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NovaGerar Landfill Gas to Energy Project
Project Design Document

Prepared for the World Bank
Carbon Finance Unit

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New York, Sydney, Rio de Janeiro,
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TABLE OF CONTENTS

A. GENERAL DESCRIPTION OF PROJECT ACTIVITY

A.1 Title of the project activity:

Brazil NovaGerar Landfill Gas to Energy Project

A.2. Description of the project activity:

NOTE: Please see the Brazil NovaGerar Landfill Gas to Energy Baseline Study and Monitoring Plan for more details and background information on all aspects of the project activity.

NovaGerar is a joint venture between EcoSecurities, an environmental finance company which specialises in greenhouse gas (GHG) mitigation issues and S.A. Paulista a Brazilian civil engineering and construction firm based in the city of São Paulo, Brazil. S.A. Paulista's core business is in traditional heavy construction sectors such as highways, railways, airports, ports, industries and sanitation. S.A. Paulista also manages the largest domestic waste transfer station in South America (Transbordo Ponte Pequena) responsible for 60% of all domestic waste from São Paulo, a city with a population of more than 10 million people.

In 2001, SA Paulista was granted a 20-year concessional licence by the Empresa Municipal de Limpeza Urbana (EMLURB - Municipal Waste Collection Company, a government agency responsible for waste collection and disposal) to manage the Marambaia and Adrianopolis landfills (officially called 'Lixao de Marambaia' and 'Aterro Sanitario de Adrianopolis') in the state of Rio de Janeiro, and to explore the landfill gas potential of these sites. As part of this concessional agreement, SA Paulista is contractually obliged to decommission and rehabilitate the Lixao Marambaia site, which opened in 1986 and ceased operation in late 2002 with approximately 2 million tonnes of waste deposited. The Adrianopolis site will commence operation in early 2003 and it is anticipated that it will receive an average of 2,000 tonnes of municipal waste per day.

The objective of the NovaGerar joint venture is to explore the landfill gas collection and utilization activities of the landfills managed by SA Paulista. This will involve investing in a gas collection system, leachate drainage system, flairing equipment and a modular electricity generation plant at each landfill site (with expected final total capacity of 12 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 reduce emissions of 10.7 million tonnes of CO_2e over the next 21 years. In addition, the project will lead to emission reductions attributable to the displacement of grid electricity, but these will not be claimed by NovaGerar at this stage.

A technical analysis was conducted in order to quantify the potential volume of emissions reductions that the project can generate. The analyses were conducted based on the projections of carbon emissions for the project and its baseline. It was found that the project has the capacity to generate 10.7 million tonnes of CO_2e credits over its 21-year lifetime.

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 Marambaia and Adrianopolis landfill sites properly the environmental health risks and the potential for explosions is greatly reduced. The project will also have a small, but positive impact on employment in the local area as a number of staff will need to be recruited to manage the landfill gas operations. Additionally, as a condition of the licence, NovaGerar will donate approximately 10% of the electricity generated on-site to the local municipal authority of Nova Iguaçu (where the project is located), to provide lighting for local schools, hospitals and other public buildings.

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. The NovaGerar project will also play an important demonstration effect, illustrating the use of a new financial mechanism for funding of the renewable energy sector, i.e. the Clean Development Mechanism.

A.3. Project participants:

- EcoSecurities, a multinational environmental finance company, specialising in greenhouse gas mitigation, NovaGerar joint venture partner and CDM project activity advisor;
- SA Paulista, a Brazilian engineering and waste management company, NovaGerar joint venture partner;
- World Bank Netherlands Clean Development Facility (WB NCDF), a CDM project facility. International Bank for Reconstruction and Development is the Trustee of the WB NCDF and purchases certified emissions reductions on behalf of and for the Netherlands Government.

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.:

Municipality of Nova Iguaçú, Rio de Janeiro, Brazil

A.4.1.3 City/Town/Community etc:

The site is located 10 km from the centre of Nova Iguaçú city

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

The Adrianopolis and Marambaia sites are adjacent to each other, and located adjacent to a densely populated section of the municipality of Nova Iguaçú, Rio de Janeiro, with more than 800,000 inhabitants. Because of their location close to the city of Rio de Janeiro, many manufacturing companies are either relocating existing facilities or establishing new plants in Nova Iguaçú. The municipality today hosts more than 600 industries and 2,400 commercial establishments. The sites are located 10 km from the centre of Nova Iguaçú city. Electric power transmission lines are located less than 1 km from the sites.

