CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

PROBIOGAS-JP – João Pessoa Landfill Gas Project
Version 2
12/01/2007

A.2. Description of the project activity:

The PROBIOGAS-JP´s aim is to capture and flare the landfill gas produced at João Pessoa Landfill, owned by Rumos Construções Ambientais and located in João Pessoa City, Paraíba, Brasil, in order to avoid emissions of methane gas to the atmosphere.

The João Pessoa (JP) Landfill counts on the best management practices for such business. Modern engineering techniques have been applied during the design and operation of this landfill. The leachate is collected and sent for treatment and all the pertinent environmental variables are continuously monitored, as presented on Figure 1.

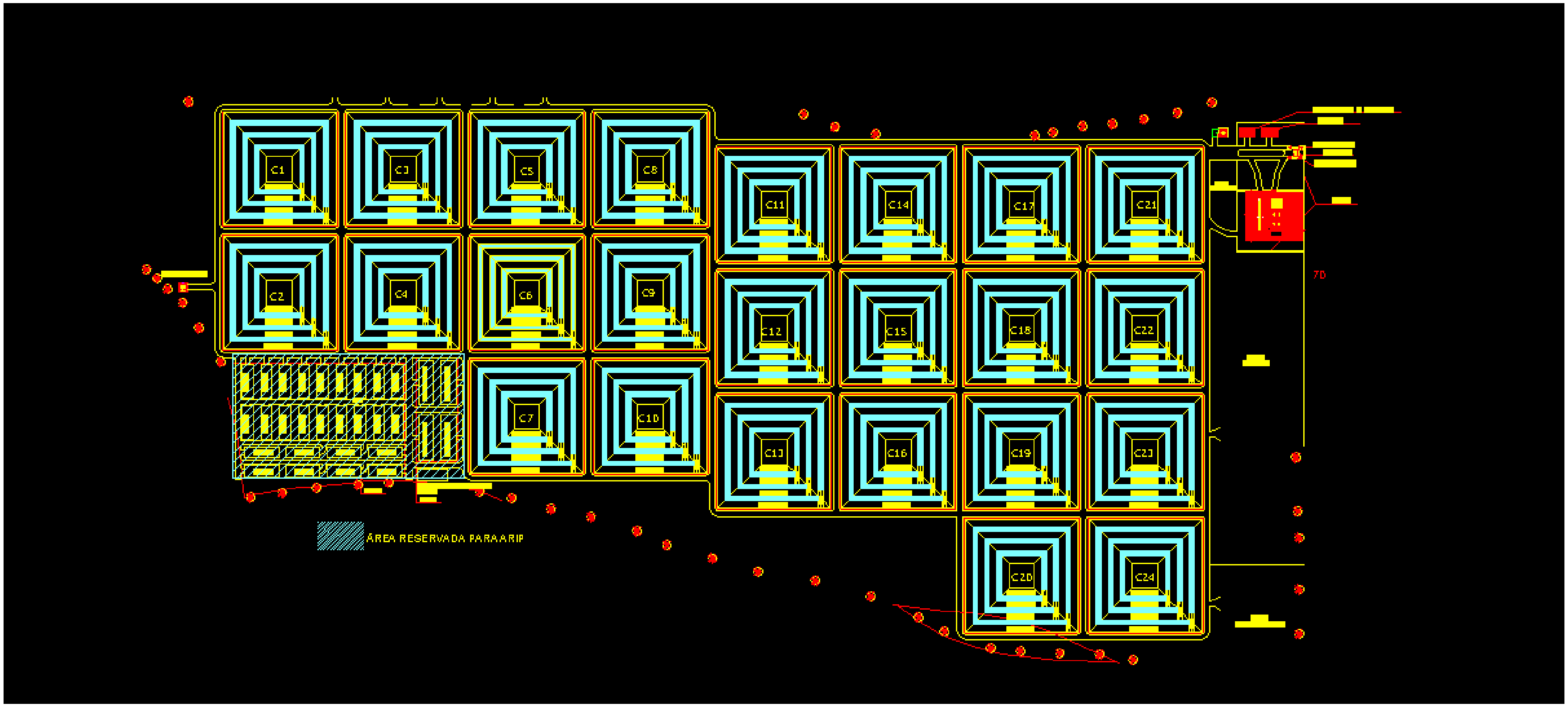


Figure 1. João Pessoa's Landfill design

The landfill gas (LFG) is collected through a passive system, with no systematic and monitored flare. Therefore, the CDM and the CERs revenue are an extra-incentive for Rumos Construções Ambientais to make additional investments, enhance its landfill gas collection rate and install appropriate facilities to properly flare the methane produced at the site.

The JP Landfill is one of the fewest landfills in the Northeast region of Brazil and it is located in the Metropolitan Region of João Pessoa, the most populated city of Paraíba State. As most of the municipalities of Paraíba does not have enough subsidy to operate the landfill, João Pessoa Landfill is considered a plausible and correct environmental choice to solve the waste disposal problem of the city.

The JP landfill attends five cities around João Pessoa, achieving a total of around 1.500 tons of waste per day (João Pessoa is responsible for 1.200 tons/day), and is projected to receive around 8.000.000 tons of waste until 2020.

The JP landfill has an estimated lifetime of more than 22 years, which means that the region attended by the landfill will be benefited for more than 20 years. Moreover, there are no potential feasible areas for landfill development in the region, as it is highly urbanized and fragile environmental systems are protected by legislation. Then, the landfill gas collection and flare will be guaranteed throughout PROBIOGAS-JP's lifetime.

The PROBIOGAS-JP will have a significant impact on sustainable development in João Pessoa. This can be evidenced by the following aspects:

- reduction of methane emissions, a greenhouse gas;
- minimization of the explosion risk at the landfill site – although João Pessoa Landfill's engineering and design avoids this type of accidents
- significant technology transfer will be necessary for the project's implementation and operation, considering that initiatives of this kind are relatively new in Brazil
- specialized operators will be necessary for project operation, which means a positive impact on employment and capacity-building.

An implementation schedule estimative for similar projects is showed in Figure 2.

REF	Work to Do	Time	Months								
			1	2	3	4	5	6	7	8	9
1	Executive Project	60 Days									
2	Approval of eventual changes in the project	30 Days									
3	Construction of equipment	120 Days									
4	Shipping of imported equipment	30 Days									
5	Construction Works	30 Days									
6	Request of national equipment	60 Days									
7	Construction of wells and HDPE lines	90 Days									
8	Start-up	30 Days									

Figure 2. Estimative of the implementation process schedule

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	• Brazilian private entity: Rumos Construções Ambientais Ltda. • Brazilian Private entity: Econergy Brasil Ltda.	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party (ies) involved is required.		

Rumos's main policy and mission is to develop activities related to the Planning and Management of Landfills, applying the following ethical principles of responsible acts:

- attend the environmental requirements and the code of its applicable practices;
- improve, continuously, the environmental management performance, using methodologies or materials that prevent, reduce or control the pollution;
- research technological innovations which reduces the environmental impacts;
- participate in public or private initiatives about the environment conservation.

