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MARCA Landfill Gas to Energy Project

Project Design Document

Prepared by

EcoSecurities Brasil Ltda.

March, 2004

Offices in Oxford, Los Angeles,
Sydney, London, Rio de Janeiro,
New York, Den Hague

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A. GENERAL DESCRIPTION OF PROJECT ACTIVITY

A.1 Title of the project activity:

Brazil MARCA Landfill Gas to Energy Project

A.2. Description of the project activity:

Brazil MARCA Landfill Gas to Energy Project is a joint initiative between EcoSecurities, an environmental finance company which specializes in greenhouse gas (GHG) mitigation issues and MARCA Ltda, a local Brazilian landfill management company with operations in several municipalities in the state of Espirito Santo. MARCA is an experienced landfill operator with thorough knowledge in regards to local landfill policies and regulations.

The objective of the project is to collect and utilize the landfill gas of the landfill managed by MARCA. This will involve investing in a gas collection system, leachate drainage system, flairing equipment and a modular electricity generation plant (with expected final total capacity of 11 MW), as well as a generator compound at each site. The generators will combust the methane in the landfill gas to produce electricity for export to the grid. Excess landfill gas, and all gas collected during periods when electricity is not produced, will be flared. Combustion and flaring combined are expected to reduce emissions of 4,859,503 tonnes of CO_2e over the next 21 years.

The main social and environmental impacts of this project will be a positive effect on health and amenity in the local area. Contaminated leachate and surface run-off from landfills can affect down-gradient ground and surface water quality consequently affecting the local environment. The uncontrolled release of landfill gas can also impact negatively on the health of the local environment and the local population and lead to risks of explosions in the local surroundings. By managing the Vitoria landfill properly the environmental health risks and the potential for explosions is greatly reduced. Economic benefits include the project acting as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity and better management of landfills throughout Brazil, which could be replicated across the region (Additional social indicators see Annex 8).

A.3. Project participants:

?? **EcoSecurities Ltd. as Project CO_2 Advisor (www.ecosecurities.com):** the company is an established environmental finance firm which specializes in advising on strategy regarding global warming issues. It was founded in 1996 to provide the new business services for new environmental markets. The company has advised United Nations Agencies, National Governments, project developers and major corporations on scientific, policy and commercial issues related to Climate Change, including the development of potential CDM projects. Readers of Environmental Finance Magazine recently voted EcoSecurities Best Greenhouse Gas Advisor of 2001, 2002 and 2003.

?? **MARCA Ltda. as the carbon credit owner and landfill management company (www.marcaambiental.com.br)**: the company was created in 1996 to operate in waste related activities. MARCA acts in a several municipalities in the Sate of Espirito Santo collecting and disposing the municipal solid waste. MARCA will operate and manage the landfill activities.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1 Host country Party(ies):

Brazil

A.4.1.2 Region/State/Province etc.:

City of Cariacica, Espirito Santo State, Brazil

A.4.1.3 City/Town/Community etc:

Nova Rosa da Penha – Cariacica.

A.4.1.4 Detail on physical location, including information allowing the unique identification of this project activity:

The landfill site is located at Km 282 of BR 101 highway, that links Vitoria (capital of Espirito Santo State) with Rio de Janeiro.

1)"Nursery Seedling" project	2) "Ecological Brooms" and "Ecological Bricks" projects areas
3) Thermoelectric area	4) Leachate treatment lagoons
5) Industrial waste deposit	6) Hospital waste deposit
7) Cell 2	8) Cell 3

Figure 1: Aerial view of landfill area and landfill facilities.

A.4.2. Category(ies) of project activity

Fugitive gas capture and alternative/renewable energy (please note that the emission reductions from the renewable energy activities will not be claimed by the project at this stage).

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

Landfill gas collection system:

State-of-the-art gas collection technology. This includes:

- ?? landfill cells coated with an impermeable high-density polyethylene membrane,
- ?? water residues channeled and treated in a wastewater treatment plant
- ?? vertical wells used to extract gas
- ?? optimal well spacing for maximum gas collection whilst minimizing costs,
- ?? gas headers designed as a looping system in order to allow for partial or total loss of header function in one direction without losing gas system functionality, and
- ?? condensate extraction and storage systems designed at strategic low points throughout the gas system.

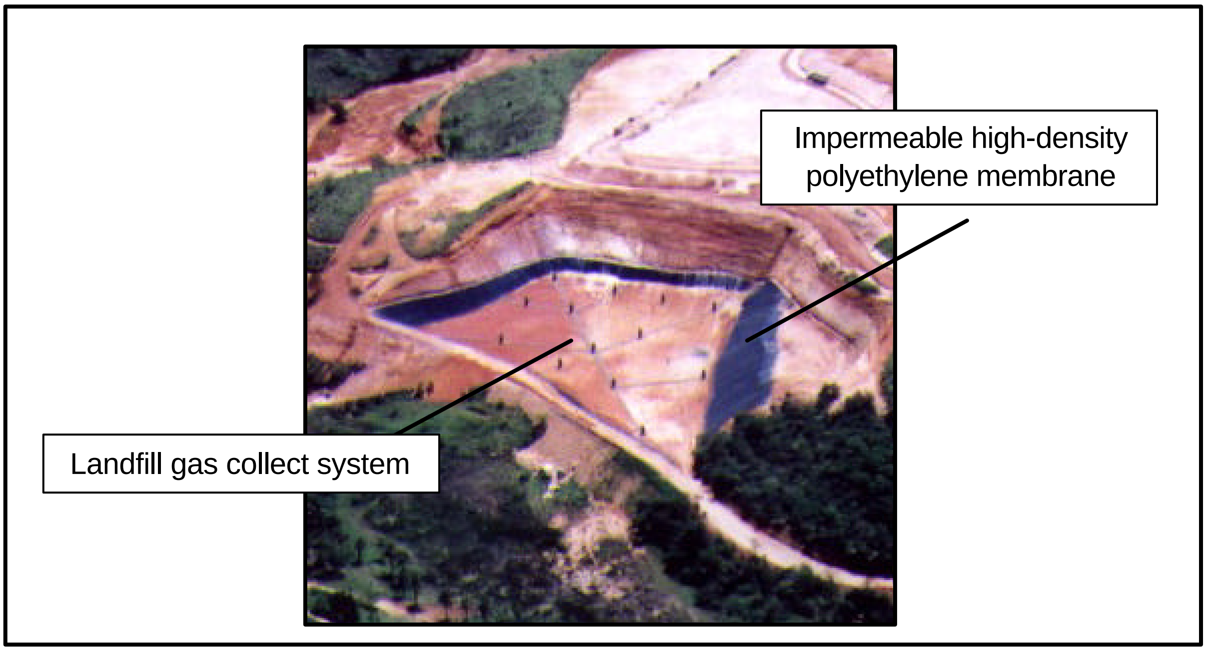

Figure 2: Picture from cell 3 during the construction of landfill gas collect system.

All efforts will be made to minimize problems in condensate management.

Energy generation technology:

As and when the project secures a power purchase agreement sufficient to enable the generation of 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

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:

This project is based on two complementary activities, as follows:

?? The collection and flaring of combustion of landfill gas, thus converting its methane content into CO_2, reducing its greenhouse gas effect; and,
?? The generation and supply of electricity to the regional grid, thus displacing a certain amount of fossil fuels used for electricity generation,.

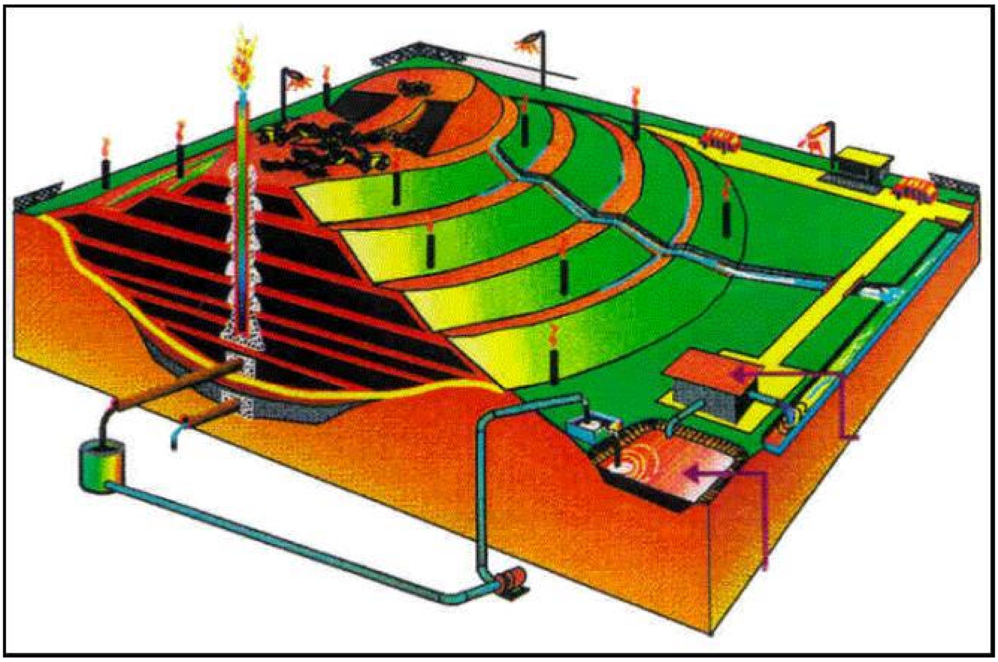

Figure 3: Landfill gas collection system schematic

The baseline scenario is defined as the most likely future scenario in the absence of the proposed CDM project activity . Establishing this future scenario requires an analysis and comparison of possible future scenarios using a comparison methodology that is justified for the project circumstances. Based on this analysis (see sections B.3. and B.4. below), the baseline scenario is the continued uncontrolled release of landfill gas to the atmosphere, similarly to most landfills in Brazil.

Given that the results of the financial analysis conducted clearly show that that implementation of the this type of project is not the economically most attractive course of action and therefore this kind of project is not part of the baseline scenario, it is concluded that the MARCA Project is additional.

Capture and combustion of the landfill gas methane component through flaring or combustion to generate electricity will result in the avoidance of methane emissions to the atmosphere and the reduction of 4,859,503 tonnes of CO2e emissions over 21 years (conservative estimate as the landfill gas generation estimates have been discounted by 25% to take into account uncertainties in the estimation method and as the final ERs will be discounted by 10% to conservatively deduct the amount of flaring that would occur in the absence of the project).

A.4.5. Public funding of the project activity:

There is no Official Development Assistance in this project.

B. BASELINE METHODOLOGY

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

The Baseline methodology used is the AM003, "Simplified financial analysis for landfill gas capture projects", which was approved by the FCCC on 12 January 2004. A copy of the methodology is shown in Annex 3 of this document.

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

Approach 48(b) appears to be most appropriate to investment projects. The proposed project involves a significant investment in gas collection and power generation that must compete with other such investments. It is therefore appropriate to assume that the decision between alternative baseline scenarios is based on an investment calculus. This justifies an investment or financial analysis as an appropriate baseline methodology for this type of project situation.

B.3. Description of how the methodology is applied in the context of the project activity:

The following paragraphs first describe how the proposed baseline methodology is applied to single out the baseline scenario for the MARCA project. Secondly, emissions resulting from the baseline scenario are estimated.

1. Identification of the baseline scenario through the baseline methodology

The baseline methodology is applied in the following way:

1. Analysis of the economic attractiveness of the project alternative without the revenue from carbon credits using an IRR calculation and comparison of the results with a reasonable expected return on investment in Brazil. The results show that the project is not an economically attractive course of action.

2. The only other plausible scenario is the continued venting of landfill gas, with no or inappropriate flaring or utilization. This scenario is determined as the baseline scenario based on an analysis of current practices and current and foreseeable regulations in the waste management sector.

The methodology is applied in the following steps:

Step 1: Draw up a list of possible baseline scenario alternatives.

Step 2: If possible, reduce the list of possible baseline scenario alternatives to the BAU scenario and the proposed project alternative through elimination of implausible alternatives. Always provide convincing justification for the elimination an alternative. For instance, a possible alternative is not plausible if it is not permissible under applicable law.

Step 3: Calculate a conservative IRR for the proposed project activity not taking carbon finance into account. The calculation must use the incremental investment as well as operation, maintenance and all other costs of upgrading the BAU scenario to the proposed project activity, and it must include all revenues generated by the project activity except carbon revenues. An IRR is calculated conservatively, if assumptions made tend to result in a rather higher than a lower IRR.

Step 4: Determine that the project IRR is clearly and significantly lower than a conservatively (i.e. rather low) expected and acceptable IRR for this or a comparable project type in this country.

