ventilation. The prevailing practice in South Africa is either vent the LFG to ensure that the concentration of methane in any particular area of the landfill stays below hazardous levels, or to not install any kind of capturing system.[5]

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

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[5] Department of Water Affairs and Forestry, 2005: Minimum requirements for waste disposal by landfill, draft 3rd edition, Chapter 8.4.6 Gas management systems, page 99 Available from:
http://www.dwaf.gov.za/Documents/Other/WQM/RequirementsWasteDisposalLandfillSep05Part4.pdf

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 which specify that is mandatory to destroy landfill gas as common practice at all landfills.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the "Tool for the demonstration and assessment of additionality", if the alternatives to the CDM project activity do not include investments of comparable scale to the project, then Option III must be used.
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", 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). Three sources have been used to establish a suitable benchmark:

- According to the database from Bloomberg, an acknowledged specialist in providing financial data and investment information, the risk free rate (equivalent to government bonds) for South Africa is taken as the average yield of South African bonds (1998 – 2006) at 9.35%.

- In order to estimate the standard market return in the host country, the average equity market return has been analysed. The FTSE/JSE index consists of all stocks traded on a South African Stock Exchange. During the most recent ten years prior to project implementation (1997-2007), the FTSE/JSE index has achieved a compounded annual return of 17.53%. The equity/country premium can be determined as the difference between the market return and the risk free rate, at 17.53% - 9.35% = **8.18%.**

- A beta coefficient applicable to renewable energy investments can also be applied in order to account for the systematic risk. A beta value of 1.42 could be applied[6], however a value of 1 will be used in order to be conservative.

[6] See http://www.stern.nyu.edu/~adamodar/pc/datasets/betaemerg.xls for Energy-Alternate Sources Unlevered Beta.

The Equity Return Benchmark can be established by risk free rate + beta * equity country premium (9.35% + 1 * 8.18%). As such a realistic Equity Return benchmark for landfill gas capture and energy generation investments in the Host Country at the time of decision making is 17.53%.

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

Table 5.1 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 lower than the chosen benchmark.

Table B5.1: Financial results of the project (LFG 1 or P1) with and without carbon finance

	Without CDM	**With CDM**
IRR	7.72%	28.96%
Discount rate (the chosen benchmark)	17.53%	

Table B5.2: Assumption for financial analysis

Input/Assumption	**Value**	**Comments**
Electricity price (ZAR/MWh)	650	650 is reflecting the 2009 value taken from Eskom Medium Term Power Purchase Programme (EMTPPP), which decreases over time[7]. See attached Financial Calculation.
Annual Increase in electricity tariff (%/yr)	5.24%	Based on average Eskom tariff price adjustments over 10 years from 1998 - 2007 (http://financialresults.co.za/eskom_ar2008/annreport08/005.htm)
Depreciation	10%	Standard value
VAT on electricity	14%	http://www.sars.gov.za/home.asp?pid=289#Income%20tax
Income tax	29%	See Guide for Tax Rates, pg 5. For historical corporate income tax rates http://www.sars.gov.za/home.asp?pid=4589
Price per CER (ZAR)	140.04	GTZ Newsletter: Highlights 64, October 2008/10-13 Euro for medium risk forwards converted at R11.67/Euro, Ave ZAR/EURO 270907-190109, (www.oanda.com)
Total Investment Costs for power generation equipment (ZAR)	20,296,055	See attached Financial Calculation
Total Investment costs for gas collection and flaring equipment (ZAR)	5,653,003	See attached Financial Calculation

[7] Schedule of the Eskom Medium Term Power Purchase Program base tariff, Appendix H. Available from (http://www.eskom.co.za/content/MTPPP%20RFT%20rev%201%2013%20May%202008%5B1%5D.doc) May 2008. At time of decision making the tariff structure of the power purchase programme (MTPPP) was not available in South Africa yet. The only available feed -in tariff available in 2007 refers to the blended price of about R220/MWh.(see: http://www.engineeringnews.co.za/print-version/no-longer-shooting-in-the-dark-2008-05-23). To use the tariff structure of the MTPPP is therefore conservative.

Total Investment Costs for Electrical Connection & Civils (ZAR)	5,000,000	See attached Financial Calculation
Average Management and Operation costs: gas collection component per year (ZAR)	250,000	See attached Financial Calculation
Average Management & Operation costs: gas flaring component per year (ZAR)	375,000	See attached Financial Calculation
Average Management & Operation costs: Power generation per year (ZAR)	3,740,909	Based on an average over the whole period. In reality these are linked to capacity. See attached Financial Calculation
Average Project support costs per year (ZAR)	1,320,000	See attached Financial Calculation

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

Sub-step 2d: Sensitivity analysis

A sensitivity analysis was undertaken using assumptions that improve the IRR to the benchmark value. As demonstrated in the table below, the investment cost would have to be 65.33% lower than anticipated, the Operation & Maintenance Costs 58.29% lower or the electricity revenue would have to increase by 47.65%.

Table B.5.3 – Sensitivity analysis

Scenario	**% Change**	**IRR (%)**
Base case	**n/a**	17.53%
Reduction in investment costs	-65.33%	17.53%
Reduction in Operational & Maintenance Costs	-58.29%	17.53%
Escalation of electricity revenue	+47.65%	17.53%

The sensitivity analysis shows that a considerable variation of major parameters would have to happen in order to improve the equity IRR to the benchmark value. Such a variation is unlikely to occur, specifically, with regard to:

<u>Investment costs:</u>
At a reduction of the investment cost by 65.33%, the IRR would reach the benchmark value. A reduction in investment costs by 65.33% is highly unlikely as these costs are based on the cost of equipment required for the Project, which is not likely to decrease substantially.

Reduction in Operational & Maintenance Costs:
At a reduction of the Operational & Maintenance Costs by 58.29%, the IRR would reach the benchmark value. A reduction in operation & maintenance costs by 58.29% is highly unlikely as these costs are not likely to decrease substantially.

Electricity revenue escalation:
With an escalation of 47.65%, the IRR would reach the benchmark value.
The financial model assumes 5.24% annual escalation of the base electricity based on Electricity price tariff adjustments over the 10 years (1998-2007)[8]. As such an escalation of 47.65% is unlikely to happen.

In conclusion, the project IRR is not substantial enough to warrant investment in this project even with an increase in electricity cost, or a decrease in investment or operation & maintenance costs. The installation of a landfill gas to energy project is therefore not viable without consideration of carbon finance, and more specifically the revenue obtained under the CDM.

Step 4. Common Practice Analysis for South Africa

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

To date there has been limited development of LFG projects in South Africa (host country). Only a few landfills in the Host Country have been designed to partially collect and flare/or utilise the generated LFG.

Although landfill gas has been recognised as a source of odour and as a potential explosion hazard, few gas management systems have been constructed in Southern Africa[9], and as a result landfill gas management at most sites in southern Africa is currently limited to passive venting of gas[10].The prevailing practice in South Africa is therefore to either vent the LFG to ensure that the concentration of methane in any particular area of the landfill stays below hazardous levels, or to not install any kind of capturing system

Since the publication of the draft "Minimum Requirements for waste disposal by landfill" in 2005, no new proper LFG collection and flaring or utilisation systems have been developed in the Host Country without considering carbon revenues. All projects similar to the proposed project activity are developed under the CDM[11], and are therefore excluded from the discussion on prevailing practice.

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[8] See Eskom Annual Report 2008. Available from: <http://financialresults.co.za/eskom_ar2008/annreport08/005.htm>

[9] Department of Water Affairs and Forestry, 1998: Minimum requirements for waste disposal by landfill, chapter 8.4.6 Gas Management Systems, page 8-11 Available from: http://www.dwaf.gov.za/Dir_WQM/docs/Pol_Landfill.PDF

[10] Department of Water Affairs and Forestry, 2005: Minimum requirements for waste disposal by landfill, draft 3rd edition, Chapter 8.4.6 Gas management systems, page 99 Available from: http://www.dwaf.gov.za/Documents/Other/WQM/RequirementsWasteDisposalLandfillSep05Part4.pdf

[11] There are 2 registered landfill gas CDM Projects in South Africa, namely the 'Durban Landfill gas to electricity project – Marianhill and La Mercy' and the 'Enviroserv Chloorkop Landfill gas Recovery Project' landfills in South Africa. There are two other landfill gas project under validation in South Africa namely: 'Ekurhuleni Landfill Gas Recovery Project – South Africa' and 'Alton Landfill Gas to Energy Project' (see http://cdm.unfccc.int/Projects/Validation/index.html). The Durban Landfill-gas-to-electricity project – Bisasar Road Landfill' is applying for registration (see http://cdm.unfccc.int/Projects/projsearch.html).

In an assessment by the World Bank, the status of LFG management for the group of landfill sites visited in South Africa is described in the table below.

Table B.5.4: The Project control group

Landfill Name	**Location**	**Waste Deposition Rate (tonnes/day)**	**Current Status**
Marie Louise Johannesburg	Gauteng	2000	No system for collecting, venting or flaring LFG[12]
Goudkoppies Soweto	Gauteng	1000	No system for collecting, venting or flaring LFG[13]
Krugersdorp	North West	1000	No system for collecting, venting or flaring LFG[13]
Durban Shongweni	KwaZulu/Natal	700	No system for collecting, venting or flaring LFG[13]
Boipatong	Gauteng	300	Passive system for venting of LFG only (no flaring)[13]
Mobeni (Known as BulBul Drive Landfill Site, Mobeni Heights, Chatsworth)[13]	KwaZulu/Natal	1000 + 200-250 t of Hazardous waste	Active gas collection and flaring. The landfill is in the process of applying for CDM[13] and should therefore be excluded from common practice analysis.
Brits	North West	100	No system for collecting, venting or flaring LFG[13]

Thus, with the exception of a few landfills developing a CDM project[14], the other landfills don't have LFG collection and flaring systems. The reason for the lack of widespread LFG collection and combustion systems is that that there currently is no law that obligates the capture and destruction (or use) of LFG, nor is there an economic incentive for capturing and utilising the LFG. In summary, the passive venting method is still prevailing practice in landfills throughout the Host Country.

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

Since the only landfills which have active landfill gas capture and flaring are CDM projects or in the process of applying for CDM, the project does not have any similar options which do not consider CDM.

Additional step: CDM consideration

[12] Observations of Solid Waste Landfills in Developing Countries: Africa, Asia, and Latin America, Lars Mikkel Johannessen with Gabriela Boyer, Urban Development Division, Waste Management Anchor Team, The World Bank, First publication: June 1999

[13] See Background Information Document of EIA Process: http://www.phelamanga.co.za/images/projects/24_bid_final_080107.pdf

[14] There are 2 registered landfill gas CDM Projects in South Africa, namely the 'Durban Landfill gas to electricity project – Marianhill and La Mercy' and the 'Enviroserv Chloorkop Landfill gas Recovery Project' landfills in South Africa. There are two other landfill gas projects under validation in South Africa namely: 'Ekurhuleni Landfill Gas Recovery Project – South Africa' and 'Alton Landfill Gas to Energy Project'(see http://cdm.unfccc.int/Projects/Validation/index.html). The Durban Landfill-gas-to-electricity project – Bisasar Road Landfill' is applying for registration (see http://cdm.unfccc.int/Projects/projsearch.html) .

