CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

Tables

Figures

SECTION A. General description of project activity

A.1 Title of the project activity:

Muribeca Landfill Gas to Energy CDM Project, Brazil
2006/3/10

A.2. Description of the project activity:

This project is to reduce greenhouse gas (“GHG”) emissions by collecting, and combusting landfill gas (“LFG”), which includes methane (“CH_4”) to generate electricity up to a generation capacity of 11.2 MW, and flaring the remaining LFG which is not combusted in an electricity generator. The project is to supply renewable electricity to a local grid. The capture and combustion of CH_4 of LFG, in an engine generator and LFG flare system, transform CH_4 (Global Warming Potential (GWP): 21) into CO_2 (GWP: 1) and water, resulting in the avoidance of CH_4 release into the atmosphere. The estimated total GHG emission reduction (“ER”) to be achieved by the project is 3,303,934; 1,523,207; 1,298,669 tCO_2e for the duration of 7-year, 14-year, and 21-year crediting period, respectively.

Landfills produce LFG as organic materials decompose under anaerobic condition. LFG is composed of approximately equal parts of methane and carbon dioxide, with trace concentrations of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and other constituents. Both of the two primary constituents of LFG (methane and carbon dioxide) are considered to be GHG which contribute to global warming. The capture and combustion of methane and its ultimate transformation into carbon dioxide occurs through combustion in a LFG flare; an engine generator resulting in a substantial net reduction of GHG emissions.

The Muribeca Landfill is located in the City of Jabaotão. This Landfill accepts municipal and non-hazardous municipal waste. At the present time, about 80 percent of the waste comes from the City of Recife and twenty percent of the waste comes from the City of Jabaotão. The waste composition is reportedly 60 percent organic waste, 15 percent paper, eight percent plastic, two percent metal, two percent glass and 13 percent other materials. The landfill is operated by a municipally-owned company named Empresa de Manutencão e Limpeza Urbana (EMLURB).

The Muribeca Landfill began operation in 1985 as an open dump. It was upgraded to a modern landfill in 1994. Currently most of the attributes of a modern sanitary landfill are in place including controlled access, well-maintained access roads, controlled dumping areas with waste compaction by bulldozers, and the application of up to 50 centimetres of intermediate cover soils in inactive areas. The landfill currently does not have a LFG collection and control system. The site does have a LFG venting system consisting of approximately 20 vents. The vents were constructed as the landfill was built by placing 1-m diameter concrete drain pipe in an upright position and filling it with rock.

The current plan is to continue to fill the site until it reaches an average elevation of 70 meters. It is currently forecast that the landfill will reach this elevation in 2009. At that time, the landfill will close, and a new landfill will be required. An additional 83-ha area has been reserved for a future landfill expansion. It has been proposed that a new landfill be constructed immediately adjacent to, and to the south of, the existing landfill. The landfill would occupy 70 hectares, a waste footprint of 23 hectares, and it would have a maximum elevation of 70 meters.

This project would contribute to sustainable development in Brazil. To collect LFG and generate energy is not a common practice in Brazil. This project could introduce a new technology of generating energy from LFG to the cities of Jabaotão and Recife. By introducing this technology, it could also diversify the energy sources of Brazil; a significant proportion of which is hydro electric.

A.3. Project participants:

Name of Party involved (*)	Private and/or public entity(ies) Project participants(*)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
U.S.A	SCS Engineers 3900 Kilroy Airport Way, Suite 100, Long Beach, CA 90806-6816 USA	Yes

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Brazil

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

State of Pernambuco

A.4.1.3. City/Town/Community etc:

City of Jabaotão

The City of Jabaotão is located right next to the City of Recife.

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 at the Muribeca Landfill in the city of Jabaotão in the State of Pernambuco, thirty minute drive from Recife. The area is surrounded by fields and hills. There are only few houses around the landfill site.

Although the Muribeca Landfill is located in the city of Jabaotão, the landfill receives solid waste mainly from the city of Recife, and is managed by the City of Recife. The local climate is tropical and wet with an average annual rainfall of 1.8 meters. There are distinct dry and wet seasons.

Photo of the existing landfill site

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

The LFG collection and combustion activity falls into:
Scope number: 13
Sectoral scope: “Waste handling and disposal”

The power plant component falls into:
Scope number:1
Sectoral scope: “Energy industries (renewable source)”

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

<Current Landfill Operation>

The landfill currently has most of the attributes of a modern sanitary landfill, including;
1. Controlled access; however scavengers are allowed on the site;
2. Waste receipts are measured using entrance scales;
3. Well maintained access roads;
4. Controlled dumping areas with compaction by bulldozers;
5. Placement of an intermediate cover over inactive areas;
6. Stormwater runoff control; which keeps most of the stormwater from contacting the waste and becoming leachate;
7. Leachate management; and
8. LFG vents.

The intermediate cover consists of 50 cm of clayey soil. The active area of the landfill is rather large, and is in the vicinity of ten hectares. Cover is not provided on the active area at the end of each day. The leachate collection system consists of an interceptor trench around the entire landfill that drains into two leachate treatment ponds. The flow of leachate into the ponds, reportedly, averages 300 litters per minutes. The ponds, reportedly, can process 90 litters per minutes. The source of the leachate is leachate seeps at the base of the landfill. On an average annual basis about 70 percent of the leachate is re-circulated to the landfill. Trucks pump leachate out of the leachate treatment ponds and use it for dust control on the on-site roads. During the dry season, all of the leachate is re-circulated or treated in the leachate ponds. During the rainy season the volume of leachate exceeds the capacity of the leachate treatment system. Treated and untreated leachate is discharged to the river.

A LFG venting system, consisting of above 50 vents, is currently in place. The vents were constructed as the LFG was being filled by placing one-meter diameter concrete pipes on top of each other and filling them with rock. A few relatively large holes were made in the side of each concrete pipe. None of the vents were equipped with combustion devices and LFG is emitted directly to the atmosphere. The vents are what are known as “passive” vents. The vents depend on LFG pressure building in the landfill and reliance on that pressure to drive the LFG toward the vents. A passive vent provides some relief against high LFG pressure; however, vents are fairly ineffective for LFG collection. LFG migrates in the direction of least resistance, and out of the top and sides of the landfill through the soil when this path is the easiest path. The limited open area on the sides of the concrete pipe and the rock fill adds to the ineffectiveness of the vents. In an active LFG collection system, a vacuum is placed and on carefully designed wells, in order to induce an area of influence around the well, which draws LFG to the well.

<Proposed LFG Technology>

(1) Proposed Landfill Gas Collection System for the existing landfill area

Waste currently covers the entire footprint of the existing landfill area. A large portion of the area has reached its final elevation. It is possible to install vertical LFG extraction wells across the entire footprint. The key components of this system are as follows:

1. 190 Vertical Extraction Wells: It has been assumed that 125 wells will average 20 m in depth, and that 65 wells will average 35 m in depth. The actual depth will be dictated by the elevation of the top of the leachate throughout the landfill and whether the well is being drilled from a surface elevation which is close to the anticipated final landfill elevation or being drilled from a lower surface elevation (in areas still being filled with waste);
2. 40 Leachate Extraction Pumps: It has been assumed that leachate extraction pumps will be installed in 40 wells. The pumps would be installed in wells which were able to be drilled a reasonable distance beyond initially encountering leachate. The function of the pumps would be to continuously dewater the wells to allow them to operate at their full potential in extracting LFG. They would gradually draw down the leachate levels in the vicinity of the wells equipped with pumps, which would further enhance LFG recovery. The pumps would be capable of being slid in or out of the well casing. They would be pneumatically driven. A compressed air line (51 mm HDPE pipe) and a leachate collection line (51 mm HDPE pipe) would be extended to these wells;
3. Landfill Gas Collection Piping: The conceptual design envisions that a network of about 11,400 m of 110 mm through 457 mm of HDPE pipe would be installed on the landfill surface. An individual well would be served by no smaller than a 110 mm pipe. The size of the pipe would increase to 457 mm as the output of the wells is aggregated;
4. Condensate and Leachate Collection and Conveyance: As the LFG cools, it moves through the piping network. Moisture will condense, and condensate will accumulate at low points in the LFG collection piping. The design will attempt to minimize the number of such low points. However, condensate sumps and pneumatic pumps will be installed in these sumps at these low points. Allowance for ten sumps and pumps has been made. Condensate will be conveyed by HDPE pipe to the leachate pond. Leachate collected through the pumps in the extraction wells will be conveyed through the same pipe to the leachate pond; and
5. Flare Station: The flare station will consist of two 4,350 m^3/hr enclosed flares, three 4,350 m^3/hr blowers, a flow meter, and a continuously recording methane analyzer.

(2) Proposed Landfill Gas Collection System for the expansion landfill area

It will not be possible to collect LFG from the expansion landfill until enough waste is in place to support installation of some type of LFG collection system. Vertical extraction wells require a minimum depth of about 15 m.

An alternative method of LFG collection employs lateral, perforated pipes installed contemporaneously with the filling of the waste. Once an area of these so-called horizontal collectors is covered with at least five meters of waste, they can be activated by pulling a vacuum on one or both ends of the horizontal collector. While horizontal collectors allow quicker collection of LFG, they tend to gradually become less effective in the lower elevations of the landfill over time, due to differential settlement and flooding with leachate. Horizontal collectors are sometimes considered to be a temporary system which is replaced by a permanent system of vertical wells installed when the landfill reaches closure elevation.

Temporary horizontal collectors will be employed, with vertical wells installed as areas of the expansion. 5m lifts will be constructed and a set of horizontal collectors can be installed between each lift.

(3) Proposed Electric Power Plant Configurations

In this proposed CDM project, the Muribeca LFG project will use a total capacity of 11.2 MW electricity generators. The remaining LFG which is not combusted in the electricity generator will be flared.

The project plans to employ Caterpillar Model 3520, which offers the advantages of high efficiency, low air emissions and a low fuel supply pressure requirement. The power plant would incorporate the following components:

1. Two 50 percent capacity inlet moisture separators sized for 65 Nm^3/min (each);
2. Three 50 percent capacity multi-stage centrifugal blowers with a capacity of 65 Nm^3/min (each). Inlet vacuum = 60 and discharge pressure = 3 PSIG (pounds per square inch gauge). The motors on the blowers will be about 150 hp in size;
3. Three gas-to-are (fin fan type) heat exchangers;
4. Tow 50 percent capacity moisture separators sized at 65 Nm^3/hr (each);
5. Seven containerized Caterpillar 3520 engine/generators with a gross power output of 1.6 MW (each). Total capacity = 11.2 MW. Generation voltage = 4,160 V;
6. Switchgear to aggregate the generators together and to supply MMC's to meet plant parasitic loads
7. Switchgear, including a step-up transformer to increase the voltage from 4,160V to 69 kV; and
8. A 5-km, 69-kV power transmission line.

The total estimated construction cost for the 11.2 MW reciprocating engine power plant will be $14,640,000, including the cost of interconnection and five km tie line. The capital cost estimate of the wellfield and flare station was estimated to be $3,743,000. The total capital cost is estimated to be $18,383,000.

The above mentioned technology is not common in Brazil. SCS Engineers would introduce the latest LFG to energy technology to the area. SCS Engineers would be in charge of operation and maintenance for this project, and support local staff to acquire the operational skills.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

In Brazil there is no regulation or control which requires landfill operators to collect LFG and flare it. The only requirement is to vent LFG through wells for safety reason, but LFG still goes into the atmosphere containing an average of 50% methane. To flare LFG is neither compulsory nor common practice in Brazil. There is also no plan to enforce such legislation in the near future.

Currently at the Muribeca landfill site, a LFG venting system, consisting of above 50 vents is in place. However none of the vents were equipped with combustion devices and LFG is emitted directly to the atmosphere.

In the situation where a regulation regarding the collection of LFG does not exist, it is not likely for a landfill operator to install landfill collection system and flare a part of or all of the LFG without any additional income. Moreover, even if the landfill operator installs landfill collection system and power generation equipment or pipeline gas transportation facilities to utilize LFG and obtain some revenue, IRR's for those projects are still negative or very low. Therefore, the LFG to energy projects without CDM activities cannot be considered as attractive projects.

On the other hand, when a gas collection and a power generation project is undertaken as a CDM project, capital cost and O&M cost can be covered with a CER income, and IRR of this CDM project goes up to 20.8 % and the project can be considered as an economically attractive project.

When this CDM project is carried out, methane in the LFG collected by the landfill collection system would be destroyed and burned with a flare combustion system or reciprocating engine system. Most of methane except the amount of incomplete combustion can be assumed to be destroyed and burned resulting in the reduction of the GHG emission.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

The crediting period of the project is a 7-year crediting period with 2 optional 7-year additional crediting periods.

The table below shows the annual tonnes of CERs from flaring LFG from the existing and expansion landfill areas at the Muribeca landfill between year 2007 and year 2027, calculated following an approved methodology ACM0001 with data taken from the project's pre-feasibility study (2005) conducted by SCS Engineers.