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 channelled 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.

All efforts will be made to minimize problems in condensate management. A schematic of the gas collection system is shown below.

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. As the gas volumes decrease over time, the modules can be relocated to other sites.

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,.

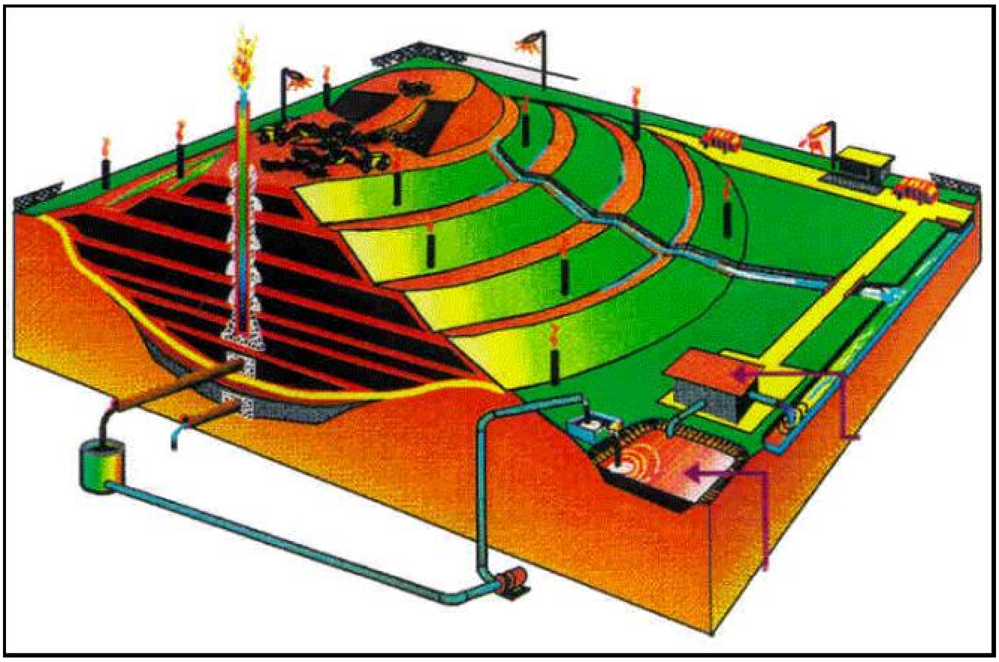

Figure 1: Landfill gas collection system schematic

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 NovaGerar 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 10.7 million 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 20% 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:

There is no methodology choice available on the UNFCCC website yet.

According to the FCCC's Drafting Group on Technical Issues text on CDM (Mechanisms) (Decision-/CP.7 Article 12, Paragraph 48) a project must select a baseline approach relevant to the activity.

The baseline approach adopted is option 48(b) of the Marrakech text: The baseline is the scenario that represents "emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

Approach 48(b) cannot readily be applied as baseline methodology and must be interpreted and made operational in view of the project circumstances. Approach 48(b) is based on the notion that the selection of the most likely future scenario is determined by economically rational behaviour. Therefore, an investment or financial analysis appears to be an appropriate interpretation of 48(b).

The project circumstances permit the use of a simplified financial analysis to determine the baseline scenario. The following name is proposed for this methodology:

"Simplified financial analysis for an investment project where business-as-usual is the only other plausible alternative scenario."

An explanation of this new methodology and the condition under which it can be applied is provided in Annex 3. A justification of the method's appropriateness given the project circumstances are given below.

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 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 NovaGerar 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 utilisation. 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: Analyse 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 'Lixão de Marambaia' is a typical case, where the previous operators have deposited waste for more than 15 years without any environmental licensing or following any environmental regulations. 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, and no landfill in operation yet in Brazil has been designed to collect and utilise (or even flare) the full amount of gas generated, although there are some sites under planning, including the NovaGerar landfills. 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.