The CDM was considered early on in the decision making process of the New England landfill. The main milestones achieved throughout the CDM project are presented below:

Table B5.6: Major Milestones achieved throughout CDM Project

Milestone	**Date Achieved**
Tender Notice published by Msunduzi Municipality to develop New England Landfill under CDM[15]	29 September 2005
Final Lease & Gas Rights Agreement Signed by Ener-G Systems Msunduzi (Pty) Ltd and the Msunduzi Municipality to develop the proposed project under CDM **(start date of the CDM project)**	**26 September 2007**
ERPA signed between the project developer and EcoSecurities	7 January 2008
EIA submitted for Approval	18 November 2008
Expected Operation Start Date	November 2009

B.6 Emission Reductions

B.6.1. Explanation of methodological choices:

Baseline emissions

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

As the proposed project activity does not include a thermal energy component, all following equations[16] will exclude this component for simplification. As the project may include an electricity generation component, all equations include this component.

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

Where:

BE_y	tCO_2e	Baseline emissions in year *y*;
$MD_{project,y}$	tCH_4	The amount of methane that would have been destroyed/combusted during the year, in the project scenario;
$MD_{BL,y}$	tCH_4	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement;
GWP_{CH4}	$tCO_2\ e/tCH_4$	Global Warming Potential value for methane[17];
$EL_{LFG,y}$	MWh	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants

[15] The Msunduzi Municipality Tender Notice, published in The Witness, Thursday September 29, 2005.
[16] All equations which are modified and/or simplified are marked with a (*). Unless specified all equations are from ACM0001.

[17] This is $21tCO_2e/tCH_4$ for the first commitment period.

		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.

As mentioned above, there is not regulation/ contract for destruction of methane from the landfill in the baseline, hence $MD_{BL,y}$ - The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement – has been taken as zero.

A. Methane destroyed by the project activity ($MD_{project,y}$) – procedure to be used during project activity:

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	The amount of methane that would have been destroyed/combusted during the year, 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*.

If several flares or several electricity generators are used in the project, $MD_{flared,y}$ and, respectively, $MD_{electricity,y}$ will be the sum of the quantities destroyed in all the flares (respectively: in all the electricity generators).

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[18] during a year *y*;
D_{CH4}:	tCH_4/Nm^3CH_4	Methane density[19];
$PE_{flare,y}$:	tCO_2e	Project emissions from flaring of the residual gas stream in year *y* determined following the procedure described in the *"Tool to determine project emissions from flaring gases containing methane"*;
GWP_{CH4}:	tCO_2e/tCH_4	Global Warming Potential of methane.

[18] Methane fraction of the landfill gas to be measured on wet basis. No landfill gas cooling units will be in place prior to the gas analyser; hence the landfill gas is not cooled down to the dew point (which would be necessary to perform a dry measurement). The measurement of methane fraction can therefore be considered to be on a wet basis.

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

Once the Project will include 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:

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

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.

B. Methane destroyed by the project activity ($MD_{project,y}$) – procedure to be used for ex ante estimate:

The amount of methane that will be destroyed/combusted during the year ($MD_{project,y}$) is estimated ex-ante with the following equation:

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4} * \varepsilon_{degasssing\ system} \qquad (13)$$[20]

$BE_{CH4,SWDS,y}$ 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"*.

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

Where:

Parameter	Unit	Default	Description
$BE_{CH4,SWDS,y}$	tCO_2e		Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y
Φ	-	0.9	Model correction factor to account for model uncertainties
f	-	0[21]	Fraction of methane captured at the SWDS and flared, combusted or used in another manner; to meet the relevant regulations or contractual requirements.

[20] This factor has been added to the equation in order to reflect the guidance provided in ACM0001 (page 10): "The efficiency of the degassing system which will be installed in the project activity should be taken into account while estimating the ex-ante estimation".

[21] Refer page 10/25 of the methodology ACM0001, ver 10.

GWP_{CH4}	$tCO_2e/t\ CH_4$	21 for 1st period	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	See B.6.2	Fraction of degradable organic carbon (by weight) in the waste type *j*;
k_j	-	See B.6.2	Decay rate for the waste type *j*;
J	-	-	Waste type category (index);
X	-	-	Year during the crediting period : x runs from the year when the landfill started receiving wastes (x=1) to the year for which emissions are calculated (x=y);
Y	-	-	Year for which methane generation potential is calculated.

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

- f: 0 according to guidance in equation 13 of ACM0001.
- 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 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 boreal and temperate (Mean Annual Temperature < 20ºC) and dry (Mean Annual Precipitation < 1000mm), which is the case in Pietermaritzburg[22].

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.).
However, this is only for the purpose of ex-ante calculation of baseline emissions. The actual baseline emissions would be based on monitored quantity of LFG avoided from release into atmosphere.

[22] See Climate Data for Pietermaritzburg from the South African Weather Service.

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

The amount of methane that would have been destroyed/ combusted in the absence of the project activity due to regulatory and/or contractual requirements is zero. This value is justified based on the fact that the regulatory requirements as specified in the Landfill Permit for the site[23] do not indicate any specific amount of gas collection and destruction or utilisation. The landfill operator is also not collecting the gas generated in the landfill. $MD_{BL,y}$ therefore equals zero.

D. 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 is calculated according to the requirements of the *"Tool to calculate the emission factor for an electricity system"*. The calculation method, steps and results are given below

- STEP 1: ***Identify the relevant electric power system.***

The landfill site where the project activity takes place is connected to the National Grid of South Africa. We therefore regarded the National Grid of South Africa as the relevant electricity system for the Project activity.

- STEP 2: ***Select an operating margin (OM) method.***

The Calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

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

As per in the aforementioned tool, the grid data for South Africa indicates that low cost must run resources constitute less than 50% of total grid generation. Thus the **Simple OM** method will be used **ex ante** to calculate the $EF_{grid,OM,y}$.

- STEP 3: ***Calculate the operating margin emission factor according to the selected method***

In accordance with the tool we have data on fuel consumption and net electricity generation of each power plant and thus Option A, and the following equation can be used:

[23] Department of Water Affairs and Forestry, 1998: Permit Number 16/2/7/U203/D3/Z1/P64 New England Road Landfill Site.

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{m} EG_{m,y}} \quad (1)$$

Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	=	Amount of fossil fuel type *i* consumed by power plant/unit *m* in year *y* (mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	=	Net electricity generated and delivered to the grid by power plant / unit *m* in year *y* (MWh)
m	=	All power plants / units serving the grid in year *y* except low-cost / must run power plants/units
i	=	All fossil fuel types combusted in power plant/unit *m* in year *y*
y	=	The three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (*ex-ante* option as defined in step 2)

- STEP 4: ***Identify the cohort of power units to be included in the build margin***

The sample group of power units *m* used to calculate the build margin consists of either:

(a) The set of five power plants that have been built most recently, or
(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built moste recently.

Additional guidance: project participants should use the set of power units that comprises the larger annual generation.
As the last 5 power plants built (see annex 3) constitute 31% of the system generation option (a) has been used.

In terms of vintage data the build margin will be calculated ex-ante i.e. using Option A of step 4.

- STEP 5: ***Calculate the build margin emission factor***

The build margin is calculated using the following equation:

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}} \quad (12)$$

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year (tCO_2/MWh)
$EG_{m,y}$	=	Net electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which power generation data is available

- STEP 6: ***calculate the combined margin emission factor***

The combined margin emission factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \text{ x } W_{OM} + EF_{grid,BM,y} \text{ x } W_{BM} \quad (13)$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year (tCO_2/MWh)
W_{OM}	=	Weighting of operating margin emission factor (%)
W_{BM}	=	Weighting of build margin emission factor (%)

In accordance with the tool W_{OM} = 0.5 and W_{BM} = 0.5 respectively.

Project emissions:

Project emissions are calculated as follows:

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

Where:

PE_y	tCO_2/yr	Project emissions in year *y*;
$PE_{EC,y}$	tCO_2/yr	Emissions 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 project emissions from electricity consumption"*.
$PE_{FCj,y}$	tCO_2/yr	The CO_2 emissions from fossil fuel combustion in case of grid failure during the year *y*. The project emissions from fossil fuel consumption $PE_{FC,y}$ will be calculated following the latest version of *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"* defined in section B.2.

On top of these two sources of project emissions, there are also emissions due to flaring, which are accounted for separately in equation 9. The procedures to calculate those 3 sources of project emissions are described below.

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*". As the project uses enclosed flares, two options are available to determine the flare efficiency. Option a) will be chosen, i.e. to use a 90% default value.

The project emissions from flaring gases are calculated as follows:

$$PE_{flare,y} = \sum_{i=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1000} \quad (15)$$

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;*
GWP	tCO_2e/tCH_4	Global Warming Potential of methane.

As the project uses the default efficiency value for enclosed flares, the flare efficiency in the hour *h* ($\eta_{flare,h}$) is:

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

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

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \quad (13)$$

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 at normal conditions in hour *h;*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas in hour *h*;
$\rho_{CH4,n}$	kg/Nm^3	Density of methane at normal conditions (0.716).

A. 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 emissions from electricity consumption"*.

Project emissions from electricity consumption will be calculated and monitored according to the procedures described in the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.

Scenario A: Electricity consumption from the grid is applicable for the project activity, using the following formula:

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

Where:

Parameter	**Unit**	**Description**
$PE_{EC,y}$	tCO_2/yr	Project emissions from electricity consumption by the project activity in year *y*;
$EC_{PJ,j,y}$	MWh	Quantity of electricity consumed by the project electricity consumption source j in year y;
$EF_{EL,j,y}$	tCO_2/MWh	Emission factor for electricity generation for source j in year y;
$TDL_{j,y}$	-	Average technical transmission and distribution losses for providing electricity to source j in year y.

According to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* Option A1 is selected to calculate the combined margin emission factor for the South African electricity system according to the *"Tool to calculate the emission factor for an electricity system"* ($EF_{EL,j,y} = EF_{grid,CM,y}$) and will be fixed ex-ante (see paragraph D of baseline emission section above). $TDL_{j,y}$ will be taken from the South African national electricity utility, Eskom, at 8%[24].

[24] Eskom 2008 Annual Report. Available from: < http://financialresults.co.za/eskom_ar2008/ar_2008/con_directors_report_02.htm>

In stage I, the auxiliary equipment will be supplied with electricity from the national grid. Project emissions due to grid electricity consumption will be measured through monitoring the electricity imported from the grid. In stage II, the auxiliary consumption will be met by the renewable electricity generated by the project activity. Surplus electricity, if any, will be exported to the grid. The baseline emissions, due to generation of renewable electricity in stage II, will be based on net electricity exported to the grid. In stage II, if any electricity is imported from the grid to meet the auxiliary consumption (during the outage of generator), the same would be monitored to calculate project emission due to grid electricity consumption.

Project emissions from electricity consumption may also include the use of a back-up fossil fuel generator. The quantity of fossil fuel used shall be monitored and the emission factor and net calorific value of the fossil fuel, according to the latest IPCC guidelines, will be used to determine the associated project emissions should a back up fossil fuel generator be used.

Leakage emissions:

No leakage effects need to be accounted under this methodology.

Emission reductions:

Equation 17 of ACM0001 is copied below and explicated in order to clearly differentiate between the various sources of project emissions. 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 do not have to be deducted once more in the overall emission reduction calculation in equation (17*). Only project emissions from electricity use and fossil fuel use are included in PE_y.

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

Where:

ER_y	tCO_2e/yr	Emission reductions in year *y*;
BE_y	tCO_2e/yr	Baseline emissions in year *y*;
PE_y	tCO_2e/yr	Project 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:

The table for parameter $CEF_{elec,BL,y}$ has been included in the list of “Data and parameters that are available at validation” while ACM0001 lists it in “Data and parameters monitored”. This is because project participants have chosen the option of ex-ante determination in accordance with the “Tool to calculate the emission factor for an electricity system”.