We expect that all predicted LFG recovered will be captured and destroyed in flaring system and engine.

Table No. 1 Predicted LFG recovery and Methane Emissions Reduction Estimates

	Predicted LFG recovery			Methane Emissions Reduction Estimates	
Year	m^3/hr	cfm	mmBtu/hr	tonnesCH_4/yr	tonnesCO_2e/yr
2007	8,451	4,974	151	26,001	546,013
2008	8,588	5,055	153	26,423	554,889
2009	8,707	5,125	156	26,789	562,567
2010	8,376	4,930	150	25,771	541,191
2011	6,308	3,713	113	19,410	407,607
2012	5,911	3,479	106	18,187	381,918
2013	4,794	2,822	86	14,750	309,749
2014	3,979	2,342	71	12,244	257,119
2015	4,044	2,380	72	12,442	261,275
2016	3,514	2,069	63	10,813	227,080
2017	3,092	1,820	55	9,513	199,783
2018	3,308	1,947	59	10,177	213,720
2019	2,958	1,741	53	9,100	191,104
2020	2,679	1,577	48	8,244	173,126
2021	3,146	1,851	56	9,678	203,248
2022	2,845	1,675	51	8,754	183,828

2023	2,593	1,526	46	7,977	167,509
2024	3,002	1,767	54	9,237	193,986
2025	2,725	1,604	49	8,385	176,075
2026	3,023	1,780	54	9,303	195,355
2027	2,765	1,628	49	8,508	178,668
Total estimated reductions (tones of CO_2e)				291,706	6,125,810
Total number of crediting years				21years	
Annual average over the crediting period of estimated reductions (tones of CO_2e)				13,890	291,705

Table No. 2 Estimated ERs for the chosen crediting period are as follow:

Combustion and Flaring	ERs for the crediting period (tCO_2e)
2007-2013	3,303,934
2014-2020	1,523,207
2021-2027	1,298,669

The average annual emission reduction over the 21-year of crediting period is 291,705 t-CO_2e/yr (= 6,125,810 t-CO_2e / 21 yr).

A.4.5. Public funding of the project activity:

The project will not receive any public funding.

SECTION B. Application of a baseline methodology

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

The following approved methodology will be used to calculate the project total ERs:

ACM0001: Consolidated baseline methodology for LFG project activities

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

At the Muribeca Landfill, a LFG venting system is currently in place. However none of the vents are equipped with combustion devices and all LFG is emitted directly to the atmosphere. Moreover, in Brazil there is no regulation or control which requires landfill operators to collect LFG and flare it. Therefore, the baseline for the CDM project can be the total atmospheric release of the LFG.

The proposed CDM project includes the collection of LFG including the flare combustion system and the power generation with reciprocating engines.

Taking the above into consideration, the methodology of ACM0001 is applicable to the proposed project activity.

The proposed project activity meets the applicability condition of ACM0001 because the project's baseline is the partial or total atmospheric release of the gas, and the project falls into situation b) of ACM0001's applicability.

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

B.2. Description of how the methodology is applied in the context of the project activity:

Baseline

The Muribeca landfill site currently is equipped most of the attributes of a modern sanitary landfill, including controlled access, well-maintained access roads, controlled dumping areas with waste compaction by bulldozers, and the application of up to 50 centimetres of intermediate cover soils in inactive areas.

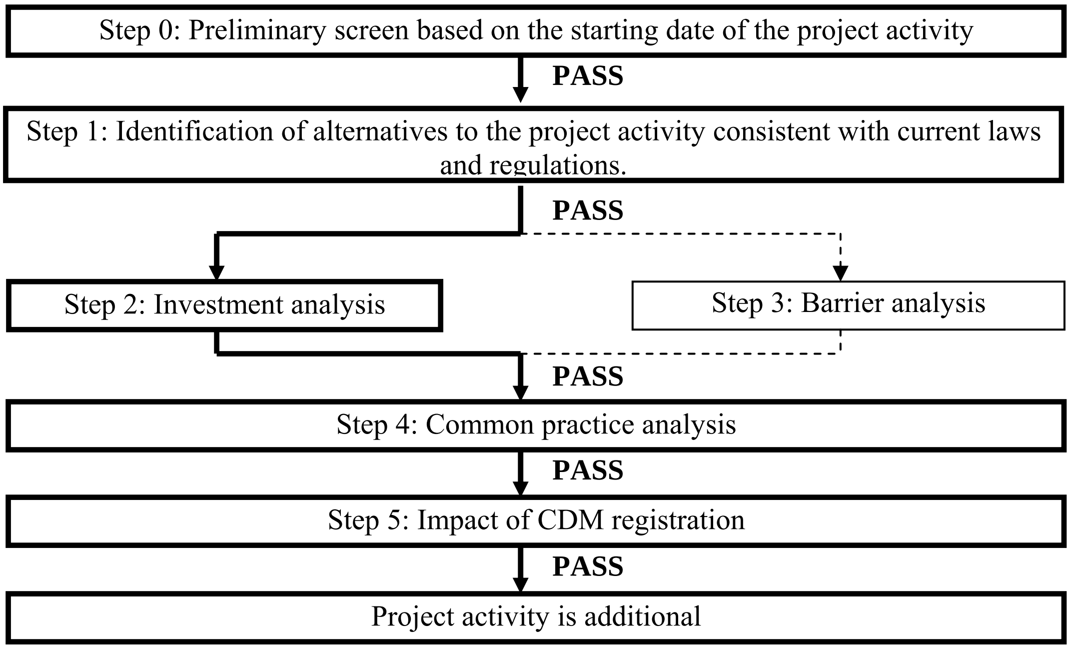
The landfill currently does not have a LFG collection and control system. The site does have a LFG venting system consisting of approximately 20 vents. The vents were constructed as the landfill was built by placing 1-m diameter concrete drain pipe in an upright position and filling it with rock. As the landfill height was extended, additional pipe segments were placed to extend the vent.

In the south of the Muribeca landfill an additional 83-ha area has been reserved for future landfill expansion. Possible plans for a future landfill has been discussed, but the decision has not been made. Because there is no legislation to collect and flare the methane and the unit price of renewable energy is not high enough to support the project without the CDM activity, having venting system is clearly the least cost option and is compliant with the current regulations in Brazil. Therefore the most likely scenario without a CDM activity would be to continue the current practice; which is to install venting system.

The process of determining the baseline scenario is demonstrated in the following additionality section (see the end of Step 4).

Additionality
ACM0001 states that the project's additionality should be demonstrated and assessed using "the Tools for the demonstration and assessment of additionality". The following steps are included in the tools.

Additionality scheme



Step 0: Preliminary screening based on the starting date of the project activity
The project is expected to start on January 1st, 2007. The crediting period will start only after the registration of the project. Step 0 does not need to be considered.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations
Define realistic and credible alternatives to the project activity that can be the baseline scenario through the following sub-steps:

Sub-step 1a. Define alternatives to the project activity:
1. *identify realistic and credible alternatives available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity.*

- **Alternative scenario 1**: Install LFG collecting system, flare system, and engines to supply electricity to a grid (the proposed CDM project).

- **Alternative scenario 2**: Install LFG collecting system and gas pipelines to supply gas to a local gas company.

- **Alternative scenario 3**: Install LFG collecting system and flare system to destroy methane.

- **Alternative scenario 4**: LFG is vented to the atmosphere for the safety purposes, but does not install LFG collection system which is to continue current practice.

The alternative scenarios above were carefully reviewed as follows.

Alternative scenario 1 is technically possible. In Brazil the development of renewable energy projects is promoted. This alternative including electric power generation with methane would be one of them. The electric power generated by the engines would be supplied to the local grid and gain revenue from the sale of electric power.

Alternative scenario 2 is also technically possible. However in order to enter into a gas sales agreement with a local gas company a constant supply of more than a certain amount of methane gas is required. The sales agreement also requires the gas to maintain a certain quality for gas sales. The generation of LFG at the landfill site would be decreasing as time passes, and would vary depending on the seasons and situations. The content and quality of gas would also change all the time. Besides, this kind of project has not been implemented in Brazil before. It seems that there are many uncertainties in this scenario and has some risks for implementation. Therefore, it can be concluded that this alternative is not a realistic or credible alternative.

Alternative scenario 3 is technically possible as the gas collection systems used are the same as some of those in alternative scenario 1. However, currently there is no regulation to collect and flare partial or all LFG at landfill site, but only to vent LFG for safety purposes. Without any regulation there is no incentive to install the gas collection system and it is very hard to imagine that landfill operators would voluntarily install LFG collection system and flare system paying $3,742,700 for the LFG collection system and flare system without any return.

Alternative scenario 4 is to continue the current practice at the Muribeca landfill. The operator would vent LFG to the atmosphere for safety purposes, as required by the current law in Brazil. The investment required for this alternative is minor and includes only the cost for the vents. This alternative scenario is considered to be the business as usual scenario as well as the baseline scenario.

Alternative scenario 1 and 4 are the realistic and credible alternatives.

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

Both alternative scenario 1 and 4 are in compliance with the current Brazilian regulations. In Brazil there is no regulation requiring the collection and flaring of LFG, but only to vent LFG.

Step 2: Investment analysis

Sub-step 2a. Determine appropriate analysis method

Option III. Benchmark analysis is chosen to perform investment analysis.

The result from Sub-step 1a, alternative scenario 1 (the proposed CDM project) and 4 are selected as realistic and credible alternatives. In alternative scenario 4 neither installation of a LFG collection system nor a electric power generation system is planned, and does not need new investment.

On the other hand, in alternative scenario 1 the installation of a LFG collecting system and electric power generation system is planned where an investment of $18,383,000 would be required.

Therefore, since alternative scenario 4 does not include an investment equivalent to alternative 1, the benchmark analysis should be applied to alternative scenario 1.

Sub-step 2b. – Option III. Apply benchmark analysis

(1) Identify financial indicator
As the financial indicator for alternative scenario 1, IRR analysis would be most suitable.

The condition of calculation

- Gross plant capacity (kW) 11,340
- Plant net capacity (kW) 9,634
- Plant availability 90%
- Net plant heat rate (Btu/kWh)(HHV) 14,140
- Initial power sales rate ($/kWh) $0.050
- Power sales rate escalation 3% p.a.
- Initial LFG cost ($/Btu) $0.50
- LFG cost escalation 3% p.a.
- LFG to energy initial operating and maintenance cost ($/kWh) $0.019
- Operating and maintenance escalation 3% p.a.
- CER value($/tonne) $6.00
- CER Escalation 0% p.a.
- Capital cost $17,417,000

(2) Identify the relevant benchmark
As the benchmark the yield of Brazilian government bond is used. The government bond is widely used to evaluate projects in Brazil; the yield of Brazilian government bond for 14 years (2005, 12, 30) was 8.875%.

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

(1) Calculating project IRR of alternative scenario1
The IRR of alternative scenario 1 was -1.3 % as described in Table No. 3.

(2) Comparing the financial indicator to the bench mark
Comparing the project IRR of alternative scenario 1 of -1.3% and the financial benchmark of 8.9%, alternative scenario 1 turns out to be a less favourable, indicating a lower IRR than the benchmark used. Alternative scenario 1 can be judged to be not economically attractive.

Sub-step 2d. Sensitivity analysis

Sensitivity analysis were conducted to test the robustness of the result above, with respect to the two key parameters; power generation efficiency and electricity sales price.

The IRRs were re-calculated with different power generation efficiencies; 95% and 85% with the sales price held constant at $0.05.

a. Power generation efficiency 95% ⇒ IRR 0.0% (Table No. 4)
b. Power generation efficiency 90% ⇒ IRR -1.3% (Table No. 3)
c. Power generation efficiency 85% ⇒ IRR -2.6% (Table No. 5)

The IRRs were re-calculated with different electricity sales prices; $0.06 and $0.036 with the power generation efficiency held constant at 90%.

d. Electricity sales price $0.060⇒ IRR 6.9% (Table No. 6)
e. Electricity sales price $0.05⇒ IRR -1.3% (Table No. 3)
f. Electricity sales price $0.036⇒ IRR – (Table No. 7)

As seen above, these IRRs are still lower than the financial benchmark of 8.9%. As a result, it can be said that the result obtained in Sub-step 2c is robust enough.