Step 5: Conclude that the project is therefore economically unattractive and that therefore the remaining BAU alternative is the most likely baseline scenario.

Step 6: Analyze and describe the anticipated development of the most likely baseline scenario during the crediting period.

Step 7: Provide a complete description of the baseline scenario.

Step 1 and 2: Possible and plausible baseline scenarios

Alternative 1: The landfill operator could continue the current business as usual practice of not collecting and flaring landfill gas from his waste operations. In this case, no power would be generated at the sites and the Brazilian power system would remain unaffected.

Alternative 2: The landfill operator would invest in some LFG collection and flaring but not in power generation. The Brazilian power system would remain unaffected.

Alternative 3: The landfill operator would invest in a landfill gas collection system of high effectiveness, as well as a high efficiency flaring system and in LFG power generation equipment (the proposed project activity). The operation would marginally reduce the generation of power for other grid-connected sources.

According to the National GHG Emissions Inventory conducted by CETESB in 1994, Brazil had over 6,000 waste deposition sites, receiving over 60,000 tonnes of waste per day (please note this study is currently being updated). According to the same study, 84% of Brazil's methane emissions came from the deposition of waste in uncontrolled rubbish dumps.

Currently, 76% of the total waste generated in Brazil is disposed in 'rubbish dumps' ("lixões") with no management, gas collection, or water treatment whatsoever. The remaining 24% of waste is disposed in 'controlled' landfills (as opposed to 'sanitary' landfills, as planned by the project), and subject to regulation by the environmental authorities.

Current Brazilian legislation does not require that landfills collect and dispose of landfill gases. So far, only two landfills in Brazil, Salvador and Tremembé, located in State of Bahia and State of São Paulo respectively have been designed to collect and utilize (or even flare) the full amount of gas generated. Both landfills were financially supported by the sale of Carbon Credits.

In the few cases where gases are collected, this is done for safety reasons (to avoid explosions), and it is often the case that the amounts effectively collected are very low, due to high levels of leachate (which is often not drained or treated, as well) blocking the drainage pipes.

The implementation of environmental protection legislation in Brazil has a relatively long lead-time, and the Ministry of the Environment has no immediate plans to introduce legislation requiring the collection and flaring of landfill gas from landfill sites. Historically in Brazil there also tends to be a gulf between stated regulations and practice with regards to the implementation of environmental protection legislation.

Given the regulatory situation in Brazil and the location and conditions of the landfill, the realization of alternative 2 is not required and would also not be an economically attractive course of action for the landfill owner and/or operator. It is therefore not considered a plausible alternative.

This reduces the list of plausible alternatives to Alternative 1 (i.e. BAU) and Alternative 3 (the proposed project).

Steps 3, 4 and 5: Financial analysis and selection of baseline scenario

Given that the main potential financial returns derived from the collection of gas is the sale of electricity, the feasibility of this project is, thus, dependent on factors related to energy sector and to the decentralization of electricity generation in Brazil. It is necessary to conduct a financial analysis to determine whether the project is an economically attractive course of action.

Energy sector and electricity market: Hydro electricity accounts for an average of 81.42 per cent of national electricity production in Brazil. This high proportion in Brazil's electricity generation technology matrix was a consequence of a policy addressed at increasing Brazilian energy independence, as the country had few oil reserves and very poor coal reserves, but rich hydrology resources. In the mid 1980's, Brazil's power sector went through a serious financial crisis, leading to the interruption of construction of many power plants - mostly hydro. In 1993 decentralization of the power sector started which added to delays in implementing planned projects.

The current Brazilian 10-year expansion plan 2004/2012 reduces the importance of hydro in the short-term, but emphasizes its role again at the end of the period. However it is unclear how the large-scale investments will be financed, particularly in view of the trend towards decentralization of the sector. During 2001 power shortages occurred, caused by a scarcity of hydrological resources. It is unclear how this will affect the National Expansion Plan data. However, in the past couple of years there has been a push towards the introduction of thermal power to avoid future blackouts, and therefore a greater reliance on fossil fuels.

Historically, tariff levels have been relatively low due to a centralized pricing structure fixed by the government. While tariff increases may be expected in locations where there is a large growth in demand for electricity, such as Espirito Santo, the ability to capture such tariffs are still uncertain due to the risks of a still incipient free electricity market in Brazil.

In parallel to the risks related to the sale of electricity, the exact amounts of landfill gas and the performance of the plants also concerns landfill operators. Given that currently there isn't a single landfill site in Brazil generating electricity, this is seen as 'unproven' technology by local investors.

Financial analysis: Financial analysis conducted for the Project (see ANNEX 5) using assumptions that are conservative from an investment decision point of view shows that the Internal Rate of Return of the project without carbon finance is negative.[1]

A sensitivity analysis was undertaken using assumptions that are highly conservative from the point of view of analyzing additionality, i.e. the best case scenario IRR was calculated. Given that the landfill operations started in 1995, the waste in place in Jan 2004 is 1,336,327 tonnes, and it was assumed that, from Jan 2004 onwards the average waste placement rate at the landfill is 1000 tonnes per day. The landfill gas generation model used, the US EPA First Order Decay Model, has an inherent error up to 50%. For the best case IRR it was assumed that there was a 0% error margin, therefore again increasing the expected landfill gas volumes from the site, and the expected electricity to be generated from the site. It was assumed that the project has unlimited access to capital to invest in all the equipment necessary to use the increased amount of gas produced. It was assumed that the US$:Rs$ exchange rate was fixed at 3.0 and the electricity tariff was fixed at R$ 120.00 over the 21 year period (equivalent to U$ 40,00/MWh at this exchange rate). These best case assumptions were inputted into the models and financial analysis to recalculate the IRR. The IRR (without carbon) is 8.94 % and still exposed to a series of risks (project, country, currency, etc.). The rate of return of Brazilian government bonds is 22%. These results show that even with the best possible conditions, which are obviously quite unrealistic, the MARCA project is still not an economically attractive course of action.

Given that the project is not an economically attractive course of action, the only remaining plausible baseline scenario is Alternative 1, i.e. the continuation of the status quo (BAU) without any LFG treatment.

Step 6 and 7: Baseline development in time and description of baseline scenario

It has been shown that the BAU baseline holds at the time of preparing the project. The main determinants of this baseline are:

- Landfill regulations applicable to the site
- The economics of landfill gas utilization.

The baseline scenario for the proposed project can thus be described as follows:

> **Inadequate collection and treatment of LFG at the landfill site and thus the unimpeded release of LFG to the atmosphere until some future time when the collection and treatment of LFG may either be required by law or becomes an economically attractive course of action.**

This baseline scenario is the basis for the determination of the project's ERs as per the monitoring plans instructions.

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[1] More detailed financial information than contained in Appendix 1 has been provided to the validator.

2. Estimation of emissions associated with baseline scenario (including estimation of the amount of flaring that would occur in the absence of the project)

This was conducted by estimating the amount of LFG that could be generated in the baseline scenario using the US EPA First Order Decay Model[2] and deducting the amount that would have been flared in the absence of the project according to the effectiveness of the gas collection systems imposed by regulatory requirements at the time of inception of the project (the 'Effectiveness Adjustment Factor').

The First Order Decay Model was used with the assumptions listed in Annex 5 and estimated that in the baseline there will be the production of 9.2 million tCO2e during the project's 21-year lifetime.

Adjustment Factor:

The estimation of the adjustment factor for this project was based on the regulatory requirements imposed on MARCA (the landfill operator) at the time they signed a contractual agreement with the Municipal waste management company to operate the landfill and by the practices that MARCA have been doing before the MDL project proposal. In essence, MARCA is not required to flare any amount of the gas that it currently emits. There is no legislation or contractual terms that require the flaring of landfill gas. Currently, cell 1 of the site, the unique totally project before the MDL project proposal, doesn't even have gas collection wells, while Cell 2 has 12 wells (very insufficient) just for safety purpose, and Cells 3 and 4 will also have wells for safety purposes only. Currently, the company has already a small flare in Cell 2, as a pilot for the gas collection project that will be implemented with carbon finance.

When a cell is full, and the activities are closing, MARCA seals the cell with marble industry residue dust layer, then a clay layer and finally vegetation recovering all the cell. With this actions the oxygen disposable to the cell will be very small, difficultating spontaneous combustion and methane oxidation. For this reason, the adjustment factor for the project was fixed at 10%.

[2] On this model, see US EPA manual "Turning a Liability into an Asset: A Landfill Gas to Energy Handbook for Landfill Owners and Operators" (December 1994).

The effectiveness of a landfill gas collection and flaring system can be affected by a number of factors including:

?? The frequency of gas wells;
?? The depth of gas wells;
?? Whether suction is applied to the gas wells;
?? The efficiency of the flares used.

These factors will impact on the area of influence of a gas well, for example a gas collection system where suction is applied will draw gas from a larger area of waste than a system without suction. Similarly, a deep gas well will have a larger area of influence than a shallow well.

The project scenario proposes the installation of pipes connecting the gas wells, the application of suction to the wells, and the installation of Modular Ground Gas flares. The flares are based on an advanced design and will be skid or base frame mounted ground flares. Ground flare stacks enable higher burning temperatures to ensure low emissions. The burner unit is fully adjustable to enable high temperature flaring of the landfill gas, which will vary in both quality and quantity from site to site, and over time. The average effectiveness of this system is estimated to be 75%.

Although current legislation does not require any collection of the gas collected through the project, and MARCA do not flare the landfill gas out of MDL project scope, all emission reductions arising from the project will nonetheless be reduced by 10%, in order to provide a large enough margin to what could have been flared in the baseline scenario during the first baseline crediting period. Hence, the chosen discount value for MARCA is conservative.

Once the project becomes operational, the emission reductions associated with project can be calculated directly by quantifying the amount of GHGs flared and deducting this 10% Adjustment Factor to conservatively account for any flaring that may have taken place in the baseline scenario.
At the end of the crediting period, this ‘Effectiveness Adjustment Factor’ will be revised, as described in Section D.2.

B.4. 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:

A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would occur in the absence of the registered CDM project activity, i.e. in the baseline scenario.

Given that the results of the financial analysis conducted clearly show that that implementation of the this type of project is not the economically most attractive course of action and therefore this kind of project is not part of the baseline scenario, it is concluded that the MARCA Project is additional.

Furthermore, the additional value derived from the sale of carbon credits appears to increase the project's financial returns to a level sufficient to justify the inherent risks associated with long-term investment decisions and capital allocation for landfill gas collection systems and electricity generation equipment. This key role that carbon credits could play in the investment decision and financial feasibility of the project, indicates that this investment will lead to emission reductions in relation to the baseline investment scenario.

In the baseline scenario (business-as-usual scenario), without any gas collection or utilization schemes in place at the landfill, the site (using estimations from the US EPA First Order Decay Model) would be responsible for the release of approximately 480,000 tonnes of methane during 21 years.

The MARCA project scenario is based on the collection and flaring or combustion of landfill gas for the generation of electricity. Flaring or combustion of the landfill gas to produce electricity will convert the highly potent methane content to less potent carbon dioxide, and result in significant greenhouse gas emission reductions. Using the US EPA Model gas predictions and projecting the amount of landfill gas which will either be combusted in engines or flares it is estimated that only 2.5 million tonnes of CO_2e will be emitted as fugitive emissions in the project scenario during the period 2004-2023, compared to 9.0 million tCO_2e in the baseline scenario. Therefore capture and combustion of the landfill gas methane to generate electricity will effectively result in the avoidance of 4,8 million tonnes of CO_2 emissions over 21 years.

B.5. Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity:

A full flow diagram of the project and system boundaries is presented in Figure 2. The flow diagram comprises all possible elements of the landfill gas collection systems and the equipment for electricity generation.