The following parameters included in ACM0001 as “Data and parameters not monitored” are not applicable:

- MD_{Hist} as $MD_{bl,y}$ =0
- MG_{Hist} as $MD_{bl,y}$ =0

The tables for the following parameters:

- “f (fraction of methane captured at SWDS and flared, combusted or used in another manner)” as ACM001 assigns it a value of 0.
- GWP_{CH4} as ACM0001 defines it as a parameter that is not monitored

have been included in “Data and parameters that are available at validation” while the ‘Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” lists them as “Data and parameters monitored”.

Parameters available at validation as per ACM0001 “Consolidated baseline and monitoring methodology for landfill gas project activities”.

Data / Parameter:	**Regulatory requirements relating to landfill gas projects**
Data unit:	-
Description:	Regulatory requirements relating to landfill gas projects
Source of data used:	Draft ‘Minimum Requirements for Waste Disposal by Landfill’, Department of Water Affairs & Forestry, 2005 and Landfill Permit for New England Landfill Site.
Value applied:	-
Justification of the choice of data or description of measurement methods and procedures actually applied:	The draft ‘Minimum Requirements for Waste Disposal by Landfill’ published in 2005 constitutes the most recent legislation on landfill site management in South Africa. They do not specify that it is a mandatory requirement to actively capture, flare or destroy landfill gas at every landfill in South Africa. They mainly provide guidelines to ensure safety by limiting landfill gas accumulation via passive ventilation. The Landfill Permit for the site, which specifies specific regulatory requirements for the site, does not specify that any landfill gas must be captured or flared.[25] At the time of renewal of crediting period the same shall be reassessed and ER shall be calculated accordingly in case new regulations are formulated requiring mandatory capture, flaring or destruction of LFG.
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

[25] Department of Water Affairs and Forestry, 1998: Permit Number 16/2/7/U203/D3/Z1/P64 New England Road Landfill Site.

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:	This parameter is also referred to in the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"

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"*.
Value applied:	See Annex 3 for values
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*" See below the tables describing the parameters used in that tool.
Any comment:	Used for *ex-ante* estimation of the amount of methane that would have been destroyed/combusted during the year.

Data / Parameter:	**$CEF_{elec,BL,y}$**
Data unit:	tCO_2/MWh
Description:	Carbon emission factor of electricity
Source of data used:	*"Tool to calculate project emissions for an electricity system"*
Value applied:	0.93
Justification of the choice of data or description of	This factor is calculated as per the "*Tool to calculate the emission factor for an electricity system*", which is one of the methods allowed by the "*Tool to calculate baseline, project and/or leakage emissions from electricity*

measurement methods and procedures actually applied:	*consumption"*. An ex-ante option is used to calculate the simple OM as allowed by the *"Tool to calculate project emissions for an electricity system"*. See Annex 3 for detailed calculations of this factor, including all assumptions used.
Any comment:	Note that $\mathbf{CEF_{elec,BL,y}}$ = $EF_{EL,j,y}$ from *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and* $EF_{grid,CM,y}$ from *"Tool to calculate the emission factor for an electricity system"*

The following parameters are taken from the *"Tool to calculate the emission factor for an electricity system"* and used to calculate $CEF_{elec,BL,y}$:

Data / Parameter:	$FC_{i,m,y}$
Data unit:	T
Description:	Amount of fossil fuel type *i* consumed by the group of power units *m* in year *y* (mass or volume unit)
Source of data used:	Eskom (South African electricity supply company) NERSA (National Electricity Regulator South Africa), Latest Electricity Supply Statistics
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Once for each crediting period (ex-ante option). Most up-to-date and publicly available data on fossil fuel consumption by power plants in South Africa.
Any comment:	

Data / Parameter:	$NCV_{i,y}$
Data unit:	GJ/mass or volume unit
Description:	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values. Once for each crediting period (ex-ante option)
Any comment:	

Data / Parameter:	$EF_{CO2,i,y}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of fossil fuel type *i* in year *y*
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	See Annex 3

Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values. Once for each crediting period (ex-ante option)
Any comment:	

Data / Parameter:	$EG_{m,y}$
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant / unit *m* in year *y*
Source of data used:	Eskom (South African electricity supply company) NERSA (National Electricity Regulator South Africa), Latest Electricity Supply Statistics
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Most recent publicly available data on electricity supply statistics sourced from South African electricity utility (Eskom) and National Energy Regulator (NERSA). Once for each crediting period (ex-ante option)
Any comment:	

The following parameters are taken from the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* and used to calculate $MG_{PR,y}$ (also designated by the symbol $BE_{CH4,SWDS,y}$).

Data / Parameter:	**Φ**
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	As defined in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* Version 04, adopted at EB 41.
Any comment:	

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	"*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* Version 04, adopted at EB 41

Value applied:	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	As defined in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* Version 04, adopted at EB 41.
Any comment:	

Data / Parameter:	**F**
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value from the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* Version 04, adopted at EB 41.
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Data / Parameter:	**DOC_f**
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value as defined in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* Version 04, adopted at EB 41.
Any comment:	

Data / Parameter:	**MCF**
Data unit:	-
Description:	Methane Correction Factor
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	1.0
Justification of the choice of data or description of measurement methods	1.0 for **anaerobic managed solid waste disposal sites**. Default value as defined in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* Version 04, adopted at EB 41; was used.

and procedures actually applied :	
Any comment:	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

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"*, version 04, adopted at EB 41.
Any comments	The values applied are for wet 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:	

Waste type *j*		Boreal and Temperate (MAT≤20°C)		Tropical (MAT>20°C)	
		Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry (MAP< 1000mm)	Wet (MAP> 1000mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
	Wood, wood products and straw	0.02	0.03	0.025	0.035
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40

Justification of the choice of data or description of measurement methods and procedures actually applied :	As per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
Any comment:	The values applied are for Boreal & temperate (MAT< 20°C) and dry (MAP < 1000mm) conditions. Proof of the Climate data for Pietermaritzburg from the South African Weather Service will be provided to the Validator upon request.

Data / Parameter:	**f**
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data used:	ACM0001
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied:	ACM0001 specifies that 'f' shall be assigned a value of 0
Any comment:	

The following parameter is taken from the *"Tool to determine project emissions from flaring gases containing methane"*

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"*.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Baseline emissions

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

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):

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

Table 1[26]:

	MD flare (t CH4)	MD electricity (t CH4)	MD project (t CH4)
2010	183	1,734	1,917
2011	308	1,734	2,042
2012	173	2,019	2,192
2013	183	2,139	2,322
2014	194	2,254	2,448
2015	305	2,254	2,560
2016	212	2,479	2,691
2017	221	2,586	2,807
Total	1,779	17,199	18,978

[26] 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 disposal of waste at a solid waste disposal site"

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

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

Table 2:

	LFG flare,y (m3)	PE flare,y (t CO2)	MD flare (t CH4)
2010	567,348	427	183
2011	954,946	719	308
2012	535,236	403	173
2013	566,957	427	183
2014	600,953	452	194
2015	946,788	713	305
2016	657,011	494	212
2017	685,471	516	221
Total	5,514,710	4,151	1,779
Default values: $w_{CH4,y}$ = 50%; D_{CH4} = 0.0007168; GWP_{CH4} = 21			

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

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

Table 3:

	LFG elec,y (m3)	MD electricity (t CH4)
2010	4,838,028	1,734
2011	4,838,028	1,734
2012	5,634,062	2,019
2013	5,967,965	2,139
2014	6,289,437	2,254
2015	6,289,437	2,254
2016	6,915,910	2,479
2017	7,215,484	2,586
Total	47,988,351	17,199
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 CH_4)	MDproject,y (t CO2)
2010	40,683	1,937
2011	43,600	2,076
2012	46,433	2,211
2013	49,184	2,342
2014	51,860	2,470
2015	54,463	2,593
2016	56,997	2,714
2017	59,466	2,832
Total	402,685	19,175
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. $MD_{BL,y}$

As explained in Section B.6.1, $MD_{BL,y}$ equals zero for the first commitment period.

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:

	FVRG,h (Nm^3/h)	TMRG,h (Kg/h)	PE flare,y (t CO_2)
2010	65	23	427

2011	109	39	719
2012	61	22	403
2013	65	23	427
2014	69	25	452
2015	108	39	713
2016	75	27	494
2017	78	28	516
Total	630	226	4,151
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

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

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

$$PE_{EC,y} = EC_{PJ,y} * 0.93 * (1 + 0.08) = PE_y$$ [27]

Table 6:

	Electricity consumption EC $_{PJ,y}$ (MWh)	PE,EC,y (t CO_2)
2010	701	5,867
2011	701	5,867
2012	701	5,867
2013	701	5,867
2014	701	5,867
2015	701	5,867
2016	701	5,867
2017	701	5,867
Total	5,608	46,939

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:

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

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

	BE,y (t $C0_2$)	PE EC,y (t CO_2)	ER,y (t CO_2)
2010	47,696	5,867	41,829
2011	50,322	5,867	44,454
2012	55,702	5,867	49,834
2013	58,430	5,867	52,562
2014	61,080	5,867	55,212
2015	63,422	5,867	57,555
2016	68,406	5,867	62,539
2017	70,854	5,867	64,986
Total	475,911	46,939	428,972

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

Table B6.4.1: Total Emission Reductions over the first crediting period

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2e)
2010 (July-Dec)	5,867	47,696	0	20,914
2011	5,867	50,322	0	44,454
2012	5,867	55,702	0	49,834
2013	5,867	58,430	0	52,562
2014	5,867	61,080	0	55,212
2015	5,867	63,422	0	57,555
2016	5,867	68,406	0	62,539
2017 (Jan-June)	5,867	70,854	0	32,493
Total (tonnes of CO2e)	46,939	475,911	0	375,564

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

B.7.1 Data and parameters monitored:

The tables for the following parameters listed in ACM0001 as “Data and Parameters monitored” are not applicable:

- $LFG_{thermal, y}$: No methane will be combusted in a boiler/air heater/heat generating equipment
- $LFG_{PL, y}$: No landfill gas will be sent through gas pipelines
- T: Flow meters will express LFG volumes in normalised cubic meters, therefore no separate monitoring of temperature is necessary
- P: Flow meters will express LFG volumes in normalised cubic meters, therefore no separate monitoring of pressure is necessary
- ET_{LFG}: No thermal energy will be generated using LFG
- $EF_{fuel,BL}$: No fossil fuel was used in baseline captive power plant or thermal generation.
- $NCV_{fuel, BL}$: No fossil fuel was used in baseline for thermal energy generation and/or electricity generation.
- $\varepsilon_{gen, BL}$: No baseline captive power plant was used.
- $\varepsilon_{boiler/airheater}$: No baseline boiler/air heater was used for producing thermal energy.
- Operation of the boiler/air heater/heat generating equipment: No boiler/air heater/heat generating equipment will be used.

The tables for the following parameters included in the 'Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site' as "Data and parameters monitored" are not applicable:

- W_x: ACM0001 specifies that sampling to determine the different waste types is not necessary
- $P_{n,j,x}$: ACM0001 specifies that sampling to determine the different waste types is not necessary
- z: ACM0001 specifies that sampling to determine the different waste types is not necessary

Parameters from ACM0001 *"Consolidated baseline and monitoring methodology for landfill gas project activities"*

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	6,514,587 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's recommendations. This will ensure that the accuracy of the measurement instrument is maintained, which can be assumed to be <3%. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meter will be subject to a regular maintenance and testing regime to ensure accuracy.
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. Whenever, the project does not generate electricity, $LFG_{total,y}$ will be identical to $LFG_{flare,y}$ since all captured landfill gas will be fed to the flare.

Data / Parameter:	**$LFG_{flare,y}$**
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	689,891 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's recommendations. This will ensure that the accuracy of the measurement instrument is maintained, which can be assumed to be <3%. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	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.