Table No. 3 Financial Analysis for LFG to Energy (Reciprocating Engine) Project without CERs

MURIBECA LANDFILL
ADDITIONALITY TEST FOR RECIPROCATING ENGINE PROJECT

	2007	2008	2009	2010	2011	2012	2013
LANDFILL GAS AVAILABLE (mmBtu/hr)	151	153	156	150	113	106	86
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	110	110	110	110	110	106	86
POWER PRODUCTION (kWh/yr)	83,885,760	83,885,760	83,885,760	83,885,760	83,885,760	81,136,311	65,827,573
POWER SALES RATE ($/kWh)	$0.050	$0.052	$0.053	$0.055	$0.056	$0.058	$0.060
POWER SALES REVENUE	$4,194,288	$4,320,117	$4,449,720	$4,583,212	$4,720,708	$4,702,961	$3,930,078
CER PRODUCTION (TONNES)	546,013	554,889	562,567	541,191	407,607	381,918	309,749
CER VALUE ($/TONNE)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CER REVENUE	$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUE	**$4,194,288**	**$4,320,117**	**$4,449,720**	**$4,583,212**	**$4,720,708**	**$4,702,961**	**$3,930,078**
ANNUAL LFG CONSUMED (mmBtu/yr)	864,023	864,023	864,023	864,023	864,023	835,704	678,024
LFG PURCHASE PRICE ($/mmBtu)	$0.50	$0.52	$0.53	$0.55	$0.56	$0.58	$0.60
ANNUAL LFG COST	$432,012	$444,972	$458,321	$472,071	$486,233	$484,405	$404,798
LFGTE NON-LFG O+M COST ($/kWh)	$0.021	$0.022	$0.022	$0.023	$0.024	$0.024	$0.025
LFGTE NON-LFG O+M COST	$1,761,601	$1,814,449	$1,868,882	$1,924,949	$1,982,697	$1,975,244	$1,650,633
WELLFIELD O+M COST -- EXISTING AREA	$412,000	$424,360	$437,091	$337,700	$347,831	$358,266	$369,014
WELLFIELD O+M COST -- EXPANSION AREA				$495,000	$46,000	$48,000	$381,000
TOTAL O+M COST	**$2,605,613**	**$2,683,781**	**$2,764,294**	**$3,229,720**	**$2,862,761**	**$2,865,915**	**$2,805,445**
NET REVENUE	**$1,588,675**	**$1,636,336**	**$1,685,426**	**$1,353,492**	**$1,857,947**	**$1,837,047**	**$1,124,633**

	2014	2015	2016	2017	2018	2019	2020
LANDFILL GAS AVAILABLE (mmBtu/hr)	71	72	63	55	59	53	48
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	71	72	63	55	59	53	48
POWER PRODUCTION (kWh/yr)	54,346,019	55,111,456	48,222,524	42,099,029	45,160,777	40,568,155	36,740,971
POWER SALES RATE ($/kWh)	$0.061	$0.063	$0.065	$0.067	$0.069	$0.071	$0.073
POWER SALES REVENUE	$3,341,937	$3,490,677	$3,145,973	$2,828,879	$3,125,654	$2,892,024	$2,697,768
CER PRODUCTION (TONNES)	257,119	261,275	227,080	199,783	213,720	191,104	173,126
CER VALUE ($/TONNE)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CER REVENUE	$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUE	**$3,341,937**	**$3,490,677**	**$3,145,973**	**$2,828,879**	**$3,125,654**	**$2,892,024**	**$2,697,768**
ANNUAL LFG CONSUMED (mmBtu/yr)	559,764	567,648	496,692	433,620	465,156	417,852	378,432
LFG PURCHASE PRICE ($/mmBtu)	$0.61	$0.63	$0.65	$0.67	$0.69	$0.71	$0.73
ANNUAL LFG COST	$344,220	$359,540	$324,035	$291,375	$321,942	$297,879	$277,870
LFGTE NON-LFG O+M COST ($/kWh)	$0.026	$0.027	$0.027	$0.028	$0.029	$0.030	$0.031
LFGTE NON-LFG O+M COST	$1,403,614	$1,466,084	$1,321,309	$1,188,129	$1,312,775	$1,214,650	$1,133,062
WELLFIELD O+M COST -- EXISTING AREA	$380,084	$391,487	$403,231	$415,328	$427,788	$440,622	$453,841
WELLFIELD O+M COST -- EXPANSION AREA	$76,000	$78,000	$444,000	$111,000	$114,000	$514,000	$151,000
TOTAL O+M COST	**$2,203,918**	**$2,295,111**	**$2,492,575**	**$2,005,832**	**$2,176,505**	**$2,467,151**	**$2,015,773**
NET REVENUE	**$1,138,020**	**$1,195,566**	**$653,398**	**$823,047**	**$949,149**	**$424,874**	**$681,995**

GROSS PLANT CAPACITY (kW)	11,200	INITIAL LFG COST ($/mmBtu)	$0.50	CAPITAL COST	$18,383,000
PLANT NET CAPACITY (kW)	10,640	LFG COST ESCALATION	3%		
PLANT AVAILABILITY	90%			PRE-TAX IRR	-1.3%
NET PLANT HEAT RATE (Btu/kWh)(HHV)	10,300	LFGTE INITIAL O+M COST ($/kWh)	$0.021		
		O+M COST ESCALATION	3%	CUMULATIVE NET REVENUE	-$1,433,397
INITIAL POWER SALES RATE ($/kWh)	$0.050				
POWER SALES RATE ESCALATION	3%	CER VALUE ($/TONNE)	$0.00		
		CER ESCALATION	0%		

Table No. 4 Financial Analysis for LFG to Energy (Reciprocating Engine) Project without CERs (Plant Availability 95%)

MURIBECA LANDFILL
ADDITIONALITY TEST FOR RECIPROCATING ENGINE PROJECT
Plant availability 95%

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LANDFILL GAS AVAILABLE (mmBtu/hr)	151	153	156	150	113	106	86	71	72	63	55	59	53	48
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	110	110	110	110	110	106	86	71	72	63	55	59	53	48
POWER PRODUCTION (kWh/yr)	88,546,080	88,546,080	88,546,080	88,546,080	88,546,080	85,643,883	69,484,660	57,365,243	58,173,204	50,901,553	44,437,864	47,669,709	42,821,942	38,782,136
POWER SALES RATE ($/kWh)	$0.050	$0.052	$0.053	$0.055	$0.056	$0.058	$0.060	$0.061	$0.063	$0.065	$0.067	$0.069	$0.071	$0.073
POWER SALES REVENUE	$4,427,304	$4,560,123	$4,696,927	$4,837,835	$4,982,970	$4,964,237	$4,148,416	$3,527,601	$3,684,604	$3,320,749	$2,986,039	$3,299,301	$3,052,692	$2,847,644
CER PRODUCTION (TONNES)	546,013	554,889	562,567	541,191	407,607	381,918	309,749	257,119	261,275	227,080	199,783	213,720	191,104	173,126
CER VALUE ($/TONNE)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CER REVENUE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUE	**$4,427,304**	**$4,560,123**	**$4,696,927**	**$4,837,835**	**$4,982,970**	**$4,964,237**	**$4,148,416**	**$3,527,601**	**$3,684,604**	**$3,320,749**	**$2,986,039**	**$3,299,301**	**$3,052,692**	**$2,847,644**
ANNUAL LFG CONSUMED (mmBtu/yr)	912,025	912,025	912,025	912,025	912,025	882,132	715,692	590,862	599,184	524,286	457,710	490,998	441,066	399,456
LFG PURCHASE PRICE ($/mmBtu)	$0.50	$0.52	$0.53	$0.55	$0.56	$0.58	$0.60	$0.61	$0.63	$0.65	$0.67	$0.69	$0.71	$0.73
ANNUAL LFG COST	$456,012	$469,693	$483,783	$498,297	$513,246	$511,316	$427,287	$363,343	$379,514	$342,037	$307,562	$339,828	$314,427	$293,307
LFGTE NON-LFG O+M COST ($/kWh)	$0.021	$0.022	$0.022	$0.023	$0.024	$0.024	$0.025	$0.026	$0.027	$0.027	$0.028	$0.029	$0.030	$0.031
LFGTE NON-LFG O+M COST	$1,859,468	$1,915,252	$1,972,709	$2,031,891	$2,092,847	$2,084,979	$1,742,335	$1,481,592	$1,547,534	$1,394,715	$1,254,136	$1,385,707	$1,282,131	$1,196,010
WELLFIELD O+M COST -- EXISTING AREA	$412,000	$424,360	$437,091	$337,700	$347,831	$358,266	$369,014	$380,084	$391,487	$403,231	$415,328	$427,788	$440,622	$453,841
WELLFIELD O+M COST -- EXPANSION AREA				$495,000	$46,000	$48,000	$381,000	$76,000	$78,000	$444,000	$111,000	$114,000	$514,000	$151,000
TOTAL O+M COST	**$2,727,480**	**$2,809,304**	**$2,893,584**	**$3,362,888**	**$2,999,924**	**$3,002,562**	**$2,919,635**	**$2,301,019**	**$2,396,535**	**$2,583,983**	**$2,088,027**	**$2,267,323**	**$2,551,180**	**$2,094,158**
NET REVENUE	**$1,699,824**	**$1,750,819**	**$1,803,343**	**$1,474,947**	**$1,983,046**	**$1,961,675**	**$1,228,780**	**$1,226,581**	**$1,288,069**	**$736,766**	**$898,012**	**$1,031,978**	**$501,512**	**$753,485**

GROSS PLANT CAPACITY (kW)	11,200	INITIAL LFG COST ($/mmBtu)	$0.50	CAPITAL COST	$18,383,000
PLANT NET CAPACITY (kW)	10,640	LFG COST ESCALATION	3%		
PLANT AVAILABILITY	95%			PRE-TAX IRR	0.0%
NET PLANT HEAT RATE (Btu/kWh)(HHV)	10,300	LFGTE INITIAL O+M COST ($/kWh)	$0.021		
		O+M COST ESCALATION	3%	CUMULATIVE NET REVENUE	-$44,161
INITIAL POWER SALES RATE ($/kWh)	$0.050				
POWER SALES RATE ESCALATION	3%	CER VALUE ($/TONNE)	$0.00		
		CER ESCALATION	0%		

Table No. 5 Financial Analysis for LFG to Energy (Reciprocating Engine) Project without CERs (Plant Availability 85%)

MURIBECA LANDFILL
ADDITIONALITY TEST FOR RECIPROCATING ENGINE PROJECT
Plant availability 85%

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LANDFILL GAS AVAILABLE (mmBtu/hr)	151	153	156	150	113	106	86	71	72	63	55	59	53	48
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	110	110	110	110	110	106	86	71	72	63	55	59	53	48
POWER PRODUCTION (kWh/yr)	79,225,440	79,225,440	79,225,440	79,225,440	79,225,440	76,628,738	62,170,485	51,326,796	52,049,709	45,543,495	39,760,194	42,651,845	38,314,369	34,699,806
POWER SALES RATE ($/kWh)	$0.050	$0.052	$0.053	$0.055	$0.056	$0.058	$0.060	$0.061	$0.063	$0.065	$0.067	$0.069	$0.071	$0.073
POWER SALES REVENUE	$3,961,272	$4,080,110	$4,202,513	$4,328,589	$4,458,447	$4,441,685	$3,711,741	$3,156,274	$3,296,751	$2,971,197	$2,671,719	$2,952,006	$2,731,356	$2,547,892
CER PRODUCTION (TONNES)	546,013	554,889	562,567	541,191	407,607	381,918	309,749	257,119	261,275	227,080	199,783	213,720	191,104	173,126
CER VALUE ($/TONNE)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CER REVENUE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUE	**$3,961,272**	**$4,080,110**	**$4,202,513**	**$4,328,589**	**$4,458,447**	**$4,441,685**	**$3,711,741**	**$3,156,274**	**$3,296,751**	**$2,971,197**	**$2,671,719**	**$2,952,006**	**$2,731,356**	**$2,547,892**
ANNUAL LFG CONSUMED (mmBtu/yr)	816,022	816,022	816,022	816,022	816,022	789,276	640,356	528,666	536,112	469,098	409,530	439,314	394,638	357,408
LFG PURCHASE PRICE ($/mmBtu)	$0.50	$0.52	$0.53	$0.55	$0.56	$0.58	$0.60	$0.61	$0.63	$0.65	$0.67	$0.69	$0.71	$0.73
ANNUAL LFG COST	$408,011	$420,251	$432,859	$445,845	$459,220	$457,494	$382,309	$325,096	$339,565	$306,033	$275,187	$304,057	$281,330	$262,433
LFGTE NON-LFG O+M COST ($/kWh)	$0.021	$0.022	$0.022	$0.023	$0.024	$0.024	$0.025	$0.026	$0.027	$0.027	$0.028	$0.029	$0.030	$0.031
LFGTE NON-LFG O+M COST	$1,663,734	$1,713,646	$1,765,056	$1,818,007	$1,872,548	$1,865,508	$1,558,931	$1,325,635	$1,384,635	$1,247,903	$1,122,122	$1,239,843	$1,147,170	$1,070,115
WELLFIELD O+M COST -- EXISTING AREA	$412,000	$424,360	$437,091	$337,700	$347,831	$358,266	$369,014	$380,084	$391,487	$403,231	$415,328	$427,788	$440,622	$453,841
WELLFIELD O+M COST -- EXPANSION AREA				$495,000	$46,000	$48,000	$381,000	$76,000	$78,000	$444,000	$111,000	$114,000	$514,000	$151,000
TOTAL O+M COST	**$2,483,745**	**$2,558,258**	**$2,635,005**	**$3,096,552**	**$2,725,599**	**$2,729,267**	**$2,691,254**	**$2,106,816**	**$2,193,687**	**$2,401,167**	**$1,923,637**	**$2,085,688**	**$2,383,121**	**$1,937,388**
NET REVENUE	**$1,477,527**	**$1,521,853**	**$1,567,508**	**$1,232,037**	**$1,732,848**	**$1,712,418**	**$1,020,486**	**$1,049,458**	**$1,103,063**	**$570,029**	**$748,081**	**$866,319**	**$348,235**	**$610,504**