The Marambaia landfill has operated in the past without LFG collection and venting/flaring. There is no reason to believe that an LFG system would be installed for safety or odour reasons at a time when the landfill is being closed. The location of the Adrianopolis site does also not require such a system to be installed for safety or other operational reasons as the site is located more than 5km from any human settlements. The installation of even a rudimentary LFG collection systems with passive venting or flaring would involve expenses for the landfill operator without any offsetting revenues.

Given the regulatory situation in Brazil and the location and conditions of the two landfills, 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 decentralisation 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 97 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 decentralisation of the power sector started which added to delays in implementing planned projects.

The current Brazilian 10-year expansion plan 2000/2009 reduces the importance of hydro in the short-term, but emphasises 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 decentralisation 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 centralised 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 Rio de Janeiro, 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 Appendix 1) 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 analysing additionality, i.e. the best case scenario IRR was calculated. It was assumed that the average waste placement rate at Adrianopolis was equal to the peak waste placement rate of 3,300 tonnes per day, currently projected to only occur in 2023, the final year of the project crediting period. Therefore the volumes of landfill gas to be generated from the site would increase significantly. The landfill gas generation model used, the US EPA First Order Decay Model, has an inherent error up to 50%. For the best case

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

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 (as of 22 November 2002 it was 3.565), and the electricity tariff was fixed at R$ 130.00 over the 21 year period (equivalent to U$ 43.30/MWh at this exchange rate, as opposed to U$ 34.90 at exchange rates operating in Nov 2002). These best case assumptions were inputted into the models and financial analysis to recalculate the IRR. The IRR (without carbon) is 4.76%, 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 NovaGerar 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 two landfill sites 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.

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

[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).

estimated that in the baseline there will be the production of 16 million tCO2e during the project's 21-year lifetime.

The estimation of the Effectiveness Factor for this project was based on the regulatory requirements imposed on SA Paulista (the landfill operator) at the time they signed a contractual agreement with the Municipal waste management company (EMLURB) to operate the landfill (Licitação por Concorrencia Publica n. 001/CP/EMLURB/2000 - Anexo 2, Item 7). Based on these specifications, NovaGerar's landfill waste consultant estimated the effectiveness of this system in comparison with the system that will be adopted by the project funded with carbon finance.

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.

While currently no regulation exist that require landfill gas control for the Adrianopolis landfill, the contract between the Marambaia landfill operator and municipal authorities foresees remediation of the existing dump and installation of a rudimentary gas drain net as a part of the bidding documents. The bidding documents (Licitação por Concorrencia Publica n. 001/CP/EMLURB/2000 - Anexo 2, Item 7) only require the installation of 40 passive (i.e. no suction) drainage wells at approximately 50 m intervals and reaching 2m in depth, resulting in a total well capacity of 80 m (40 x 2 m). The total area of the Marambaia landfill cells is estimated to be 79,820 m^2; the peak depth of the landfill is estimated to be between 40-50 m, with an estimated total volume of waste in place of 1,914,498 m^3. Expressed as a function of the total volume of the landfill, the necessary wells as required by the municipal contract represent 0.0042 cm of well/m^3 waste.

In the project scenario, 40 wells are also proposed, but with a depth of 23 m rather than 2 m as required in the Marambaia bidding documents. This gives a total well capacity of 920 m (40 x 23 m). Expressed as a function of the total volume of the landfill, the proposed wells in the project scenario represent 0.0481 cm of well/m^3 waste. This ratio is 11.4 times greater than that required by the municipal contract. The proposed well capacity in the baseline scenario represents 8.73% of the well capacity proposed in the project scenario.

Furthermore, the system required is based on the passive drainage of gas, which is not an effective system. The project will adopt suction to improve the landfill gas extraction and reduce emissions to the atmosphere.

Another factor that reduces the effectiveness is that the wells required by the municipal contract are very shallow (2 m) compared to the depth of the Marambaia landfill (peak depth

40 - 50 m, average depth 23.9 m). It is assumed that in the top layers of waste, decomposition will be both aerobic and anaerobic. Therefore, the gas captured in the shallow wells is assumed to have a lower methane percentage than gas collected from deeper wells. Current flaring practice in Brazil usually takes the form of a landfill operator manually lighting the top of gas wells in the landfill. It is therefore very common for flares to 'blow out'. Given that the gas collected by the wells required by the municipal contract is likely to have a lower methane percentage it is assumed that the use of typical flaring practices would not be very effective. If a reduction factor of 40% is attributed to each of these additional problems, it can be estimated that the effectiveness of this system can be less than 4% of the well capacity of the project.