The company provides adequate solutions for final destination of waste class II-A and II-B[1], generated by municipalities, commerce and industrial companies.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

João Pessoa Landfill is located in the city of João Pessoa (the capital of Paraíba State), at BR 101, km 23.

A.4.1.1. Host Party(ies):

Brazil

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

Paraíba

A.4.1.3. City/Town/Community etc:

João Pessoa

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The Figure 3 shows the location of Paraíba State, João Pessoa city and the JP Landfill.

[1] Residues in Brazil are classified under standard NBR 10004, from ABNT, from November 2004. Class I residues are classified as hazardous or present one of the following characteristics: flammability, power of corrosion, reactive properties, toxicity and pathogenicity. Class II residues are classified as non-hazardous residues and divided into II-A Class – Non-Inerts, not classified as Class I residues nor Class II-B, might present the following characteristics: biodegradability, power of combustion or water solubility. Class II-B residues are inerts, not presenting constitutants when solubilized in standard above the potable water

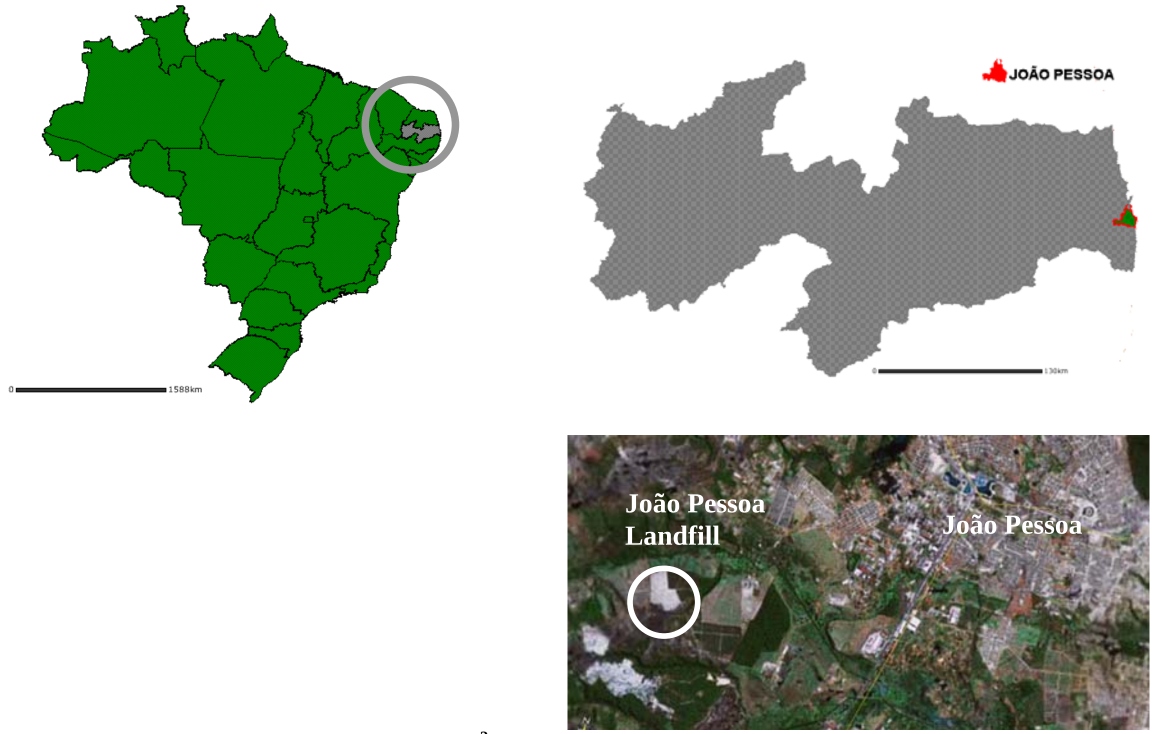


Figure 3. PROBIOGAS-JP's location (Source: IBGE[2] and Google Earth)

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

PROBIOGAS-JP is designed as a sectoral scope 13 – waste handling and disposal – project.

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

Rumos uses only state-of-the-art landfill technology in JP landfill, such as:

- installation in an area used previously as a sand mine for the civil construction;
- impermeabilization of the landfill's basis, with a 1,5 meter clay layer;
- leachate collection and treatment in biologic lagoons;
- use of tractors to compact the waste disposed;
- draining of LFG from inside the landfill to the atmosphere (concrete wells);
- control of waste reception;
- monitoring of underground water, in order to analyze if the leachate is being collected correctly.

The technology to be employed will be the improvement of landfill gas collection and flaring, through the installation of an active recovery system composed by:

- a collection pipeline;
- a transportation pipeline network;
- a blowering system; and
- a flaring system.

Figure 4 presents a lay-out of such kind of installation.

[2] Adapted from <http://mapas.ibge.gov.br >

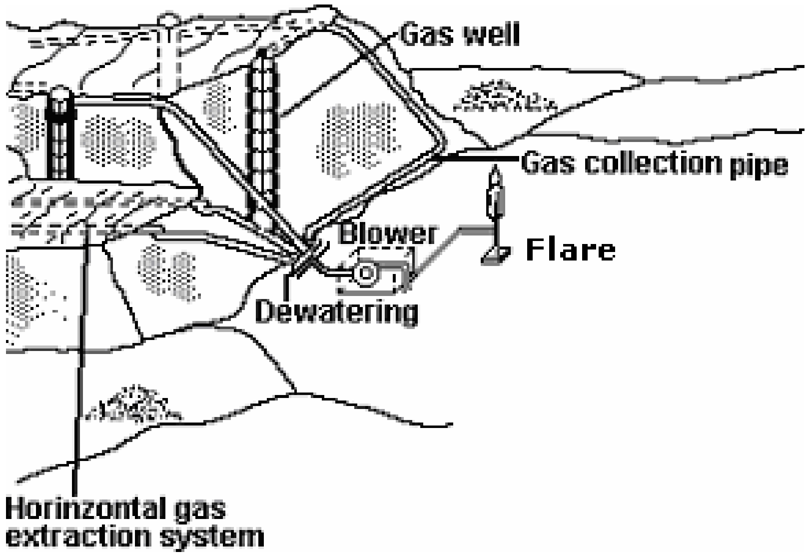


Figure 4. Schematic situation of a landfill with active gas recovery (Source: WILHELM, 1991[3])

a) Collecting System

Following concrete examples from other landfill gas projects in the world, the PROBIOGAS-JP will involve the installation of wellheads at the existing concrete wells to avoid the emission of methane to the atmosphere. An example of wellhead and the detail of its construction are shown in Figure 5 and Figure 6.