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	5,824,695 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's recommendations. This will ensure that the accuracy of the measurement instrument is maintained, which can be assumed to be <3%. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	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. This Parameter shall only be measured if and when the project generates electricity.

Data / Parameter:	$\mathbf{PE_{flare,y}}$
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data to be used:	Calculated as per the '*Tool to determine project emissions from flaring gases containing Methane*"
Value of data applied for the purpose of calculating expected emission reductions in section B.5	519 (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:	$\mathbf{w_{CH4}}$
Data unit:	Nm^3CH_4 / Nm^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Project Developer
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:	Methane content will be measured continuously with a gas analysing unit by the Project Developer. Alternatively, the methane content shall be analysed at least 4 measurements every year. The lower bound of the 95% confidence interval obtained from the periodical measurements will be used. The gas analysing unit will be maintained and calibrated regularly in line with the manufacturer's requirements in order to ensure that factory standards of accuracy are maintained.
QA/QC procedures to be applied:	The gas analysing unit will be maintained and calibrated regularly in line with the manufacturer's requirements in order to ensure accuracy.
Any comment:	

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	10,057 (annual average over first crediting period)
Description of measurement methods and procedures to be applied:	Electricity will be measured continuously using electricity meter(s).
QA/QC procedures to be applied:	Electricity meter(s) 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. Will be used if and when the project produces electricity.

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 (ex-ante estimate)
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	
Any comment:	Data shall only be collected if and when the Project generates electricity.

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 project emissions from electricity consumption"*.
Value of data applied for the purpose of calculating expected emission reductions in	5,867(Annual average over the first crediting period)

section B.5	
Measurement procedures (if any):	As per the *“Tool to calculate project emissions from electricity consumption”*.
QA/QC procedures to be applied:	As per the *“Tool to calculate project emissions from electricity consumption”*.
Any comment:	

The following parameters are taken from 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*”.
QA/QC procedures to be applied:	The thermocouple will be subject to a regular exchange and/or calibration according to manufacturer’s recommendation to ensure accuracy.
Any comment:	

Data / Parameter:	**Other flare operational parameters**
Data unit:	-
Description:	Includes 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. This may include but is not limited to Minimum Combustion Temperature, Maximum Combustion Temperature and Minimum Methane content.
Source of data to be used:	Measurement by project participants
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:	Continuously
QA/QC procedures to be applied:	
Any comment:	Only applicable in case of use of a default value.

The following parameters are taken from the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* and used to calculate $PE_{EC,y}$.

Data / Parameter:	**$EC_{PJ,j,y}$**
Data unit:	MWh
Description:	Onsite consumption of electricity attributable to the project activity during the year *y*
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	701 (ex-ante estimate from Project Developer)
Description of measurement methods and procedures to be applied:	Electricity will be measured continuously using electricity meter(s) and aggregated annually.
QA/QC procedures to be applied:	Electricity meter(s) 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:	

Data / Parameter:	**$TDL_{j,y}$**
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*.
Source of data to be used:	South African national electricity utility, Eskom Annual Report 2008, Directors Report, Page 105.
Value of data applied for the purpose of calculating expected emission reductions in section B.5:	8.0%
Description of measurement methods and procedures to be applied:	Eskom is South Africa's National Electricity Utility and has published in the 2008 Annual Report a percentage for Line losses. The most recent figure will be sourced annually and used for TDL_y. However, if data is not available or if this figure is older than 5 years, then the default value of 20% will be used, in accordance with the requirements of the *"Tool to calculate project emissions from electricity consumption"*.
QA/QC Procedures to be applied:	
Any comment:	

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

Monitoring data will be measured & collected as detailed in section B.7.1. 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 collected on site will be compiled in an electronic format which will be sent to EcoSecurities on a regular basis.

Data Quality Control and Quality Assurance

All data collected on site will be checked internally before being stored 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

Procedures will be developed to ensure that all equipment will be maintained and calibrated in line with manufacturer's recommendations. This will assure that the equipment operates at accuracy as stated by monitoring equipment provider.

All monitoring equipment will be identified with specific serial or tag numbers.

Staff training

Training is conducted on site at regular intervals to ensure that staff is capable to perform their designated tasks at high standards. The parties will agree upon procedures and responsibilities for 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 a designated CDM Monitoring Manager 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 him.

Please see Annex 4 for details.

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 of the baseline and monitoring methodology: 13 March 2009

Person/entity:

Jennifer Orr
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South Africa
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e-mail: Jennifer.orr@ecosecurities.com

Detailed baseline and monitoring information are attached in 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:

26/09/2007 (Signature Date of Lease and Gas Rights Agreement)

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

Up to 20 years[28]

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

C.2.1. Renewable crediting period

7*3 years

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

The crediting period will start on 01/06/2010, 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 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

[28] Terms of Lease and Gas Rights Agreement between Ener-G Systems Msunduzi (Pty) Ltd and the Msunduzi Municipality (26 September 2007), which allow agreement to continue for 15 years from commissioning date, with the option to extend for a further 5 years.

SECTION D. Environmental impacts

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

The project will actively collect and combust 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 minimise the environmental impact of landfill gas emissions, which is significantly less harmful than the continued uncontrolled release of LFG into the atmosphere. 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 project developer to continue to improve waste management practices.

In South Africa it is nevertheless a legal requirement that a professional body conducts the Environmental Impact Assessment (EIA) which needs to be submitted to the Kwazulu Natal Department of Agriculture & Environmental Affairs (DAEA). The EIA Scoping Report was submitted to DAEA on the 18th of November 2008 and in parallel to the CDM project implementation the process is underway to receive the Record of Decision from DAEA, necessary to be in compliance with South African Environmental legislation. The EIA Scoping report is available for the DoE on request and the Record of Decision will be provided as soon as it is received, before the start of the crediting period.

The potential impacts of the Project have been divided into those that can be mitigated during the design phase and those impacts that require management during the construction and operational phase of the project:

- **Preconstruction (Design phase):**

Surface and groundwater impacts

- **Construction phase:**

Employment opportunities
Dust
Noise
Waste disposal
Safety

- **Operational Phase**

Solid Waste Management
Vegetation
Noise
Safety

Identified issues are addressed in Section D.2.

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:

Identified environmental impacts	**Measures taken**
Pre-Construction (Design Phase)	
Surface & Groundwater impacts	The potential negative impacts of the Project on the surface and groundwater quality downstream will be insignificant provided that the storm-water and wash-water are managed as specified. It is recommended that storm-water drains divert water falling on land to prevent 'clean' water from coming into contact with any contaminated water.
Vegetation & Biodiversity	The vegetation at the site has been highly disturbed and invaded and as such there are no significant environmental impacts.
Construction Phase	
Employment	Temporary employment opportunities will be available during the construction of the site. The proponent has agreed to employ local labour where possible during the construction phase.
Dust	The following measures will be taken to control the dust nuisance generated during the construction phase: - All road surfaces must be wetted frequently to suppress dust; and - Stockpiles of builders sand or any other dust causing materials must be wetted frequently to suppress dust; and - Vegetation cover must only be cleared from those areas where construction is imminent.

Noise	The following measures must be implemented on site to minimise potential noise impacts: - Construction activities must not take place after 18:00 or before 07:00; - Construction activities must not take place on weekends without prior negotiations - The labour force must keep shouting, whistling, music etc to an absolute minimum; - All site vehicles must be serviced to ensure they are not causing any noise due to poor vehicle maintenance; and - Drivers must be instructed to turn off their engines during long periods of standstill during on loading and offloading.
Soil erosion & compaction	The following mitigation measures will reduce the risk of any negative impacts on in situ soil: - Controlling and confining the movement of construction vehicles to the immediate construction footprint only; - Removing and stockpiling soil for rehabilitation; - Clearing only the areas to be worked in; - Ensuring immediate revegetation of areas where construction has been completed; - Rehabilitation of compacted surfaces; and - Prohibit the stockpiling of material beyond the construction footprint area.
Vegetation Damage	Most natural vegetation in the construction footprint is already degraded and the only plants to be maintained are situated along the fence line. Potential damage to vegetation and biodiversity impacts will be insignificant.
Waste Disposal	Waste such as builder's rubble, fill material, oils, general waste and sewage will be generated during the construction phase. All waste must be disposed of in a legally accepted manner, with no burning of refuse to take place on site. Provided that these management recommendations are implemented, the impacts of waste generated by the development will be insignificant.
Safety	All employees must be made aware of the dangers associated with landfill gas. No smoking is to be allowed on site due to the risks associated with landfill gas.
Operational Phase	
Solid Waste Management	All solid waste must be disposed of at a permitted

	landfill site. The impacts of solid waste from this site will be insignificant.
Effluent Management	The conservancy tank systems must be inspected regularly to ensure they are operational.
Vegetation Management	Minimum vegetation management will be required at this site.
Stormwater Management	All storm-water drains must be maintained on a regular basis and cleared of refuse and debris.
Surface Water Quality	All storm-water drains must be regularly maintained to ensure there are no blockages.

SECTION E. Stakeholders' comments

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

Geomeasure Group (Pty) Ltd was appointed by Ener G Systems (Pty) Ltd to carry out the environmental scoping for the development of the New England landfill site into a CDM Project. The Scoping report and stakeholder consultation clearly specified that the project would be designed under the CDM. A Scoping report was prepared as part of the scoping phase of the Environmental Impact Assessment (EIA) Process as specified by Section 26 of the Environmental Conservation Act (Act 73 of 1989).

The following authorities have been advised of the proposed development:

- KwaZulu-Natal Department of Agriculture & Environmental Affairs
- uMsunduzi Municipality
- Department of Water Affairs and Forestry

Interested& Affected Parties (I&APs) were identified by placing official notices of the EIA process for the proposed development in the Echo and Natal Witness on 16 August 2007, allowing I&APs 14 days to respond or comment. Furthermore a knock and drop of Project Background Information Documents was conducted to residents surrounding the site. Copies of the adverts and Background Information Documents are attached to the Scoping Report.[29]

Table E1.1: Summary of Public and Authority Involvement to date

Date	Event/Activity	Comments
2 February 2006	Meeting with DAEA & DWAF	
February 2006	Submission of DEAT Section 22 application and Plan of Study for Scoping to KZN DAEA.	
August 2007	Advert of EIA Notification appears in the Echo and Witness	Appendix A
September 2007	Knock and drop to surrounding I&APss	Appendix B
October 2007	Scoping Report submitted to the I&AP's And DWAF and DAEA	
October 2007	Registered I&AP's notified of availability of Scoping Report.	A 14 day comment period has been allowed and the comments received will be forwarded to the DAEA assessing officer.

E.2. Summary of the comments received:

The following issues have been raised by the Authorities and I&APs:

- Odours

[29] A copy of the 'New England Road Landfill CDM Scoping Report' is available to the Validator on request.

- Aesthetics/Appearance
- Employment

Support has been received from a number of the adjacent Bed& Breakfasts. Furthermore it is felt that the project will include much needed employment for the local residents as unemployment is very high in the area. A summary of the issues identified during the scoping phase is provided below:

Table E2.1: Issues identified during the Scoping Phase

Issue	Raised by	Description of Issue
Social		
Waste Disposal	Geomeasure Group	There is a possibility that fuels and other materials will be stored on site. Should these materials and waste produced during the construction phase there is a potential that they could have an impact on the receiving environment.
Visual impacts	Geomeasure Group	Any development has the potential to change the landscape and hence changes the visual aesthetics of a place.
Employment	Community	The community expressed their concerned with potential employment opportunities related to the development and the importation of migrant labour.
Noise	Geomeasure Group	There will be a potential of noise impacts from the construction activities.
Environmental		
Solid Waste	Geomeasure Group	Poor solid waste management on site can result in negative impacts and off site.
Dust	Geomeasure Group	Due to exposure of areas of soil to wind and vehicle movements, dust could become a negative impact during construction only.
Noise	Geomeasure Group	Noise levels will increase during the construction phase of the project and there will be a potential of noise impacts from the construction during working hours.