Conversely, 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 effectiveness of this system is estimated to be 85%.

Although current legislation and municipal contracts only require an approximate collection of 0% (Adrianopolis) and 4% (Marambaia), respectively, of the gas collected through the project, all emission reductions arising from the project will nonetheless be reduced by 20%, 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 NovaGerar is extremely 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 20% 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 NovaGerar 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 utilisation schemes in place at Marambaia and Adrianopolis, the two sites (using estimations from the US EPA First Order Decay Model) would be responsible for the release of approximately 36,350 tonnes of methane every year during this period. Using a Global Warming Potential (GWP) of 21 this is equivalent to carbon dioxide emissions of approximately 763,000 million tonnes per year. Cumulative CO_2-e emissions without the project over the crediting period are conservatively estimated at more than 16 million tonnes.

The NovaGerar 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 2.38 million tonnes of CO_2e will be emitted as fugitive emissions in the project scenario during the period 2003-2023, compared to 16 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 10.7 million tonnes of CO2 emissions over 21 years as the ERs will be discounted by 20% for conservativeness.

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.

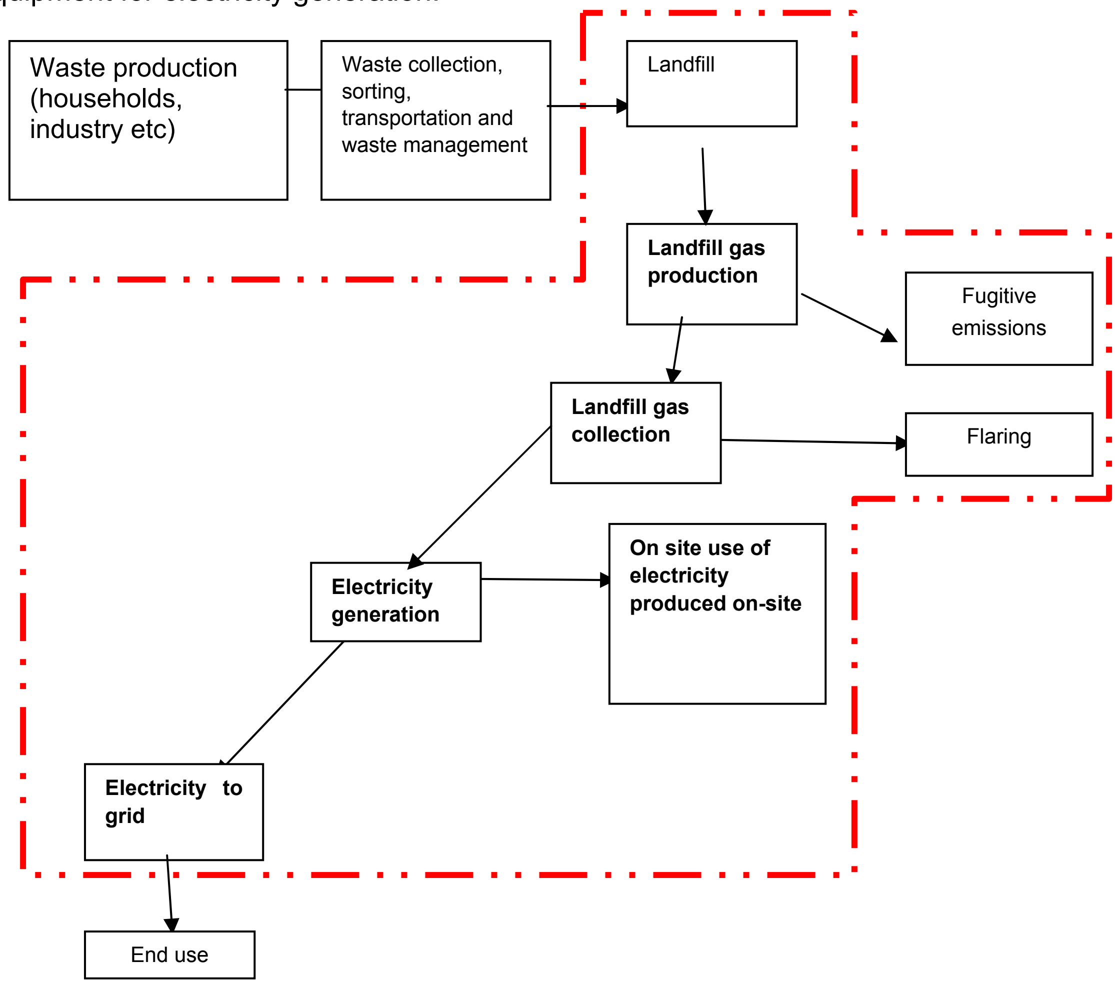

Figure: Flow chart of system boundaries

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

Table: 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 85% of LFG generated will be captured meaning the remaining 15% 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:

13/12/2002

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 01/11/2003. (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 01/11/2003

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:

There is no methodology choice available in the UNFCCC website yet, but this project requires only a straight forward monitoring methodology.

The following name is suggested for the monitoring approach used here:
"Direct monitoring and calculation of ERs in landfill gas utilization or flaring projects".

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 85 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 85 % collection efficiency and 20 % would have to be collected in the baseline scenario, the monitored ERs must simply be reduced by approx. 23.5 % to arrive at the additional reductions that can be claimed.)

The NovaGerar 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 NovaGerar 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 20 % (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 NovaGerar 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: The NovaGerar 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**	

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 20% is still appropriate, or whether it should be changed to 20% + n%. If the average collection practice exceeds the discount factor of the first commitment period of 20%, 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 NovaGerar 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.

[3] Please note that for the purpose of comparing the two factors, the 20% discount factor applied to NovaGerar needs to be converted into overall collection efficiency. The 20% discount factor applied to NovaGerar 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 20% methane captured also in the baseline scenario represents a collection efficiency **lower** than 20%.