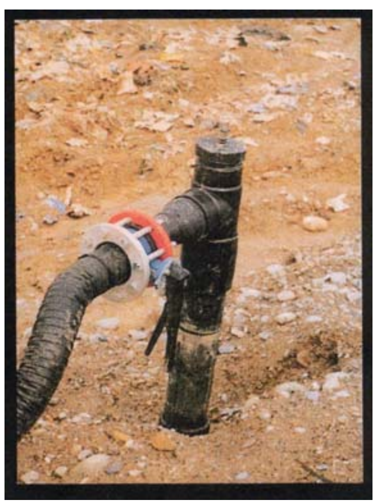


Figure 5. Example of wellhead (source: Multiambiente[4])

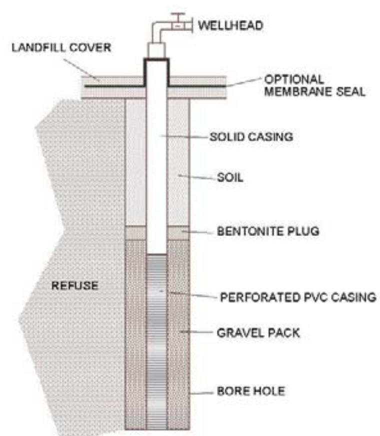


Figure 6. Internal detail of a well and wellhead (source: USEPA, 1996[5])

The use of the existing wells represents a distinct advantage since they are already installed and at that

[3] **V. WILHELM;** *Safety Aspects of the Planning, Construction and Operation of Landfill Gas Plants*; paper; Sardinia 91 Third International Landfill Symposium; S. Margherita di Pula, Cagliari, Italy; 14 - 18 October 1991

[5] USEPA – United States Environmental Agency; *Turning a Liability into an Asset: a Landfill Gas-to-Energy Project Development Handbook*; LMOP – Landfill Methane Outreach Program, 1996

location most of the gas flows to the atmosphere. However, some physical barriers might interrupt the gas flow from the generation point to the well, so new wells might need to be drilled.

Usually, the wellheads are made of PCV of HDPE, due to the flexibility and the corrosion resistance.

The wellheads are connected to a collecting pipeline. This pipeline transports the landfill gas to the manifolds or gas regulation stations. These facilities can regulate the concentrations of O_2 in the gas collected. Case the concentrations are above a certain value, it means that maybe some air are infiltrating in the landfill and the valve corresponding to the wellhead must be closed. These facilities transfer the collected gas to the transmission pipeline and can be connected to more than ten wellheads.

Figure 7. Example of manifold, connected to the transmission pipeline

Figure 8. Example of Gas Regulation Station (source: Multiambiente, accessed on January 31st, 2006[6])

b) Transmission Pipeline

The transmission pipeline is the last step of the collecting system. It transports the collected landfill gas to the flare. The transmission pipeline might be connected to all manifolds or gas regulation stations around the landfill.

Figure 9. Example of a transmission pipeline

The collecting pipeline and the transmission pipeline are both usually in HDPE, because this material can support high pressures and is flexible. The transmission pipeline is finally connected to the flare. A

[6]Multiambiente; available at <http://www.multiambiente.com.br/tecnologias/html/biogas.asp>; accessed on Jan 31st, 2006

common practice all over the world is to use HDPE equipment. It has the advantage to be more flexible and more resistant to high pressure, if compared to metal or concrete equipment. The disadvantage is represented by the high cost involved.

c) Blowering System

The blowering system is responsible to give negative pressure to the landfill, blowing the gas to the pipeline. The dimensioning of the blower will depend on the final use of the gas (flare, boiler, electricity). As the PROBIOGAS-JP will only flare the gas, the collecting pressure will not be higher than 1,5 bar.

In order to preserve the operation of the blowers, a dewatering system might be installed to remove the condensate. This equipment might be an absorption chiller (depending on the landfill gas flows and the final use and the gas moisture) or a single knock-out dewatering component.

Figure 10. Example of a blowering system (source: John Zink, accessed on January 31st, 2006[7])

Figure 11. Example of Absorption Chiller (source: Biogás Ambiental, acessed on January 31st, 2006[8])

d) Flare System

The destruction of the methane content in the landfill gas collected will be made via an enclosed flare, in order to assure a higher methane destruction (above 99%).

Basically, the flare is constructed using refractory material, a gas inlet, dampers to control the air inlet, an ignition spark, e flame viewer and points to sample collection, as presented in the pictures below:

[7] John Zink Company LLC, available at http://www.johnzink.com/products/flares/pdfs/biog_advanced_flare_wastewater.pdf, accessed on January 31st, 2006

[8] Biogás Ambiental, available at <http://www.biogas-ambiental.com.br>, acessed on Jasnuary 31st, 2006

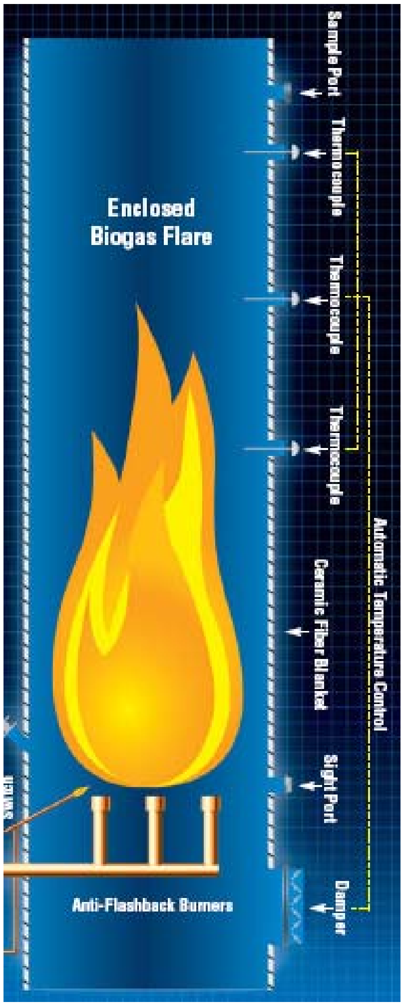


Figure 12. Detail of an Enclosed Flare (source: John Zink, accessed on January 31st, 2006)

Figure 13. Enclosed Flare installed (source: John Zink, accessed on January 31st, 2006)

This kind of technology is still not widely applied in Brazil. Very few landfills have already installed equipment for improving the amount of landfill gas collected. Therefore, Rumos will need engineers and other specialists with experience in this area to advice the company while implementing the project. These professionals will also train local operators and engineers on operations and maintenance of the facilities.

Despite the fact that landfill gas projects can be of great potential in Brazil, the local market does not have flare suppliers. Technology will have to come from abroad and mainly from the United States and Europe. Hence, technology transfer will occur from countries with strict environmental legislative requirements and environmentally sound technologies.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Years	Annual estimation of emission reductions in tonnes of CO2e
2007*	28 627
2008	140 615
2009	166 521
2010	192 308
2011	217 923
2012	243 447
2013	268 824
2014*	219 791
Total estimated reductions (tonnes of CO2e)	**1 478 057**
Total Number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	**211 150**

* The crediting period will be from 01/10/2007 to 30/09/2014.

A.4.5. Public funding of the project activity:

There is no Annex I public funding involved in this project activity.

