EcoSecurities Ltd
Environmental Finance Solutions

21 Beaumont Street
Oxford OX1 2NH, UK
Telephone (44) 1865 202 635
Fax (44) 1865 251 438
E-mail: uk@ecosecurities.com
Web site: www.ecosecurities.com

NovaGerar Landfill Gas to Energy Project
Project Design Document

Prepared for the World Bank
Carbon Finance Unit

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

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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 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 14.072 million tonnes of CO_2 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.

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 14 million tonnes of CO_2 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;
- EnerG, a British specialist landfill-gas-to-energy company, EPC contractor
- 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 site is located 10 km from the centre of Nova Iguaçú city. Electric power transmission lines are located less than 1 km from the site.

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).

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:

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,.

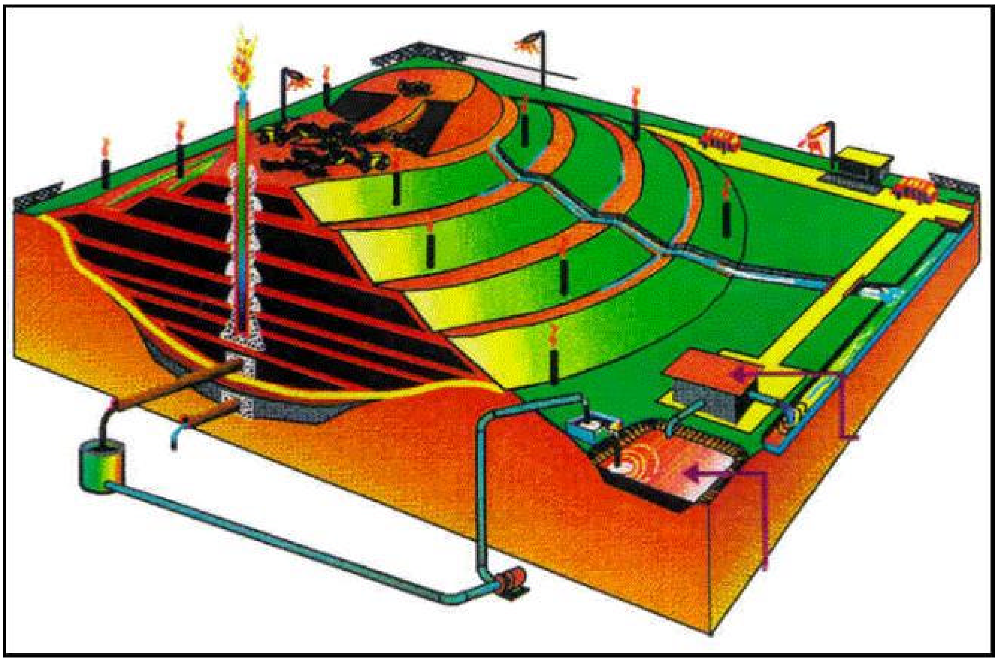

Figure 1: Landfill gas collection system schematic

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 to generate electricity will result in the avoidance of methane emissions to the atmosphere and the reduction of 14.072 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% for the Marambaia site for conservativeness).

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:

AM0003: Simplified Financial Analysis for Landfill Gas Capture Projects

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

The methodology was developed specifically based on NovaGerar Landfill Gas to Energy Project.

As a consequence, all conditions for the use of the AM0003 methodology are met.

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

The above methodology is here 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 continued non-utilization of landfill gas. 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 power generation from LFG (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 environmental 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 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 current exchange rates). These best case assumptions were inputted into the models and financial analysis to recalculate the IRR. The IRR (without carbon) is negative 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.

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

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

It is possible that future regulatory requirements for landfills in Brazil will necessitate some level of LFG collection in the baseline scenario. If this occurs, the future baseline scenario will include compliance with such regulations.

It is also possible that the economics of LFG utilization for power generation may change at some time in the future. If such changes lead to a sufficient increase in the profitability of LFG utilization at the two sites in question, the proposed project could well be implemented without the help of carbon finance. If this occurs, the future baseline scenario will include an LFG to power project.

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

> **No 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 will either be required by law or becomes an economically attractive course of action. The time of such possible and anticipated junction in the future baseline scenario will be determined by the monitoring plan for the project.**

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

While there is no regulatory requirements for flaring landfill gas, in the interests of conservatism, and to enhance the environmental integrity of the NovaGerar project, all emission reductions arising from the Marambaia site of the project will nonetheless be discounted by 20%. This is done given that for the Marambaia landfill, the contract between the operator and municipal authorities foresees remediation of the existing dump and installation of a rudimentary gas drain net and some flares for safety reasons as a part of the bidding documents.