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

The raised concerns were related to temporary phases of the project relating to construction of the project activity. Post implementation, the aforesaid raised issues would cease to exist. Further all the raised concerns were already anticipated in the EIA assessment and mitigation measures were suggested to keep its impact, if any, to minimum. The Project is environmentally and socially acceptable provided that the mitigation measures are implemented.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Project developer:

Organization:	ENER·G Systems Msunduzi (PTY) LTD
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Represented by:	Represented by:
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Salutation:	Mr
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Project Annex 1 participant:

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Represented by:	
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Salutation:	Mr.

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Middle Name:	-
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The project will not receive any public funding from an Annex 1 country.

Annex 3

BASELINE INFORMATION

1. Baseline & Emission reduction calculations

a) Baseline Emissions (First Crediting Period):

Baseline emissions calculations

		WASTE STREAM																			
		First Type		Second Type		Third Type		Fourth Type		Fith Type		Sixth Type									
Year (x)	Total Amount waste	Amount	$w_{jx} * DOC_j$	Amount	$w_{jx} * DOC_j$	Amount	$w_{jx} * DOC_j$	Amount	$w_{jx} * DOC_j$	Amount	$w_{jx} * DOC_j$	Amount	$w_{jx} * DOC_j$	2010	2011	2012	2013	2014	2015	2016	2017
1996	88,600	4,873	2,095	7,017	2,807	5,024	754	1,994	478	26,137	5,227	43,591	0	1,420	1,359	1,301	1,245	1,192	1,141	1,093	1,046
1997	97,400	5,357	2,304	7,714	3,086	5,523	828	2,192	526	28,733	5,747	47,921	0	1,632	1,561	1,494	1,430	1,369	1,310	1,254	1,201
1998	107,200	5,896	2,535	8,490	3,396	6,078	912	2,412	579	31,624	6,325	52,742	0	1,877	1,796	1,718	1,644	1,574	1,506	1,442	1,381
1999	117,900	6,485	2,788	9,338	3,735	6,685	1,003	2,653	637	34,781	6,956	58,007	0	2,158	2,065	1,975	1,890	1,809	1,731	1,657	1,586
2000	129,700	7,134	3,067	10,272	4,109	7,354	1,103	2,918	700	38,262	7,652	63,812	0	2,482	2,374	2,271	2,173	2,079	1,990	1,904	1,823
2001	142,600	7,843	3,372	11,294	4,518	8,085	1,213	3,209	770	42,067	8,413	70,159	0	2,853	2,729	2,610	2,497	2,389	2,286	2,187	2,094
2002	156,900	8,630	3,711	12,426	4,971	8,896	1,334	3,530	847	46,286	9,257	77,195	0	3,283	3,139	3,003	2,872	2,747	2,629	2,515	2,407
2003	172,600	9,493	4,082	13,670	5,468	9,786	1,468	3,884	932	50,917	10,183	84,919	0	3,777	3,611	3,454	3,303	3,159	3,022	2,892	2,767
2004	189,800	10,439	4,489	15,032	6,013	10,762	1,614	4,271	1,025	55,991	11,198	93,382	0	4,344	4,153	3,971	3,798	3,632	3,474	3,324	3,180
2005	200,000	11,000	4,730	15,840	6,336	11,340	1,701	4,500	1,080	59,000	11,800	98,400	0	4,788	4,577	4,376	4,185	4,002	3,827	3,661	3,502
2006	205,000	11,275	4,848	16,236	6,494	11,624	1,744	4,613	1,107	60,475	12,095	100,860	0	5,134	4,907	4,692	4,486	4,289	4,102	3,923	3,752
2007	210,000	11,550	4,967	16,632	6,653	11,907	1,786	4,725	1,134	61,950	12,390	103,320	0	5,502	5,259	5,027	4,806	4,595	4,394	4,202	4,019
2008	215,000	11,825	5,085	17,028	6,811	12,191	1,829	4,838	1,161	63,425	12,685	105,780	0	5,894	5,633	5,384	5,147	4,920	4,704	4,498	4,302
2009	220,000	12,100	5,203	17,424	6,970	12,474	1,871	4,950	1,188	64,900	12,980	108,240	0	6,311	6,031	5,764	5,509	5,267	5,035	4,814	4,603
2010	221,958	12,208	5,249	17,579	7,032	12,585	1,888	4,994	1,199	65,478	13,096	109,203	0	6,664	6,367	6,085	5,815	5,558	5,313	5,080	4,857
2011	223,933	12,316	5,296	17,736	7,094	12,697	1,905	5,039	1,209	66,060	13,212	110,175	0	0	6,723	6,424	6,139	5,867	5,608	5,361	5,125
2012	225,926	12,426	5,343	17,893	7,157	12,810	1,922	5,083	1,220	66,648	13,330	111,156	0	0	0	6,783	6,481	6,194	5,919	5,658	5,408
2013	227,937	12,537	5,391	18,053	7,221	12,924	1,939	5,129	1,231	67,241	13,448	112,145	0	0	0	0	6,843	6,539	6,249	5,972	5,708
2014	229,966	12,648	5,439	18,213	7,285	13,039	1,956	5,174	1,242	67,840	13,568	113,143	0	0	0	0	0	6,904	6,597	6,304	6,025
2015	232,013	12,761	5,487	18,375	7,350	13,155	1,973	5,220	1,253	68,444	13,689	114,150	0	0	0	0	0	0	6,966	6,656	6,361
2016	234,077	12,874	5,536	18,539	7,416	13,272	1,991	5,267	1,264	69,053	13,811	115,166	0	0	0	0	0	0	0	7,028	6,715
2017	236,161	12,989	5,585	18,704	7,482	13,390	2,009	5,314	1,275	69,667	13,933	116,191	0	0	0	0	0	0	0	0	7,090
2018	238,263	13,104	5,635	18,870	7,548	13,509	2,026	5,361	1,287	70,287	14,057	117,225	0	0	0	0	0	0	0	0	0
2019	240,383	13,221	5,685	19,038	7,615	13,630	2,044	5,409	1,298	70,913	14,183	118,268	0	0	0	0	0	0	0	0	0
2020	242,522	13,339	5,736	19,208	7,683	13,751	2,063	5,457	1,310	71,544	14,309	119,321	0	0	0	0	0	0	0	0	0
2021	244,681	13,457	5,787	19,379	7,751	13,873	2,081	5,505	1,321	72,181	14,436	120,383	0	0	0	0	0	0	0	0	0
2022	246,859	13,577	5,838	19,551	7,820	13,997	2,100	5,554	1,333	72,823	14,565	121,454	0	0	0	0	0	0	0	0	0
2023	249,056	13,698	5,890	19,725	7,890	14,121	2,118	5,604	1,345	73,471	14,694	122,535	0	0	0	0	0	0	0	0	0
2024	251,272	13,820	5,943	19,901	7,960	14,247	2,137	5,654	1,357	74,125	14,825	123,626	0	0	0	0	0	0	0	0	0
2025	253,509	13,943	5,995	20,078	8,031	14,374	2,156	5,704	1,369	74,785	14,957	124,726	0	0	0	0	0	0	0	0	0
2026	255,765	14,067	6,049	20,257	8,103	14,502	2,175	5,755	1,381	75,451	15,090	125,836	0	0	0	0	0	0	0	0	0
2027	258,041	14,192	6,103	20,437	8,175	14,631	2,195	5,806	1,393	76,122	15,224	126,956	0	0	0	0	0	0	0	0	0
2028	260,338	14,319	6,157	20,619	8,247	14,761	2,214	5,858	1,406	76,800	15,360	128,086	0	0	0	0	0	0	0	0	0
2029	262,655	14,446	6,212	20,802	8,321	14,893	2,234	5,910	1,418	77,483	15,497	129,226	0	0	0	0	0	0	0	0	0
2030	264,992	14,575	6,267	20,987	8,395	15,025	2,254	5,962	1,431	78,173	15,635	130,376	0	0	0	0	0	0	0	0	0
2031	267,351	14,704	6,323	21,174	8,470	15,159	2,274	6,015	1,444	78,868	15,774	131,537	0	0	0	0	0	0	0	0	0
TOTAL	7,620,357	419,120		603,532		432,074		171,458		2,248,005		3,749,216		58,119	62,286	66,332	70,263	74,085	77,804	81,424	84,951

		2010	2011	2012	2013	2014	2015	2016	2017
BE *CH4, SWDS,y*	t CO2	**58,119**	**62,286**	**66,332**	**70,263**	**74,085**	**77,804**	**81,424**	**84,951**
With collection efficiency									
BE *CH4, SWDS,y*	t CO2	**40,683**	**43,600**	**46,433**	**49,184**	**51,860**	**54,463**	**56,997**	**59,466**
Total LFG collected per year	m3/year	5,405,376	5,792,974	6,169,298	6,534,921	6,890,390	7,236,224	7,572,922	7,900,956
Total LFG combusted in power gen	m3/year	4,838,028	4,838,028	5,634,062	5,967,965	6,289,437	6,289,437	6,915,910	7,215,484
Total LFG to be flared	m3/year	567,348	954,946	535,236	566,957	600,953	946,788	657,011	685,471
MD electricity	t CH4	1,734	1,734	2,019	2,139	2,254	2,254	2,479	2,586
$FV_{RG,h}$	m3/h	65	109	61	65	69	108	75	78
$TM_{RG,h}$	kg/hr	23	39	22	23	25	39	27	28
$PE_{flare,y}$	t CO2	427	719	403	427	452	713	494	516
MD flared	t CH4	183	308	173	183	194	305	212	221
MD project	t CH4	1,917	2,042	2,192	2,322	2,448	2,560	2,691	2,807
MD,Baseline		0	0	0	0	0	0	0	0
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
m3 Biogas/hour collected	m3/hr	617	661	704	746	787	826	864	902
Total LFG to be flared	m3/hr	12	57	0	0	0	40	0	0
Total LFG combusted in power gen	m3/hr	605	605	704	746	786	786	864	902
Potential MW	MW	1.02	1.09	1.16	1.23	1.30	1.37	1.43	1.49
Expected Installed capacity	MW	1.00	1.00	1.30	1.30	1.30	1.30	1.60	1.60

b) Emission Reductions (First Crediting Period)

Baseline emission BE y									
ACM001 vers10& Tool methane avoidance	Units	2010	2011	2012	2013	2014	2015	2016	2017
Baseline emission BE CH4,SWDS,y	tCO_2e	40,683	43,600	46,433	49,184	51,860	54,463	56,997	59,466
MD project,y= BE/GWP CH4	tCH4	1,937	2,076	2,211	2,342	2,470	2,593	2,714	2,832
LFG volume collected per year	m3/year	5,405,376	5,792,974	6,169,298	6,534,921	6,890,390	7,236,224	7,572,922	7,900,956
Total LFG volume to be combusted in power generation	m3/year	4,838,028	4,838,028	5,634,062	5,967,965	6,289,437	6,289,437	6,915,910	7,215,484
Total LFG volume to be flared	m3/year	567,348	954,946	535,236	566,957	600,953	946,788	657,011	685,471
Methane combusted in power generation	tCH4	1,734	1,734	2,019	2,139	2,254	2,254	2,479	2,586
Methane mass flow rate in the residual gas	kg / h	23	39	22	23	25	39	27	28
Project Emissions from flaring	tCO2e	427	719	403	427	452	713	494	516
Methane destroyed by the flare	tCH4	183	308	173	183	194	305	212	221
MD project,y = MD flared + MD electricity	**tCH4**	**1,917**	**2,042**	**2,192**	**2,322**	**2,448**	**2,560**	**2,691**	**2,807**
Baseline Emission Reductions	tCH4	0	0	0	0	0	0	0	0
Emission reductions from methane destruction									
(MD project,y - MD reg,y)* GWP CH4	tCO_2e	40,256	42,882	46,030	48,758	51,408	53,750	56,502	58,950
Emission reductions from Grid displacement									
Installed capacity	MW	1.00	1.00	1.30	1.30	1.30	1.30	1.60	1.60
Electricity generation	MWh/year	8,000	8,000	10,400	10,400	10,400	10,400	12,800	12,800
EL LFG,y *CEF elec, BL,y	tCO2e	7,440	7,440	9,672	9,672	9,672	9,672	11,904	11,904
Baseline emissions									
Baseline emissions	tCO2e	47,696	50,322	55,702	58,430	61,080	63,422	68,406	70,854