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 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 generators' standard heat rate plate ratings*
4	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.*
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	-

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 implemented in the context of the NovaGerar project are as follows:

Daily Monitoring Records: On the larger more active sites site staff take 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. At the smaller/older 300kW unit sites the readings are taken at weekly or other set periods depending on the activity and consistency of the gas field and engine operation. All engines will have telemetry links back to a central computer at head office, which continually monitors the performance of the engine detecting problems and highlighting them for attention.

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 analyser 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. Again the telemetry link records a lot of the data automatically.

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 300kW 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 NovaGerar staff
- NovaGerar management will make a decision, in consultation with the EPC and Paulista, on appropriate corrective actions to eliminate the non-conformity and its causes
- Corrective actions are implemented and reported back to the NovaGerar management.

In addition to the quality assurance measures described above, NovaGerar will prepare an Operational Manual which is a part of the legal arrangements with the municipality and the Public Attorney. The Operational Manual will include procedures for training, capacity building, proper handling of equipment, emergency plans, reforestation plans and work security. The environmental agency, FEEMA, monitors compliance with the Operational Manual as a precondition for the issuance of the operational license for the Project and the landfill operations.

NovaGerar will also ensure that both NovaGerar staff, EPC operator staff and Paulista (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.

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

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 CO2 emissions. The source of the methane and therefore the CO2 emissions is the organic fraction in deposited waste, which forms part of the natural organic CO2 cycle. The project sponsors therefore take the view that these CO2 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 efficiency of 85%. Therefore 15% 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 NovaGerar 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 NovaGerar 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 channelled to flares (m^3)

⇩

Multiplied by methane fraction of landfill gas (readings from the gas analyser 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 (20 %) 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 flairing system requested by the regulatory agency. While this factor was estimated to be below 5% for the NovaGerar project (see Section B3 – 2), the project adopted a higher factor (20%) 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 CO2 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 10.7 million tonnes of CO2 emissions over 21 years after the 20% discount for conservativeness.

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: Summary of Baseline and Project Emissions (in tCO_2e), after adjustment for conservativeness (20% reduction).