GROSS PLANT CAPACITY (kW)	11,200	INITIAL LFG COST ($/mmBtu)	$0.50	CAPITAL COST	$18,383,000
PLANT NET CAPACITY (kW)	10,640	LFG COST ESCALATION	3%		
PLANT AVAILABILITY	85%			PRE-TAX IRR	-2.6%
NET PLANT HEAT RATE (Btu/kWh)(HHV)	10,300	LFGTE INITIAL O+M COST ($/kWh)	$0.021		
		O+M COST ESCALATION	3%	CUMULATIVE NET REVENUE	-$2,822,633
INITIAL POWER SALES RATE ($/kWh)	$0.050				
POWER SALES RATE ESCALATION	3%	CER VALUE ($/TONNE)	$0.00		
		CER ESCALATION	0%		

Table No. 6 Financial Analysis for LFG to Energy (Reciprocating Engine) Project without CERs (Initial Power Sales Rate $0.06)

MURIBECA LANDFILL
ADDITIONALITY TEST FOR RECIPROCATING ENGINE PROJECT
INITIAL POWER SALES RATE $0.06

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LANDFILL GAS AVAILABLE (mmBtu/hr)	151	153	156	150	113	106	86	71	72	63	55	59	53	48
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	110	110	110	110	110	106	86	71	72	63	55	59	53	48
POWER PRODUCTION (kWh/yr)	83,885,760	83,885,760	83,885,760	83,885,760	83,885,760	81,136,311	65,827,573	54,346,019	55,111,456	48,222,524	42,099,029	45,160,777	40,568,155	36,740,971
POWER SALES RATE ($/kWh)	$0.060	$0.062	$0.064	$0.066	$0.068	$0.070	$0.072	$0.074	$0.076	$0.078	$0.081	$0.083	$0.086	$0.088
POWER SALES REVENUE	$5,033,146	$5,184,140	$5,339,664	$5,499,854	$5,664,850	$5,643,553	$4,716,094	$4,010,325	$4,188,813	$3,775,167	$3,394,654	$3,750,785	$3,470,429	$3,237,321
CER PRODUCTION (TONNES)	546,013	554,889	562,567	541,191	407,607	381,918	309,749	257,119	261,275	227,080	199,783	213,720	191,104	173,126
CER VALUE ($/TONNE)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CER REVENUE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUE	**$5,033,146**	**$5,184,140**	**$5,339,664**	**$5,499,854**	**$5,664,850**	**$5,643,553**	**$4,716,094**	**$4,010,325**	**$4,188,813**	**$3,775,167**	**$3,394,654**	**$3,750,785**	**$3,470,429**	**$3,237,321**
ANNUAL LFG CONSUMED (mmBtu/yr)	864,023	864,023	864,023	864,023	864,023	835,704	678,024	559,764	567,648	496,692	433,620	465,156	417,852	378,432
LFG PURCHASE PRICE ($/mmBtu)	$0.50	$0.52	$0.53	$0.55	$0.56	$0.58	$0.60	$0.61	$0.63	$0.65	$0.67	$0.69	$0.71	$0.73
ANNUAL LFG COST	$432,012	$444,972	$458,321	$472,071	$486,233	$484,405	$404,798	$344,220	$359,540	$324,035	$291,375	$321,942	$297,879	$277,870
LFGTE NON-LFG O+M COST ($/kWh)	$0.021	$0.022	$0.022	$0.023	$0.024	$0.024	$0.025	$0.026	$0.027	$0.027	$0.028	$0.029	$0.030	$0.031
LFGTE NON-LFG O+M COST	$1,761,601	$1,814,449	$1,868,882	$1,924,949	$1,982,697	$1,975,244	$1,650,633	$1,403,614	$1,466,084	$1,321,309	$1,188,129	$1,312,775	$1,214,650	$1,133,062
WELLFIELD O+M COST -- EXISTING AREA	$412,000	$424,360	$437,091	$337,700	$347,831	$358,266	$369,014	$380,084	$391,487	$403,231	$415,328	$427,788	$440,622	$453,841
WELLFIELD O+M COST -- EXPANSION AREA				$495,000	$46,000	$48,000	$381,000	$76,000	$78,000	$444,000	$111,000	$114,000	$514,000	$151,000
TOTAL O+M COST	**$2,605,613**	**$2,683,781**	**$2,764,294**	**$3,229,720**	**$2,862,761**	**$2,865,915**	**$2,805,445**	**$2,203,918**	**$2,295,111**	**$2,492,575**	**$2,005,832**	**$2,176,505**	**$2,467,151**	**$2,015,773**
NET REVENUE	**$2,427,533**	**$2,500,359**	**$2,575,370**	**$2,270,134**	**$2,802,088**	**$2,777,639**	**$1,910,649**	**$1,806,407**	**$1,893,702**	**$1,282,592**	**$1,388,823**	**$1,574,279**	**$1,003,279**	**$1,221,548**

GROSS PLANT CAPACITY (kW)	11,200	INITIAL LFG COST ($/mmBtu)	$0.50	CAPITAL COST	$18,383,000
PLANT NET CAPACITY (kW)	10,640	LFG COST ESCALATION	3%		
PLANT AVAILABILITY	90%			PRE-TAX IRR	6.9%
NET PLANT HEAT RATE (Btu/kWh)(HHV)	10,300	LFGTE INITIAL O+M COST ($/kWh)	$0.021		
		O+M COST ESCALATION	3%	CUMULATIVE NET REVENUE	$9,051,402
INITIAL POWER SALES RATE ($/kWh)	$0.060				
POWER SALES RATE ESCALATION	3%	CER VALUE ($/TONNE)	$0.00		
		CER ESCALATION	0%		

Table No. 7 Financial Analysis for LFG to Energy (Reciprocating Engine) Project without CERs (Initial Power Sales Rate $0.036)

MURIBECA LANDFILL
ADDITIONALITY TEST FOR RECIPROCATING ENGINE PROJECT
INITIAL POWER SALES REATE $0.036

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LANDFILL GAS AVAILABLE (mmBtu/hr)	151	153	156	150	113	106	86	71	72	63	55	59	53	48
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	110	110	110	110	110	106	86	71	72	63	55	59	53	48
POWER PRODUCTION (kWh/yr)	83,885,760	83,885,760	83,885,760	83,885,760	83,885,760	81,136,311	65,827,573	54,346,019	55,111,456	48,222,524	42,099,029	45,160,777	40,568,155	36,740,971
POWER SALES RATE ($/kWh)	$0.036	$0.037	$0.038	$0.039	$0.041	$0.042	$0.043	$0.044	$0.046	$0.047	$0.048	$0.050	$0.051	$0.053
POWER SALES REVENUE	$3,019,887	$3,110,484	$3,203,799	$3,299,912	$3,398,910	$3,386,132	$2,829,656	$2,406,195	$2,513,288	$2,265,100	$2,036,793	$2,250,471	$2,082,258	$1,942,393
CER PRODUCTION (TONNES)	546,013	554,889	562,567	541,191	407,607	381,918	309,749	257,119	261,275	227,080	199,783	213,720	191,104	173,126
CER VALUE ($/TONNE)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CER REVENUE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUE	**$3,019,887**	**$3,110,484**	**$3,203,799**	**$3,299,912**	**$3,398,910**	**$3,386,132**	**$2,829,656**	**$2,406,195**	**$2,513,288**	**$2,265,100**	**$2,036,793**	**$2,250,471**	**$2,082,258**	**$1,942,393**
ANNUAL LFG CONSUMED (mmBtu/yr)	864,023	864,023	864,023	864,023	864,023	835,704	678,024	559,764	567,648	496,692	433,620	465,156	417,852	378,432
LFG PURCHASE PRICE ($/mmBtu)	$0.50	$0.52	$0.53	$0.55	$0.56	$0.58	$0.60	$0.61	$0.63	$0.65	$0.67	$0.69	$0.71	$0.73
ANNUAL LFG COST	$432,012	$444,972	$458,321	$472,071	$486,233	$484,405	$404,798	$344,220	$359,540	$324,035	$291,375	$321,942	$297,879	$277,870
LFGTE NON-LFG O+M COST ($/kWh)	$0.021	$0.022	$0.022	$0.023	$0.024	$0.024	$0.025	$0.026	$0.027	$0.027	$0.028	$0.029	$0.030	$0.031
LFGTE NON-LFG O+M COST	$1,761,601	$1,814,449	$1,868,882	$1,924,949	$1,982,697	$1,975,244	$1,650,633	$1,403,614	$1,466,084	$1,321,309	$1,188,129	$1,312,775	$1,214,650	$1,133,062
WELLFIELD O+M COST -- EXISTING AREA	$412,000	$424,360	$437,091	$337,700	$347,831	$358,266	$369,014	$380,084	$391,487	$403,231	$415,328	$427,788	$440,622	$453,841
WELLFIELD O+M COST -- EXPANSION AREA				$495,000	$46,000	$48,000	$381,000	$76,000	$78,000	$444,000	$111,000	$114,000	$514,000	$151,000
TOTAL O+M COST	**$2,605,613**	**$2,683,781**	**$2,764,294**	**$3,229,720**	**$2,862,761**	**$2,865,915**	**$2,805,445**	**$2,203,918**	**$2,295,111**	**$2,492,575**	**$2,005,832**	**$2,176,505**	**$2,467,151**	**$2,015,773**
NET REVENUE	**$414,275**	**$426,703**	**$439,504**	**$70,193**	**$536,148**	**$520,217**	**$24,212**	**$202,277**	**$218,177**	**-$227,475**	**$30,961**	**$73,966**	**-$384,893**	**-$73,380**

GROSS PLANT CAPACITY (kW)	11,200	INITIAL LFG COST ($/mmBtu)	$0.50	CAPITAL COST	$18,383,000
PLANT NET CAPACITY (kW)	10,640	LFG COST ESCALATION	3%		
PLANT AVAILABILITY	90%			PRE-TAX IRR	#DIV/0!
NET PLANT HEAT RATE (Btu/kWh)(HHV)	10,300	LFGTE INITIAL O+M COST ($/kWh)	$0.021		
		O+M COST ESCALATION	3%	CUMULATIVE NET REVENUE	-$16,112,116
INITIAL POWER SALES RATE ($/kWh)	$0.036				
POWER SALES RATE ESCALATION	3%	CER VALUE ($/TONNE)	$0.00		
		CER ESCALATION	0%		

<u>Step 4: Common practice analysis</u>
Sub-step 4a. Analyze other activities similar to the proposed project activityl
Sub-step 4b. Discuss any similar options that are occurring

In Brazil, about 6,000 or more garbage dumps exist now. According to Brazilian greenhouse gas emission inventory in 1994, 84 % of methane emissions in Brazil occur from these landfill sites. Currently 76% of all the waste generated in Brazil is discarded in dumping grounds where neither LFG management nor LFG recovery is performed. The remaining 24% is discarded in managed landfill sites.

Similar projects registered by the CDM executive board in Brazil include:.

- NovaGerar Landfill Gas to Energy Project
- Salvador da Bahia Landfill Gas Management Project
- Onyx Landfill Gas Recovery Project
- Marca Landfill Gas to Energy Project

The sale of carbon credits from the projects support their own management.

As required by law there are landfills where venting LFG is carried out without CDM registration in Brazil. In all landfills venting is performed for safety purposes only.

Generally, it is difficult to gain profit from collecting LFG and generating electricity in Brazil because the wholesale price of electricity is very low. To the best of our knowledge, there is no LFG to energy project in Brazil, private or public, without any intention of CDM registration.

Therefore, alternative scenario 1 cannot be implemented without a CDM project.

As the above result shows, alternative scenario 4 is the only scenario left. Alternative scenario 4 is to vent LFG to the atmosphere for the safety purpose, as required by the current law in Brazil. The investment required for this alternative is minor and includes only the cost for the vents. Clearly alternative 4 is the least cost option and most likely to happen without CDM activity. Therefore, alternative 4 is the baseline scenario

<u>Step 5: Impact of CDM registration</u>

The impact of this project to be registered as a CDM project would be as follows.
(1) The amount of GHG can be reduced.
(2) A project income can be obtained from the sales profit of CER.

As demonstrated in Step 1 to 4, alternative scenario 1 will not be implemented without CDM registration, because of financial hurdles. On the other hand, the CDM registration of alternative scenario 1 would increase its IRR rate up to 20.8% (table 8). The sales profit of CER would enable the proposed CDM project activity to be undertaken.

The above steps were passed, and it can be concluded that the project activity is additional.