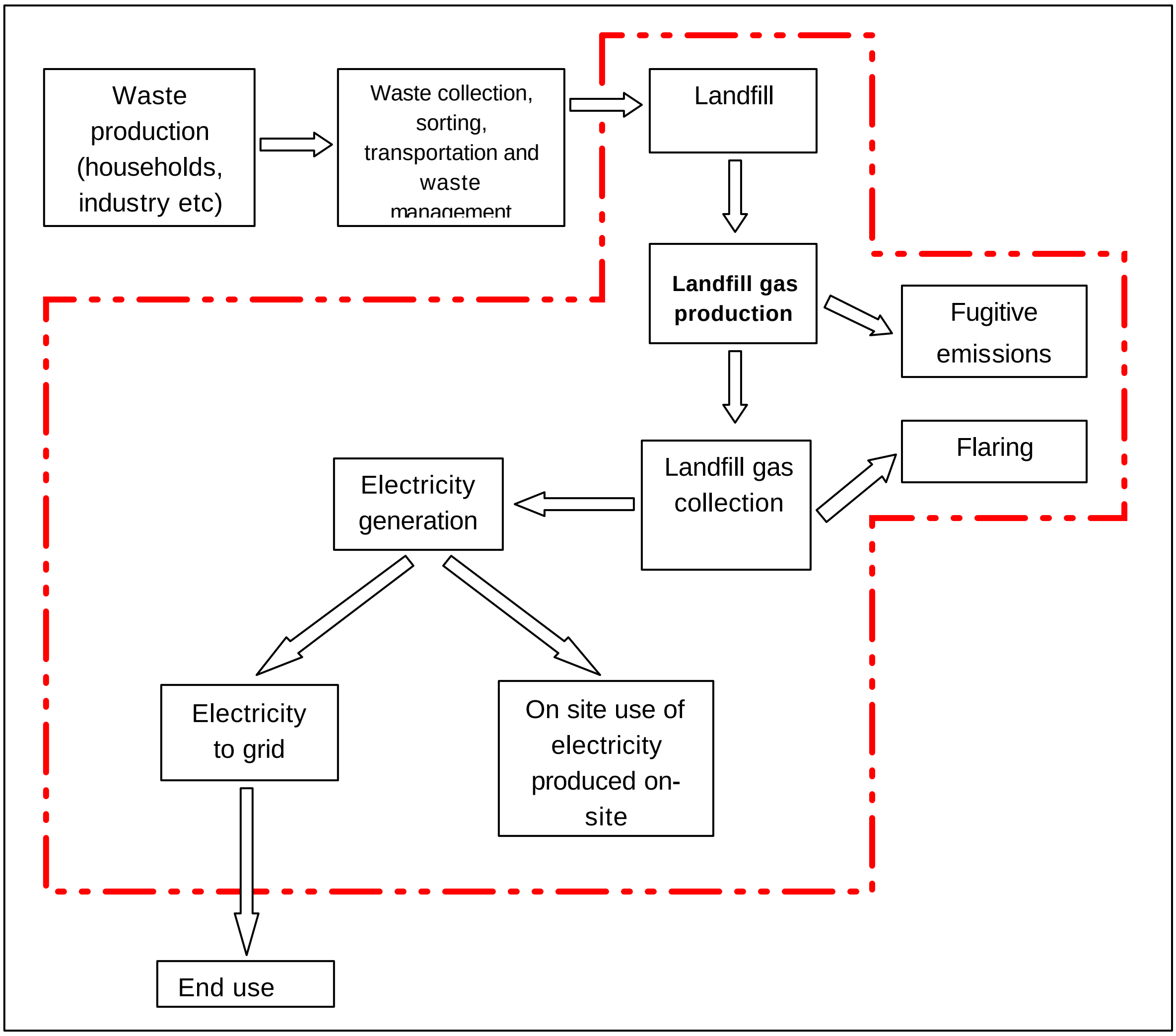

Figure 4: Flow chart of system boundaries

The table below contains a summary of the system and project boundaries for the MARCA project.

Table 1: Summary of system and project boundaries

Emissions	Project Scenario	Baseline Scenario
Direct on-site	Emissions associated with fugitive landfill gas emissions. EcoSecurities estimates that only 75% of LFG generated will be captured meaning the remaining 25% is released as fugitive emissions.	Uncontrolled release of landfill gas generated.
Direct off-site	Transportation of equipment to project site – excluded	None identified
	Use of electricity generated from landfill gas, reducing CO2 emissions in the electricity grid	Emissions associated with use of grid electricity – in the interests of conservatism emission reductions arising from the displacement of more carbon intensive electricity will not be included in the projects volume of CERs
Indirect on-site	Emissions from electricity use for operation of lights and fans of on-site workshop – excluded, since it is carbon neutral Emissions from construction of the project – excluded as would occur even if an alternative project was constructed	–
Indirect off-site	Transport of waste to the landfill site(s) – excluded	Transport of waste to the landfill site(s) - excluded

B.6. Details of baseline development

B.6.1 Date of completing the final draft of this baseline section:

31/12/2003

B.6.2 Name of person/entity determining the baseline:

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C. DURATION OF THE PROJECT ACTIVITY / CREDITING PERIOD

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

Estimated as 01/07/2004 (defined as the start of operation of the landfill gas collection and electricity generation system).

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

21 years

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

C.2.1. Renewable crediting period (at most seven (7) years per period)

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

Estimated as 01/07/2004

C.2.1.2. Length of the first crediting period:

7 years

D. MONITORING METHODOLOGY AND PLAN

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

The monitoring methodology is AM 0003, Simplified Financial Analysis for Landfill Gas Capture Projects. A copy is shown in Annex 4 of this document.

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

For a landfill methane gas capture project such as this one it is most appropriate to accurately measure the methane combusted in flares and generators, i.e. the emission reductions attributable to the project.

Characteristic for LFG collection and utilization projects of the kind described above is that the emissions not released to the atmosphere can directly be monitored. The emissions reductions achieved by the project do not have to be derived from a comparison between baseline and project emissions, because every ton of methane collected and destroyed equals one ton of methane not released to the atmosphere and thus one tone of methane emissions reduced. In other words, a monitoring and ER calculation method can be used that does not rely on information about baseline emissions, i.e. the quantity of emissions in the baseline scenario can remain unknown. This is convenient, since the monitoring of baseline emissions from landfills is also unpractical except on a sample basis. The proposed monitoring and ER calculation method can also be expected to be more accurate than an attempt to derive ERs as the difference between monitored or estimated baseline and project emissions.

In cases where a certain collection and treatment of LFG is already part of the baseline and information exist on the efficiency of the collection system actually installed by the project (e.g. the installed system captures 75 per cent of all LFG emissions), direct monitoring of LFG quantities not released can be corrected by applying an appropriate factor. (E.g. if a collection system is known to have an average 75 % collection efficiency and 10 % would have to be collected in the baseline scenario, the monitored ERs must simply be reduced by approx. 13.3 % to arrive at the additional reductions that can be claimed.)

The MARCA monitoring plan sets out a number of monitoring tasks in order to ensure that all aspects of projected greenhouse gas (GHG) emission reductions for the MARCA project are controlled and reported. This requires an ongoing monitoring of the project to ensure performance according to its design and that claimed Certified Emission Reductions (CERs) are actually achieved.

Revision of the Effectiveness Adjustment Factor

Please note that, in the interests of making a conservative claim to ERs achieved by the project, the monitoring plan proposed to reduce the directly monitored ERs by an 'effectiveness adjustment factor' of 10 % (see section B3-2). The effectiveness adjustment factor will need to be revised at the time of each baseline revision (at the end of each baseline crediting period), by estimating the amount of GHG flaring taking place as part of common industry practices at that point in the future.

As the baseline scenario is the continued uncontrolled release of landfill gas to the atmosphere, similarly to most landfills in Brazil. The Brazilian Ministry of the Environment has no immediate plans to introduce legislation requiring the collection and flaring of landfill gas from landfill sites. The implementation of environmental protection legislation in Brazil has a relatively long lead-time. In addition, historically in Brazil there also tends to be a gulf between stated regulations and actual practice with regards to the implementation of environmental protection legislation. Therefore it is considered sufficient to reconfirm the baseline assumptions at seven-year intervals, i.e. when the crediting period is renewed.

However, to account for the implementation of regulatory requirements, or improvements in waste management practices, within Brazil, a control group will be formed and surveyed at each baseline revision point in the future. The survey will aim at estimating the amount of GHG flaring taking place as part of common industry practices at that point in the future, within the companies in the control group. At every baseline revision point in the future, an expert consultant will provide an estimation of:

- Whether there are sufficient gas collection wells in place;
- The depth of the wells in relation to the depth of the sites;
- The number of gas collection wells operating satisfactorily i.e. gas is flowing;

- The number of gas collection wells not operating i.e. blocked by leachate, poorly maintained etc.;
- The number of flares operating satisfactorily i.e. burning landfill gas;
- Whether the site applies suction to the wells;
- Whether the site is appropriately capped, to avoid venting;
- The efficiency of the flares utilized.

A Control Group was already formed and a preliminary initial survey was conducted by the MARCA project and has shown that none of these landfills is currently capturing and/or flaring landfill gas except for safety purposes (see table below).

Table 2: The MARCA control group.

Landfill	*Waste in place (million of tons)*	*Waste deposition rate (tons/day)*	*Current flaring status*
Natal (RN)	8.0	450.0	No exhaust system, no flaring
Salvador (BA)	2.5	2500.0	Only natural exhaust system, no controlled flaring
São João landfill (SP)	17.0	6500.0	Only natural exhaust system, no controlled flaring
Cariacica (ES)	4.3	800.0	No exhaust system, no flaring
Marambaia (RJ)	3.0	1100.0	No exhaust system, no flaring
Guarulhos (SP)	3.5	1000.0	Only natural exhaust system, no controlled flaring
Itaquaquecetuba (SP)	2.0	2000.0	Only natural exhaust system, no controlled flaring
Maua (SP)	3.0	1500.0	Only natural exhaust system, no controlled flaring
Osasco (SP)	3.4	500.0	Only natural exhaust system, no controlled flaring
Florianópolis (SC)	1.2	350.0	Only natural exhaust system, no controlled flaring
Gravatai (RS)	4.3	1000.0	Only natural exhaust system, no controlled flaring
Joao Pessoa (PB)	2.8	400.0	No exhaust system, no flaring
Total	**55.0**	**18,100**	

Note- Salvador (BA) is operating since Dec 2003 an Automatic Exhaust System, Controlled Flaring

Based on the data collected, the expert will estimate the percentage of gas being flared at each of the control group landfills and a decision will be made on whether the discount factor of 10% is still appropriate, or whether it should be changed to 10% + n%. If the average collection practice exceeds the discount factor of the first commitment period of 10%, a new discount factor shall be established, based on the findings of the control group.[3] A new conservative factor based on current practice and reasonably anticipated changes shall be determined. If the average collection practice however stays below the initial discount factor, no changes to the factor shall be made. The new discount factor of *X*% shall be proposed by

[3] Please note that for the purpose of comparing the two factors, the 10% discount factor applied to MARCA needs to be converted into overall collection efficiency. The 10% discount factor applied to MARCA represents the share of methane that would also have been captured in the baseline scenario, by which the emission reductions need to be reduced. It does not represent the overall collection efficiency of the baseline scenario. As the project is not able to collect 100% of the emissions generated in the landfill, the share of 10% methane captured also in the baseline scenario represents a collection efficiency **lower** than 10%.

MARCA and the appropriateness of the proposed factor reviewed and verified by the designated Operational Entity in the context of the renewal of the project crediting period.

In addition, after the first and second crediting periods, the consultant will also determine whether electricity generation has become the most attractive course of action.

D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

Not applicable, because the project directly monitors and calculate ERs. The following data will be collected.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data variable	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)	For how long is archived data to be kept?	Comment
1	Flow of landfill gas to flares	M^3	m	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
2	Pressure of landfill gas to flares	BAR	m	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
3	Temperature of landfill gas to flares	°C	m	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
4	Gross electricity produced	MWh	M	Continuous	100%	Electronic (spreadsheet)		*Data will be aggregated monthly and yearly*
5	Generator heat rate	GJ/ MWh	M & C	Semi-annual determination of flare efficiency (if	Semi-annually or more frequent depending on	Electronic (spreadsheet)	2 years and duration of the project crediting period in	*Data will be used to test and, if necessary correct*

				significant variation since last monitoring, monitoring repeated every month)	observed deviation from previous rating		files	*the generators' standard heat rate plate ratings*
6	Flare efficiency	%	M & C	Semi-annual determination of flare efficiency (if significant variation since last monitoring, monitoring repeated every month)	Semi-annually or more frequent depending on observed deviation from previous rating	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be used to test and, if necessary correct the flares' efficiency ratings.*
7	Methane fraction in LFG	%	M & C	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly.*
8	LFG collected by Control group	%	E	Every 7 years	A minimum of 10 control sites	Electronic (spreadsheet)	2 years and duration of the project in files	-

D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are however insignificant and would likely also occur if alternative power generation capacity were to be constructed at alternative sites. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs directly monitoring of ERs, indirect emissions will not distort their calculation.

See sections B.5. and E.2. for more detailed discussion.

D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and identification if and how such data will be collected and archived.

Not applicable, because the project directly monitors and calculate ERs. The data above will be collected.