SECTION B. Application of a baseline and monitoring methodology

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

- Version 05 of ACM0001: *"Consolidated baseline methodology for landfill gas project activities"*;

- Version 06 of ACM0002: *"Consolidated Methodology for grid-connected electricity generation from renewable sources"*;

- Version 02 of the *"Tool for demonstration and assessment of additionality";*

- Version 01 of the *"Methodological Tool to determine project emissions from flaring gases containing methane"*.

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

ACM0001 is applicable to PROBIOGAS-JP because:

i) the baseline scenario is the partial or total gas release to the atmosphere (business as usual scenario);
ii) the project activity is the capture of the LFG through a blower and the installation of a collecting system and the use of a flare to burn the methane.

B.3. Description of the sources and gases included in the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Baseline emissions	CO_2	No	

		CH_4	Yes	Natural methane emissions due to the decomposition of the waste.
		N_2O	No	
Project Activity	Electricity consumption	CO_2	Yes	Electricity consumed by the LFG blower and/or electricity produced by diesel engines installed.
		CH_4	No	
		N_2O	No	

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The baseline scenario is the natural emission of the LFG (generated due to the decomposition of the waste) to the atmosphere as a continuation of the landfill's operation (business as usual situation). As per security and odour concerns, it's estimated that about 10% of the total LFG generated is burned in the concrete wells.

B.5. 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 (assessment and demonstration of additionality):

Application of the Tool for the demonstration and assessment of additionality.

Step 0. Preliminary screening based on the starting date of the project activity

Step 0 is not applicable for the project activity because the crediting period of the PROBIOGAS-JP will start after the registration of the project activity.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations.

Sub-step 1a: Define alternatives to the project activity

As there is no legislation that obligates the landfill to destroy methane, there is one single alternative to the project activity that is to continue with its core business (final disposal of solid waste) without methane destruction.

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

The continuation of the business as usual situation is consistent with the applicable laws and regulations of Brazil.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

As the CDM project activity generates no financial or economic benefits other than CDM related income, the simple cost analysis scenario is applied.

Sub-step 2b. – Option I. Apply simple cost analysis

As the baseline scenario is in accordance with national laws and regulations and as the project activity will not receive income from the sale of electricity or methane, the implementation of the project activity will have no other benefits than the CDM revenues. The Table 1 below shows a simple estimative of a similar project cost.

TOTAL COLLECTION PIPELINE	1.216	**m**
TOTAL TRANSPORTATION PIPELINE	450	**m**
TOTAL WELLHEADS	28	**units**

UNIT PRICE		
Collection Pipeline	7,10	**EUR/m**
Transportation Pipeline	32,10	**EUR/m**
Wellheads	465,00	**EUR/unit**

FINAL COLLECTION AND TRANSPORTATION PIPELINE COSTS	***€ 36.089,61***
COSTS OF MONITORING AND FLARING SYSTEM	***€ 260.400,00***
TOTAL COSTS	***€ 296.489,61***

Income without the CERs revenue	€ 0,00
Total income	*€ 0,00*
Material costs	€ 296.489,61
Executive Projects	€ 100.000,00
Facility build and system assembly	€ 15.000,00
Total costs	*€ 411.489,61*
Income - Costs	**€ 411.489,61**
IRR (%)	**Not applicable**

Table 1 – Cost estimative

Step 4. Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity
According to the latest official statistics on urban solid waste in Brazil – *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000) – the country produces 228,413 tons of waste per day, which corresponds to 1.35 kg/inhabitant/day. And though there is a worldwide trend towards reducing, reusing and recycling, therefore reducing the amount of urban solid waste to be disposed in landfills, the situation in Brazil is peculiar. Most of the waste produced in the country is sent towards open dumps which are, in most of the cases, areas without any sort of proper infrastructure to avoid environmental hazards. Figure 14 shows the final destination of the waste per municipality, according to PNSB 2000.

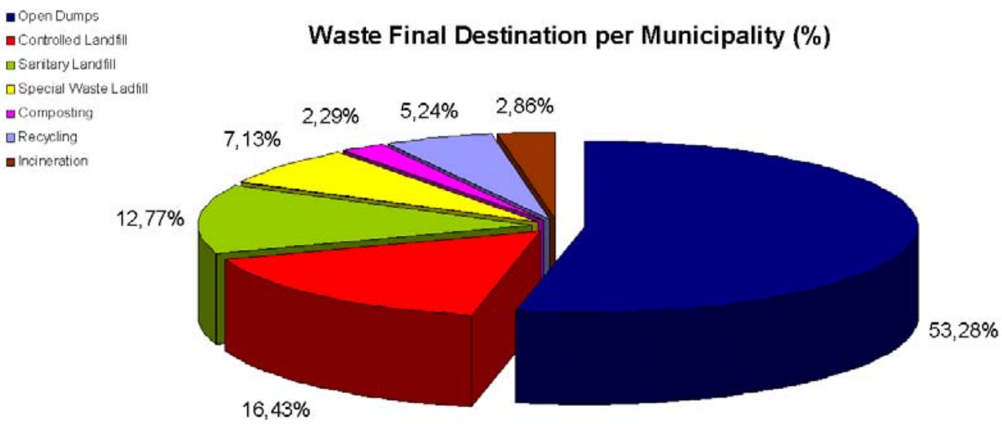


Figure 14. Waste Final Destination per Municipality in Brazil (Source: PNSB, 2000[9])

Only few of the existing Brazilian landfills have installed a collecting and flaring methane system. The majority of landfills operate with natural emission of methane to the atmosphere, through concrete wells.

Sub-step 4b. Discuss any similar options that are occurring:
There is no project activity implemented in Brazil with a forced methane extraction and destruction, using blowers, collection system and flaring system, without the CDM incentive.

However, there are some CDM project activities implemented using a similar technology, as examples the Bandeirantes Landfill, Nova Gerar Landfill, Onyx Landfill, Marca Landfill, Sertãozinho Landfill, Salvador da Bahia Landfill and ESTRE Paulínia Landfill.

This kind of project activity is not widely spread in Brazil and the landfills that operate this type of project represent only a small portion of the total existing solid waste disposal sites.

Step 5. Impact of CDM registration
CDM registration will be the only way to implement the project activity. The commercialization of the generated CERs represents the sole benefit of the project. Registration will reduce investment risk and foster the project owners into expanding business activities.