Table No. 8 Financial Analysis for LFG to Energy (Reciprocating Engine) Project with CERs

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LANDFILL GAS AVAILABLE (mmBtu/hr)	151	153	156	150	113	106	86	71	72	63	55	59	53	48
LANDFILL GAS REQUIRED (mmBtu/hr)	110	110	110	110	110	110	110	110	110	110	110	110	110	110
LANDFILL GAS CONSUMPTION RATE (mmBtu/hr)	110	110	110	110	110	106	86	71	72	63	55	59	53	48
POWER PRODUCTION (kWh/yr)	83,885,760	83,885,760	83,885,760	83,885,760	83,885,760	81,136,311	65,827,573	54,346,019	55,111,456	48,222,524	42,099,029	45,160,777	40,568,155	36,740,971
POWER SALES RATE ($/kWh)	$0.050	$0.052	$0.053	$0.055	$0.056	$0.058	$0.060	$0.061	$0.063	$0.065	$0.067	$0.069	$0.071	$0.073
POWER SALES REVENUE	$4,194,288	$4,320,117	$4,449,720	$4,583,212	$4,720,708	$4,702,961	$3,930,078	$3,341,937	$3,490,677	$3,145,973	$2,828,879	$3,125,654	$2,892,024	$2,697,768
CER PRODUCTION (TONNES)	546,013	554,889	562,567	541,191	407,607	381,918	309,749	257,119	261,275	227,080	199,783	213,720	191,104	173,126
CER VALUE ($/TONNE)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
CER REVENUE	$3,276,078	$3,329,334	$3,375,402	$3,247,146	$2,445,642	$2,291,508	$1,858,494	$1,542,714	$1,567,650	$1,362,480	$1,198,698	$1,282,320	$1,146,624	$1,038,756
TOTAL REVENUE	**$7,470,366**	**$7,649,451**	**$7,825,122**	**$7,830,358**	**$7,166,350**	**$6,994,469**	**$5,788,572**	**$4,884,651**	**$5,058,327**	**$4,508,453**	**$4,027,577**	**$4,407,974**	**$4,038,648**	**$3,736,524**
ANNUAL LFG CONSUMED (mmBtu/yr)	864,023	864,023	864,023	864,023	864,023	835,704	678,024	559,764	567,648	496,692	433,620	465,156	417,852	378,432
LFG PURCHASE PRICE ($/mmBtu)	$0.50	$0.52	$0.53	$0.55	$0.56	$0.58	$0.60	$0.61	$0.63	$0.65	$0.67	$0.69	$0.71	$0.73
ANNUAL LFG COST	$432,012	$444,972	$458,321	$472,071	$486,233	$484,405	$404,798	$344,220	$359,540	$324,035	$291,375	$321,942	$297,879	$277,870
LFGTE NON-LFG O+M COST ($/kWh)	$0.021	$0.022	$0.022	$0.023	$0.024	$0.024	$0.025	$0.026	$0.027	$0.027	$0.028	$0.029	$0.030	$0.031
LFGTE NON-LFG O+M COST	$1,761,601	$1,814,449	$1,868,882	$1,924,949	$1,982,697	$1,975,244	$1,650,633	$1,403,614	$1,466,084	$1,321,309	$1,188,129	$1,312,775	$1,214,650	$1,133,062
WELLFIELD O+M COST -- EXISTING AREA	$412,000	$424,360	$437,091	$337,700	$347,831	$358,266	$369,014	$380,084	$391,487	$403,231	$415,328	$427,788	$440,622	$453,841
WELLFIELD O+M COST -- EXPANSION AREA				$495,000	$46,000	$48,000	$381,000	$76,000	$78,000	$444,000	$111,000	$114,000	$514,000	$151,000
TOTAL O+M COST	**$2,605,613**	**$2,683,781**	**$2,764,294**	**$3,229,720**	**$2,862,761**	**$2,865,915**	**$2,805,445**	**$2,203,918**	**$2,295,111**	**$2,492,575**	**$2,005,832**	**$2,176,505**	**$2,467,151**	**$2,015,773**
NET REVENUE	**$4,864,753**	**$4,965,670**	**$5,060,828**	**$4,600,638**	**$4,303,589**	**$4,128,555**	**$2,983,127**	**$2,680,734**	**$2,763,216**	**$2,015,878**	**$2,021,745**	**$2,231,469**	**$1,571,498**	**$1,720,751**

GROSS PLANT CAPACITY (kW)	11,200	INITIAL LFG COST ($/mmBtu)	$0.50	CAPITAL COST	$18,383,000
PLANT NET CAPACITY (kW)	10,640	LFG COST ESCALATION	3%		
PLANT AVAILABILITY	90%			PRE-TAX IRR	20.8%
NET PLANT HEAT RATE (Btu/kWh)(HHV)	10,300	LFGTE INITIAL O+M COST ($/kWh)	$0.021		
		O+M COST ESCALATION	3%	CUMULATIVE NET REVENUE	$27,529,449
INITIAL POWER SALES RATE ($/kWh)	$0.050				
POWER SALES RATE ESCALATION	3%	CER VALUE ($/TONNE)	$6.00		
		CER ESCALATION	0%		

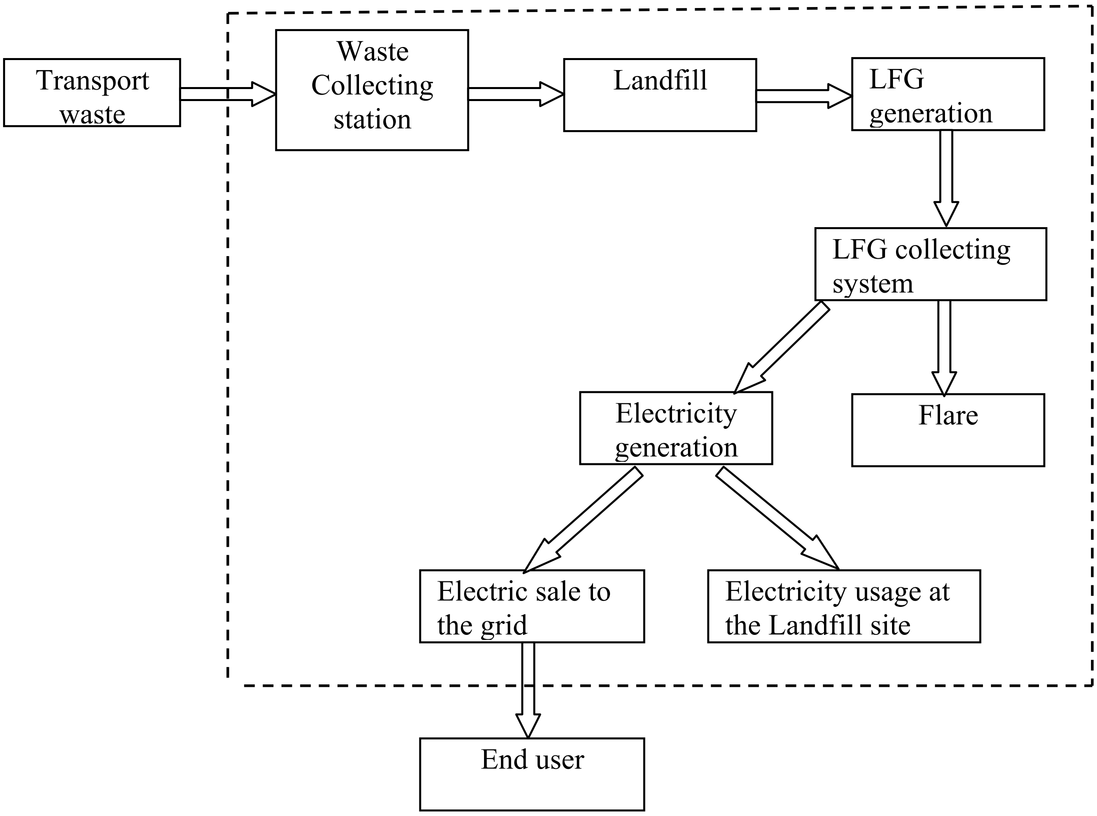
B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

Please refer the content of B.2.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary is defined by the emissions of the project activities, including the operation of the project. All relevant emissions of the baseline situation and the project situation were identified.

Figure No. 1 Project Boundary



B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Date of completion of the baseline study: 10/3/2005

The entity determining the baseline: AZSA Sustainability Co,. Ltd.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/01/2007 (DD/MM/YYYY)

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

30 years

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

C.2.1. Renewable crediting period

21 years

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

01/01/2007 (DD/MM/YYYY)

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

N/A

C.2.2.2. Length:

N/A

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

The project will use the approved monitoring methodology ACM0001: Consolidated monitoring methodology for LFG project activities.

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

ACM0001 monitoring methodology is applicable to the project because the project is a landfill capture project activity where the baseline scenario is the partial or total atmospheric release of the gas and the project activity falls into situation b).

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

In addition, ACM0001 specifies that this baseline methodology shall be used in conjunction with the approved monitoring methodology ACM0001 (“Consolidated monitoring methodology for LFG project activities”).

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

N/A

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)

The estimated project emissions due to the project activity are zero.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

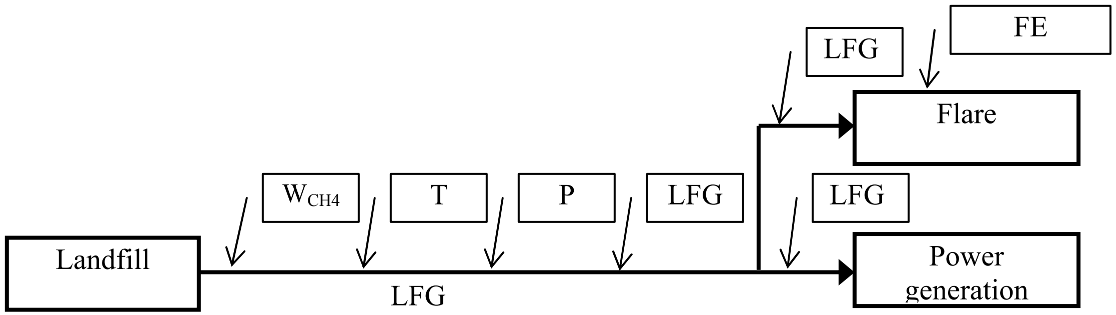
D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

n/a

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

Each parameter' ID number refers to ID number defined in the ACM 0001: Consolidated monitoring methodology for LFG project activities.

Figure No. 2 Monitoring Plan



D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. $LFG_{total,y}$	Total amount of LFG captured	Flow meter	m^3	m	Continuously	100%	Electronic	Measured by a low meter. Date to be aggregated monthly and yearly.
2. $LFG_{flared,y}$	Amount of LFG flared	Flow meter	m^3	m	Continuously	100%	Electronic	Measured by a low meter. Date to be aggregated monthly and yearly.

3. $LFG_{electricity, y}$	Amount of LFG combusted in power plant	Flow meter	m^3	m	Continuously	100%	Electronic	Measured by a low meter. Date to be aggregated monthly and yearly.
5. FE	Flare/combustion efficiency, determined by the operation hours (1) and the CH_4 content in the exhaust gas (2)	Meter	%	m/c	(1) Continuously (2) Periodically	n/a	Electronic	(1) Continuous measurement of operation time of flare (2) Periodic measurement of the CH_4 content of flare exhausts gas. The period of 5-year was recommended by SCS Engineers, because: • 5-year would be the typical interval that is required for exhaust testing of biogas flares in US.
6. W_{CH4}	Methane fraction in the LFG	Meter	m^3CH_4/ m^3LFG	m	Periodically	100%	Electronic	Preferably measured by continuous gas quality analyser.
7. T	Temperature of the LFG	Meter	Celsius	m	Periodically	100%	Electronic	Measured to determine the density of CH_4: D_{CH4}
8. P	Pressure of the LFG	Meter	m	m	Periodically	100%	Electronic	Measured to determine the density of CH_4: D_{CH4}
11.	Regulatory requirements relating to LFG projects	Brazil Law	Test	n/a	Annually	100%	Electronic	Required for any changes to the AF

- Parameter 4. LFG $_{thermal, y}$ will not be monitored since the project does not include thermal energy.
- Parameter 9: Total amount of and/or other energy carries used in the project will not be monitored because the project will not count CO_2 emission reductions from displacing or avoiding energy generation from other sources.
- Parameter 10: CO_2 emissions intensity of the electricity and/or other energy carriers will not be monitored because the project will not count CO_2 emission reductions from displacing or avoiding energy generation from other sources.

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

N/A

D.2.3. Treatment of leakage in the monitoring plan **D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

N/A

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

The formulae in ACM0001 will be used to estimate emissions reduction of the project activity.
The GHG emissions reduction achieved by the project activity during a given year "y" (ER_y) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$), times the approved Global Warming Potential value for methane (GWP_{CH4}).

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4}$$

ER_y is measured in tCO_2e. $MD_{project,y}$ and $MD_{reg,y}$ are measured in tCH_4. The approved GWP_{CH4} for the first committed period is 21 tCO_2e/tCH_4.