The bidding document requires installation of passive drainage wells only in 50m intervals and reaching 2m in depth and to flare the gas captured by the system. While the exact volume of gas such a system would capture is uncertain, it is highly likely that the volume captured would be very low given that most of the methane is generated in the deeper layers of the landfill (the dump is estimated to be 50-70m deep).

The flow of gas from the top layer of the dumps (where decomposition is mostly aerobic) could actually be so low that no flaring would be possible and only venting would occur.

The bidding documents contain no specification as to the percentage of gas that needs to be collected and flared to meet this contractual requirement. Given that the Marambaia site is away from any human settlements, it is reasonable to assume that no more than 20% of gas would need to be **flared** (as opposed to mere venting) to sufficiently mitigate the risk of explosions. It is also very likely that not even close to 20% could actually be captured and flared by the required system.

Therefore, it is argued that the 20% discount on ERs claimed by the NovaGerar Project from the Marambaia site more than sufficiently covers the volume of gas that would be flared to meet the requirements of the Marambaia concession/bidding documents. No discounting of ERs from the Adrianapolis site is done as there are no regulatory nor concession/contract requirements to vent or flare gas.

The NovaGerar baseline assumptions will be revisited every 7 years to ensure that the assumptions made in the baseline scenario still hold true, or they will be revised accordingly. In addition, the introduction of Brazilian legislation regarding the collection and flaring of landfill gas will be monitored **annually** as a part of the Monitoring Plan.

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 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 70,000 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 800,000 tonnes per year. Cumulative CO_2-e emissions without the project over the crediting period are conservatively estimated at more than 16,8 million tonnes.

The NovaGerar project scenario is based on the collection and combustion of landfill gas for the generation of electricity. Combustion of the landfill gas to produce electricity will convert the highly potent methane content to less potent carbon dioxide, and result in significant greenhouse gas emission reductions. Using the US EPA Model gas predictions and projecting the amount of landfill gas which will either be combusted in engines or flares it is estimated that only 2.5 million tonnes of CO_2e will be emitted as fugitive emissions in the project scenario during the period 2003-2023, compared to 16,8 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 14.072 million tonnes of CO2 emissions over 21 years as the ERs will be discounted by 20% for Marambaia site 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.