Project emission PE y									
ACM001 vers10 & Tool to calculate baseline, project and/(	Units	2010	2011	2012	2013	2014	2015	2016	2017
Electricity consumption	MWh/year	701	701	701	701	701	701	701	701
Project emissions	tCO2e	5,867	5,867	5,867	5,867	5,867	5,867	5,867	5,867

Emission reduction ER y									
ACM0001 vers10	Units	2010	2011	2012	2013	2014	2015	2016	2017
Emission reduction	tCO2e	41,829	44,454	49,834	52,562	55,212	57,555	62,539	64,986

2. Financial Analysis and Benchmark Determination (Please see attached Benchmark and Financial Analysis Calculators for full calculations)

a) Market return: Sourced from FTSE/JSE Africa All share average market return (1997-2007)

b) Risk Free Rate for South Africa: Sourced from Financial Database Bloomberg Finance L.P.

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SAGB (33 Found) Cpn Typ All Mty Typ All Exclude Matured/called

Issuer	Coupon	Maturity	Series	Rtg	Mty Type	Announce	Curr	Ask Px	PCS
1)SOUTH AFRICA I/L	2.600	03/31/28	R210	NR	BULLET	09/17/07	ZAR	N.A.	N.A.
2)REP SOUTH AFRICA	6.750	03/31/21	R208	NR	BULLET	08/23/06	ZAR	83.0152	BGN
3)REP SOUTH AFRICA	6.250	03/31/36	R209	NR	BULLET	07/12/06	ZAR	75.8834	BGN
4)REP SOUTH AFRICA	10.000	02/28/09	R196	A	BULLET	10/28/05	ZAR	99.5709	BGN
5)REP SOUTH AFRICA	7.500	01/15/14	R206	NR	BULLET	07/08/05	ZAR	92.8403	BGN
6)REP SOUTH AFRICA	FLOAT	03/31/12	R205	NR	BULLET	07/01/05	ZAR	N.A.	N.A.
7)REP SOUTH AFRICA	7.250	01/15/20	R207	NR	BULLET	06/08/05	ZAR	87.4235	BGN
8)REP SOUTH AFRICA	8.250	09/15/17	R203	A	BULLET	04/16/04	ZAR	94.8370	BGN
9)REP SOUTH AFRICA	8.000	12/21/18	R204	A	BULLET	04/16/04	ZAR	92.9713	BGN
10)SOUTH AFRICA I/L	3.450	12/07/33	R202	A	BULLET	08/11/03	ZAR	N.A.	N.A.
11)REP SOUTH AFRICA	8.750	12/21/14	R201	A	BULLET	05/19/03	ZAR	97.8324	BGN
12)SOUTH AFRICA I/L	5.500	12/07/23	R197	A	BULLET	05/09/01	ZAR	N.A.	N.A.
13)SOUTH AFRICA I/L	6.250	03/31/13	R189	A	BULLET	03/09/00	ZAR	N.A.	N.A.
14)REP SOUTH AFRICA	10.500	12/21/26	R186	A	BULLET	03/19/98	ZAR	114.6395	BGN
15)REP SOUTH AFRICA	0.000	09/15/16	Z109	A	BULLET	11/24/97	ZAR	N.A.	N.A.
16)REP SOUTH AFRICA	0.000	09/30/19	Z083	A	BULLET	04/01/96	ZAR	N.A.	N.A.
17)REP SOUTH AFRICA	0.000	11/30/14	Z025	A	BULLET	05/18/94	ZAR	N.A.	N.A.
18)REP SOUTH AFRICA	0.000	04/30/09	Z021	A	BULLET	04/26/94	ZAR	N.A.	N.A.
19)REP SOUTH AFRICA	0.000	06/30/14	Z019	A	BULLET	04/21/94	ZAR	N.A.	N.A.
20)REP SOUTH AFRICA	0.000	03/31/14	Z018	A	BULLET	04/21/94	ZAR	N.A.	N.A.

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000

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c) Financial Analysis without CDM Revenue

Financial Analysis without CDM:

CASH FLOW WITHOUT CDM		0	1	2	3	4	5	6	7
		2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Projected Emission Reductions (tCO_2)	tCO_2	*0*	*41,829*	*44,454*	*49,834*	*52,562*	*55,212*	*57,555*	*62,539*
REVENUE									
Electricity Generation									
Evolution of Power Tariff	ZAR / MWh	*R 650.00*	*R 684.06*	*R 719.90*	*R 757.63*	*R 797.33*	*R 774.56*	*R 679.29*	*R 571.91*
Annual Electricity Generation	MWh	0	8,000	8,000	10,400	10,400	10,400	10,400	12,800
Gross Electricity Revenue (ZAR)		R -	R 5,472,480.00	R 5,759,237.95	R 7,879,328.63	R 8,292,205.45	R 8,055,431.09	R 7,064,613.06	R 7,320,417.27
Electricity Revenue	ZAR	**R -**	**R 5,472,480.00**	**R 5,759,237.95**	**R 7,879,328.63**	**R 8,292,205.45**	**R 8,055,431.09**	**R 7,064,613.06**	**R 7,320,417.27**
INVESTMENT & COSTS									
a) Capital Cost									
Flaring systems (Shipped and commissioned)	ZAR	*R 2,897,585.85*	*R -*	*R -*	*R -*	*R -*	*R -*	*R -*	*R -*
Gas collection system and civil works	ZAR	*R 2,755,418.00*	*R -*	*R -*	*R -*	*R -*	*R -*	*R -*	*R -*
Subtotal: Investment gas collection & flaring	ZAR	***R 5,653,003.85***	**R -**	**R -**	**R -**	**R -**	**R -**	**R -**	**R -**
Electrical Generating Equipment	ZAR	*R 8,062,152.40*	*R -*	*R 8,062,152.40*	*R -*	*R -*	*R 4,171,750.42*	*R -*	*R -*
Connection to Grid & Civils	ZAR	*R 3,250,000.00*	*R -*	*R 750,000.00*	*R -*	*R -*	*R -*	*R 250,000.00*	*R -*
Subtotal: Investment Energy Generation	ZAR	***R 11,312,152.40***	**R -**	**R 8,812,152.40**	**R -**	**R -**	**R 4,171,750.42**	**R 250,000.00**	**R -**
TOTAL INVESTMENT	ZAR	***R 16,965,156.25***	**R -**	**R 8,812,152.40**	**R -**	**R -**	**R 4,171,750.42**	**R 250,000.00**	**R -**
b) O&M Cost									
O&M - Gas Collection & Flaring	ZAR	*R 625,000.00*	*R 625,000.00*	*R 625,000.00*	*R 625,000.00*	*R 625,000.00*	*R 625,000.00*	*R 625,000.00*	*R 625,000.00*
O&M - Electricity Generation	ZAR	*R 2,350,000.00*	*R 2,350,000.00*	*R 3,200,000.00*	*R 3,200,000.00*	*R 3,200,000.00*	*R 4,000,000.00*	*R 4,000,000.00*	*R 4,000,000.00*
Project Support	ZAR	*R 1,320,000.00*	*R 1,320,000.00*	*R 1,320,000.00*	*R 1,320,000.00*	*R 1,320,000.00*	*R 1,320,000.00*	*R 1,320,000.00*	*R 1,320,000.00*
TOTAL O&M and PROJECT SUPPORT COST	ZAR	***R 4,295,000.00***	***R 4,295,000.00***	***R 5,145,000.00***	***R 5,145,000.00***	***R 5,145,000.00***	***R 5,945,000.00***	***R 5,945,000.00***	***R 5,945,000.00***
TOTAL INVESTMENT & OPERATIONAL COST	ZAR	***R 21,260,156.25***	**R 4,295,000.00**	**R 13,957,152.40**	**R 5,145,000.00**	**R 5,145,000.00**	**R 10,116,750.42**	**R 6,195,000.00**	**R 5,945,000.00**
Depreciation	ZAR	R 1,696,515.63	R 1,696,515.63	R 2,577,730.87	R 2,577,730.87	R 2,577,730.87	R 2,994,905.91	R 3,019,905.91	R 3,019,905.91
Gross profit before tax	ZAR	R -5,991,515.63	R -519,035.63	R -1,963,492.91	R 156,597.76	R 569,474.58	R -884,474.82	R -1,900,292.84	R -1,644,488.64
Cummulative (for carryforward tax)	ZAR	R -5,991,515.63	R -6,510,551.25	R -8,474,044.16	R -8,317,446.40	R -7,747,971.82	R -8,632,446.64	R -10,532,739.48	R -12,177,228.12
Income Tax	ZAR	R -	R -	R -	R -	R -	R -	R -	R -
Net Profit	ZAR	R -5,991,515.63	R -519,035.63	R -1,963,492.91	R 156,597.76	R 569,474.58	R -884,474.82	R -1,900,292.84	R -1,644,488.64
Cashflow without CDM	ZAR	***R -21,260,156.25***	**R 1,177,480.00**	**R -8,197,914.45**	**R 2,734,328.63**	**R 3,147,205.45**	**R -2,061,319.33**	**R 869,613.06**	**R 1,375,417.27**
Cummulativ	ZAR	*R -21,260,156.25*	R -20,082,676.25	R -28,280,590.70	R -25,546,262.07	R -22,399,056.63	R -24,460,375.96	R -23,590,762.89	R -22,215,345.62
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	20 years without CDM
Net Present Value (ZAR)	R -14,363,704.58
IRR	7.72%
Benchmark	17.53%