Where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor (AF)" is used and justified, taking into account the project context. $MD_{reg,y}$ is determined as the following equation.

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

In Brazil, there is no regulation that a part or all of the LFG which occurs from landfill must be collected. Moreover, at the Muribeca landfill site, the contracts do not mention anything about LFG collection. The only regulation is to install vents and vent a part of LFG for safety purpose. Also according to the central government was conducted, there was no plan to introduce a regulation which imposes LFG collection at the present. Therefore it is appropriate to assume that AF (Adjustment Factor) =0 at the present. However if the situation changes, the value of AF (=0) will be updated at any time from the monitoring result.

$AF=0$
$MD_{reg,y} = MD_{project,y} * 0$
$MD_{reg,y} = 0$

Therefore at present $MD_{reg,y}$ can be assumed to be zero.

The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared ($MD_{flared,y}$), and gas used to generate electricity ($MD_{electricity,y}$).

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

$$MD_{flared,y} = LFG_{flared,y} * W_{CH4} * D_{CH4} * FE$$

Where $MD_{flared,y}$ is the quantity of methane destroyed by flaring, $LFG_{flared,y}$ is the quantity of LFG flared during the year measured in cubic meters (m^3), W_{CH4} is the average methane fraction of the LFG as measured during the year and expressed as a fraction (in m^3CH_4/m^3LFG), FE is the flare efficiency, and D_{CH4} is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4).

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

Where $MD_{electricity,y}$ is the quantity of CH_4 destroyed by generation of electricity and $LFG_{electricity,y}$ is the quantity of LFG fed into the electricity generator.

All of these parameters will be monitored as instructed by the monitoring plan.

$$MD_{project,y} = (LFG_{flared,y} * W_{CH4} * D_{CH4} * FE) + (LFG_{electricity,y} * W_{CH4} * D_{CH4})$$

Therefore, the GHG emission reduction can be calculated as follows;
$ER_y = ((LFG_{flared,y} * \mathrm{FE}) + LFG_{electricity,y}) * W_{CH4} * D_{CH4} * GWP_{CH4}$

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1-3 LFGy	Low	Flow meters will be subject to regular maintenance and test s to ensure accuracy.
5. FE	Medium	Flare efficiency will be tested once within 180 days of the start-up of the Flare system. The test of Flare Efficiency will be repeated at 5 year intervals.
6. W_{CH4}	Low	The gas analyser will be subject to regular maintenance and testing to ensure accuracy.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

EMLURB
- Daily inspection of the site
- Periodical monitoring
- Reporting

→

SCS Engineers
- Assure data
- Maintain LFG recovery system
- Maintain engines and flare system.
- Periodical site visit
- Report emission reduction

→

Natsource
- Emission reduction registration
- Communication with EB

SCS Engineers will also prepare an operational manual. The operational manual will include procedures for handling equipment, reporting, maintenance, emergency plans and work security. SCS Engineers will also ensure that technical operating staff working at EMLURB will receive appropriate training before implementing the monitoring plan.

D.5 Name of person/entity determining the monitoring methodology:

The monitoring methodology was determined by AZSA Sustainability Co., Ltd.

AZSA Sustainability Co., Ltd.
1-2 Tsukudo-cho, Shinjuku-ku
Tokyo 162-0821, Japan
Tel: +81-3-3266-7520

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

The estimated emission reduction due to the proposed project activity is calculated as follows.

As shown in Annex 3, predicted amount of LFG recover by the proposed project are calculated. The estimated amount of methane emissions reduction can be calculated as follows; for the calculation of predicted LFG recovery, please refer to Annex 3.

In the estimation of GHG emissions reduction, it is assumed that all predicted LFG recovery would be flared.

Methane emissions reduction estimates	=	Predicted LFG recovery	*	Operating hours	*	Methane contents	*	Flare efficiency	*	Methane density	*	Methane GWP
				8,760		50		98		0.0007168		21
(tonnes CO_2e)		(m^3/hr)		(hours/yr)		(%)		(%)		(tCH_4/m^3CH_4)		

The parameters used are the follows.

Assumptions used in the calculation:
- Methane contents: 50%
- Operating hours: 8,760 hours/year (365 days/year, 24 hours/day)
- Flare efficiency: 98%

Table No. 9 Factor used for converting methane to carbon dioxide equivalents

Factor (CO_2e/CH_4)	Applicable period	Source
21	1996-actual	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

Table No. 10 Conversion Factor used for methane density

	Factor	Unite	Period Applicable
Methane Density	At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4	tonnes CH_4/m^3CH_4	Default

The table below shows the estimated annual tonnes of predicted LFG recovery and methane emissions reduction from flaring LFG from existing and expansion landfill area at the Muribeca landfill between year 2007 and year 2027, calculated following an approved methodology ACM0001 with data taken from the project's pre-feasibility study (2005) conducted by SCS Engineering.

Table No. 11 Predicted LFG recovery and Methane Emission Reduction Estimates

Year	Predicted LFG recovery			Methane Emissions Reduction Estimates	
	m^3/hr	cfm	mmBtu/hr	tonnesCH_4/yr	tonnesCO_2e/yr
2007	8,451	4,974	151	26,001	546,013
2008	8,588	5,055	153	26,423	554,889
2009	8,707	5,125	156	26,789	562,567
2010	8,376	4,930	150	25,771	541,191
2011	6,308	3,713	113	19,410	407,607
2012	5,911	3,479	106	18,187	381,918
2013	4,794	2,822	86	14,750	309,749
2014	3,979	2,342	71	12,244	257,119
2015	4,044	2,380	72	12,442	261,275
2016	3,514	2,069	63	10,813	227,080
2017	3,092	1,820	55	9,513	199,783
2018	3,308	1,947	59	10,177	213,720
2019	2,958	1,741	53	9,100	191,104
2020	2,679	1,577	48	8,244	173,126
2021	3,146	1,851	56	9,678	203,248
2022	2,845	1,675	51	8,754	183,828
2023	2,593	1,526	46	7,977	167,509
2024	3,002	1,767	54	9,237	193,986
2025	2,725	1,604	49	8,385	176,075
2026	3,023	1,780	54	9,303	195,355
2027	2,765	1,628	49	8,508	178,668
Total				291,706	6,125,810

E.2. Estimated leakage:

According to ACM0001, there is no leakage effects needed to be accounted for.
The only source of leakage is the emissions resulting from operating LFG system, flaring system, as well as engines to generate electricity. However the electricity required for operating the whole system would be covered by the electricity generated at the landfill site, because the amount of required electricity would be insignificant.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Because the estimated emission reduction is calculated in E.1, the sum of E.1 and E.2 would not represent the project activity emissions. Calculating project activity emissions from the project is not applicable in this context.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Because the estimated emission reduction is calculated in E.1, the estimated anthropogenic emissions by source of GHG of the baseline are not applicable in this context. However, it would be found from the information (LFG Recovery Potential) of Table No. 17 in Annex 3.

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

The emission reductions of the project activity are explained in E.1.

E.6. Table providing values obtained when applying formulae above:

The table below shows the estimated amount of emission reductions from the proposed project.

Table No. 12 Estimation of emission reductions

Year	Estimation of emission reductions (tonnes of CO_2e)
2007	546,013
2008	554,889
2009	562,567
2010	541,191
2011	407,607
2012	381,918
2013	309,749
2007-2013	3,303,934
2014	257,119
2015	261,275
2016	227,080
2017	199,783
2018	213,720
2019	191,104
2020	173,126
2014-2020	1,523,207
2021	203,248
2022	183,828
2023	167,509
2024	193,986
2025	176,075
2026	195,355
2027	178,668
2021-2027	1,298,669
Total of 2007-2027	6,125,810

SECTION F. Environmental impacts

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

The environmental impact assessment will be conducted before submitting the PDD to the CDM EB.

The principal environmental impacts of the project which SCS Engineers recognised are in the following areas;

- Global climate change;
- Ambient air quality (hazardous air pollutant emissions); and
- Ambient air quality (conventional air pollutants).

Lesser environmental impacts will occur in the following areas:

- Surface water;
- Groundwater; and
- Noise.

One of the principal goals of this project, and its major environmental benefit, is a reduction in GHG emissions. It is projected that the project will eliminate almost 4.8 million tons of carbon dioxide equivalents between 2007 and 2020.

LFG contains volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) in low concentrations. When LFG is not collected and combusted the bulk of the LFG is emitted to the ambient air. While low in concentration, the mass of VOCs and HAPs emitted at a large landfill is significant. SCS Engineers estimates, based on typical LFG characteristics (USEPA AP-42), that VOC emissions and HAPs emissions will peak at about 63 tonnes per year and 16 tonnes per year, respectively, in 2009. Destruction of LFG in a flare or in an internal combustion engine will reduce VOCs and HAPs emissions by about 98 percent.

The reciprocating engines will employ Best Available Control Technology (BACT) for control of conventional air pollutants. As with all combustion-based power generation some air emissions will be generated. SCS Engineers estimates that emissions of conventional air emissions will peak in 2009 as follows:

Table No. 13 Estimated amount of emissions

Nitrogen Oxides (NO_x)	136.7 tonnes/year
Carbon Monoxide (CO)	210.6 tonnes/year
Sulfur Dioxide (SO_2)	14.1 tonnes/year
Particulates (PM)	28.9 tonnes year

The project will generate a small quantity of wastewater in the form of condensate. Condensate is moisture removed from the LFG as it cools on its way to the flare station at a maximum of ten liters per minute. Condensate is usually combined with the landfill's leachate for treatment and/or disposal. The quantity of condensate is insignificant when compared to the 300 litters per minute of leachate which is now reportedly produced. An undetermined amount of leachate will be pumped from selected LFG extraction wells. However, this will result in little, if any, long-term increases in leachate production.

Leachate withdrawn through the wells will reduce leachate seeps through the side and base of the landfill. Reduced leachate seepage will aid in its control and will result in some unquantifiable improvement to surface and groundwater quality. Extraction of the LFG will probably also produce a slight reduction in groundwater contamination as a result of reduced contact between the LFG (with its impurities) and the groundwater.

Reciprocating engines are the noisiest pieces of equipment associated with the project. Noise will be attenuated by installing the engines in individual soundproof enclosures (or in a building) and equipping the engine exhaust with silencers.

F.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:

There is no environmental impact which is considered significant.

SECTION G. Stakeholders' comments

The official consultation with Stakeholders will be held before submitting the real PDD to the CDM EB.

As a reference, the followings are the comments received during the feasibility study.

Name	Mr. Luiz Quental Coutinho Technical Director of the metropolitan Government of Pernambuco
	Mr. Geraldo Miranda Cavalcaniti Ambient Control Government of Pernambuco
	Ms. Terezinha Hunes Secretariat of Urban Development Government of Pernambuco
Comments	Basically they are in accordance with the tenants of the project. (GHG emission reductions, safety and sanitary improvements, new renewable energy source, etc). However they wish to proceed slowly due to various political issues.

Name	Mr. Tito Livio de Barros e Souza State agency of environment and resources (CPRH-Agência Estadual de meio Ambiente e Recursos)
Comments	He welcomes this project with its promise of an additional energy source and reducing LFG emissions from the landfill. He mentioned that the City of Recife promotes the development of energy sources and renewable energy. A license has to be obtained from this organization in moving toward implementation of the project.

Name	Mr. Roberto Gomes Secretariat of Sanitation and Environment (Secretaria de Saneamento e Meio Ambiente)
Comments	He is pleased about the prospects of this proposed project. It would improve the safety of the site as well as add renewable alternative energy source to the local power grid. The project would also decrease GHG emissions. He hopes that the

	project would aid in local sustainable development.

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

N/A

G.2. Summary of the comments received:

N/A

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

N/A

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	
Street/P.O.Box:	
Building:	
City:	
State/Region:	
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved.

Annex 3

BASELINE INFORMATION

<Predicted Landfill gas recovery>

In order to estimate anthropogenic emissions by sources of GHG of the baseline the First Order Decay Model of the USEPA was used and the equation is as follows:

$$\boxed{Q_M = \sum_{i=1}^{n} 2\, k\, L_o\, M_i \,(e^{-k\, t_i})}$$

$\sum_{i=1}^{n}$ = sum from opening year +1 (i=1) through year of projection (n);
Q_M = maximum expected LFG generation flow rate（m^3/year）（=LFG recovery potential）
k = methane decay rate constant（1/year）
L_o = ultimate methane generation potential（m^3/Mg）
M_i = mass of solid waste disposed in the i^{th} year（Mg）
t_i = age of the waste disposed in the i^{th} year（year）

The EPA model required that the site's waste disposal history be known. The model employs a first-order exponential decay function, which assumes that LFG generation is at its peak following a time lag representing the period prior to methane generation.

A first-order model makes the assumption that LFG productions from a given mass of waste is at its peak rate shortly after its burial, and after anaerobic conditions have been established. LFG production decays each year after the first year in proportion to the amount of waste remaining after the prior year's waste decay.

SCS Engineers used the model to estimate the projected LFG recovery rates for the landfill through 2040 using the following criteria and assumptions.