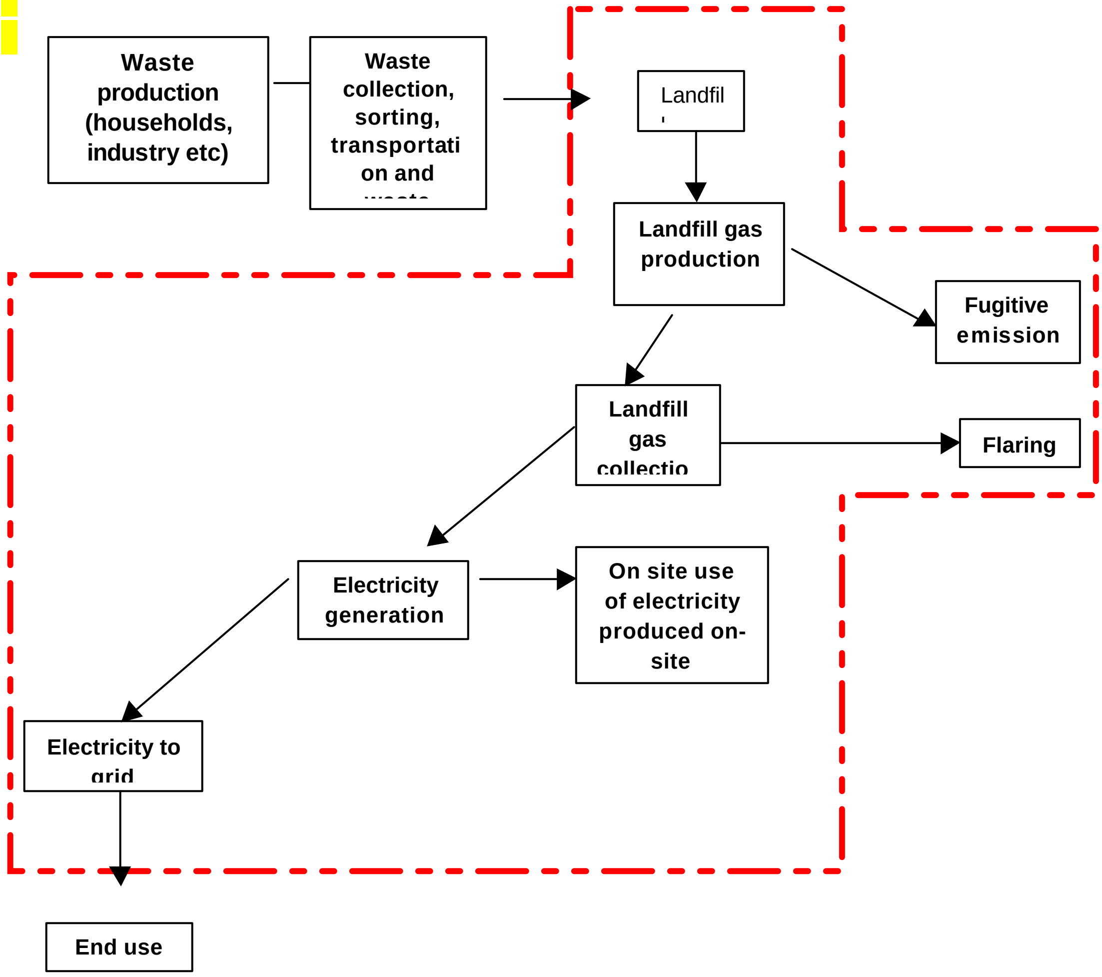

Figure 2: Flow chart of system boundaries

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

Table 1: Summary of system and project boundaries

Emissions	Project Scenario	Baseline Scenario
Direct on-site	Emissions associated with fugitive landfill gas emissions. EcoSecurities estimates that only 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:

Pedro Moura Costa and Belinda Kinkead
EcoSecurities
21 Beaumont Street
Oxford OX1 2NH, UK
Telephone (44) 1865 202635
Fax: (44) 1865 251438
www.ecosecurities.com

C. DURATION OF THE PROJECT ACTIVITY / CREDITING PERIOD

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

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

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

21 years

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

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

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

Estimated as 01/07/2004

C.2.1.2. Length of the first crediting period:

7 years

D. MONITORING METHODOLOGY AND PLAN

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

AM0003: Simplified Financial Analysis for Landfill Gas Capture Projects

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

The methodology was developed based on the NovaGerar Landfill Gas to Energy Project.

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.

Table 2: Data to be collected to monitor emissions from the project activity.

ID number	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.*

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 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-confirmity 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.

Tabela 3: Quality assurance and quality control procedures (QA/QC).

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:

Pedro Moura Costa and Belinda Kinkead
Ecosecurities
21 Beaumont Street
Oxford OX1 2NH, UK
Telephone (44) 1865 202635
Fax: (44) 1865 251438
www.ecosecurities.com

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.

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 Based on the stoichiometry for the methane to CO2 conversion (explained in the MP) the global warming potential would be 18.25 if CO2 emissions were treated as non-organic.

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.4. for formulate 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

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)

⇩

Volume of methane combusted in flare
(m^3)

⇩

Multiplied by flare efficiency (98 %)

⇩

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) NOTE: For Marambaia site this result is further discounted by a factor of 20% for conservativeness

⇩

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 discounted by 20% for the Marambaia site for conservativeness.

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 14 million tonnes of CO2 emissions over 21 years after the 20% discount for the Marambaia site for conservativeness.

Please note: 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, the above formula cannot be directly used to complete the table below.

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 a rough estimates of expected values.

Table 4: Summary of Baseline and Project Emissions.

Crediting Period	Emissions Baseline	Emissions Project	Emissions Reductions[a]
7 yrs	2,358,500	353,775	1,895,256
10 yrs	4,339,849	650,977	3,548,494
14 yrs	8,000,971	1,200,146	6,631,322
21 yrs	16,790,727	2,518,609	14,072,802

a. The emission reductions in the Marambaia site are already reduced by a 20% conservative factor.

Table 5: Baseline and project emissions from the NovaGerar project.