Crediting period	Emissions Baseline	Emissions Project	Emission Reductions
7 yrs	2,240,474	311,442	1,380,494
10 yrs	4,017,049	577,928	2,578,674
14 yrs	7,378,394	1,082,130	4,855,068
21 yrs	16,033,468	2,380,391	10,730,978

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 NovaGerar 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 colourless and odourless. 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 odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation. Through appropriate management of the Marambaia and Adrianopolis sites, 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 minimise 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 stabilisation 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 NovaGerar 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 minimised by appropriate management of the Marambaia and Adrianopolis landfill sites include the risks of fire or explosions, landfill gas migration, dust, odour, pests, vermin, unsightliness and litter, each of which may occur on-site or off-site.

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 utilisation schemes, such as the NovaGerar 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 environmental licenses to operate the new Adrianopolis landfill. This EIA was subjected to a prolonged stakeholder consultation process which culminated in an official public hearing in 2001. The concerns of stakeholders are recorded in the official minutes of this hearing (Ata de Reunião de Audiência Pública), kept by FEEMA, the environmental agency responsible.

The project developer’s response to stakeholder concerns is contained in a statement of social responsibility between SA Paulista and the relevant Ministry in Brazil (Termo de Compromisso c/o Ministério Público). Among various other points, SA Paulista agreed to remediate the highly polluting Marambaia rubbish dump, which was expected to close at the end of 2001, and finally closed in August 2002.

G. STAKEHOLDERS COMMENTS

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

For the environmental licenses and Operational permits, the State environmental agency FEEMA, has already conducted a public hearing in 2001, which was only focusing on the waste disposal and management facilities in Adrianopolis and not on the clean up of Marambaia. All comments have been incorporated into the executive project. The documentation is available to the public on request.

The new Stakeholder Consultation Process for the NovaGerar project includes both sites, Adrianopolis and Marambaia and is being carried out by an independent organization specializing in sanitary engineering and environmental issues, Associacao Brasileira de Engenharia Sanitaria e Ambiental - ABES. The consultation process is based on meetings and interviews and will be concluded by the end of 2002.

The target groups were divided in 5 interest groups. (i) public sector representatives, including environmental agencies, municipalities, federal and state government and local universities; (ii) non-governmental organizations, including relevant local and national organizations specializing on climate change; (iii) private sector representatives (local electric power supplier and gas distributor); (iv) international climate change organization (IETA); and (v) scavengers.

All scavengers, who have been working in Marambaia, were interviewed. Their socio-economic situation was analysed with the intention to reintegrate them into the landfill operations. In a public hearing, where the local association of the scavengers, a representative of the municipality, SA Paulista and ABES participated, the project was explained, labor rights outlined and discussed how scavengers could be legally absorbed by the concessionaire. By today, already 10 former scavengers have been legally contracted for the construction site by SA Paulista.

Other interest groups have been contacted personally or by mail, where the project has been outlined and the risks and benefits explained. They have been asked for their comments or no-objection regarding the technical, environmental and social issues. Up to present date, all organizations agreed with the project concept and most of them emphasize the environmental importance of the landfill when considering the precarious waste disposal situation in Brazil and in particular the Rio de Janeiro metropolitan area. Most interesting is that 50% of all contacted stakeholders recognize the project's contribution to the mitigation of the global warming impacts.

The report will be concluded by the end of 2002 and made available to the public. The project sponsor will announce where it can be accessed. In any case, it will be available at the project sponsor's web site as well as on the site of the WB/carbon finance.

G.2. Summary of the comments received:

Up to present date, all organizations have agreed with the project concept and most of them emphasized the environmental importance of the landfill when considering the precarious

waste disposal situation in Brazil and in particular the Rio de Janeiro metropolitan area. Most interesting is that 50% of all contacted stakeholders recognize the project's contribution to the mitigation of the global warming impacts.

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

All comments received in the context of the environmental licensing and Operation permits process have been incorporated into the executive project. The documentation is available to the public on request.

In a public hearing, where the local association of the scavengers, a representative of the municipality, SA Paulista and ABES participated, the project was explained, labor rights outlined and discussed how scavengers could be legally absorbed by the concessionaire. By today, already 10 former scavengers have been legally contracted for the construction site by SA Paulista.