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

The quality assurance practices that will be corroborated by the implementation of ISO 9001 program, the certification is expected to the end of 2004. All the landfill activities will be inside the certification scope. The quality assurance practices that will be implemented in the context of the MARCA project are as follows:

Daily Monitoring Records: On the larger more active sites site staff takes daily gas field and engine readings and fax these to head office. These readings are then checked for any anomalies before being filed for future reference.

Gas Field Monitoring Records: Taken on a weekly basis or at periods to be determined. The Site Technician walks the gas field taking readings at each gas well and recording these on a form, which is then faxed to head office. These readings are then checked for any anomalies before being filed for future reference. A gas analyzer will be installed in order to enable accurate measurement of the methane content on the landfill gas. These gas field inspections will also observe occurrence of any unintended releases of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

Routine Reminders for Site Technicians: All Site Technicians are issued with a reminder list to guide them through their daily, weekly and monthly routine. The Engineering Manager,Operations Manager and Training and Health & Safety Co-ordinator go through this routine during site visits to ensure all aspects of the role are being performed. In addition paperwork due at head office is checked to ensure it has arrived. This includes monitoring records, oil sample reports and meter readings.

Site Audits: The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator make regular site visits. In addition to ensuring the site routines are being performed any additional training needs are assessed and an audit is taken of any outstanding task on site.

Outstanding Work Notice: Following the Site Audit a 'Plant Outstanding Works Notice' is issued to the Site Technician listing all the jobs that the management team consider necessary to be undertaken. This is checked on subsequent site audits to ensure these jobs have been carried out.

Permit to Work Scheme: The form is completed before any work is carried out. This is forwarded to head office and attached to the service records for each engine. The same form is used for any works associated with the gas field.

Service Sheets: A specialist landfill-gas-to-energy company carries out 750, 1500, and 3000 hour services on all 1MW engines followed by major servicing at 12,000 hours, and 500 and 1000 hours on the 1000kW engines with a major service at 16,000 hours. Service sheets are completed for each service to ensure all aspects of the service are completed and recorded. An engineer is present at all major services and on earlier services if the site technician or management team feel this would be beneficial. Based on these services operators will determine whether the generator heat rate changes throughout the project life.

It is anticipated that with such a rigorous maintenance the heat rate is likely to stay constant throughout the life of the engine.

Calibration of measurement equipment: Calibration of measurement equipment will be done monthly in accordance with the requirements of the National Measurement Regulation Agency, INMETRO (Instituto Nacional de Metrologia).

Corrective Actions: The quality assurance measures include procedures to handle and correct non-conformities in the implementation of the Project or this Monitoring Plan. In case such non-conformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by MARCA staff
- MARCA management will make a decision, in consultation with the EPC, on appropriate corrective actions to eliminate the non-conformity and its causes
- Corrective actions are implemented and reported back to the MARCA management.

In addition to the quality assurance measures described above, MARCA will prepare an Operational Manual. The Operational Manual will include procedures for training, capacity building, proper handling of equipment, emergency plans, reforestation plans and work security. The environmental agency, IEMA (ES), monitors compliance with the Operational Manual is a precondition for the issuance of the operational license for the Project and the landfill operations.

MARCA will also ensure that both MARCA staff, EPC operator staff the landfill operator staff will receive appropriate training on the implementation of this Monitoring Plan and of the project.

The table below summarizes the quality control and quality assurance procedures suggested implemented in the context of the Project.

Table 4: Summary of Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored.

Data (Indicate table and ID number e.g. D.4-1; D.4-2.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
D 3 - 1	Low	Yes	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy
D 3 - 2	Low	Yes	Meters will be subject to a regular maintenance and testing regime to ensure accuracy
D 3 - 3	Low	Yes	Meters will be subject to a regular maintenance and testing regime to ensure accuracy
D 3 - 4	Low	Yes	Meters will be subject to a regular maintenance and testing regime to ensure accuracy. Their readings will be double-checked by the electricity distribution company
D 3 - 5	Low	Yes	Regular maintenance will ensure optimal operation of engines and generators. The heat rate used for calculation of ERs will be checked annually or more often if significant deviations from standard or previously used heat rate is observed.
D 3 – 6	Low	Yes	Regular maintenance will ensure optimal operation of flares. Flare efficiency will be calibrated annually or more often, if significant deviation from previous efficiency rating is observed.
D 3 - 7	Low	Yes	Gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy

D.7 Name of person/entity determining the monitoring methodology:

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E. CALCULATION OF GHG EMISSIONS BY SOURCES

E.1 Description of formulae used to estimate anthropogenic emissions by sources of greenhouse gases of the project activity within the project boundary:

Not applicable, because the project directly monitors and calculate ERs. See comment under E.3 below, and description of calculation procedure in E.5.

The destruction of methane in flares and engines will lead to a conversion of methane emissions to CO_2 emissions. The source of the methane and therefore the CO_2 emissions is the organic fraction in deposited waste, which forms part of the natural organic CO_2 cycle. The project sponsors therefore take the view that these CO_2 emissions should not be counted as net contributors to climate change. The global warming potential thus applied to the methane destroyed by the project is 21.

The only source of project emissions identified within the system boundary is fugitive methane emissions from the landfill. It has been assumed that the gas collection system installed will have an average efficiency of 75%. Therefore 25% will continue to escape as fugitive emissions. See section E.5. for formulae used to estimate the landfill gas and corresponding methane generation and table in Section E.6. for the estimated amounts of fugitive gas.

E.2 Description of formulae used to estimate leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and that is measurable and attributable to the project activity:

See D.4.

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

Not applicable, because the project directly monitors and calculate ERs. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 above).

E.4 Description of formulae used to estimate the anthropogenic emissions by sources of greenhouse gases of the baseline:

Not applicable, because the project directly monitors and calculate ERs. See comment under E.3 below.

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

The monitoring plan provides for the calculation of the ERs in the following way:

STEP 1 – Methane combustion in electricity generators

As and when electricity is generated, take the metered gross annual (aggregated from monthly readings) electricity produced by the MARCA project
(MWh)

⇩

Multiplied by generator heat rate
(GJ/MWh)

⇩

Total energy input
(GJ)

⇩

Convert GJ to equivalent tonnes of methane (using factors 0.0357 GJ/m^3 CH_4 and 0.000679 tCH_4/m^3CH_4)
(tonnes of CH_4)

⇩

Multiply by Global Warming Potential of methane (21)
(tCO_2e)

⇩

Annual CO_2 emissions displaced by the MARCA project through methane combustion to generate electricity
(tonnes CO_2 equivalent)

The CO_2 emission reductions from methane combustion in flares will be calculated on an annual basis as shown diagrammatically below:

STEP 2 – Methane combustion in flares

Volume of landfill gas channeled to flares (m^3)

⇩

Multiplied by methane fraction of landfill gas (readings from the gas analyzer or deducted from the electricity generation readings)

⇩

Volume of methane combusted in flare (m^3)

⇩

Multiplied by flare efficiency

⇩

Net volume of methane combusted in flare (m^3)

⇩

Multiplied by volume:mass conversion factor (0.00067899 $tCH_4 = 1m^3\ CH_4$) (tonnes of methane)

⇩

Multiplied by Global Warming Potential of methane (21) (tonnes of CO_2 equivalent)

⇩

Annual emission reductions due to methane combustion in flares (tonnes of CO_2 equivalent)

(Results of Step 1 + Step 2) minus Effectiveness Adjustment Factor (10 %) related to a conservative estimate of the amount of flaring that may have taken place in the absence of the project.

⇩

Total CERs generated by the project (tCO_2)

The total emission reductions (in tonnes of CO_2 equivalent) are the summation of results from Step 1 (- Methane combustion in generators) and Step 2 (– Methane combustion in flares). The sum is, then, reduced by the Effectiveness Adjustment Factor. This factor is meant to conservatively represent the amount of flaring that would have taken place in the absence of the project, if the landfill had simply implemented the gas collection and flaring system requested by the regulatory agency. While this factor was estimated to be 0% for the MARCA project (see Section B3 – 2), the project adopted a higher factor (10%) to ensure conservativeness. This factor will be revised at the end of each baseline crediting period, to take into account the practices adopted by a Control Group of other landfill operators in the country (see Section D2 for an explanation).

No correction for CO_2 emissions from flares and engines/generators is made. For justification of this approach see E.1 and the discussion in the BLS/MP.

Capture and combustion of the landfill gas methane to generate electricity will effectively result in the avoidance of 4.8million tonnes of CO2 emissions over 21 years.

Please note: At this stage, the project does not claim ER reductions associated with the replacement of electricity that would otherwise have to be generated by other power plants. No methodology is therefore provided for this component of the project.

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

Due to the nature of the ER monitoring and calculation process most appropriate for this project (i.e., direct monitoring of emission reductions), the above formula cannot be directly used to complete the table below. However, given that the monitoring method proposed by the project is only applicable after the project becomes operational, the emissions occurring in the project and baseline scenarios were estimate using a first order decay model, as described above. Based on a variety of assumptions regarding waste volume and deposition rates, methane generation profile, LFG collection efficiency, methane contents in LFG, flare efficiency, engine heat rates and so forth, the projected emission reductions are as shown in the following tables. Please note that these tables are only an estimate of expected values.

Table 5: Summary of Baseline and Project Emissions (in tCO_2e), after adjustment for conservativeness (10% reduction).

ERUs summary (tCO2e)	Emissions Baseline	Emissions Project	ERUs - uncertainty adjusted
7 yrs	2,110,595	586,276	1,193,499
10 yrs	3,628,061	1,007,795	2,015,459
14 yrs	5,959,738	1,655,483	3,278,451
21 yrs	9,064,177	2,517,827	4,859,503
Total (40 yrs)	11,231,876	2,971,846	5,373,673

F. ENVIRONMENTAL IMPACTS

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

According to the National GHG Emissions Inventory conducted by CETESB in 1994, at that time Brazil had over 6,000 waste depositing sites, receiving over 60,000 tonnes of waste per day (please note this study is currently being updated). Of this amount, 76% of the total waste is disposed in 'rubbish dumps' ("lixões") with no management, gas collection, or water treatment whatsoever, and usually without any license or under no control by the environmental agencies concerned. According to the same study, 84% of Brazil's methane emissions come from the deposition of waste in uncontrolled rubbish dumps. The remaining 24% of waste is disposed in 'controlled' landfills (as opposed to 'sanitary' landfills, as planned by the project), but these are usually highly ineffective in relation to emissions and percolate control. In the few cases where gases are collected, this is done for safety reasons (to avoid explosions), and it is often the case that the amounts effectively collected are very low, due to high levels of percolates (which are often not drained or treated, as well) blocking the drainage pipes.

By collecting and combusting landfill gas, the MARCA project's 'sanitary' landfills will reduce both global and local environmental effects of uncontrolled releases. The major components of landfill gas, methane and carbon dioxide, are colorless and odorless. The main global environmental concern over these compounds is the fact that they are greenhouse gases. Although the majority of landfill gas emissions are quickly diluted in the atmosphere, in confined spaces there is a risk of asphyxiation and/or toxic effects if landfill gas is present at high concentrations. Landfill gas also contains over 150 trace components that can cause other local and global environmental effects such as odor nuisances, stratospheric ozone layer depletion, and ground-level ozone creation. Through appropriate management of the site, landfill gas will be captured and combusted, removing the risks of toxic effects on the local community and local environment.

Landfill gas electricity generators can also produce nitrogen oxides emissions that vary widely from one site to another, depending on the type of generator and the extent to which steps have been taken to minimize such emissions. Combustion of landfill gas can also result in the release of organic compounds and trace amounts of toxic materials, including mercury and dioxins, although such releases are at levels significantly lower than if the landfill gas is flared. These emissions are also viewed as significantly less harmful than the continued uncontrolled release of landfill gas.

Where methane is used for electricity generation, operational practices at the landfill are improved thus contributing to sustainable development. Specifically for landfills, sustainable means accelerating waste stabilization such that the landfill processes can be said to be largely complete within one generation (30- 50 years). This ensures that both leachate and methane are more carefully managed and controlled, and the degradation processes are accelerated.

Groundwater and surface water can be contaminated by untreated leachate from landfill sites. Leachate may cause serious water pollution if not properly managed. Surface water runoff from a landfill site can also cause unacceptable sediment loads in receiving waters, while uncontrolled surface water run-on can lead to excessive generation of leachate and migration of contaminated waters off-site. With MARCA providing appropriate management on the site, these potential problems should be avoided. Also there are few water impacts associated with landfill gas electricity generation plants. Unlike other power plants that rely upon water for cooling, landfill gas power plants are usually very small, and therefore pollution discharges into local lakes or streams are typically quite small.