Year	Total Emissions Baseline (t CO2)	Total Emissions Fugitive Methane	Total Emissions Reductions	Emissions Reductions reduced by 20% [a]	Cumulative Emissions Reductions
2,004	94,539	14,181	80,358	68,931	68,931
2,005	235,560	35,334	200,226	179,547	248,479
2,006	290,604	43,591	247,013	228,303	476,781
2,007	346,757	52,014	294,743	277,813	754,595
2,008	403,374	60,506	342,868	327,549	1,082,143
2,009	462,337	69,351	392,987	379,126	1,461,269
2,010	525,329	78,799	446,529	433,987	1,895,256
2,011	591,430	88,715	502,716	491,367	2,386,623
2,012	659,816	98,972	560,843	550,575	2,937,198
2,013	730,103	109,515	620,587	611,296	3,548,494
2,014	802,185	120,328	681,857	673,450	4,221,944
2,015	876,568	131,485	745,083	737,475	4,959,420
2,016	952,490	142,873	809,616	802,733	5,762,152
2,017	1,029,880	154,482	875,398	869,170	6,631,322
2,018	1,107,972	166,196	941,776	936,141	7,567,463
2,019	1,190,394	178,559	1,011,835	1,006,736	8,574,198
2,020	1,270,073	190,511	1,079,562	1,074,948	9,649,146
2,021	1,347,315	202,097	1,145,218	1,141,043	10,790,189
2,022	1,422,399	213,360	1,209,039	1,205,262	11,995,451
2,023	1,287,040	193,056	1,093,984	1,090,566	13,086,017
2,024	1,164,562	174,684	989,878	986,785	14,072,802
TOTAL	**16,790,727**	**2,518,609**	**14,272,118**	**14,072,802**	

a – This applies to the emission reductions from the Marambaia site.

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.

ANNEX 1: CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	EcoSecurities Ltd
Street/P.O.Box:	21 Beaumont Street
Building:	
City:	Oxford
State/Region:	Oxfordshire
Postfix/ZIP:	OX1 2NH
Country:	United Kingdom
Telephone:	+44 (0) 1865 202 635
FAX:	+44 (0) 1865 251 438
E-Mail:	uk@ecosecurities.com
URL:	www.ecosecurities.com
Represented by:	
Title:	Director
Salutation:	Dr
Last Name:	Moura Costa
Middle Name:	-
First Name:	Pedro
Department:	-
Mobile:	
Direct FAX:	+44 (0) 1865 251 438
Direct tel:	+44 (0) 1865 202 635
Personal E-Mail:	pedro@ecosecurities.com

Organization:	SA Paulista
Street/P.O.Box:	Av. Nove de Julho, 3800
Building:	
City:	Jardim Paulista - São Paulo
State/Region:	SP
Postfix/ZIP:	CEP 01406-100
Country:	Brasil
Telephone:	(55) 11 30648300
FAX:	
E-Mail:	josif@sapaulista.com.br
URL:	
Represented by:	
Title:	Director
Salutation:	Mr
Last Name:	Melamed
Middle Name:	
First Name:	Josif
Department:	
Mobile:	
Direct FAX:	
Direct tel:	(55) 11 3064 8300
Personal E-Mail:	josif@sapaulista.com.br

Organization:	NovaGerar EcoEnergia Ltda.
Street/P.O.Box:	Rua Assembleia 10
Building:	Ed. Candido Mendes
City:	Rio de Janeiro
State/Region:	RJ
Postfix/ZIP:	20-021-040
Country:	Brasil
Telephone:	+55 (0) 21 2222 9018
FAX:	+44 (0) 21 2222 7615
E-Mail:	br@ecosecurities.com
URL:	www.ecosecurities.com
Represented by:	
Title:	Director
Salutation:	Mr
Last Name:	Braga
Middle Name:	-
First Name:	Paulo
Department:	-
Mobile:	
Direct FAX:	+55 (0) 21 2222 7615
Direct tel:	+55 (0) 21 2222 9018
Personal E-Mail:	braga@ecosecurities.com

Organization:	World Bank Netherlands Clean Development Facility
Street/P.O.Box:	1818 H Street, NW
Building:	MC Building
City:	Washington
State/Region:	DC
Postfix/ZIP:	20043
Country:	United States of America
Telephone:	+1-202-473 6010
FAX:	+1-202-522 7432
E-Mail:	knewcombe@worldbank.org
URL:	www.carbonfinance.org
Represented by:	
Title:	Manager
Salutation:	Mr.
Last Name:	Newcombe
Middle Name:	-
First Name:	Kenneth
Department:	ENVCF
Mobile:	
Direct FAX:	+44 (0) 1865 251 438
Direct tel:	+44 (0) 1865 202 635
Personal E-Mail:	pedro@ecosecurities.com

ANNEX 2: INFORMATION REGARDING PUBLIC FUNDING

There is no Official Development Assistance in this project.