The benefits and incentives mentioned in the Tool for demonstration and assessment of additionality will also be experienced by the PROBIOGAS-JP: anthropogenic GHG reductions; financial benefits from the revenue obtained by selling CERs; and, likelihood to attract new players and new technologies (currently there are companies developing new technologies of LFG extraction and extra-efficient flares and the purchase of such equipment is to be fostered by the CER sales revenue) thus reducing investor's risk.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The Methodology ACM0001 states that greenhouse gas emission reduction achieved by the project activity during a given year "*y*" (ER_y) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,\ y}$) and the amount of methane that would have been

[9] IBGE - Instituto Brasileiro de Geografia e Estatística. *Pesquisa Nacional de Saneamento Básico*, 2000.

destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$), times the approved Global Warming Potential value for methane (GWP_{CH4}), plus the emission reductions of the net electricity fed to the grid ($EL_{EX,LGFG} - EL_{IMP}$) minus the emission reduction due to the replacement of the fossil fuel used in the baseline, as follows:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times 21 + \left(EL_{EX,LGFG} - EL_{IMP}\right) \times CEF_{electricity} - ET_y \times CEF_{thermal} ,$$

where:
ER_y = emission reductions of the project activity in year *y* (tCO_2e);
$MD_{project,y}$ = quantity of methane destroyed at year *y* (tCH_4);
$MD_{reg,y}$ = methane that would have been destroyed during the year *y* in the absence of the project activity (tCH_4);
GWP_{CH4} = Global Warming Potential of Methane (tCO_2e/tCH_4);
$EL_{EX,LGFG}$ = net quantity of electricity exported during year y, produced using landfill gas (MWh).
EL_{IMP} = net incremental electricity imported, defined as difference of project imports less any imports of electricity in the baseline, to meet the project requirements (MWh);
$CEF_{electricity}$ = CO_2 emissions intensity of the electricity displaced (tCO_2e/MWh);
ET_y = incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y (TJ);
$CEF_{thermal}$ = CO_2 emissions intensity of the fuel used to generate thermal/mechanical energy, (tCO_2e/TJ);

As the PROBIOGAS-JP is not a project to produce and sell electricity to the grid and as the landfill did not consume fossil fuel for energy requirements in the baseline, $EL_{EX,LGFG} = 0$ and $ET_y = 0$.

So, the formula is updated to:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times 21 - EL_{IMP} \times CEF_{electricity}$$

The PROBIOGAS-JP does not have any contractual obligations to burn methane; so $MD_{reg,y}$ is calculated based on the “Adjustment Factor”, a value estimated as 10% of total methane produced at the baseline that is flared due to odor and security concerns:

$$MD_{reg,y} = 0,1 \times MD_{project,y}$$

and

$$ER_y = 0,9 \times MD_{project,y} \times 21 - EL_{IMP} \times CEF_{electricity}$$

As the project won’t produce electricity or replace a fossil fuel consumed in the baseline, the methane destroyed by the project activity $MD_{project,y}$ during year *y* is determined by monitoring only the quantity of methane actually flared:

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

and

$$MD_{flared,y} = LFG_{flared,y} \times w_{CH_4} \times D_{CH_4} \times FE \text{ , where}$$

$MD_{flared,y}$ = quantity of methane destroyed by flaring during year y (tCH_4);
$LFG_{flared,y}$ = quantity of landfill gas flared during the year (Nm^3_{LFG});
$w_{CH4,y}$,= methane fraction of the landfill gas (Nm^3CH_4/Nm^3_{LFG});
D_{CH4} = methane density (0,0007168 t_{CH4}/Nm^3_{CH4} at 0ºC and 1,013 bar);
FE = flare efficiency (%).

The estimate of the amount of landfill gas produced during year y is shown in B.6.3. The data used to determine the baseline scenario is presented in Annex 3

In other words, ER_y is equal to:

$$ER_y = \left(0{,}9 \times LFG_{flared,y} \times w_{CH_4} \times D_{CH_4} \times FE \times 21\right) - EL_{IMP} \times CEF_{electricity}$$

$LFG_{flared,y}$ was estimated using IPCC's guidelines[10]. In the case of PROBIOGAS-JP, the derivative of first order decay model approach was used:

$$LFG_{flared,y} = CE \times \frac{k \times R_y \times L_0 \times \sum_{i=y}^{T} \sum_{j=y}^{i} \left[e^{-k(i-j)}\right]}{F}$$, where:

- CE = collection efficiency (%);
- k = decay constant (1/year);
- R_y = amount of waste disposed on year y (kg);
- L_0 = methane potential generation (m^3_{CH4}/Mg_{waste});
- T = actual year;
- y = year of waste disposal;
- F = fraction of methane at the landfill gas (%).

Thus, the ER_y is calculated as follows:

$$ER_y = \left(0{,}9 \times CE \times \frac{k \times R_y \times L_0 \times \sum_{i=y}^{T} \sum_{j=y}^{i} \left[e^{-k(i-j)}\right]}{F} \times w_{CH_4} \times D_{CH_4} \times FE \times 21 \right) - EL_{IMP} \times CEF_{electricity}$$

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**CE**
Data unit:	%
Description:	Collection Efficiency
Source of data used:	**USEPA**; *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook*; September 1996

[10] Revised 1996 IPCC Guidelines for National Greenhouse Gases Inventory.

Value applied:	65%
Justification of the choice of data or description of measurement methods and procedures actually applied :	According with USEPA, a collection efficiency for energy recovery between 75% and 85% sounds reasonable "because each cubic foot of gas will have a monetary value to the owner/operator". A conservative value of 65% was adopted. So, $LFG_{flare,y}$ is equal to 65% of total landfill gas emitted to the atmosphere at the baseline
Any comment:	

Data / Parameter:	**k**
Data unit:	1/year
Description:	Decay Constant
Source of data used:	**USEPA**; *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook*; September 1996
Value applied:	0,1
Justification of the choice of data or description of measurement methods and procedures actually applied :	It was chosen this parameter as *0,1/year*, upper from the lowest of the suggested value, considering a wet climate (the situation of João Pessoa).
Any comment:	

Data / Parameter:	$\mathbf{R_y}$
Data unit:	t_{waste}
Description:	Tons of waste disposed in year *y*
Source of data used:	Rumos
Value applied:	Variable
Justification of the choice of data or description of measurement methods and procedures actually applied :	Estimative from Rumos of waste received.
Any comment:	Estimated based on Rumo's project.

Data / Parameter:	$\mathbf{L_0}$
Data unit:	m^3_{CH4}/kg_{waste}
Description:	Methane Potential Generation
Source of data used:	**USEPA**; *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook*; September 1996
Value applied:	0,07 m^3_{CH4}/kg_{waste}
Justification of the choice of data or description of measurement methods and procedures actually applied :	The source suggest values of *k* and L_0 to be applied to the model. Because of the uncertainty in estimating L_0, gas flow estimates derived from the model should also be bracketed by a range of plus or minus 50 percent. To make a conservativeness approach, L_0 was assumed to be minus 50% of the lowest value of the range (2,25-2,88 ft^3/lb). Converting the units to m^3_{CH4}/kg_{waste}, the value assumed for L_0 is *0,07*.
Any comment:	

Data / Parameter:	Regulatory requirements relating to landfill gas projects
Data unit:	N/A
Description:	Legal requirements of methane destruction.
Source of data used:	National Legislation or any other applicable.
Justification of the choice of data or description of measurement methods and procedures actually applied :	As there is no obligation to burn the gas produced, a conservative value of 10% was applied.
Any comment:	Required for any changes to the adjustment factor (AF), at the renewal of the crediting period.