d) Financial Analysis with CDM Revenue

	B	C	D	E	F	G	H	I	J	K
1	**Financial analysis with CDM:**									
2										
3	**CASHFLOW WITH CDM**			**1st crediting period**						
4			**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
5	Projected emission reductions (tCO_2)		0	41,829	44,454	49,834	52,562	55,212	57,555	62,539
6				41,829	86,283	136,117	188,680	243,892	301,446	363,985
7										
8	**REVENUE**									
9	**I) Electricity Generation**									
10	Evolution of base Power Tariff	cZAR / kWh	R 650.00	R 684.06	R 719.90	R 757.63	R 797.33	R 774.56	R 679.29	R 571.91
11	Annual power output	MWh	0.00	8000.00	8000.00	10400.00	10400.00	10400.00	10400.00	12800.00
12	Gross electricity revenue (ZAR)	ZAR	R -	R 5,472,480.00	R 5,759,237.95	R 7,879,328.63	R 8,292,205.45	R 8,055,431.09	R 7,064,613.06	R 7,320,417.27
13	**Electricity revenue**	ZAR	R -	R 5,472,480.00	R 5,759,237.95	R 7,879,328.63	R 8,292,205.45	R 8,055,431.09	R 7,064,613.06	R 7,320,417.27
14										
15	**II) Carbon Sales**									
16	Carbon Revenue	ZAR	R -	R 5,857,683.25	R 6,225,357.82	R 6,978,808.94	R 7,360,831.27	R 7,731,910.66	R 8,059,968.36	R 8,757,957.97
17										
18	**Total Revenue**	ZAR	**R -**	**R 11,330,163.25**	**R 11,984,595.77**	**R 14,858,137.57**	**R 15,653,036.72**	**R 15,787,341.75**	**R 15,124,581.43**	**R 16,078,375.24**
19										
20	**COSTS & INVESTMENT**									
21	**a) Capital Cost**									
22	Flaring systems (Shipped and commissioned)	ZAR	R 2,897,585.85	R -	R -	R -	R -	R -	R -	R -
23	Gas collection system and civil works	ZAR	R 2,755,418.00	R -	R -	R -	R -	R -	R -	R -
24	**Subtotal: Investment gas collection & flaring**	ZAR	**R 5,653,003.85**	**R -**	**R -**	**R -**	**R -**	**R -**	**R -**	**R -**
25	Electrical Generating Equipment	ZAR	R 8,062,152.40	R -	R 8,062,152.40	R -	R -	R 4,171,750.42	R -	R -
26	Connection to Grid & Civils	ZAR	R 3,250,000.00	R -	R 750,000.00	R -	R -	R -	R 250,000.00	R -
27	**Subtotal: Investment Energy Generation**	**ZAR**	**R 11,312,152.40**	**R -**	**R 8,812,152.40**	**R -**	**R -**	**R 4,171,750.42**	**R 250,000.00**	**R -**
28	**TOTAL INVESTMENT**	**ZAR**	**R 16,965,156.25**	**R -**	**R 8,812,152.40**	**R -**	**R -**	**R 4,171,750.42**	**R 250,000.00**	**R -**
29	**b) O&M Cost**									
30	O&M - Gas Collection & Flaring	ZAR	R 625,000.00	R 625,000.00	R 625,000.00	R 625,000.00	R 625,000.00	R 625,000.00	R 625,000.00	R 625,000.00
31	O&M - Electricity Generation	ZAR	R 2,350,000.00	R 2,350,000.00	R 3,200,000.00	R 3,200,000.00	R 3,200,000.00	R 4,000,000.00	R 4,000,000.00	R 4,000,000.00
32	Project Support Costs	ZAR	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00
33	**TOTAL O&M and PROJECT SUPPORT COST**	**ZAR**	**R 4,295,000.00**	**R 4,295,000.00**	**R 5,145,000.00**	**R 5,145,000.00**	**R 5,145,000.00**	**R 5,945,000.00**	**R 5,945,000.00**	**R 5,945,000.00**
35	**TOTAL INVESTMENT & COST**	**ZAR**	**R 21,260,156.25**	**R 4,295,000.00**	**R 13,957,152.40**	**R 5,145,000.00**	**R 5,145,000.00**	**R 10,116,750.42**	**R 6,195,000.00**	**R 5,945,000.00**
36	Depreciacion	ZAR	R 1,696,515.63	R 1,696,515.63	R 2,577,730.87	R 2,577,730.87	R 2,577,730.87	R 2,994,905.91	R 3,019,905.91	R 3,019,905.91
37	Gross profit before tax	ZAR	R -5,991,515.63	R 5,338,647.63	R 4,261,864.90	R 7,135,406.70	R 7,930,305.85	R 6,847,435.85	R 6,159,675.52	R 7,113,469.33
38	Cummulative (for carryforward tax)	ZAR	R -5,991,515.63	R -652,868.00	R 3,608,996.90	R 10,744,403.61	R 18,674,709.46	R 25,522,145.30	R 31,681,820.82	R 38,795,290.15
39	**Income Tax**	ZAR	R -	R -	R -	R 1,132,945.75	R 1,896,828.95	R 2,108,139.64	R 1,820,276.70	R 1,637,447.08
40	Net Profit	ZAR	R -5,991,515.63	R 5,338,647.63	R 4,261,864.90	R 6,002,460.95	R 6,033,476.90	R 4,739,296.21	R 4,339,398.82	R 5,476,022.26
41	**Cashflow with CDM**	ZAR	**R -21,260,156.25**	**R 7,035,163.25**	**R -1,972,556.63**	**R 8,580,191.81**	**R 8,611,207.77**	**R 3,562,451.69**	**R 7,109,304.73**	**R 8,495,928.16**
42	Cummulativ	ZAR	R -21,260,156.25	R -14,224,993.00	R -16,197,549.63	R -7,617,357.82	R 993,849.95	R 4,556,301.64	R 11,665,606.37	R 20,161,534.54
43										
44										
45		**20 years**								
46		**With CDM**								
47	Net Present Value (ZAR)	R 16,096,998.90								
48	IRR	28.96%								
49	Benchmark	17.53%								
50	Present Value of carbon sold (ZAR)	**R 37,418,236.14**								
51										

e) Investment & Costs

Project investment				
Units in ZAR	**units**	**Unitary Price**	**Total**	**Comment**
Power Generation equipment	2(1.1MW)	R 8,062,152.40	R 16,124,304.80	Based on Quote from Ener-G Natural Power (10 October 2008) plus budgeted amount for shipping, installation & commissioning .Using a historical exchange rate of 14.89ZAR:1GBP for period 1 September 2007 - 19 January 2009 (http://www.oanda.com/convert/fxhistory)
	1 (500kW)	R 4,171,750.42	R 4,171,750.42	Based on Quote from Ener-G Natural Power on (09.01.2009) plus budgeted amount for shipping installation & commissioning. Using a historical exchange rate of 14.89ZAR:1GBP for period 1 September 2007 - 19 January 2009 (http://www.oanda.com/convert/fxhistory)
Electrical connection		R 1,500,000.00	R 1,500,000.00	This is budgeted by Project Developer
Civil Works		R 3,500,000.00	R 3,500,000.00	This is budgeted by Project Developer
Total power generation			**R 25,296,055.22**	
Gas collection system	1	R 2,755,418.00	R 2,755,418.00	Based on quote breakdownfrom Megapile (23 January 2008)
Flaring system and monitoring equipment	1	R 2,897,585.85	R 2,897,585.85	Based on quote from Biogas Technology (22 October 2008) plus budgeted amount for lighting, Weather protection, electrical connection for distribution boards & interface with genset . Using a historical exchange rate of 14.89ZAR:1GBP for period 1 September 2007 - 19 January 2009 (http://www.oanda.com/convert/fxhistory)
Total gas collection and flaring			**R 5,653,003.85**	
Total project investment			**R 30,949,059.07**	

Project cost categories			**Annual cost (ZAR)**	
Installed Capacity	*1MW*	*2MW*	*2.5MW*	**Comment**
O&M cost - power generation	2,350,000.00	3,200,000.00	4,000,000.00	Budgeted by Project Developer. O&M costs are linked to capacity
O&M - gas collection	250,000.00	250,000.00	250,000.00	Budgeted by Project Developer. This is based on a 2 year average.
O&M cost - flare	375,000	375,000	375,000.00	Budgeted by Project Developer
Project support costs	1,320,000	1,320,000	1,320,000.00	Budgeted by Project Developer

Generation Capacity	0	1	1	1.3	1.3	1.3	1.3	1.6

Year	2009	2010	2011	2012	2013	2014	2015	2016
Used capacity (KW)	0	1,000	1,000	1,300	1,300	1,300	1,300	1,600
Electricity generation (MWh)	**0**	**8,000**	**8,000**	**10,400**	**10,400**	**10,400**	**10,400**	**12,800**
Electricity Tariff (ZAR/MWhr-'08)	**650**	**684**	**720**	**758**	**797**	**775**	**679**	**572**
Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Investment								
Power generation equipment	R 8,062,152.40		R 8,062,152.40			R 4,171,750.42		
Gas collection system	R 2,755,418.00							
Flaring system	R 2,897,585.85							
Electrical Connection	R 1,500,000.00							
Civil works	R 1,750,000.00		R 750,000.00				R 250,000.00	
Total investment	R 16,965,156.25	R 0.00	R 8,812,152.40	R 0.00	R 0.00	R 4,171,750.42	R 250,000.00	R 0.00
Operation and admin costs								
O&M cost - power generation	R 2,350,000.00	R 2,350,000.00	R 3,200,000.00	R 3,200,000.00	R 3,200,000.00	R 4,000,000.00	R 4,000,000.00	R 4,000,000.00
O&M - gas collection	R 250,000.00	R 250,000.00	R 250,000.00	R 250,000.00	R 250,000.00	R 250,000.00	R 250,000.00	R 250,000.00
O&M - flare	R 375,000.00	R 375,000.00	R 375,000.00	R 375,000.00	R 375,000.00	R 375,000.00	R 375,000.00	R 375,000.00
Project support costs	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00	R 1,320,000.00
Total annual project costs	R 4,295,000.00	R 4,295,000.00	R 5,145,000.00	R 5,145,000.00	R 5,145,000.00	R 5,945,000.00	R 5,945,000.00	R 5,945,000.00
Total cost per MWh			R 643.13	R 494.71	R 494.71	R 571.63	R 571.63	R 464.45
Depreciation								
Depreciation of equipment installed in 2008	R 1,696,515.63	R 1,696,515.63	R 1,696,515.63	R 1,696,515.63	R 1,696,515.63	R 1,696,515.63	R 1,696,515.63	R 1,696,515.63
Depreciation of equipment installed in 2011	R -	R -	R 881,215.24	R 881,215.24	R 881,215.24	R 881,215.24	R 881,215.24	R 881,215.24
Depreciation of equipment installed in 2014	R -	R -	R -	R -	R -	R 417,175.04	R 417,175.04	R 417,175.04
Depreciation of equipment installed in 2015	R -	R -	R -	R -	R -	R -	R 25,000.00	R 25,000.00
Depreciation of equipment installed in 2019	R -	R -	R -	R -	R -	R -	R -	R -
Depreciation of equipment installed in 2023	R -	R -	R -	R -	R -	R -	R -	R -
Depreciation of equipment installed in 2027	R -	R -	R -	R -	R -	R -	R -	R -
Total depreciation costs	R 1,696,515.63	R 1,696,515.63	R 2,577,730.87	R 2,577,730.87	R 2,577,730.87	R 2,994,905.91	R 3,019,905.91	R 3,019,905.91

f) Project Cost split up

Split up of project costs:	Split Up	Value		Source
Power Generation	Generator cost (1.1MW)	R	7,257,386.00	Based on Quote from Ener-G Natural Power (10 October 2008). Using a historical exchange rate of 14.89ZAR:1GBP for period 1 September 2007 - 19 January 2009 (http://www.oanda.com/convert/fxhistory)
	Shipping, Installation and Commissioning	R	804,766.40	Budgeted by Project Developer
		R	**8,062,152.40**	
	Generator cost (500kW)	R	3,758,504.02	Based on Quote from Ener-G Natural Power on 09.01.2009. Using a historical exchange rate of 14.89ZAR:1GBP for period 1 September 2007 - 19 January 2009 (http://www.oanda.com/convert/fxhistory)
	Shipping, Installation and Commissioning	R	413,246.40	Budgeted by Project Developer
		R	**4,171,750.42**	
Civil Costs and Electrical Connection	Electrical Connection	R	1,500,000.00	Budgeted by Project Developer
	Civils	R	3,500,000.00	Budgeted by Project Developer
		R	**5,000,000.00**	
Gas Collection System	Gas Collection System (excluding infrastructure in compound)	**R**	**2,755,418.00**	Portion of Quote from Megapile (23 Januray 2008) See breakdown to left
Flaring System	Flare cost (shipped and commissioned)	R	2,517,569.93	Based on quote from Biogas Technology (22 October 2008). Using a historical exchange rate of 14.89ZAR:1GBP for period 1 September 2007 - 19 January 2009 (http://www.oanda.com/convert/fxhistory)
	Lighting, Weather protection, electrical connection for distribution boards & interface with genset	R	380,015.92	Budgeted by Project Developer
		R	**5,653,003.85**	

