

**D. MONITORING METHODOLOGY AND PLAN****D.1. Name and reference of approved methodology applied to the project activity:**

AM0003 version 1: 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:**

The project directly monitors and calculates ERs. The following data will be collected.

Additional Information on Parameters to be monitored during Phase I:

<b>Data / Parameter:</b>	$Q_{\text{biogas}}$
Data unit:	Nm <sup>3</sup>
Description:	Amount of biogas sent to flare, at normal Temperature and Pressure
Source of data to be used:	Project developer
Description of measurement methods and procedures to be applied:	Data will be measured with a Thermal Mass Flow Meter and monitored continuously (average value in a time interval not greater than 10 minutes) by the Project Developer. Separate monitoring of Temperature and Pressure is no longer necessary when using modern flow meters, which automatically measure the temperature and pressure, expressing LFG volumes in normalised cubic meters Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	The flow meter will be calibrated as per manufacturer specifications. The calibration frequency will be every 18 months, with a standard gas certified by Laboratories or Manufacturer
Any comment:	It will be subject to a regular maintenance. Data will be kept on the electronic spreadsheet for 2 years after the end of the crediting period

<b>Data / Parameter:</b>	Flare Efficiency
Data unit:	%
Description:	Percentage of methane in the biogas

Source of data to be used:	Project Developer
Description of measurement methods and procedures to be applied:	<p>Calculated according to the “Tool to determine project emissions from the flaring gases containing methane” (Step 6) using data from methane content in the exhaust gas, methane content in the residual gas and recorded temperature (i.e., if the temperature is less than 760°C for any particular hour, then it shall be assumed that during that hour the flare efficiency is zero).</p> <p>The gas analysis and calculation will be done by Laboratories.</p> <p>This parameter will be monitored every 6 months or monthly if unstable according to the applied Methodology AM0003. Version 1.</p>
QA/QC procedures to be used:	The Project Participants or Laboratories will provide the calculations, for the flare efficiency following the steps, of calculation of the Annex 13 – UNFCCC - “Tool to determine project emissions from flaring gases containing methane” in the EB 28 Meeting Report
Any comment:	Data will be kept on the electronic spreadsheet for 2 years after the end of the crediting period

<b>Data / Parameter:</b>	Tf
Data unit:	°C
Description:	Temperature of the Flare
Source of data to be used:	Project Developer
Description of measurement methods and procedures to be applied:	<p>Measured according to the “Tool to determine project emissions from the flaring gases containing methane” EB28. The temperature of the exhaust gas stream in the flare will be measured using a Type N thermocouple. A temperature above 760 °C indicates that a significant amount of gases are still being burnt and that the flare is operating. This value was selected for conservativeness following manufacturer specifications (i.e., the optimal operational conditions for methane destruction (flare efficiency) are between 760 C degrees (or 1400 F).</p> <p>Separate monitoring of flare working hours is therefore no longer necessary, because non operational hours are recorded simultaneously by the thermocouple when the flare operates below 760 °C. Nevertheless, the PLC system registers the number of flare working hours, which is used as a reference to confirm that the flare is working.</p>
QA/QC procedures to be used:	Thermocouples should be replaced or calibrated as per manufacturer specifications
Any comment:	This will be monitored every 6 months. Data will be kept on the electronic spreadsheet for 2 years after the end of the crediting period

<b>Data / Parameter:</b>	% CH4
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Data unit:	m <sup>3</sup> CH <sub>4</sub> / m <sup>3</sup> LFG
Description:	Percentage of methane in the biogas
Source of data to be used:	Project Developer
Description of measurement methods and procedures to be applied:	Methane content will be measured continuously (average value in a time interval not greater than 10 minutes) with a gas analyzer by the Project Developer. Data will be aggregated monthly and yearly.
QA/QC procedures to be used:	The gas analyzer will be subject to regular maintenance, and testing. The calibration regime is regular 6 month intervals, after being placed in service, in accordance with manufacturer specifications to ensure its accuracy
Any comment:	Data will be kept on the electronic spreadsheet for 2 years after the end of the crediting period