Other potential hazards and amenity impacts minimized by appropriate management of the MARCA landfill site include the risks of fire or explosions, landfill gas migration, dust, odor, pests, vermin, unsightliness and litter, each of which may occur on-site or off-site. More information about environmental impact see the environmental impact assessment and the environmental impact report (EIA – RIMA, protocol number nº 3439/02 – Process nº 23997141.)

The following aspects of the operation of the landfill gas to energy project have also been addressed:

?? Noise – There will be some increase in noise from the site associated with energy recovery, although the engines will be housed to reduce noise emissions. The impacts are likely to be marginal given the noise typically associated with operations at the landfills.

- ?? Visual amenity – Placement of energy recovery facilities at the landfill site will increase the visual presence of the site, however the impacts are expected to be marginal given the visual intrusion currently associated with the waste disposal operations.

Where landfill gas utilization schemes, such as the MARCA project, are developed in countries like Brazil, there is also an opportunity to promote best practices to improve landfill management standards, and contribute towards global sustainable development.

F.2. If impacts are considered significant by the project participants or the host Party:

An Environmental Impact Assessment (EIA-RIMA, in Brazil) was conducted as a requirement to obtain the necessary environmental licenses. All the licenses necessary to the operation of landfill were obtained (see Annex 7).

G. STAKEHOLDERS COMMENTS

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

According with the Resolution n°. 1 dated on December 2nd, 2003, from the Inter-Ministerial Commission of Climate Change (Comissão Interministerial de Mudança Global do Clima - CIMGC), decreed on July 7th, 1999[4], any CDM project must send a letter with description of the project and an invitation for comments by local stakeholders. In this case, the local stakeholders are represented by:

- City Hall of Cariacica;
- Chamber of Alderman of Cariacica;
- Environmental agencies from the State and Local Authority;
- Brazilian Forum of NGOs;
- District Attorney (known in Portuguese as Ministério Público, i.e. the permanent institution essential for legal functions responsible for defend the legal order, democracy and social/individual interests) and;
- Local communities associations.

Local stakeholders were invited to raise their concerns and provide comments on the project activity for 30 days after they received the letter of invitation. EcoSecurities Brasil Ltda. and MARCA were prepared to answer any doubts about the project during this period. Letters were delivered by MARCA or dispatched by registered letters (post-mail) to the institution mentioned above. The project was disposable, at MARCA internet web site (www.marcaambiental.com.br) , in Portuguese and English versions.

[4] Source: http://www.mct.gov.br/clima/comunic/pdf/Resolução01p.pdf

The letters were sent from 10th to 12th march, 2004. The period to provide comments was from 12th march until 12th April, 2004. The entities contacted were:

- *Grande Nova Rosa da Penha Popular Organization*, a local community association,
- City Halls of Serra, Domingos Martins, Marechal Floriano, Viana, Linhares, Vitória and Cariacica municipalities;
- *Fórum* Lixo e Cidadania, a local NGO related to waste activities;
- Large industries from Espírito Santo State as Queiroz Galvão S.A., Corpus Ltda., Noberto Odebrecht S.A., Companhia Siderúrgica de Tubarão, Samarco S.A., Vale do Rio Doce S.A. and B.M.P. Siderurgia S.A;
- *SEAMA/IEMA* and *IBAMA*, state and federal environmental agencies, respectively.
- Cariacica´s Environmental secretariat, Serra Environmental secretariat , Vitória Environmental secretariat, Vila Velha Environmental secretariat;
- SEDETUR (Secretaria Estadual de Desenvolvimento Econômico e Turismo);
- Chamber of Alderman of Cariacica, Vitória (cities) and Espirito Santo state;
- State District Attorney and
- Brazilian Forum of NGOs.

G.2. Summary of the comments received:

No comments were received during the 30 days.

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

Not applicable. No comments were received during the 30 days.

ANNEX 1: CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

MARCA:

Organization:	MARCA Construtora e Serviços
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ANNEX 2: INFORMATION REGARDING PUBLIC FUNDING

There is no Official Development Assistance in this project.

ANNEX 3: NEW BASELINE METHODOLOGY

1. Title of the proposed methodology:

AM 0003 - “Simplified financial analysis for an Landfill Gas Capture Projects”

2. Description of the methodology:

2.1. General approach (Please check the appropriate option(s))

? Existing actual or historical emissions, as applicable;

X? Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

? The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

The proposed methodology is an interpretation of Art 48(b).

2.2. Overall description (other characteristics of the approach):

Approach 48(b) cannot be readily applied as a baseline methodology but must be interpreted and operationalized in a project-based context. The suggested baseline methodology is based on the premise that investment analysis can be seen as an appropriate and practical operationalization of the baseline approach defined in 48(b) and can adequately identify “an economically attractive course of action” as indicated by the particular baseline approach defined in 48(b). The suggested methodology uses the internal rate of return (IRR) calculations to assess the financial attractiveness of the investment project and to determine whether the investment for which the IRR has been calculated is likely to be made given the forecasted rate of return from the investment.

The suggested methodology can accurately determine the most likely baseline scenario in the following way:

<u>Step 1:</u> Draw up a list of possible baseline scenario alternatives.

<u>Step 2:</u> If justified, through elimination reduce the list of possible baseline scenario alternatives to the business as usual (BAU) scenario and the proposed project alternative.[5] Always provide convincing justification for the elimination of an alternative. For instance, a possible alternative is not plausible if it is not permissible under applicable law.

<u>Step 3:</u> Calculate a conservative IRR for the proposed project activity not taking carbon finance into account. The calculation must include the incremental investment cost, the operations and maintenance costs, and all other costs of upgrading the BAU scenario to the proposed project activity. It must also include all revenues generated by the project activity except carbon revenues. An IRR is calculated conservatively if the assumptions made tend to raise the IRR of the project scenario instead of lowering it. To ensure this, values that tend to lead to a higher IRR should be used for all assumptions. Conservatism of these assumptions should be ensured by obtaining expert opinions and by the Operational Entity validating the project.

<u>Step 4:</u> Determine whether the project IRR is clearly and significantly lower than a conservatively (i.e. rather low) expected and acceptable IRR for an alternative to this project or a comparable project type in the relevant country. This can be determined by comparing the project IRR to relevant comparators. These can include:

- **a.** government bond rates
- **b.** expert views on expected IRRs for this or comparable project type
- **c.** other hurdle rates that can be applied for the country or sector

In the case of MARCA project government bond rate was used as the comparator.

[5] BAU is understood to mean the continuation of key present policies and practices. If BAU is conceived of as a set of concentric circles, this implies that no changes are expected to take place at the "core"—the "core" is constituted by the key present practices and policies. Changes at the "periphery", however, may likely happen over time, as for instance minor regulations and policy adjustments. But such minor changes will not have any impact on the "core" which therefore will remain intact and unchanged.

Step 5: If the project IRR is clearly and significantly lower than a conservatively acceptable IRR, conclude that the project is not an economically attractive course of action and that therefore the BAU alternative is the most economically attractive course of action and the most likely baseline scenario.

Step 6: Analyze and describe the anticipated development of the most likely baseline scenario during the crediting period.

Step 7: Provide a summary description of the baseline scenario.

If applied successfully and the conditions for its use are satisfied (see below), the methodology determines BAU as the most likely baseline scenario for the following two reasons. First, a clearly and significantly low and conservatively estimated IRR indicates that the proposed project activity is not an economically attractive course of action from an investor standpoint. The proposed project alternative would therefore not be expected to be implemented. Second, it is relevant to consider just two plausible alternatives and, thus, by eliminating the project alternative, the BAU scenario necessarily becomes the most likely baseline scenario. This is so because the BAU is the only plausible baseline approach apart from the project alternative itself.

Usually, after a baseline scenario is determined, it is then necessary to determine the emissions associated with this scenario. This type of project, however, enables the direct measurement of emission reductions (without the need for separate measurements of emissions in baseline and project scenarios – see Annex 4 – 1 and Section 6, below).

Applicability of Methodology

Importantly, the proposed methodology can only determine the most likely baseline scenario when the following two conditions are satisfied:

Condition 1: The set of plausible baseline scenario alternatives is comprised of two alternatives only: (1) the proposed project alternative and (2) the BAU scenario (*or* the BAU with minor changes and modifications).

Condition 2a: The internal rate of return (IRR) (without carbon revenues) of the proposed investment project is clearly and significantly lower than the normally expected and acceptable IRR for comparable investments with a similar risk profile in the relevant sector and country. This is determined by comparing the project IRR to relevant comparators. These can include:

- **a.** government bond rates
- **b.** expert views on expected IRRs for this or comparable project type
- **c.** other hurdle rates that can be applied for the country or sector

The project IRR must be calculated conservatively, that is using assumptions that tend to raise the IRR instead of lowering it.

Hence, as pointed out below in Section 5, the method cannot be used if the calculated IRR does not, without any doubt, indicate that the project is not an economically attractive course of action. This implies that the method cannot be applied to borderline cases.

3. Key parameters/assumptions (including emission factors and activity levels), and data sources considered and used:

- Information on acceptable IRRs or discount rates for comparable investment with a similar risk profile in the relevant sector and country. Data source: various business statistics, expert judgment.
- Conservative calculation of IRR as explained above. To be checked by designated OE.
- Expert judgment without reasonable doubt. To be confirmed by designated OE.
- Although once the project is operational the emission reductions for the project can be calculated directly (i.e., without the need for calculating the project and baseline emissions separately), in a preliminary phase the emissions in the project and baseline scenarios were estimated using a first order decay model equation for landfill gas generation[6], as follows:

$$\mathbf{LFG=2L_0R(e^{-kc}-e^{-kt})}$$

Where:

LFG = total landfill gas generated in current year (cf) (conversion factor from cubic feet to cubic meters is 1cf = 0.02832 m3)

L_0 = theoretical potential amount of landfill gas generated (cf/lb) (conversion factor 1b = 0.4536 kg)

R = waste disposal rate (lb/year)

t = time since landfill opened (years)

c = time since landfill closed (years)

k = rate of landfill gas generation (1/year)

This first order decay model also enables the estimation of landfill gas amounts that would be flared by the inefficient gas collection systems proposed in the baseline scenario. This is done by estimating the total amount of GHGs that a site can generate, and the amount of

[6] On this model, see US EPA manual "Turning a Liability into an Asset: A Landfill Gas to Energy Handbook for Landfill Owners and Operators" (December 1994).

GHGs that the gas collection systems in place are capable of extracting and flaring in relation to how much a state-of-the-art system would collect.

4. Definition of the project boundary related to the baseline methodology:

The project boundary, for the purpose of establishing the baseline scenario, defines where possible alternative scenarios to the proposed project are likely to be found. For investment projects applying the proposed methodology the physical site(s) of the business-as-usual activities and of the proposed project activity typically define the boundary.

The project boundary, for the purpose of monitoring and calculating emission reductions, defines where sources of GHG emissions are to be found that are under the control of project participants, significant, and reasonably attributable to the project activity, and conversely which GHG sources are outside of the boundary and may have to be treated as leakage. GHG emissions that occur from the same source and in the same amounts in baseline and project scenarios are usually not significant for the purpose of calculating emission reductions and may not be attributable to the proposed project activity. Such sources can be treated as insignificant and not attributable (in the sense of the above definition) and can therefore be excluded from the monitoring boundaries.

For landfill gas to energy projects, the geographic monitoring boundaries are typically drawn around the site of the landfill and of the power production facilities in baseline and project scenarios, since the sources inside the boundaries can be controlled by project participants, may be significant and attributable to the project activity. This includes the landfill gas emissions in the baseline and project scenarios. The system boundaries may exclude some on-site emissions, because they may be insignificant such as from the use of operating equipment. For projects that claim emission reductions from displacement of electricity, the system boundaries for the purpose of monitoring may have to include the electricity system in which power is displaced by the project’s generation.

Consequently, the analysis leading to the definition of the monitoring boundaries should comprise all elements of the waste management and landfill gas collection systems and the equipment for electricity generation in the baseline and project scenarios.

The following GHG sources are typically inside the monitoring boundaries:

- ?? Direct on-site emissions: landfill gas released to the atmosphere in baseline and project scenarios.

The following GHG sources are typically excluded from the monitoring boundaries, because they are not under the control of project participant, insignificant, or not attributable to the project activity.

- ?? Indirect on-site emissions: e.g., landfill operation equipment (no change due to project), electricity used to operate the project (parasitic load: insignificant, most likely generated from LFG), emissions from construction of the project (not significant)
- ?? Direct off-site emissions: e.g., transport of equipment and construction materials (not significant, not under control of participants), emissions associated with the electricity generated (insignificant, where LFG contains only climate neutral biological carbon),
- ?? Indirect off-site emissions: e.g., transport of waste to the landfill (no change due to project).