The report will be concluded by the end of 2002 and made available to the public. The project sponsor will announce where it can be accessed. In any case, it will be available at the project sponsor's web site as well as on the site of the WB/carbon finance.

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ANNEX 2: INFORMATION REGARDING PUBLIC FUNDING

There is no Official Development Assistance in this project.

ANNEX 3: NEW BASELINE METHODOLOGY

(The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. A baseline shall cover emissions from all gases, sectors and source categories listed in Annex A of the Kyoto Protocol within the project boundary. The general characteristics of a baseline are contained in para. 45 of the CDM M&P.

For guidance on aspects to be covered in the description of a new methodology, please refer to the UNFCCC CDM web site.

Please note that the table "Baseline data" contained in Annex 5 is to be prepared parallel to completing the remainder of this section.)

1. Title of the proposed methodology:

"Simplified financial analysis for an investment project where business-as-usual is the only other plausible alternative scenario (suggested short title Simplified Financial Analysis)."

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.

Step 2: If justified, through elimination reduce the list of possible baseline scenario alternatives to the business as usual (BAU) scenario and the proposed project alternative.[4] 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.

Step 3: 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.

Step 4: 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 NovaGerar project government bond rate was used as the comparator.

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

[4] 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.

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 judgement.
- Conservative calculation of IRR as explained above. To be checked by designated OE.
- Expert judgement 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[5], as follows:

[5] 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).

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

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 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:

(Please describe and justify the project boundary bearing in mind that it 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. Please describe and justify which gases and sources included in Annex A of the Kyoto Protocol are included in the boundary and outside the boundary.)

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:

(Please indicate uncertainty factors and how those uncertainties are to be addressed)

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:

(Formulae and algorithms used in section E)

(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 Model6 -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.

(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:

(Please note: Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary and which is measurable and attributable to the CDM project activity.)

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[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).

(Formulae and algorithms used in section E.5)

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

Proposed new monitoring methodology

(Please provide a detailed description of the monitoring plan, including the identification of data and its quality with regard to accuracy, comparability, completeness and validity)

"Direct monitoring and calculation of ERs in landfill gas utilization or flaring projects."

1. Brief description of new methodology

(Please outline the main points and give a reference to a detailed description of the monitoring 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, tTake 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 CO2 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 channelled to flares (m^3)

⇩

Multiplied by methane fraction of landfill gas (readings from a gas analyser 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 CO2 equivalent) are the summation of results from Step 1 (Methane combustion in generators) and Step 2 (Methane combustion in flares)[7]. 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 CO2 emissions. The source of the methane and therefore the CO2 emissions is the organic fraction in deposited waste, which forms part of the natural organic CO2 cycle. Therefore, these CO2 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.

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

(Please add rows to the table below, as needed)

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.

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

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.

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, 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 flares' efficiency ratings.*
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	%	E	Every 7 years	A minimum of 10	Electronic (spreadsheet)	2 years and duration of	-

	by Control group				control sites		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

(Please add rows to the table below, as needed.)

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:

(Please list information used in the calculation of emissions which is not measured or calculated, e.g. use of any default emission factors)

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 NovaGerar project, and incorporated in the monitoring plan.

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?

(Please outline how the accuracy and completeness of the new methodology compares to that of approved methodologies).

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.

After completing above, please continue filling sub-sections D.2. and following.

ANNEX 5: BASELINE 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 NovaGerar:

FINANCIAL PARAMETERS	
Exchange rate US$/€	1.15
Exchange rate RS/US$	3.00
Electricity tariff (Rs$/MWh)	130.0
Rate of increase (%) and evolution of tariff	0%
Tariff (Us$/MWh)	43.3
Taxes (PIS+COFINS)	18.65%
Income tax 15%+9%	24%
Income tax +10% > 240000	10%
Flaring Equipment, complete (U$)	314,308
Gas Plant (U$)	301,370
Gas Plant & Flaring O&M/ Month (U$)	10,501
1Mw Generating System (5 x 200Kw units) complete	748,509
Assembling and testing	34,133
Maintenance engine, supervision (US$/month)	19,212
Connection to grid (U$ per site)	83,333
Carbon Credits Administrative Expenses (U$/y)	12,000
Electricity Generation Administrative Expenses (U$/y)	120,000
Pre-operational costs (US$)	150,000
World Bank yearly administration costs (US$)	20,000
% of Sales due to Municipalities	10%
Land Rent (US$/y)	16,000
Discount rate	12.0%