ANNEX 3: NEW BASELINE METHODOLOGY

Baseline Methodology already approved by EB Meth Panel, known as AM0003: Simplified Financial Analysis for Landfill Gas Capture Projects.

ANNEX 4: NEW MONITORING METHODOLOGY

Monitoring Methodology already approved by EB Meth Panel, known as AM0003: Simplified Financial Analysis for Landfill Gas Capture Projects.

ANNEX 5: TABLE: BASELINE DATA

The AM0003 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 AM0003 methodology uses the internal rate of return (IRR), or the net present value (NPV), 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. The first one shows the financial parameters used for the determination of baseline (i.e., conservative financial assumptions), while the second set of tables shows the technical parameters used for the quantification of emission reductions in the realistic scenario.

PHASE I- FLARING --Data Inputs	
Price of carbon (€/tCO2)	3.35
Exchange rate US$/€	1.15
Exchange rate RS/US$	3.00
Net price of carbon (U$/tCO2) (deducting 2% adapt.levy)	3.78
Taxes (Cofins + ISS)	13%
% of Carbon Sales due to Municipalities	10%
Gas Plant & Flaring O&M/ Month (U$)	6,800

PHASE II- POWER GENERATION -- Data Inputs	
Tariff (Rs$/MWh)	130
Rate of increase (%) and evolution of tariff	0%
Tariff (Us$/MWh) (minimum)	43.33
Taxes (PIS+COFINS)	18.65%
Land owner Royalty	10%
% of Energy due to Municipalities	10%
Power Plant O&M + Capital Costs (U$/MWh)	38.00

PROJECT CASH FLOW- -Data Inputs	
Pre-operational costs (US$)	250,000
Project Administrative Expenses (U$/month)	11,850
World Bank yearly administration costs (US$/year)	20,000
Discount rate	15.0%
Income tax (> RS$ 240 000)	34%
Income tax (< RS$ 240 000)	15%

	With Carbon	Without carbon
IRR (%)	**18.72%**	**negative**

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)	2004
Proportion of methane collected (%)	85%
Reduction due to uncertainty	20%
Electricity generaion factors:	
Engine Heat Rate:Btu/Kwh	10,625
Reciprocating Engine Generator Rating: kW	1,000
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)	132,912,418	215,867,120
Total Methane Produced (t)	36,098	58,629

LANDFILL ERs (t CO2e)	Emissions Baseline	Emissions Project	ERs
7 yrs	686,861	103,029	467,066
10 yrs	880,798	132,120	598,943
14 yrs	1,063,550	159,532	723,214
21 yrs	1,250,608	187,591	850,413

TOTAL ERs (tCO2e) (landfill + electricity)	Emissions Baseline	Emissions Project	ERs
7 yrs	686,861	103,029	467,066
10 yrs	880,798	132,120	598,943
14 yrs	1,063,550	159,532	723,214
21 yrs	1,250,608	187,591	850,413

ELECTRICITY GENERATION	10 yrs	21 yrs
Total Net Power Output: MWh	65,400	65,400
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	0%
PROJECT DATA	
Date gas collection project starts (year)	2004
Proportion of methane collected (%)	85%
Reduction due to uncertainty	20%
Electricity generaion factors:	
Engine Heat Rate:Btu/Kwh	10,625
Reciprocating Engine Generator Rating: kW	1,000
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)	335,024,723	2,165,219,516
Total Methane Produced (t)	113,739	735,081

LANDFILL ERs (t CO2e)	Emissions Baseline	Emissions Project	ERs
7 yrs	1,828,872	274,331	1,554,541
10 yrs	3,748,373	562,256	3,186,117
14 yrs	7,470,819	1,120,623	6,350,196
21 yrs	16,659,501	2,498,925	14,160,576

TOTAL ERs (tCO2e) (landfill + electricity)	Emissions Baseline	Emissions Project	ERs
7 yrs	1,828,872	274,331	1,554,541
10 yrs	3,748,373	562,256	3,186,117
14 yrs	7,470,819	1,120,623	6,350,196
21 yrs	16,659,501	2,498,925	14,160,576

ELECTRICITY GENERATION	10 yrs	21 yrs
Total Net Power Output: MWh	327,000	588,600
Total ERs (21 years - t CO2)	0	0