5. Assessment of uncertainties:

The proposed methodology can lead to an erroneous baseline scenario in the following situations:

1. The set of plausible alternatives is incomplete. A careful analysis of possible and plausible alternatives and confirmation by a designated OE of the validity of the analysis and the conclusions drawn from it is imperative in order to mitigate risks and to ensure credibility of the result.
2. The financial analysis is not conservative. The designated OE must carefully control and check all assumptions used in order to ensure a conservative result.
3. The investment is a borderline case that is not clearly non-attractive. The methodology cannot be applied to cases where there is doubt whether the project is financially attractive from an investor standpoint (compare with condition 2).

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:

1. The baseline methodology described in Section 2 of Annex 3 above determines the baseline scenario as an economically attractive course of action. The methodology identifies that only two alternative scenarios (the business as usual scenario and the proposed project activity) are plausible courses of action and then shows that one of them (the proposed project) is not an economically attractive course of action. This demonstrates (a) that the business as usual scenario is the only economically attractive course of action and (b) that the proposed project is not part of the baseline scenario and thus additional.

2. In LFG-to-energy projects (such as the above), project-related reductions in methane emissions can often be directly monitored and calculated (see Annex 4, section 1). Hence, monitoring emissions in the baseline scenario and the project are not necessary. What is needed, however, is to estimate the amount of flaring that would have taken place in the absence of the project, so to deduct this amount from the emission reductions that will be directly measured by the monitoring program once the project becomes operational.

3. In order to estimate the amount of flaring that would occur in the absence of the project, it is necessary to estimate the future GHG emissions of the landfill (the proposed methodology uses the US EPA First Order Decay Model[7] -see Section 3 above) and subtracting the amount of landfill gas that would be flared or otherwise destroyed in the absence of the project activity taking into account the effectiveness of the gas collection systems that would be imposed by regulatory or contractual requirements or similar circumstances at the time of inception of the project (the 'Effectiveness Adjustment Factor'). Given the complexity and variability of conditions in landfills, the need for interpretation of regulation and other requirements and the variability in landfill gas systems, any estimates of the expected landfill gas generation and of the type and effectiveness of a gas collection systems in the baseline scenario should be done as an application of the methodology on a case-by-case basis by a specialist in this field.

4. The 'Effectiveness Adjustment Factor' will need to be revised at the end of the baseline crediting period, by estimating the amount of GHG flaring taking place as part of common industry practices at that point in the future.

[7] On this model, see US EPA manual "Turning a Liability into an Asset: A Landfill Gas to Energy Handbook for Landfill Owners and Operators" (December 1994).

5. Once the project becomes operational, the emission reductions associated with project can be calculated directly by measuring the amount of GHGs flared and deducting the amount that would have been flared in the baseline scenario (the 'effectiveness adjustment factor'). The method used for the calculation of emission reductions after the project becomes operational is described in Annex 4, Section 1.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

Leakage is identified by defining the monitoring boundaries, by identifying indirect emissions in the baseline and project scenarios, and by including a methodology for monitoring and estimating such emissions in the monitoring plan (refer to New Monitoring Plan, Section 3).

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

The proposed baseline methodology is a simplification of a standard investment analysis. Investment analysis produces a ranking of plausible investment options in order to identify the most economically attractive course of action (referring to Art. 48b). In contrast, the proposed simplified method relies on external information to determine that a proposed investment is not economically attractive.

The following criteria were used in developing this methodology:

(a) Availability of information: The methodology permits the determination of a baseline scenario where financial information and analysis is available only for the proposed project.

(b) Reduction of transaction costs: No additional information must be produced.

(c) Realistic simulation of investment decisions: Investment decision for projects that are optional (such as LFG utilization) are often made on the basis of a comparison with acceptable rates of return. The proposed methodology captures this investment rationale.

The proposed baseline methodology is transparent and conservative:

- ?? It uses the conventional understanding of why a proposed course of action is not economically attractive.
- ?? It can be applied in a transparent manner as it relies on conventional financial analysis that can be checked by an auditor to ensure completeness, correctness, plausibility and conservative assumptions (as defined above).
- ?? It can be applied in a conservative manner provided the conditions for its use above are followed.

9. Assessment of strengths and weaknesses of the baseline methodology:

Strengths: Simplification, cost reduction and realistic simulation of investment decision.
Weaknesses: Only limited applicability as the project alternative and BAU are the only two plausible alternatives; the methodology is not applicable to borderline cases.

10. Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account:

The methodology takes national and sectoral regulations into account in that the baseline scenario must be in compliance with existing regulation and must be updated to comply with new regulations and evolving economic/sectoral conditions.

ANNEX 4: NEW MONITORING METHODOLOGY

AM 0003 - "Simplified financial analysis for an Landfill Gas Capture Projects"

1. Brief description of new methodology

The proposed methodology utilizes direct monitoring of the emission reductions from the project activity. The emission reductions due to the project activity are monitored and calculated as a differential. Accordingly, the methodology does not monitor the emissions emitted in the project and baseline scenarios in order to calculate the emission reductions as the difference between the two amounts of GHG emissions released.

Calculation of the emission reductions for the project should be done in the following way:

STEP 1 – Methane combustion in electricity generators

As and when electricity is generated, take the metered gross annual (aggregated from monthly readings) electricity produced by the project (MWh)

⇩

Multiplied by generator heat rate (GJ/MWh)

⇩

Total energy input (GJ)

⇩

Convert GJ to equivalent tonnes of methane (using appropriate factors for GJ/m^3 *CH_4 and tCH_4/m^3CH_4) (tonnes of CH_4)*

⇩

Multiply by Global Warming Potential of methane (tCO_2e)

⇩

Annual CO_2 emissions displaced by the project through methane combustion to generate electricity (tonnes CO_2 equivalent)

If the project decides to claim the CO_2 emission reductions from fossil fuel displacement derived from electricity generation, this component will need to be calculated using the appropriate methodology for electricity generation (grid- or non grid- connected systems). Given that this specific project is not currently claiming credits for the emission reductions associated with fossil fuel displacement, this methodology is not described in this document.

The CO_2 emission reductions from methane combustion in flares will be calculated on an annual basis as shown diagrammatically below:

STEP 2 – Methane combustion in flares

Volume of landfill gas channeled to flares (m^3)

⇩

Multiplied by methane fraction of landfill gas (readings from a gas analyzer or deducted from the electricity generation readings)

⇩

Volume of methane combusted in flare
(m^3)

⇩

Multiplied by flare efficiency (%)

⇩

Net volume of methane combusted in flare
(m^3)

⇩

Multiplied by volume:mass conversion factor (0.00067899 tCH_4 = $1m^3$ CH_4)
(tonnes of methane)

⇩

Multiplied by Global Warming Potential of methane
(tonnes of CO_2 equivalent)

⇩

Annual emission reductions due to methane combustion in flares
(tonnes of CO_2 equivalent)

(Results of Step 1 + Step 2) – Effectiveness Adjustment Factor X% related to the amount of flaring achievable by using the gas collection system requested by regulatory agencies at the inception of the project and adjusted in the future.

⇩

Total ERs generated by the project (tCO_2)

The total emission reductions (in tonnes of CO_2 equivalent) are the summation of results from Step 1 (Methane combustion in generators) and Step 2 (Methane combustion in flares)[8]. The sum is then discounted by an Effectiveness Adjustment Factor - an appropriate factor to reflect the level of flaring that would occur if the project adopted the gas collection system requested by regulatory agencies at the inception of the project. Given the complexity and variability of conditions among such systems, such estimates of the effectiveness of gas collection systems would have to be done in a case-by-case basis by specialists in the field, and the results verified by the Operational Entity validating the project design (or the revision of the baseline).

This 'Effectiveness Adjustment Factor' will then need to be revised at the end of the baseline crediting period, by estimating the amount of GHG flaring taking place as part of common industry practices at that point in the future. This can be done using a control group of landfill operations that did not receive carbon finance for their development. At every baseline revision point in the future, an expert will need to provide an estimation of the percentage of gas being flared at each of the control group landfills, in relation to the potential gas collected by a state of the art installation. The averaged of these sites will become the new 'Effectiveness Adjustment Factor' to be applied to the revised project baseline.

The destruction of methane in flares and engines will lead to a conversion of methane emissions to CO_2 emissions. The source of the methane and therefore the CO_2 emissions is the organic fraction in deposited waste, which forms part of the natural organic CO_2 cycle. Therefore, these CO_2 emissions should not be counted as net contributors to climate change.

The methodology is currently mainly applicable in waste management projects involving methane destruction. In principle, all project types that involve a treatment of measurable GHG quantities that would otherwise be released are conducive to the application of modified forms of the proposed direct monitoring methodology. Such project types are: geological sequestration of CO_2 (e.g. in oil wells) and other applications that directly bind CO_2 or destroy or modify GHGs in a chemical or physical process that removes or diminishes their global warming potential.

[8] If emission reductions from fossil fuel displacement were to be claimed, this amount of ERs would need to be added here.

2. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

The proposed methodology utilizes direct monitoring of the emission reductions from the project activity. The emission reductions due to the project activity are monitored and calculated as a differential. Accordingly, the methodology does not monitor the emissions emitted in the project and baseline scenarios in order to calculate the emission reductions as the difference between the two amounts of GHG emissions released.

Data to be collected depends crucially on project type. Typically, the quantity of destroyed, modified, or sequestered GHG either is directly measured (flow meters) or a proxy indicator is measured (e.g. power output) that allows easy back-calculation of the GHG quantity involved in the process.

In addition, every 7 years a survey of 10 other landfills in the country (the 'Control Group') will be conducted to determine the percentage of flaring (with relation to the total achievable) that these companies do in their sites in the absence of carbon finance incentives. This percentage (called here the Effectiveness Adjustment Factor), will be used to reduce the amount of emission reductions claimed by the project. In addition, after the first and second crediting periods, it is also needed to be determined whether electricity generation has become the most attractive course of action.

Table 6: In LFG-to-energy projects one will typically monitor the following variables:

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data variable	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)	For how long is archived data to be kept?	Comment
1	Flow of landfill gas to flares	m^3	M	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
2	Gross electricity produced	MWh	M	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
3	Generator heat rate	GJ/ MWh	M & C	Semi-annual verification of validity of generator plate rating (if significant variation since last monitoring, monitoring repeated every month)	Semi-annually or more frequently depending on observed deviations from previous rating	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be used to test and, if necessary correct the generators' standard heat rate plate ratings*
4	Flare efficiency	%	M & C	Semi-annual determination of flare efficiency (if significant variation since last monitoring,	Semi-annually or more frequently depending on observed deviations from	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be used to test and, if necessary correct the flares' efficiency ratings.*

				monitoring repeated every month)	previous rating			
5	Methane fraction in LFG	%	M & C	Continuous	100%	Electronic (spreadsheet)	2 years and duration of the project crediting period in files	*Data will be aggregated monthly and yearly*
6	LFG collected by Control group	%	E	Every 7 years	A minimum of 10 control sites	Electronic (spreadsheet)	2 years and duration of the project in files	-

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources

The project boundary, for the purpose of defining the monitoring domain of a project, shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the project activity.

When applying the proposed methodology to LFG-to-energy projects the physical site of the project typically constitutes the project boundary. Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are however insignificant and would likely also occur if alternative power generation capacity were to be constructed at alternative sites. No increase in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of ERs, indirect emissions will not distort their calculation.

LFG-to-energy projects that do not claim carbon credits for the displacement of electricity generated by thermal power plants powered by fossil fuel have positive leakage effects. Net leakage is defined at the sum of positive and negative leakage effects on anthropogenic GHG emissions.

4. Assumptions used in elaborating the new methodology:

The proposed methodology makes use of the technical and physical processes involved in the project to reduce the complexity of monitoring and calculation of ERs.

There are no specific assumptions used in elaborating the monitoring methodology.

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. (see tables in sections 2 and 3 above)

Procedures for quality control and quality assurance are greatly dependent on the specifics of individual project categories and the project configuration in the individual case. Such procedures can only be elaborated for a concrete application. To illustrate, the table below summarizes the quality control and quality assurance procedures developed in the context of a LFG-to-energy project, the MARCA project, and incorporated in the monitoring plan.