INPUTS MARAMBAIA

LANDFILL DATA	
Year started landfill operation	1987
Year finished operation	2002
Waste in place at beginning of project (tonnes)	1,806,373
R = Average daily waste rate (t/day)	329.9
Lo (cf/lb) =	2.63
k (1/year)=	0.1
Methane content of landfill gas=	0.5
Methane GWP	21
BASELINE DATA	
Residual emission factor CH4 to CO2	0
Proportion of methane flared in baseline (%)	0%
Reduction of ERs for conservativeness	20%
PROJECT DATA	
Date gas collection project starts (year)	2003
Proportion of methane collected (%)	85%
Reduction due to uncertainty	25%
Electricity generaion factors:	
Engine Heat Rate:Btu/Kwh	10,625
Reciprocating Engine Generator Rating: kW	200
Parasitic Power Loss (%)	5%
Estimated On-line availability of Equipment (%)	91%

RESULTS FOR 21 YEARS OPERATION - MARAMBAIA

LANDFILL GAS AND METHANE	10 yrs	21 yrs
Total Landfill Gas Produced (m3)	**203,975,923**	**286,930,624**
Total Methane Produced (t)	**51,937**	**73,059**

LANDFILL ERs (t CO2e)	Emissions Baseline	Emissions Project	ERs
7 yrs	950,135	117,891	521,483
10 yrs	1,151,073	148,032	656,968
14 yrs	1,340,421	176,434	785,176
21 yrs	1,534,232	205,506	916,734

TOTAL ERs (tCO2e) (landfill + electricity)	Emissions Baseline	Emissions Project	ERs
7 yrs	950,135	117,891	521,483
10 yrs	1,151,073	148,032	656,968
14 yrs	1,340,421	176,434	785,176
21 yrs	1,534,232	205,506	916,734

ELECTRICITY GENERATION	10 yrs	21 yrs
Total Net Power Output: MWh	53,217	53,217
Total ERs (t CO2)	0	0

INPUTS ADRIANOPOLIS

LANDFILL DATA	
Year started landfill operation	2003
Year finished operation	2022
Waste in place at beginning of project (tonnes)	0
R = Average daily waste rate (t/day)	see sheet
Lo (cf/lb) =	2.63
k (1/year)=	0.1
Methane content of landfill gas=	0.5
Methane GWP	21
BASELINE DATA	
Residual emission factor CH4 to CO2	0
Proportion of methane flared in baseline (%)	0%
Reduction of ERs for conservativeness	20%
PROJECT DATA	
Date gas collection project starts (year)	2004
Proportion of methane collected (%)	85%
Reduction due to uncertainty	25%
Electricity generaion factors:	
Engine Heat Rate:Btu/Kwh	10,625
Reciprocating Engine Generator Rating: kW	200
Parasitic Power Loss (%)	5%
Estimated On-line availability of Equipment (%)	91%

RESULTS FOR 21 YEARS OPERATION - ADRIANOPOLIS

LANDFILL GAS AND METHANE	10 yrs	21 yrs
Total Landfill Gas Produced (m3)	317,918,161	2,033,725,779
Total Methane Produced (t)	107,932	690,440

LANDFILL ERs (t CO2e)	Emissions Baseline	Emissions Project	ERs
7 yrs	1,290,339	193,551	859,011
10 yrs	2,865,976	429,896	1,921,706
14 yrs	6,037,973	905,696	4,069,892
21 yrs	14,499,236	2,174,885	9,814,244

TOTAL ERs (tCO2e) (landfill + electricity)	Emissions Baseline	Emissions Project	ERs
7 yrs	1,290,339	193,551	859,011
10 yrs	2,865,976	429,896	1,921,706
14 yrs	6,037,973	905,696	4,069,892
21 yrs	14,499,236	2,174,885	9,814,244

ELECTRICITY GENERATION	10 yrs	21 yrs
Total Net Power Output: MWh	365,292	1,287,720
Total ERs (21 years - t CO2)	0	0