B.6.3 Ex-ante calculation of emission reductions:

As mentioned on B.6.1, the calculation of emission reductions for a certain year *y* will be calculated through the formula below:

$$ER_y = \left(0,9 \times CE \times \frac{k \times R_y \times L_0 \times \sum_{i=y}^{T} \sum_{j=y}^{i} \left[e^{-k(i-j)} \right]}{F} \times w_{CH_4} \times D_{CH_4} \times FE \times 21 \right) - EL_{IMP} \times CEF_{electricity}$$

The following data is applied to the formula:

Year of Opening	2003
Year of Closure	2020*
Daily Waste Flow (t/day)	Variable
Collection Efficiency (%)	65%
Flare Efficiency (%)	90%
Blower consumption (MWh/year)	3.000
Emission Factor (tCO_2e/MWh)	0,0767
k (1/year)	0,1
L_0 ($m^3_{methane}/kg_{waste}$)	0,07

* There is an expectative to increase the lifetime of the project activity until 2028.

a) Baseline emissions:

Appling the derivative of the First Order Decay Model, the methane baseline estimative is:

Table 2. Estimative of methane emissions in the baseline

Year	LFG emissions (Nm^3_{lfg})	Methane Emissions (Nm^3_{CH4})	Year	LFG emissions (Nm^3_{lfg})	Methane Emissions (Nm^3_{CH4})
2003	2.007.648	1.003.824	2021	101.494.651	50.747.326
2004	8.824.787	4.412.394	2022	91.836.158	45.918.079
2005	15.639.494	7.819.747	2023	83.096.792	41.548.396
2006	22.327.199	11.163.599	2024	75.189.087	37.594.544
2007	28.954.485	14.477.243	2025	68.033.899	34.016.950
2008	35.543.101	17.771.551	2026	61.559.618	30.779.809
2009	42.080.728	21.040.364	2027	55.701.446	27.850.723
2010	48.588.217	24.294.109	2028	50.400.752	25.200.376
2011	55.052.437	27.526.219	2029	45.604.487	22.802.243
2012	61.493.505	30.746.753	2030	41.264.646	20.632.323
2013	67.897.624	33.948.812	2031	37.337.796	18.668.898
2014	74.284.311	37.142.156	2032	33.784.635	16.892.317
2015	80.655.224	40.327.612	2033	30.569.602	15.284.801
2016	86.995.865	43.497.932	2034	27.660.519	13.830.260
2017	93.309.114	46.654.557	2035	25.028.273	12.514.136
2018	99.613.578	49.806.789	2036	22.646.518	11.323.259
2019	105.894.092	52.947.046	2037	20.491.417	10.245.708
2020	112.168.937	56.084.469	2038	18.541.401	9.270.700

b) Project emissions:

The only source of GHG project emissions is the CO_2 emissions due to the import of electricity is calculated multiplying the grid's Emission Factor (EF) by the amount of electricity imported, in MWh, as presented on Annex 3.

As demonstrated on Annex 3, the EF for the N-NE Brazilian electric grid is equal to 0,0767 tCO_2e/MWh. Assuming that the blower is estimated to need around 3 000 MWh/year (imagining a 380 kW blower installed). That gives emission due to the import of electricity equals to 230 tCO_2e/year.

c) Leakage

According with ACM0001 – version 5, no Leakage emissions need to be considered for PROBIOGAS-JP.

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emission (tonnes of CO_2e)	Estimation of the baseline emission (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2007	58	28 684	0	28 627
2008	230	140 845	0	140 615
2009	230	166 751	0	166 521
2010	230	192 538	0	192 308
2011	230	218 154	0	217 923
2012	230	243 677	0	243 447
2013	230	269 054	0	268 824
2014	172	219 963	0	219 791
TOTAL	**1 610**	**1 479 667**	**0**	**1 478 057**

*Obs: the crediting period will be from 01/10/2007 to 30/09/2014.

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**$LFG_{flare, y}$**
Data unit:	m^3
Description:	Amount of landfill gas collected and sent to flares
Source of data to be used:	Readings from the flow-meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable (see Table 2).
Description of measurement methods and procedures to be applied:	Continuous readings from the flow-meter installed. The equipment is connected to a supervisory computer system, which measures continuously the LFG measured.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations; - Monitoring under responsibility of the PROBIOGAS-JP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	**FE**
Data unit:	%
Description:	Flare Efficiency
Source of data to be	Measurements of the temperature of the combustion chamber, according with

used:	the *"Methodological Tool to determine project emissions from flaring gases containing methane – version 1"*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	90%
Description of measurement methods and procedures to be applied:	The approach selected from the *"Methodological Tool to determine project emissions from flaring gases containing methane – version 1"* was to monitor the temperature of the exhaust gas of the flare. The temperature measurements will be done continuously. The measure will be done by a Type N thermocouple. The readings of temperature will be made by a computer based system, with continuous storage. If the temperature read is below 500ºC for any particular hour, then the flare efficiency during that hour is zero. By the time of validation the flare was not installed. Thus, the specifications of the flare's manufacturer will be available during the verification stage.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated according with the manufacturer's specifications.
Any comment:	Monitoring of under responsibility of the PROBIOGAS-JP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	$\mathbf{w_{CH4,y}}$
Data unit:	m^3_{CH4}/m^3_{LFG}
Description:	Methane fraction in the landfill gas
Source of data to be used:	Readings from Gas Analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50 %
Description of measurement methods and procedures to be applied:	Continuous measurements from gas quality analyzer.
QA/QC procedures to be applied:	The gas analyzer should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	Monitoring under responsibility of the PROBIOGAS-JP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	**T**
Data unit:	^oC
Description:	Temperature of the LFG.
Source of data to be used:	Readings from the temperature-meter.
Value of data applied for the purpose of	0 ^oC

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Direct readings from the temperature-meter installed. The equipment is connected to a supervisory computer system, which counts continuously the temperature measured.
QA/QC procedures to be applied:	Flow meters with temperature reading should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations. - Monitoring under responsibility of the PROBIOGAS-JP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	**p**
Data unit:	Pa
Description:	Pressure of the LFG.
Source of data to be used:	Readings from the pressure-meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	101 325 Pa
Description of measurement methods and procedures to be applied:	Direct readings from the pressure-meter installed. The equipment is connected to a supervisory computer system, which counts continuously the pressure measured.
QA/QC procedures to be applied:	Flow meters with pressure reading should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations. - Monitoring under responsibility of the PROBIOGAS-JP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	**EL_{imp}**
Data unit:	MWh
Description:	Electricity consumed by the blowers
Source of data to be used:	Readings from the electricity meter
Value of data applied for the purpose of calculating expected emission reductions in	3 000 MWh/year