- Waste Filling History: the amount of waste in tonnes placed in the landfill each year
- Ultimate Methane Recovery Factor (Lo): The ultimate methane recovery factor (Lo) is the total amount of methane that could be expected to be produced by a specific amount of waste if an unlimited amout of time was available for waste decay. Lo is normally expressed as m3/Mg.
- Decay Rate Constant (k): The decay rate constant, normally expressed 1/ year, takes into account the rate at which LFG production declines, equal to the rate at which the waste decays.
- Methane Constant: SCS Engineers estimates future methane contents to be 50%
- System Coverage: SCS Engineers estimates a measure of the fraction of the refuse mass which is under active collection.

(1) Waste Filling History

Table No. 14 Waste Disposal History and Projected waste Disposal Rates for existing landfill area

Year	Total Annual Tonnes	Total Accumulated Tonnes
1994	767,370	767,370
1995	831,230	1,598,600
1996	939,961	2,538,561
1997	1,007,519	3,546,080
1998	928,967	4,475,047
1999	892,491	5,367,538
2000	959,626	6,327,164
2001	924,340	7,251,504
2002	1,006,297	8,257,801
2003	985,662	9,243,463
2004	1,000,000	10,243,463
2005	1,000,000	11,243,463
2006	1,000,000	12,243,463
2007	1,000,000	13,243,463
2008	1,000,000	14,243,463
2009	156,537	14,400,000

Notes:

1) Data provided by the EMLURB.
2) Historic disposal rates (1994-2003) based on weights measured by site scale.
3) 2004 and future estimates are based on preliminary 2004 data.
4) Remaining capacity of 5 million tonnes as of February 27, 2004 provided by EMLURB. Total site capacity (14.4 million tonnes) and closure date based on remaining capacity and historical and projected future disposal rates.
5) A conservative, level rate of waste disposal of 1,000,000 tonnes per year was assumed for future years of 2008 and 2009, until the capacity of the existing landfill area was reached.

Table No. 15 Projected Waste Disposal Rates for Expansion Landfill Area

Year	Total Annual Tonnes	Total Accumulated Tonnes
2009	185,000	185,000
2010	185,000	370,000
2011	185,000	555,000
2012	185,000	740,000
2013	185,000	925,000
2014	185,000	1,110,000
2015	185,000	1,295,000
2016	185,000	1,480,000
2017	185,000	1,665,000
2018	220,000	1,885,000
2019	220,000	2,105,000
2020	220,000	2,325,000
2021	220,000	2,545,000
2022	220,000	2,765,000
2023	220,000	2,985,000
2024	220,000	3,205,000

2025	260,000	3,465,000
2026	260,000	3,725,000
2027	260,000	3,985,000
2028	260,000	4,245,000
2029	260,000	4,505,000
2030	295,000	4,800,000
2031	295,000	5,095,000
2032	295,000	5,390,000

Notes:
1) The waste disposal is planned to end in 2032
2) The expansion landfill area is supposed to close in 2035.

(2) Ultimate Methane Recovery Factor (Lo)

The Lo was derived by modifying an estimated Lo value for U.S. landfills that experience 1,800 millimetres of precipitation. The modification is based on the ratios of organic waste percentages and dry waste contents of U.S. vs Muribeca Landfill waste. The table below summarizes the calculation of the Lo value.

Table No. 16 Lo values for U.S. Landfills and Muribeca Landfill

	U.S. Landfills	Muribeca Landfill	Ratio: Muribeca/U.S.
Organic %	68.2%	78.8%	1.15
Dry Weight %	80.3%	59.3%	0.74
Lo value	93.6m^3/Mg	79.8m^3/Mg	0.85

Therefore the value for the potential methane generation capacity (Lo) for the Muribeca Landfill is estimated to be 79.8 m^3/Mg

(3) Decay Rate Constant (k)

The k value reflects the fraction of refuse which decays in a given year and produces methane. An alternative approach to estimating a single k value for the entire landfill is to assign k values to different portions of the waste stream, based on their relative decay rates.

SCS Engineers has developed a set of default k values for U.S landfills that vary with average annual precipitation. The k values are based on a database of 288 years of recovery data from landfill with active gas collection systems to calibrate the LFG models. The procedure of developing k values for the Muribeca Landfill was based on the appropriate U.S. k value for a landfill experiencing 1,800 mm/year of precipitation is as follows:

1. Prepare a single-k LFG model run using the Muribeca Landfill disposal data and the k value that would be appropriate for a U.S. site experiencing 1,800 mm/year of precipitation.
2. Using the percentage of fast, medium, and slow-decaying waste components in the U.S. waste stream and the Muribeca landfill disposal quantity data, prepare a multi-phased LFG model. Keeping the fast to medium to slow k value ratios constant, adjust the fast-decaying waste k value so that the resulting LFG recovery projection matches as closely as possible the results of the single k model-run using the U.S. default k value. The resulting k values are to be used in a 3-k model run for Muribeca landfill.

The values for the three methane generation rate constants (k) used for modelling LFG recovery at the Muribeca Landfill are as follows.

- Fast-decay waste: 0.40 per year
- Medium-decay waste:0.080 per year
- Slowly-decaying waste:0.020 per year

(4) System Coverage

In addition, the SCS Engineers approach to modeling discounts recoverable LFG on a year-by-year basis to account for factors that are known to reduce LFG recovery below ideal recovery. The discount is applied by incorporating a factor for "collection system effectiveness" into the model's output. As a consequence, SCS Engineers' LFG recovery projections more accurately reflect actual, rather than theoretical, LFG recovery. Factors that impair collection system effectiveness include: 1) incomplete coverage of the waste (most often due to interference of active waste filling operations with LFG collection); 2) high leachate levels impairing extraction well performance; 3) areas of waste too thin to allow effective LFG collection; and 4) an ongoing lack of continuous optimization of wellfield operation.

At Muribeca Landfill system coverage for the existing area in the years (2007-2009), while the landfill is operating is assumed to be 65%. Beginning in the year following site closure system coverage is assumed to increase to 80%. For the expansion area, system coverage varies every year depending on the construction situation.

<Predicted LFG recovery>

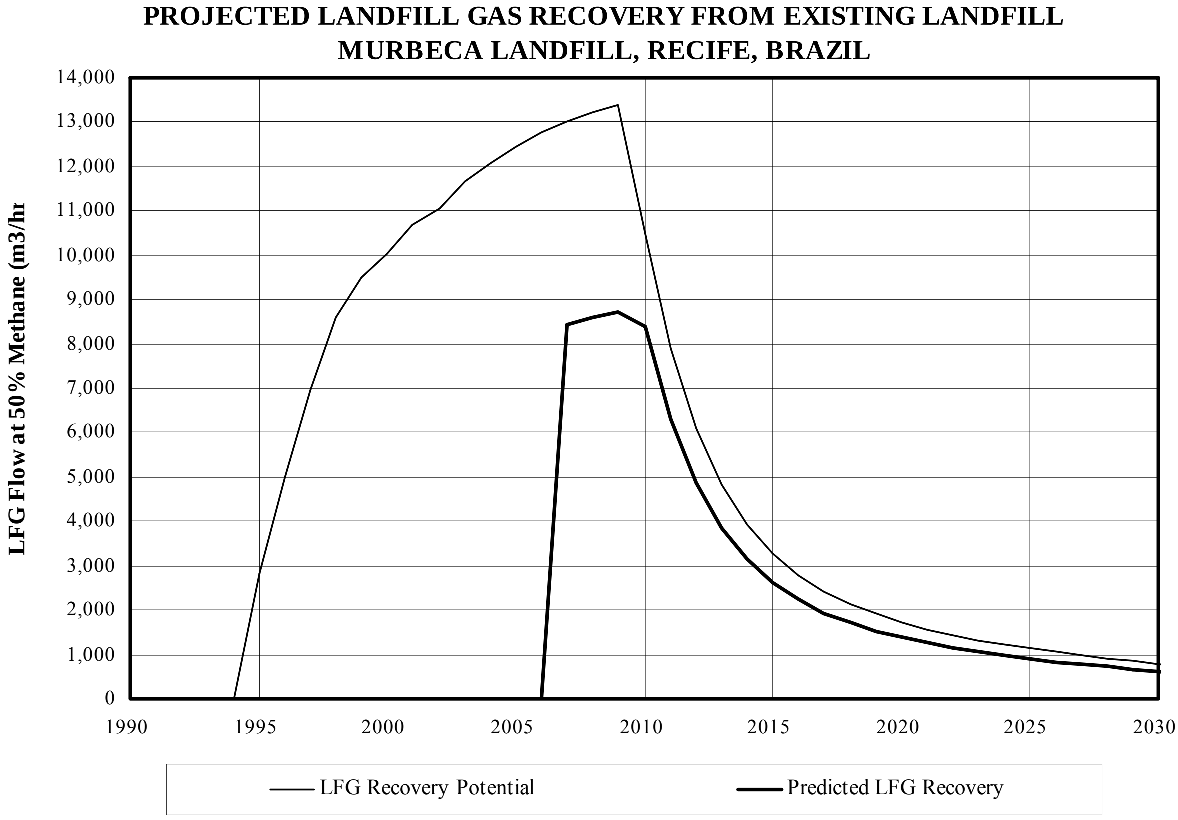
The predicted LFG recovery for the **existing area** between 2007 and 2040 is shown in the table below.

Table No. 17 Predicted LFG Recovery for the existing area between 2007 and 2040

Year	Disposal Rate (Mg/yr)	Refuse In-Place (Mg)	LFG Recovery Potential (m^3/hr)	LFG Recovery Potential (mmBtu/hr)	Collection System Coverage (%)	Predicted LFG Recovery (m^3/hr)	Predicted LFG Recovery (mmBtu/hr)
1994	767,370	767,370	0	0	0%	0	0
1995	831,230	1,598,600	2,807	50	0%	0	0
1996	939,961	2,538,561	5,002	89	0%	0	0
1997	1,007,519	3,546,080	6,949	124	0%	0	0
1998	928,967	4,475,047	8,587	153	0%	0	0
1999	892,491	5,367,538	9,482	169	0%	0	0
2000	959,626	6,327,164	10,020	179	0%	0	0
2001	924,340	7,251,504	10,688	191	0%	0	0
2002	1,006,297	8,257,801	11,071	198	0%	0	0
2003	985,662	9,243,463	11,684	209	0%	0	0
2004	1,000,000	10,243,463	12,080	216	0%	0	0
2005	1,000,000	11,243,463	12,451	222	0%	0	0
2006	1,000,000	12,243,463	12,752	228	0%	0	0
2007	1,000,000	13,243,463	13,001	232	65%	8,451	151

2008	1,000,000	14,243,463	13,212	236	65%	8,588	153
2009	156,537	14,400,000	13,395	239	65%	8,707	156
2010	0	14,400,000	10,470	187	80%	8,376	150
2011	0	14,400,000	7,886	141	80%	6,308	113
2012	0	14,400,000	6,090	109	80%	4,872	87
2013	0	14,400,000	4,829	86	80%	3,863	69
2014	0	14,400,000	3,929	70	80%	3,143	56
2015	0	14,400,000	3,276	59	80%	2,621	47
2016	0	14,400,000	2,793	50	80%	2,234	40
2017	0	14,400,000	2,426	43	80%	1,941	35
2018	0	14,400,000	2,141	38	80%	1,713	31
2019	0	14,400,000	1,913	34	80%	1,531	27
2020	0	14,400,000	1,727	31	80%	1,382	25
2021	0	14,400,000	1,571	28	80%	1,257	22
2022	0	14,400,000	1,438	26	80%	1,150	21
2023	0	14,400,000	1,322	24	80%	1,058	19
2024	0	14,400,000	1,220	22	80%	976	17
2025	0	14,400,000	1,128	20	80%	903	16
2026	0	14,400,000	1,046	19	80%	837	15
2027	0	14,400,000	971	17	80%	777	14
2028	0	14,400,000	903	16	80%	722	13
2029	0	14,400,000	840	15	80%	672	12
2030	0	14,400,000	783	14	80%	626	11
2031	0	14,400,000	730	13	80%	584	10
2032	0	14,400,000	682	12	80%	545	10
2033	0	14,400,000	636	11	80%	509	9
2034	0	14,400,000	595	11	80%	476	9
2035	0	14,400,000	556	10	80%	445	8
2036	0	14,400,000	521	9	80%	417	7
2037	0	14,400,000	488	9	80%	390	7
2038	0	14,400,000	457	8	80%	366	7
2039	0	14,400,000	429	8	80%	343	6
2040	0	14,400,000	402	7	80%	322	6