Table 7: Quality control (QC) and quality assurance (QA) procedures being undertaken for the items monitored:

Data (Indicate table and ID number e.g. D.4-1; D.4-2.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
D3 – 1	Low	Yes	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy
D3 – 2	Low	Yes	Meters will be subject to a regular maintenance and testing regime to ensure accuracy. Their readings will be double-checked by the electricity distribution company
D3 – 3	Low	Yes	Regular maintenance will ensure optimal operation of engines and generators. The heat rate used for calculation of ERs will be checked annually or more often if significant deviations from standard or previously used heat rate is observed.
D3 – 4	Low	Yes	Regular maintenance will ensure optimal operation of flares. Flare efficiency will be calibrated annually or more often, if significant deviation from previous efficiency rating is observed.
D3 – 5	Low	Yes	Gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy.

6. What are the potential strengths and weaknesses of this methodology?

The potential strengths of the methodology may be summarized as simplification, cost reduction, and accuracy. There seem to be no significant weaknesses.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

The methodology has been proposed and validated before for the PCF Latvia: Liepaja Municipal Waste Management Project. However, experience with the use of the monitoring and calculation of actual ERs using this methodology does not exist because the Liepaja project is not yet operational.

ANNEX 5: BASELINE / FINANCIAL DATA

As already explained, the suggested baseline methodology is based on the premise that investment analysis can be seen as an appropriate and practical operationalization of the baseline approach defined in 48(b) and can adequately identify "an economically attractive course of action" as indicated by this particular baseline approach. The suggested methodology uses the internal rate of return (IRR) calculations to assess the financial attractiveness of the investment project and to determine whether the investment for which the IRR has been calculated is likely to be made given the forecasted rate of return from the investment.

The following tables show the key data and assumptions used in the case of MARCA:

Financial Parameters	
Tariff (Rs$/MWh)	120.0
Tariff (Us$/MWh)	40.00
Taxes on Electricity Sales	20.25%
Net price of carbon (U$/tCO2)	3.50
Taxes on Carbon Sales	13.25%
Rs$/US$	3.00
Power Plant O&M (US$/MWh)	13.00
Gas Plant & Flaring O&M (U$/TCO2)	0.56
Flaring Units	150,000
Civil works and drilling	150,000
1 MW Engine (US$)	544,000
Instrumentation and telemetry systems	31,789
Import Duties	34%
Assembl ing and testing	20,000
Connection to Main	80,000
Compoud	100,000
Administrative Expenses (U$/y)	60,000
Pre-operational costs (US$)	50,000
Validation Costs	20,000
Verification Costs	8,000
Discount rate	12%
Income Tax	34%

Financial Results	with carbon	without carbon
Present Value @ 12% (AT)	**1,562,992**	**(762,108)**
IRR	**17.84%**	**8.94%**

INPUTS	
LANDFILL	
Year started landfill operation	**1995**
Year finished operation	**2017**
Year started Project	**2004**
Waste in place at beginning of project	**1,336,327**
R = Average daily waste rate	**1,000**
Lo (cf/lb) =	**2.63**
k (1/year)=	**0.1**
Methane GWP	**21**
Methane content of landfill	**0.5**
BASELINE DATA	
Residual emission factor CH4 to	**0**
Proportion of methane flared in baseline	**10%**
PROJECT	
Date gas collection project starts	**2004**
Proportion of methane collected	**75%**
Reduction due to	**25%**
Electricity generaion factors:	
Engine Heat	**10,625**
Reciprocating Engine Generator Rating:	**840**
Parasitic Power Loss (%)	**5%**
Estimated On-line availability of Equipment	**91%**
Flaring capacity	**2,000**

RESULTS

LANDFILL GAS AND	10 yrs	21 yrs
Total Landfill Gas Produced (m3)	**511,497,836**	**1,365,451,746**
Total Methane Produced (t)	**201,780**	**479,586**

LANDFILL ERUs (t CO2e)	**Emissions Baseline**	**Emissions Project**	**ERUs**
7 yrs	2,110,595	586,276	1,193,499
10 yrs	3,628,061	1,007,795	2,015,459
14 yrs	5.959.738	1.655.483	3.278.451
21 yrs	9,064,177	2,517,827	4,859,503

TOTAL ERUs (landfill + electricity)	**Emissions Baseline**	**Emissions Project**	**ERUs**
7 yrs	2.110.595	586.276	1.193.499
10 yrs	3,628,061	1,007,795	2,015,459
14 yrs	5,959,738	1,655,483	3,278,451
21 yrs	9,064,177	2,517,827	4,859,503

ELECTRICITY	10 yrs	21 yrs
Total Net Power Output: MWh	**381,680**	**1,215,015**

ANNEX 6. ENVIRONMENTAL LICENSES

As indicated in chapter F.2, all the licenses necessary to implement the project were shown here.

Operation license for landfill activities

GOVERNO DO ESTADO DO ESPÍRITO SANTO
INSTITUTO ESTADUAL DE MEIO AMBIENTE E RECURSOS HÍDRICOS

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LICENÇA DE OPERAÇÃO

LO GCA /Nº 010/2002 /CLASSE IV

O INSTITUTO ESTADUAL DE MEIO AMBIENTE E RECURSOS HÍDRICOS, no uso das atribuições que lhes são conferidas no Inciso IV do Artigo 5º da Lei Complementar nº 248, de 02 de julho de 2002, regulamentada pelo Decreto Estadual nº 1.050-R, de 03 de julho de 2002, e fundamentada no Decreto Estadual nº 4.344-N, de 07 de outubro de 1998, expede a presente **LICENÇA DE OPERAÇÃO**, requerida através do Processo nº 22055118 (56/2002) que autoriza a:

EMPRESA / NOME: MARCA CONSTRUTORA E SERVIÇOS LTDA
CNPJ / CPF: 35.971.738/0001-80
ENDEREÇO DA ATIVIDADE: BR 101 – KM 282 – SITIO VARGEM ALTA
MUNICÍPIO: CARIACICA/ES

a exercer a atividade: OPERAÇÃO DA CÉLULA III DO ATERRO SANITÁRIO XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Esta **LO** é válida pelo período de 1460 dias, a contar da presente data, observadas as CONDICIONANTES no verso discriminadas, bem como seus anexos, que, embora não transcritos, são partes integrantes da mesma.

Espírito Santo, 08 de outubro de 2002.

Instituto Estadual de Meio Ambiente e Recursos Hídricos
Domingos Sávio Pinto Martins
Diretor Presidente - IEMA

Condições de validade desta LICENÇA DE OPERAÇÃO:

1. Garantir a estabilidade da célula III do aterro, conforme diretrizes a seguir:
   - a medida que os resíduos forem dispostos a barragem deverá ser construída;
   - a face externa da barragem deverá ser revestida com vegetação;
   - na crista da barragem e na face externa deverá ser implantado sistema de drenagem de águas pluviais;
   - durante a movimentação de terra na construção da barragem, nada poderá ser armazenado entre o córrego e a referida obra (barragem);
   - a camada de terra da barragem deverá ser construída de 20 em 20 cm.
2. Monitorar o sistema de drenagem de líquidos percolados continuamente de forma a evitar rupturas devido a pressões hidrostáticas e hidrogeológicas;
3. Manter sempre em perfeitas condições os sistemas de drenagem de gases, e à medida que os resíduos forem sendo dispostos, os drenos de gases deverão ser elevados e a sua interligação deverá ser executada como na primeira camada de resíduos;
4. Deverá ser dada continuidade ao monitoramento de águas subterrâneas, com apresentação de relatório das análises com frequência trimestral, seguindo rigorosamente os procedimentos estabelecidos na Norma Técnica ABNT – NBR 13.896/97;
5. Apresentar Plano de Encerramento da Célula II. **Prazo 60 dias;**
6. Manter o acesso viário até a Célula III em bom estado de conservação;
7. Deverá ser feita a impermeabilização de toda a Célula III com a manta de PEAD de 1,5 mm, conforme projeto aprovado;
8. Deverá ser evitada a mistura de águas pluviais com chorume, além da infiltração de águas pluviais;
9. Deverão ser construídas canaletas circundando a Célula III. As canaletas deverão ter as seguintes dimensões: base: 40,00 cm e altura: 30,00 cm e inclinação de 1%, de acordo com o projeto aprovado;
10. A operação do aterro deverá conduzir a disposição de resíduos na forma de pilhas, com correta estrutura de confinamento de células de resíduos compactados;
11. Os resíduos sólidos dispostos na célula deverão receber cobrimento diário de argila em camadas de 20 a 25 cm;
12. A célula III estará destinada ao recebimento de resíduos Classe II e III, dessa forma, não poderão ser destinados resíduos de serviços de saúde na mesma;
13. O chorume gerado na Célula III deverá ser destinados às lagoas de armazenamento implantadas;
14. Proceder ao encerramento da Célula II atualmente em operação conforme critérios estabelecidos no item 5.8.2 da NBR 13.896/97;
15. Inspecionar periodicamente a barragem de terra/bermas de contenção. Caso haja alterações que possam comprometer a estrutura da mesma, este Instituto deverá ser comunicado imediatamente;
16. Todas as condicionantes referentes a projetos e relatórios deverão ser apresentadas em pasta própria;
17. Apresentar folha original de publicação, tornando público a obtenção da Licença de Operação, em jornal de grande circulação, no local de abrangência da atividade licenciada e ainda no Órgão Oficial do estado, podendo este ser substituído por jornal contratado para publicações oficiais. **Prazo 30 dias;**
18. Requerer renovação desta 120 (cento e vinte) dias antes do seu vencimento;
19. Apresentação obrigatória da Licença expedida pelo Órgão Ambiental sempre que a atividade for vistoriada;
20. A contagem dos prazos estabelecidos nas condicionantes acima, iniciar-se-á a partir do recebimento da Licença;
21. O não cumprimento das condicionantes acima, penalizará a empresa com a imposição das penalidades de multa e/ou interdição/embargo das atividades/obra, conforme previsto nos incisos II, III e IV do Artigo 8º da Lei Estadual Nº 7058/2002, e ainda determinada a suspensão ou cassação da Licença, conforme previsto no artigo 17 da mesma Lei.

Previous License for landfill gas collection and treatment

GOVERNO DO ESTADO DO ESPÍRITO SANTO
INSTITUTO ESTADUAL DE MEIO AMBIENTE E RECURSOS HÍDRICOS

iema

LICENÇA PRÉVIA

LP GCA /Nº 002/2003 /CLASSE II

O INSTITUTO ESTADUAL DE MEIO AMBIENTE E RECURSOS HÍDRICOS, no uso das atribuições que lhes são conferidas no Inciso IV do Artigo 5º da Lei Complementar nº 248, de 02 de julho de 2002, regulamentada pelo Decreto Estadual nº 1.050-R, de 03 de julho de 2002, e fundamentada no Decreto Estadual nº 4.344-N, de 07 de outubro de 1998, expede a presente **LICENÇA PRÉVIA**, requerida através do Processo nº 22802849 que autoriza a:

EMPRESA / NOME: MARCA CONSTRUTORA E SERVIÇOS LTDA

CNPJ / CPF: 35.971.738/0001-80

ENDEREÇO DA ATIVIDADE: RODOVIA BR 101, KM 282 – SÍTIO VAREGM ALTA – NOVA ROSA DA PENHA

MUNICÍPIO: CARIACICA/ES

a localizar a atividade: SISTEMA DE CAPTAÇÃO E TRATAMENTO DE GÁS XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Esta LP é válida pelo período de 1460 dias, a contar da presente data, observadas as CONDICIONANTES no verso discriminadas, bem como seus anexos, que, embora não transcritos, são partes integrantes da mesma.

Espírito Santo, 16 de Janeiro de 2002.