Project cost categories		Annual cost		Source
Operation and Management - Electricity & Gas Collection	O&M Power Generation	R	3,740,909.00	Budgeted by Project Developer. This is based on an average over whole period, however O&M costs are linked to capacity in reality. These costs include monthly services as well as major services that would be required
	O&M Gas Collection	R	250,000.00	Budgeted by Project Developer
		R	**3,775,000.00**	
O&M flare		R	375,000.00	Budgeted by Project Developer
Project support costs	For Power Gen & Flaring	R	1,320,000.00	Budgeted by Project Developer

Categories in PDD			Comment
Total Investment Costs Power Generation	R	20,296,055.22	2 units 1.1 MW and 1 unit 500kW
Total Investment Costs Gas Collection & Flaring	R	5,653,003.85	
Total Investment Cost Electrical Connection & Civils	R	5,000,000.00	
Average Management & Operation Costs - Gas Collection	R	250,000.00	Annual average
Average Management & Operation Costs - Gas Flaring	R	375,000.00	Annual average
Average Management & Operation Costs - Power Generation	R	3,740,909.00	This is based on an average over the whole period. In reality these are linked to capacity.
Average Project Support Costs	R	1,320,000.00	Annual average

3. **Grid Emission Factor of the South African Electricity Grid** (Please see attached Grid Emission Factor Calculator)

Plant name and type	Fuel	OM plant?	2004 BM plant? (1=yes)	2005 BM plant?	Date of commission	Licensed capacity (MW)	Net energy sent out *MWh* 2002	2003	2004	2005	Fossil fuel consumption *(various units - see separate column)* 2002	2003	2004	2005	Unit
Grand Total						43 034	204,511,108	219,198,686	226,393,919	226,346,226	173,221	178,408	184,716	187,998	
Eskom generation						39 810	196,067,796	210,218,785	217,919,213	217,754,872	93,823	96,460	104,370	109,898	
Coal fired stations		1				35 607	181,749,299	194,046,490	203,564,592	206,605,894	93,823	96,460	104,370	109,898	
Arnot	Coal	1			1971/09/21	1 980	11,974,764	14,135,237	13,032,188	11,798,514	5,595	5,799	6,655	6,609	*kt*
Camden	Coal	1		1	2005-2006	1 520				768,108	-	-	-	390	*kt*
Duvha	Coal	1			1980/01/18	3 450	23,320,444	21,384,335	25,450,613	25,034,970	10,560	10,682	9,989	11,908	*kt*
Grootvlei	Coal	1			1969/06/30	1 130				-	-	-	-	-	*kt*
Hendrina	Coal	1			1970/05/12	1 895	12,752,987	12,329,325	12,037,179	12,513,689	6,475	6,551	6,432	6,644	*kt*
Kendal	Coal	1			1988/10/01	3 840	26,006,905	27,820,202	27,005,053	26,897,931	13,518	14,156	15,746	15,430	*kt*
Komati	Coal	1			1969/06/30	891				-	-	-	-	-	*kt*
Kriel	Coal	1			1976/05/06	2 850	19,165,265	18,347,304	19,866,814	20,120,150	10,033	10,020	9,307	9,297	*kt*
Lethabo	Coal	1	1	1	1985/12/22	3 558	22,019,627	23,505,543	22,807,524	24,041,645	15,309	15,368	16,410	17,042	*kt*
Majuba	Coal	1	1	1	1996/04/01	3 843	4,600,976	10,015,560	12,539,663	17,170,166	2,593	2,370	5,539	6,363	*kt*
Matimba	Coal	1	1	1	1987/12/04	3 690	25,145,393	26,510,802	26,894,454	28,401,085	12,362	12,960	13,803	13,786	*kt*
Matla	Coal	1			1979/09/29	3 450	25,577,292	25,802,219	25,673,648	23,938,437	12,884	12,924	13,169	13,445	*kt*
Tutuka	Coal	1	1		1985/06/01	3 510	11,185,646	14,195,963	18,257,456	15,921,199	4,493	5,629	7,320	8,984	*kt*
Gas turbine stations		1				342	-	341	350	77,942					
Acacia	Kerosene	1			1976/05/13	171	0	299	305	47,848	7	18	43	17,488	*kl = m3*
PortRex	Kerosene	1			1976/09/30	171	0	42	45	30,094	1	106	17	10,999	*kl = m3*
Hydro power stations		-				661	2,356,753	777,041	777,041	725,360					
Gariep	Hydro	-			1971/09/08	360	1,164,640	383,991	383,991	402,432	-	-	-	-	
Vanderkloof	Hydro	-			1977/01/01	240	1,192,113	393,050	393,050	322,928	-	-	-	-	
Colleywobbles(Mbashe)	Hydro	-				42	-	-	-	-	-	-	-	-	
First Falls	Hydro	-				6	-	-	-	-	-	-	-	-	
Second Falls	Hydro	-				11	-	-	-	-	-	-	-	-	
Ncora	Hydro	-				2	-	-	-	-	-	-	-	-	
Nuclear stations		-				1 800	11,961,744	12,662,591	13,365,123	11,292,654					
Koeberg	Nuclear	-			1984/07/21	1 800	11,961,744	12,662,591	13,365,123	11,292,654	-	-	-	-	
Pumped-storage stations		1				1 400	-	2,732,322	212,107	(946,978)					
Drakensberg	Hydro	1			1981/06/17	1 000	-	1,787,554	-	-	-	-	-	-	
Palmiet	Hydro	1	1	1	1988/04/18	400	-	944,768	212,107	-	-	-	-	-	
Municipal generation						1 837	1,218,826	1,326,122	1,040,945	1,476,686	11,772	10,148	10,031	10,890	
Coal fired stations		1				1 323	1,201,006	1,038,433	1,027,337	1,110,036	11,685	10,104	9,996	10,800	
Athlone	Coal	1			n/a	180	76,596	76,596	10,230	(84)	745	745	100	(1)	*TJ*
Kroonstad	Coal	1				30					-	-	-	-	*TJ*
Swartkops	Coal	1				240					-	-	-	-	*TJ*
Bloemfontein	Coal	1			n/a	103	8,233	19,444	5,931	16,890	80	189	58	164	*TJ*
Orlando	Coal	1				300					-	-	-	-	*TJ*
Rooiwal	Coal	1			n/a	300	949,078	826,217	895,000	985,000	9,234	8,039	8,708	9,584	*TJ*
Pretoria West	Coal	1			n/a	170	167,099	116,176	116,176	108,230	1,626	1,130	1,130	1,053	*TJ*
Gas turbine stations		1				330	7,189	3,654	2,976	7,445	86	44	36	89	
Roggebaai	Kerosene	1			n/a	50	2,787	2,787	1,141	7,037	33	33	14	84	*TJ*
Athlone	Kerosene	1			n/a	40	867	867	1,827	229	10	10	22	3	*TJ*
Port Elizabeth	Kerosene	1			n/a	40	-	-	8	279	-	-	0	3	*TJ*
Johannesburg	Kerosene	1			n/a	176	3,535	-	-	(100)	42	-	-	(1)	*TJ*
Pretoria West	Kerosene	1				24					-	-	-	-	*TJ*
Hydro power stations		-				4	10,632	10,632	10,632	10,632	-	-	-	-	
Lydenburg	Hydro	-			n/a	2	6,000	6,000	6,000	6,000	-	-	-	-	
Ceres	Hydro	-			n/a	1	1,082	1,082	1,082	1,082	-	-	-	-	
Piet Retief	Hydro	-			n/a	1	3,550	3,550	3,550	3,550	-	-	-	-	
Pumped-storage stations		1				180	-	273,403	-	348,573	-	-	-	-	
Steenbras	Hydro	1			n/a	180	-	273,403	-	348,573	-	-	-	-	
Private generation						1 387	7,224,486	7,653,779	7,433,761	7,114,668	67,627	71,800	70,314	67,210	
Bagasse / coal fired stations		-				105	259,317	259,317	192,337	192,337	-	-	-	-	
Tongaat-Hulett Amatikulu	Bagasse-coal	-			n/a	12	26,781	26,781	26,781	26,781					
Tongaat Hulett - Darnall	Bagasse-coal	-			n/a	12	21,704	21,704	21,704	21,704	(Assumed pure bagasse by conservativeness)				
Tongaat Hulett - Felixton	Bagasse-coal	-			n/a	32	66,510	66,510	66,510	66,510	=> Fossil fuel consumption = zero				
Tongaat Hulett - Maidstone Mill	Bagasse-coal	-			n/a	29	67,397	67,397	67,397	67,397					
Transvaal Suiker Ltd	Bagasse-coal	-			n/a	20	76,925	76,925	9,945	9,945					
Coal fired stations		1				1 279	6,950,506	7,379,448	7,226,761	6,907,668	67,627	71,800	70,314	67,210	
Kelvin	Coal	1			n/a	540	1,721,353	1,721,353	1,568,666	1,568,666	16,748	16,748	15,263	15,263	*TJ*
Sasol Synth Fuels	Coal	1			n/a	600	4,421,074	4,738,677	4,738,677	4,606,484	43,016	46,106	46,106	44,820	*TJ*
Sasol Chem Ind	Coal	1			n/a	139	808,079	919,418	919,418	732,518	7,862	8,946	8,946	7,127	*TJ*
Hydro power stations		-				3	14,663	15,014	14,663	14,663	-	-	-	-	
Friedenheim	Hydro	-			n/a	3	14,663	15,014	14,663	14,663	-	-	-	-	

Calculation of fuel emission factors:				
	NCV GJ/t fuel	EF tCO2/TJ	Density t / m3	=> Emission factor
Coal	19.9	89.5		1.781 tCO2/t coal
Kerosene	42.4	70.8	0.804	2.414 tCO2/m3

Conversion factor:	277.78	MWh/TJ

Emission factors (tCO2/MWh)	2004	2005
OM	0.900	0.908
BM	0.950	0.951
CM	**0.925**	**0.930**

Sources and Assumptions made for the grid emission calculation

Sources:		
1a/b/c/d. NERSA (2005/2006/2007/2008) Electricity supply statistics for South Africa 2002/2003/2004/2005 (brochures, with 2004 & 2005 electronic versions copied in tabs 1c, 1d)		
2. Eskom (2008) Website (http://www.eskom.co.za/live/content.php?Item_ID=4226)		
	%	i.e. MWhprod /TJcons
3a. Using CDM Tool default efficiency for old oil-fired gas turbines	30%	83.3
3b. Using CDM Tool default efficiency for old subcritical coal-fired plants	37%	102.8
4. IPCC (2006) Guidelines on National GHG Inventories, table 1.2 of Chapter 1 of Vol. 2 (Energy) Default values at the lower limit of the uncertainty at a 95% confidence interval		
5. Engineers Edge (2008) - See http://www.engineersedge.com/fluid_flow/fluid_data.htm		
Areas shaded: where net electricity sent out is negative, it is set to zero		

Note: White and grey cells are for calculations

Annex 4

MONITORING INFORMATION

Table: CDM Monitoring System Procedures

Procedure	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 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. Data and records will be stored and archived according to this procedure.	All relevant 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 relevant monitoring equipment occurs.	This procedure should be established by the project developer.

Equipment calibration	This procedure details the process of organising and managing the calibration process as per recommendation by the manufacturer.	The calibration of the meters will be conducted according to manufacturer's recommendations. 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.