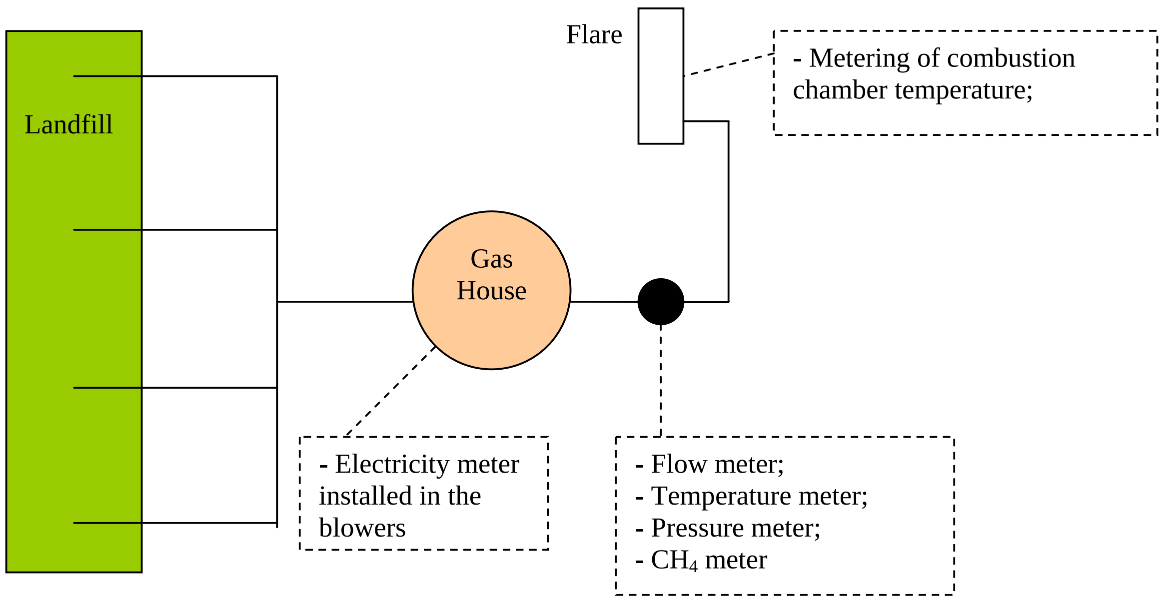
section B.5	
Description of measurement methods and procedures to be applied:	Direct readings from the electricity-meter installed. The equipment is connected to a supervisory computer system, which counts continuously the eletricity measured.
QA/QC procedures to be applied:	According with ACM0001 – version 5, no QA/QC procedures are listed.
Any comment:	- Calibration of the equipment will be made according with the manufacturers recommendations or according with any national standard; - Monitoring under responsibility of the PROBIOGAS-JP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	**Emission factor / $CEF_{2003-2005}$**
Data unit:	tCO_2 /MWh
Description:	CO_2 emission factor of the grid
Source of data to be used:	ONS
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0767
Description of measurement methods and procedures to be applied:	This data will be archived electronically and according to internal procedures, until 2 years after the end of the crediting period. Calculated at the validation and renewal of the crediting period.
QA/QC procedures to be applied:	Default data.
Any comment:	Calculated as weighted sum of the OM and BM emission factors, as explained in Annex 3. Required to determine CO2 emissions from use of electricity to operate the project activity

B.7.2 Description of the monitoring plan:

The following variables need to be measured as to determine and account for emission reductions due to PROBIOGAS-JP.

- The amount of landfill gas being sent to flares;
- The amount of methane in the landfill gas;
- The flares' efficiencies.
- The pressure of the LFG;
- The temperature of the LFG; and
- The electric consumption of the blower, in MWh.



According with ACM0001, when a landfill project only flares the methane, only one flow-meter must be installed provided that the meter used is calibrated periodically by an officially accredited entity.

Except from the methane content in the flue gas, all other data need to be monitored continuously, through proper meters or analyzers. The flare efficiency will be monitored by the combustion chamber temperature, and the landfill gas flow to the flare system. Will not be measured the methane content in the flue gas
Considering PROBIOGAS-JP's facilities will have computer-based equipment and generate continuous data, such equipment will be used for generating data relevant for the annual emission reduction verification report. A model of the summary table (Table 3) for such report will be filled in, with the metered data provided as background.

Table 3. Summary Worksheet

DAY	Total PROBIOGÁS-JP - Aterro de João Pessoa										
	LFG Collected (m3)	Temperature (°C)	Pressure (mbar)	LFG Collected (Nm3)	Methane (%)	Methane Collected (N.m³)	Temperature FLARE (°C)	Hours of Operation FLARE	Flare Efficiency (%)	Methane Destroyed (Nm3)	Electricity Consumed from the Grid(MWh)
1/6/2007	0,0000	0,0000	0,0000	0,0000	0,0	0,0000			99,78%	0,0000	
2/6/2007				0,0000		0,0000				0,0000	
3/6/2007				0,0000		0,0000				0,0000	
4/6/2007				0,0000		0,0000				0,0000	
5/6/2007				0,0000		0,0000				0,0000	
6/6/2007				0,0000		0,0000				0,0000	
7/6/2007				0,0000		0,0000				0,0000	
8/6/2007				0,0000		0,0000				0,0000	
9/6/2007				0,0000		0,0000				0,0000	
10/6/2007				0,0000		0,0000				0,0000	
11/6/2007				0,0000		0,0000				0,0000	
12/6/2007				0,0000		0,0000				0,0000	
13/6/2007				0,0000		0,0000				0,0000	
14/6/2007				0,0000		0,0000				0,0000	
15/6/2007				0,0000		0,0000				0,0000	
16/6/2007				0,0000		0,0000				0,0000	
17/6/2007				0,0000		0,0000				0,0000	
18/6/2007				0,0000		0,0000				0,0000	
19/6/2007				0,0000		0,0000				0,0000	
20/6/2007				0,0000		0,0000				0,0000	
21/6/2007				0,0000		0,0000				0,0000	
22/6/2007				0,0000		0,0000				0,0000	
23/6/2007				0,0000		0,0000				0,0000	
24/6/2007				0,0000		0,0000				0,0000	
25/6/2007				0,0000		0,0000				0,0000	
26/6/2007				0,0000		0,0000				0,0000	
27/6/2007				0,0000		0,0000				0,0000	
28/6/2007				0,0000		0,0000				0,0000	
29/6/2007				0,0000		0,0000				0,0000	
30/6/2007				0,0000		0,0000				0,0000	

Landfill gas into flares and methane content in the landfill gas are metered through a flow meter and a gas analyzer installed at the facility and monitored electronically through a programmable logic control system. After that, once the flow, as well as flares' efficiencies, become inputs for the sheet, the amount flared is calculated. The sum of both quantities is the total methane destroyed. Discounting such number by 10% (Effectiveness Adjustment Factor), the emission reductions from the project are determined.

There will be similar sheets for the three crediting periods. They will be presented to the verifier as the collected and stored data for verification purposes.

There will be a team assigned to monitor emission reductions from the project. They will be responsible for collecting and archiving the pertinent data according to the monitoring plan.
The team and the operational and management structure and the responsibility of each member will be defined by the time of the project operation.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

The baseline study and monitoring methodology was completed on 12/01/2007, by Econergy Brasil Ltda. See contact information in Annex I.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/10/2007

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

21y – 0m

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

C.2.1. Renewable crediting period

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

01/10/2007

C.2.1.2. Length of the first crediting period:

7y – 0m

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Left blank on purpose.

C.2.2.2. Length:

Left blank on purpose.