Data / Parameter:	PE <sub>LPG</sub>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from fossil fuel (LPG) combustion
Source of data to be used:	2006 IPCC Guidelines for national Greenhouse Gas Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Calculated by monitoring the number of ignitions and then multiplying these by the emissions per ignition, as per IPCC Guidelines (9.97E-11 per ignition)
Description of measurement methods and procedures to be applied:	Calculated by multiplying number of ignitions used to ignite the flare system, times the emissions per ignition.
QA/QC procedures to be used:	The information for calculation of the LPG consumption will need sources with Manufactures, Scientific Handbooks, or evidences that will be validated for the DOE
Any comment:	Data will be kept on the electronic spreadsheet for 2 years after the end of the crediting period

Data / Parameter:	PE <sub>EC,y</sub>
Data unit:	tCO <sub>2</sub>
Description:	Project emissions from electricity consumption by the project activity during the year y
Source of data to be used:	Publication by Brazilian Ministry of Science and Technology of values for OM <sub>grid</sub> and BM <sub>grid</sub>
Description of	This parameter is calculated using the "Tool to calculate the emission

measurement methods and procedures to be applied:	factor for an electricity system” Version 2, involving the calculation of the $EF_{grid,CM,y}$ , which in its turn is calculated using the $OM_{grid}$ and $BM_{grid}$ published by Brazilian Ministry of Science and Technology
QA/QC procedures to be used:	
Any comment:	Data will be kept on the electronic spreadsheets for two years after the end of the crediting period.

<b>Data / Parameter:</b>	<b>EC</b>
Data unit:	MWh per month
Description:	Electrical energy consumed per month
Source of data to be used:	Project Developer (measured by the Project Developer in the Adrianopolis site, and by the Local Supplier Energy (Light Energia SA) in the Marambaia Site)
Description of measurement methods and procedures to be applied:	The electrical energy consumed will be measured by an electricity meter installed in the Flare Unit. This parameter is monitored continuously and archived daily in electronic format and monthly in paper format. Data will be aggregated weekly, monthly and yearly.
QA/QC procedures to be used:	Electricity meter will be subject to regular (in accordance with manufacturer specifications) maintenance and testing to ensure accuracy
Any comment:	Maintenance and calibration will be per manufacturer specifications. Data will be kept on the electronic spreadsheet for 2 years after the end of the crediting period

#### **Parameters that will be monitored after implementation of Phase II**

<b>Data / Parameter:</b>	<b>EGy</b>
Data unit:	MWh
Description:	Amount of electricity generated using LFG
Source of data to be used:	Project Developer
Description of measurement methods and procedures to be applied:	To be monitored continuously with an electricity meter
QA/QC procedures to be used:	Electricity meter will be subject to regular (in accordance with manufacturer specifications) maintenance and testing to ensure accuracy. Their readings will be double-check by the electricity distribution company.
Any comment:	Required to estimate the emission reductions from electricity generation

	from LFG. Data will be aggregated monthly and yearly
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<b>Data / Parameter:</b>	Heat Rate
Data unit:	GJ/MWh
Description:	Generator heat rate
Source of data to be used:	Project Developer
Description of measurement methods and procedures to be applied:	The procedure to calculate the Heat Rate is as follows: the methane flow sent to the engines is multiplied by the calorific power of the methane, and divided by the electrical energy generated. This parameter will be monitored every 6 months or monthly if unstable according to the applied Methodology AM0003. Version 1.
QA/QC procedures to be used:	All parameters will be monitored by internal procedures that will be developed in accordance with manufacturer specifications of the equipments.
Any comment:	Required to estimate the emission reductions from electricity generation from LFG. Data will be used to test and, if necessary, correct the generator's name plate heat rate

**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 in accordance with the requirements of the manufacturer of the equipments (meter)

**Procedure for replacement of monitoring equipment :** NovaGerar will develop a specific Instruction of work for controlling and replacement equipments. This procedure has daily routines for check the calibration date, and whenever is necessary change the meters, NovaGerar staff will register in a specific form the date, hour, serial number, operator name, operator signature, and other relevant information for crosscheck information and ensure the calibration of the meters.

**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.