Figure No. 3   Projected LFG Recovery from Existing Landfill



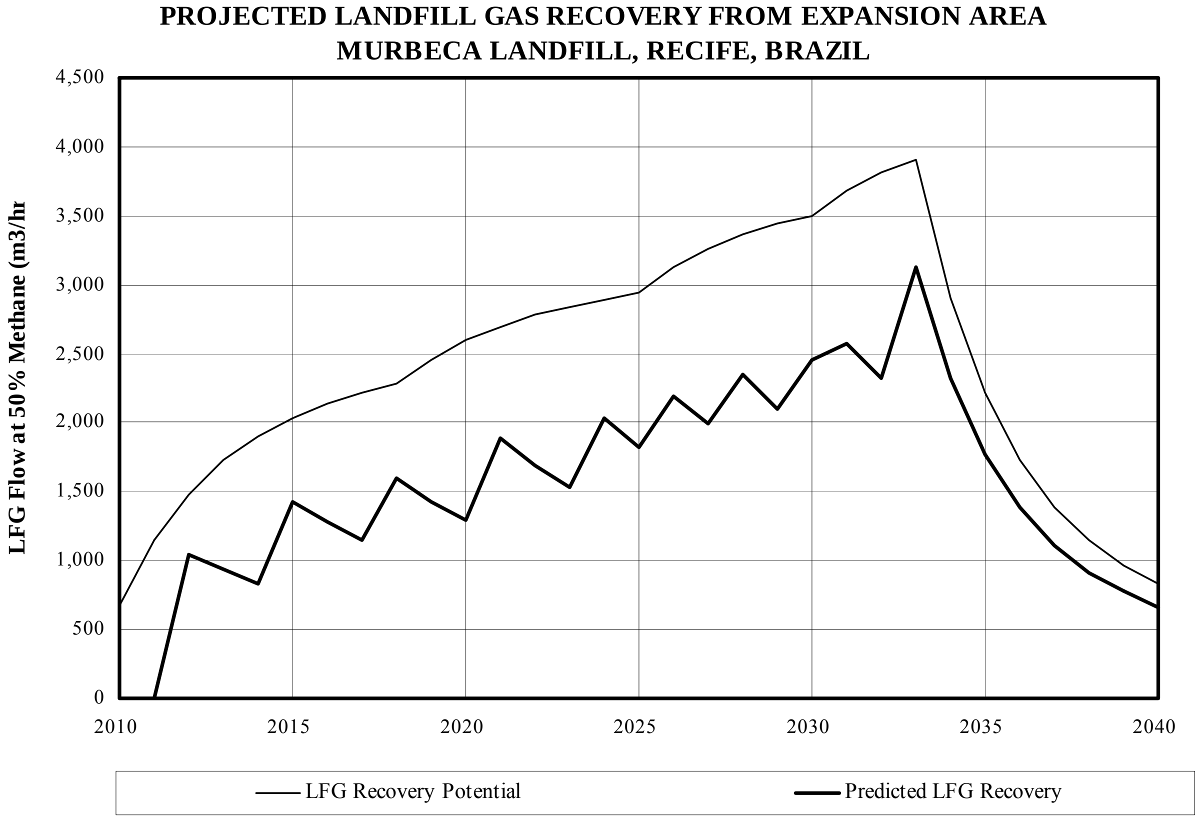
The predicted LFG recovery for the **expansion area** between 2007 and 2040 is shown in the table below.

Table No. 18 Predicted LFG Recovery from the expansion area between 2007 and 2040

Year	Disposal Rate (Mg/yr)	Refuse In-Place (Mg)	LFG Recovery Potential (m³/hr)	LFG Recovery Potential (mmBtu/hr)	Collection System Coverage (%)	Predicted LFG Recovery (m³/hr)	Predicted LFG Recovery (mmBtu/hr)
1994	0	0	0	0	0%	0	0
1995	0	0	0	0	0%	0	0
1996	0	0	0	0	0%	0	0
1997	0	0	0	0	0%	0	0
1998	0	0	0	0	0%	0	0
1999	0	0	0	0	0%	0	0
2000	0	0	0	0	0%	0	0
2001	0	0	0	0	0%	0	0
2002	0	0	0	0	0%	0	0
2003	0	0	0	0	0%	0	0
2004	0	0	0	0	0%	0	0
2005	0	0	0	0	0%	0	0
2006	0	0	0	0	0%	0	0

2007	0	0	0	0	0%	0	0
2008	0	0	0	0	0%	0	0
2009	185,000	185,000	0	0	0%	0	0
2010	185,000	370,000	677	12	0%	0	0
2011	185,000	555,000	1,149	21	0%	0	0
2012	185,000	740,000	1,484	27	70%	1,039	19
2013	185,000	925,000	1,724	31	54%	931	17
2014	185,000	1,110,000	1,900	34	44%	836	15
2015	185,000	1,295,000	2,032	36	70%	1,423	25
2016	185,000	1,480,000	2,134	38	60%	1,280	23
2017	185,000	1,665,000	2,214	40	52%	1,151	21
2018	220,000	1,885,000	2,279	41	70%	1,595	29
2019	220,000	2,105,000	2,460	44	58%	1,427	25
2020	220,000	2,325,000	2,595	46	50%	1,298	23
2021	220,000	2,545,000	2,698	48	70%	1,889	34
2022	220,000	2,765,000	2,778	50	61%	1,695	30
2023	220,000	2,985,000	2,842	51	54%	1,535	27
2024	220,000	3,205,000	2,895	52	70%	2,026	36
2025	260,000	3,465,000	2,939	53	62%	1,822	33
2026	260,000	3,725,000	3,124	56	70%	2,187	39
2027	260,000	3,985,000	3,259	58	61%	1,988	36
2028	260,000	4,245,000	3,361	60	70%	2,353	42
2029	260,000	4,505,000	3,440	61	61%	2,098	37
2030	295,000	4,800,000	3,502	63	70%	2,451	44
2031	295,000	5,095,000	3,681	66	70%	2,577	46
2032	295,000	5,390,000	3,812	68	61%	2,325	42
2033	0	5,390,000	3,911	70	80%	3,129	56
2034	0	5,390,000	2,909	52	80%	2,327	42
2035	0	5,390,000	2,216	40	80%	1,773	32
2036	0	5,390,000	1,732	31	80%	1,386	25
2037	0	5,390,000	1,390	25	80%	1,112	20
2038	0	5,390,000	1,145	20	80%	916	16
2039	0	5,390,000	965	17	80%	772	14
2040	0	5,390,000	831	15	80%	664	12

Figure No. 4 Projected LFG recovery from expansion area



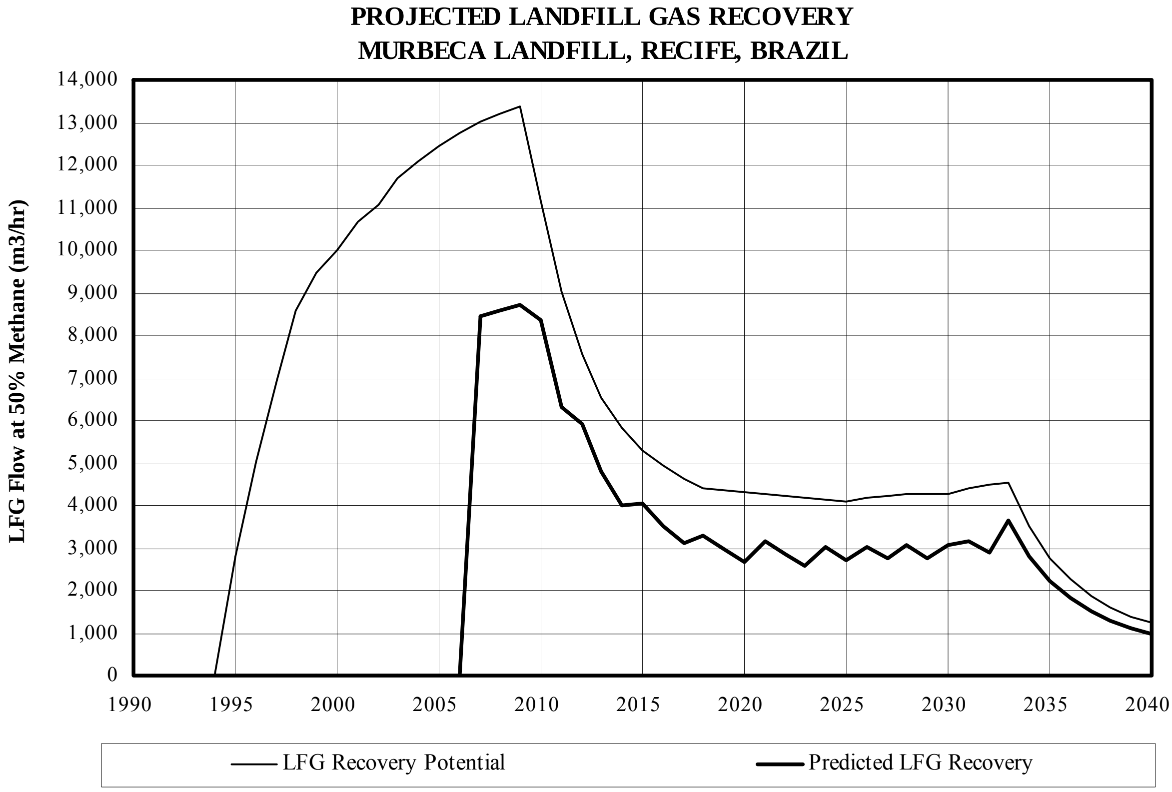
The calculation result of predicted LFG recovery for **both existing and expansion areas** between 2007 and 2040 is shown in table below.

Table No. 19 Predicted LFG Recovery from both existing and expansion area

Year	Disposal Rate (Mg/yr)	Refuse In-Place (Mg)	LFG Recovery Potential		Collection System Coverage (%)	Predicted LFG Recovery	
			(m^3/hr)	(mmBtu/hr)		(m^3/hr)	(mmBtu/hr)
1994	767,370	767,370	0	0	0%	0	0
1995	831,230	1,598,600	2,807	50	0%	0	0
1996	939,961	2,538,561	5,002	89	0%	0	0
1997	1,007,519	3,546,080	6,949	124	0%	0	0
1998	928,967	4,475,047	8,587	153	0%	0	0
1999	892,491	5,367,538	9,482	169	0%	0	0
2000	959,626	6,327,164	10,020	179	0%	0	0

2001	924,340	7,251,504	10,688	191	0%	0	0
2002	1,006,297	8,257,801	11,071	198	0%	0	0
2003	985,662	9,243,463	11,684	209	0%	0	0
2004	1,000,000	10,243,463	12,080	216	0%	0	0
2005	1,000,000	11,243,463	12,451	222	0%	0	0
2006	1,000,000	12,243,463	12,752	228	0%	0	0
2007	1,000,000	13,243,463	13,001	232	65%	8,451	151
2008	1,000,000	14,243,463	13,212	236	65%	8,588	153
2009	341,537	14,585,000	13,395	239	65%	8,707	156
2010	185,000	14,770,000	11,147	199	75%	8,376	150
2011	185,000	14,955,000	9,035	161	70%	6,308	113
2012	185,000	15,140,000	7,574	135	78%	5,911	106
2013	185,000	15,325,000	6,553	117	73%	4,794	86
2014	185,000	15,510,000	5,829	104	68%	3,979	71
2015	185,000	15,695,000	5,309	95	76%	4,044	72
2016	185,000	15,880,000	4,927	88	71%	3,514	63
2017	185,000	16,065,000	4,640	83	67%	3,092	55
2018	220,000	16,285,000	4,419	79	75%	3,308	59
2019	220,000	16,505,000	4,374	78	68%	2,958	53
2020	220,000	16,725,000	4,323	77	62%	2,679	48
2021	220,000	16,945,000	4,269	76	74%	3,146	56
2022	220,000	17,165,000	4,216	75	67%	2,845	51
2023	220,000	17,385,000	4,164	74	62%	2,593	46
2024	220,000	17,605,000	4,115	74	73%	3,002	54
2025	260,000	17,865,000	4,068	73	67%	2,725	49
2026	260,000	18,125,000	4,170	75	73%	3,023	54
2027	260,000	18,385,000	4,231	76	65%	2,765	49
2028	260,000	18,645,000	4,264	76	72%	3,075	55
2029	260,000	18,905,000	4,280	76	65%	2,771	50
2030	295,000	19,200,000	4,285	77	72%	3,078	55
2031	295,000	19,495,000	4,411	79	72%	3,161	56
2032	295,000	19,790,000	4,494	80	64%	2,871	51
2033	0	19,790,000	4,548	81	80%	3,638	65
2034	0	19,790,000	3,504	63	80%	2,803	50
2035	0	19,790,000	2,772	50	80%	2,218	40
2036	0	19,790,000	2,253	40	80%	1,802	32
2037	0	19,790,000	1,878	34	80%	1,502	27
2038	0	19,790,000	1,602	29	80%	1,282	23
2039	0	19,790,000	1,394	25	80%	1,115	20
2040	0	19,790,000	1,233	22	80%	986	18

Figure No. 5 Projected LFG Recovery from both existing and expansion areas



In the proposed CDM project, almost all of the LFGes collected at the Muribeca landfill site is assumed to go to either flare system or power generation system, where methane is destroyed / combusted, except the amount of incomplete combustion.