Jadir Viana Santos
Diretor Técnico - IEMA
Instituto Estadual de Meio Ambiente e Recursos Hídricos

Condições de validade desta LICENÇA PRÉVIA:

1. Apresentar mapa (escala 1:2000 ou maior) com a localização prevista para a instalação do empreendimento através de coordenadas UTM, indicando a situação do terreno (raio de 200 metros) a recursos hídricos, destacando prováveis corpos(s) receptore(es); áreas naturais protegidas (Unidade de Conservação Ecológica e Bens Naturais e Culturais Tombados, entre outros); acessos disponíveis; edificações existentes (inclusive caracterização); direção dos ventos predominantes, etc. **Prazo: Quando do requerimento da Licença de Instalação;**
2. Apresentar "Croqui" (desenho) da área total do terreno e da construção, localizando e especificando as edificações a serem construídas, bem como localização prevista do Canteiro de Obras. **Prazo: Quando do requerimento da Licença de Instalação;**
3. Apresentar mão-de-obra prevista, inclusive o Canteiro de Obras;
   - Indicar o número de funcionários (administração e produção);
   - Indicar os turnos, horários e regimes de trabalho. **Prazo: Quando do requerimento da Licença de Instalação**
4. Apresentar a descrição do sistema de captação e tratamento de gás, citando todas as matérias primas, inclusive as auxiliares, produtos e subprodutos, combustíveis utilizados no processo, bem como a estimativa de consumo e a capacidade de produção. **Prazo: Quando do requerimento da Licença de Instalação**
5. Apresentar o fluxograma simplificado do sistema de captação e tratamento de gás, indicando o(s) ponto(s) de geração de impactos ambientais (efluentes líquidos, resíduos sólidos e/ou emissões atmosféricos/ruídos). **Prazo: Quando do requerimento da Licença de Instalação;**
6. Apresentar a concepção do tratamento/disposição final prevista para os efluentes líquidos (industriais e domésticos), resíduos sólidos (industriais, domésticos e de serviço de saúde), emissões atmosféricas (material particulado e gases) e tratamento de gás.). **Prazo: Quando do requerimento da Licença de Instalação;**
7. Apresentar informações quanto à forma provável (intermediária e/ou final) de armazenagem ou estocagem das matérias primas, produtos e subprodutos.). **Prazo: Quando do requerimento da Licença de Instalação;**
8. Apresentar os resultados do estudo de viabilidade qualitativa e quantitativa do gás produzido nas células do aterro.). **Prazo: Quando do requerimento da Licença de Instalação;**
9. Apresentar relatório fotográfico dos serviços executados na área do sistema de captação e tratamento de gás (aéreo ou outro).). **Prazo: Quando do requerimento da Licença de Instalação;**
10. Apresentar folha original de publicação, tornando público a obtenção da Licença Prévia, em jornal de grande circulação, no local de abrangência da atividade licenciada e ainda no Órgão Oficial do Estado, podendo este ser substituído por jornal contratado para publicações oficiais. **Prazo 30 (trinta) dias;**
11. Apresentação obrigatória da Licença expedida pelo Órgão Ambiental sempre que a atividade for vistoriada;
12. A contagem dos prazos estabelecidos nas condicionantes acima, inicia-se a partir do recebimento da Licença;
13. O não cumprimento das condicionantes acima, penalizará a empresa com a imposição das penalidades de multa e/ou interdição/embargo das atividades/obra, conforme previsto nos incisos II, III e IV do Artigo 8º da Lei Estadual 7058/2002, e ainda determinará a suspensão ou cassação da Licença, conforme previsto no artigo 17 da mesma Lei.

ANNEX 7. LETTERS SEND TO STAKEHOLDERS CONSULTANT

Example of letters sent to the stakeholders

MARCA
ambiental

Cariacica, 10 de março de 04.

À
Organização Popular da Grande Nova Rosa da Penha

Att. Sr. José Santana

Assunto: Projeto MARCA - Aproveitamento Energético do Biogás de Aterro Sanitário com conseqüente minimização de gases efeito estufa.

Prezado Senhor,

Vimos, por meio deste, informar a V.Sa. que estamos desenvolvendo um projeto para a minimização dos impactos relacionados aos Gases de Efeito Estufa produzidos pela atividade de aterramento de resíduos sólidos urbanos na Central de Tratamento e Destinação Final de Resíduos da MARCA AMBIENTAL, situada em Cariacica/ES. Este projeto tem como escopo final à captação do biogás (gases gerados em aterros sanitários e ricos em metano), e sua utilização para a geração de energia elétrica. O projeto está em consonância com as diretrizes do Protocolo de Quioto e critérios de desenvolvimento sustentável do país.

Com esta iniciativa a MARCA AMBIENTAL visa mitigar, de forma voluntária, os impactos ambientais causados pelos gases de aterro, gerados através da decomposição bioquímica dos resíduos orgânicos presentes no lixo urbano. Além de mitigar os impactos ambientais dos gases de aterro, a MARCA AMBIENTAL pretende utilizar esse gás para geração de energia, desenvolvendo assim uma fonte de energia limpa e renovável a partir de um subproduto dos resíduos descartados pela sociedade.

O projeto encontra-se em fase de validação pela empresa Det Norske Veritas – DNV e, ainda no primeiro semestre de 2004, deverá ser apresentado à Comissão Interministerial de Mudanças Climáticas, atendendo os procedimentos estabelecidos na Resolução n°.1 da Comissão Interministerial de Mudança Global do Clima (CIMGC), de 11 de setembro de 2003, para a geração de créditos de carbono através da redução de emissões certificadas.

Assim, para o cumprimento de uma das diretrizes do Protocolo de Quioto e da Resolução n°.1 da CIMGC, a MARCA AMBIENTAL está entrando em contato com as partes interessadas para divulgação do projeto e chamando para consulta e comentários do relatório técnico do projeto para a redução dos gases de efeito estufa, num prazo de 30 dias, a partir da presente data. O documento encontra-se disponível em nosso site: www.marcaambiental.com.br . Caso haja necessidade, favor entrar em contato para o envio de cópia por meio eletrônico ou em papel.

00 455 611/0001-24
OPGNRP - Organização Popular da Grande Nova Rosa da Penha
Rua 15 Praça da Bíblia - Nova Rosa da Penha I - CEP 29157-080
Cariacica - ES

Atenciosamente;

MARCA AMBIENTAL

RECEBEMOS
EM
O.P.G.N.R.P.

Matriz: CNPJ 35.971.738/0001-80 - I.E. 081.417.65-9
BR 101 - KM 282 - Nova Rosa da Penha - Cep 29140-000 - Cariacica - ES
Filial: CNPJ 35.971.738/0005-04 - I.E.
Rua Alfredo Alcury, 06 - Campo Grande - Cep 29146-220 - Cariacica - ES
Tel.: (27) 3286-6070 - E-mail: marca@marcaambiental.com.br - www.marcaambiental.com.br

MARCA
ambiental

Cariacica, 09 de março de 04.

Ilm° Sr.
Dr. Ivan Luiz Paganini
MD. Prefeito Municipal de Domingos Martins
Domingos Martins/ES

Prefeitura Mun. Domingos Martins
Protocolado sob o N.o 229
Em 15.03.04
Gláucia R. Almeida
Encarregado

Assunto: Projeto MARCA - Aproveitamento Energético do Biogás de Aterro Sanitário com conseqüente minimização de gases efeito estufa.

Senhor Prefeito,

Vimos, por meio deste, informar a V.Sa. que estamos desenvolvendo um projeto para a minimização dos impactos relacionados aos Gases de Efeito Estufa produzidos pela atividade de aterramento de resíduos sólidos urbanos na Central de Tratamento e Destinação Final de Resíduos da MARCA AMBIENTAL, situada em Cariacica/ES. Este projeto tem como escopo final à captação do biogás (gases gerados em aterros sanitários e ricos em metano), e sua utilização para a geração de energia elétrica. O projeto está em consonância com as diretrizes do Protocolo de Quioto e critérios de desenvolvimento sustentável do país.

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Atenciosamente;

MARCA AMBIENTAL

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ANNEX 8. SOCIAL INDICATORS

1)Contribution to the local sustainable development

The Brazilian baseline scenario is the waste disposal in 'rubbish dumps' ("lixões"), located in areas totally unprepared for receiving waste and without any management. In this scenario there is air, soil, water and visual pollution, besides it is a disease and vector diseases proliferation focus. The waste stays in open areas, polluting the landscape, discharging stinking gases, and acting as a proliferation area of rats, flies, cockroaches, black vultures and other disease vectors. Moreover, the leachate, as the landfill gases are discharged directly in the environment, with no treatment or detoxification. The leachate contaminate the soil, the ground and the surface water, being it inappropriate for human consumption. The landfill gases, if not flared, represent risks of spontaneous explosions and liberation of greenhouse gases. Besides the environmental impacts, there is social impacts as result of this kind of displacement. The main social impacts are health problems, the sub employment of waste collection, and the sub human conditions of labor and life of people living near the "rubbish dumps".

The project scenario consists the efficient collection of landfill gases, attending all the environmental laws. To reach it, numerous steps and cares were done to built a modern and efficient landfill. The disposal cells were sealed and the leachate collected and treated. The waste is covered with soil daily, avoiding the proliferation of diseases and vectors. Finally, the landfill gas will be collected and flared, avoiding the spontaneous explosions and the greenhouse effect. In a second moment, MARCA pretend to generate energy using landfill gases as fuel, implementing a renewable energy source.

The social benefits can be perceived through the welfare improvements in the life of people living near the landfill, specially from the Grande Nova Rosa da Penha community, the nearest community. The detailed descriptions of social improvements are better described in the section below.

The environmental impacts mitigation, the clean and renewable energy generation, the employment generation and the maintenance of all the structure to prevent pollution contributes to the local and global sustainable development.

2)Contributions to the development of labor conditions and net employment generation

As described just before, the baseline scenario would be the non use of landfill gas, and consequently the non realization of any environmental or social benefits.

To the implantation of project scenario structure a significant and additional effort was made. The impermeable process installation, the construction of a landfill gas pipeline collection system, the maintenance of leachate treatment station and landfill gas flaring unit (or energy generation unit) will create employment, with the Grande Nova Rosa da Penha, the nearest community, the main beneficiaries of employment generation and the environmental improvement. The employment generated will be to high school and college formation degrees. The landfill unit will be highly automated, promoting security to workers.

Besides it, MARCA contributes to numerous social initiatives related with the landfill activities, creating jobs and rent to the region. Among these activities, are detached the projects called “Ecological brooms (Vassouras Ecológicas)”, “Ecological Bricks (Tijolos Ecológicos)”, “Nursery of seedlings (Viveiro de Mudas)” and environmental education projects with public and private schools.

The project “Ecological Brooms” is a partnership among MARCA, *Pet Indústria* and Vitória municipality. The project consists in the production of broom from PET bottles collected from waste. The jobs created by this project were fulfilled with people from Grande Nova Rosa da Penha community. The brooms production is over 3500 units per month.

The project “Ecological Bricks” is the production of brick using manual press process, without cooking process or cement. With this new process there is an energy economy. Besides it, the brick have a new design, with a mortise system device, which permits the construction of wall without building cement. These brick are also very resistance. The production capacity is about 600 brick per day.

The “Nursery of seedlings” project is a partnership between MARCA and the NGO *Bem Verde* , planting native species seedlings, with a production capacity of 160,000 seedlings per year. Part of production is used for recuperate areas inside the landfill, part is used for environmental education project and part is used by the municipalities near to the project area.

All these project, together with the landfill activities create more than 70 jobs, with great part coming from Grande Nova Rosa da Penha community, the nearest vicinity. With all the economic activity, the social commitment, creating job and improving the social and welfare of local and regional population and the environmental commitment, MARCA is promoting the sustainable development.

3) Contribution to the rent distribution

From the national point of view, MARCA project will contribute to the rent distribution due to the fact that renewable energy , following the Mines and Energy Ministry (Ministério de Minas e Energia) data, is less pollutant (and consequently presents a smaller social cost), diminish the national exposition to the fossil fuel price variation, promote local economic development, independent energy production units, and presents a higher energy efficiency (specially in transmissions lines, due to a better location in relation to the consumption sites). All these aspects will promote the decentralization of the energy production activities, distributing better the revenues from it.

From the local and regional point of view, the employment generation and all the revenue from the project, considering the landfill and social activities done by MARCA, promotes the revenue distribution due to the participation of all social classes, with a special attention to the nearest communities.

4) Contribution to the technological development and capacitating

Due to the fact that the MARCA project is one of the first projects in energy generation from landfill gases, an expertise company from England (EnerG) was contracted to elaborate the project and to operate the unit.

The technology and the training program are from England. But the equipment will be produced in Brazil, and labor used to operate and maintain the MARCA electricity generation unit will be also from Brazil. Thus, there will be a knowledge and technology transfer to Brazil.

Projects like MARCA are very important to promote and increase the replication of landfill gas to energy projects through the Brazilian territory. Initiatives of carbon credit sales, associated with the governmental initiative to promote renewable energy sources (PROINFA) will make easier the replication of landfill gas to energy projects.

Besides it, MARCA support a sort of activities and projects, related with the landfill activities, with new ecological and technological improvements, promoting the sustainable development. Attitudes like this will be promoting not just the technological transference, but also the creation of new technologies genuinely Brazilians.

5) Contributions to the regional integration and to the articulation with other sectors.

The landfill gases flared or used to produce energy are from waste of many cities near the landfill, including Cariacica, Vila Velha, Vitória ans Serra, besides a range of companies from region. MARCA project will be installing the most modern landfill of region, and one the most modern landfill from Brazil, acting as an example to other entertainment on region and Brazil.

The production a and distribution of energy from landfill gases represents the integration between waste management sector, environmental sector, energy production and distribution sectors from Brazil, showing that with union and dialog is possible to promote the sustainable development.