SECTION D. Environmental impacts

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

PROBIOGAS-JP does not have any Environmental License because the project has not been implemented yet. Rumos will wait for the project's registration in order to start the licensing process. As the project will destroy the landfill gas collected in a more efficient way, no transboundary impacts are expected.

However, according with Resolução CONAMA 01/86, prior to the implementation of João Pessoa Landfill, a complete Environmental Impact Assess was developed and submitted to SUDEMA - Superintendência de Administração do Meio Ambiente. This document concluded that the site selected presents the necessary conditions to the landfill's installation without any significant changes on their actual environmental quality.

With the approval of the EIA, Rumos received, from SUDEMA, the Operational License no. 329/2006.It is worth mentioning that Rumos has all pertinent licenses to operate the landfill.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

All environmental assesses were analyzed by SUDEMA and João Pessoa Landfill has all pertinent Licenses for the landfill's operation. Thus, no significant environmental impact was identified.

SECTION E. Stakeholders' comments

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

Previously to the development of PROBIOGAS-JP, Rumos made a public call for comments from local stakeholders when constructing João Pessoa Landfill, as a requirement of the Environmental Licensing process.

As required by the Interministerial Comission on Global Climate Change (CIMGC), the Brazilian DNA - Designated National Authority, invitations must be sent for comments to local stakeholders as part of the procedures for analyzing CDM projects and issuing letters of approval. This procedure was followed by Rumos to take its GHG mitigation initiative to the public. Letters and the Executive Summary of the project were sent to the following local stakeholders:

- Prefeitura Municipal de João Pessoa – PB / *Municipal Administration of João Pessoa – PB.*
- Câmara Municipal de João Pessoa – PB / *Municipal Legislation Chamber of João Pessoa –PB;*
- Ministério Público Estadual / *State Prosecutor's Office;*
- Fórum Brasileiro de ONGs / *Brazilian NGO Forum;*
- SUDEMA - Superintendência de Administração do Meio Ambiente;
- Secretaria de Estado do Meio Ambiente */ Environment Secretary of State;*
- Rotary Club de João Pessoa - PB / *Rotary Club of João Pessoa – PB.*

E.2. Summary of the comments received:

No comments were received.

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

As no comments were received, Rumos continued with the PROBIOGAS-JP implementation.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Project Participant -1:

Organization:	Rumos Construções Ambientais Ltda
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FAX:	+ 55 (83) 3246-3581
E-Mail:	cedres@cedrespb.com.br
URL:	www.cedrespb.com.br
Represented by:	Sérgio Augusto Duarte / Lavanério Queiroz Duarte Jr
Title:	Engineer / Engineer
Salutation:	Mr. / Mr.
Last Name:	Duarte / Duarte Jr
Middle Name:	Queiroz / Queiroz
First Name:	Sérgio / Lavanério
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Personal E-Mail:	sergio@rdincorporacoes.com.br / lavanerio@rdincorporacoes.com.br

Project Participant -2:

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Postfix/ZIP:	01228-200
Country:	Brazil
Telephone:	+ 55 (11) 3555 5700
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E-Mail:	-
URL:	http://www.econergy.com
Represented by:	Marcelo Schunn Diniz Junqueira / Francesca Maria Cerchia
Title:	Engineer / Administrator
Salutation:	Mr. / Mrs.
Last Name:	Diniz Junqueira / Cerchia
Middle Name:	Schunn / Maria
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Personal E-Mail:	junqueira@econergy.com.br / cerchia@econergy.com.br

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in PROBIOGAS-JP.

Annex 3

BASELINE INFORMATION

Table 4. Baseline determination information

DATA	VALUE	UNIT	SOURCE
L_0 (methane potential generation)	0,07	m^3_{CH4}/kg_{waste}	USEPA, 1996
k (decay constant)	0,1	1/year	
Year of opening	2003		Rumos
Year of closure	2020		
R_x	Variable	t_{waste}	
EAF (Emission Adjustment Factor)	10	%	Estimated
CE	65	%	USEPA, 1996
FE	90	%	Enclosed Flare

USEPA (1996) suggests values of k and L_0 to be applied to the model. Because of the uncertainty in estimating L_0, gas flow estimates derived from the model should also be bracketed by a range of plus or minus 50 percent. To make a conservativeness approach, L_0 was assumed to be minus 50% of the lowest value of the range (2,25-2,88 ft^3/lb). Converting the units to m^3_{CH4}/kg_{waste}, the value assumed for L_0 is 0,07.

USEPA (1996) also recommends the adoption of a collection efficiency of a range between a 75% and 85%. For conservative reasons, the efficiency of PROBIOGAS-JP was estimated as 65%. The Flare Efficiency of 90% was adopted considering the *"Tool to determine project emissions from flaring gases containing methane"*.

The value of k was estimated as 0,1/year, the lowest suggested value.

The data of annual waste disposal was estimated by Rumos from 2003 to 2020. However, there is an intention to extend the landfill's operational lifetime until 2028.

Project Emissions due to electricity purchased were estimated through approved methodology ACM0002 "Consolidated methodology for grid-connected electricity generation from renewable sources" – version 6.

ACM0002 considers the determination of the emissions factor for the grid to which the project activity is connected as the core data to be determined in the baseline scenario. In Brazil, there are two main grids, South-Southeast-Midwest and North-Northeast, therefore the North-Northeast Grid is the relevant one for this project.

The method that will be chosen to calculate the Operating Margin (OM) for the electricity baseline emission factor is the option (b) *Simple Adjusted OM*, since the preferable choice (c) *Dispatch Data Analysis OM* would face the barrier of data availability in Brazil.

In order to calculate the Operating Margin, daily dispatch data from the Brazilian electricity system manager (ONS) needed to be gathered. ONS does not regularly provide such information, which implied in getting it through communicating directly with the entity.

The provided information covers years 2003, 2004 and 2005, and is the most recent information available at this stage (At the end of 2005 ONS supplied raw dispatch data for the whole interconnected grid in the form of daily reports[11] from Jan. 1, 2003 to Dec. 31, 2005, the most recent information available at this stage).

Simple Adjusted Operating Margin Emission Factor Calculation

According to the methodology, the project is to determine the Simple Adjusted OM Emission Factor ($EF_{OM, simple adjusted, y}$). Therefore, the following equation is to be solved:

$$EF_{OM,simple\_adjusted,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y}.COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y \frac{\sum_{i,k} F_{i,k,y}.COEF_{i,k}}{\sum_k GEN_{k,y}} \text{ (tCO}_2\text{e/GWh)}$$

It is assumed here that all the low-cost/must-run plants produce zero net emissions.

$$\frac{\sum_{i,k} F_{i,k,y}.COEF_{i,k}}{\sum_k GEN_{k,y}} = 0 \text{ (tCO}_2\text{e/GWh)}$$

Please refer to the methodology text or the explanations on the variables mentioned above.

The ONS data as well as the spreadsheet data with the calculation of emission factors have been provided to the Designated Operational Entity (DOE). In the spreadsheet, the dispatch data is treated as to allow calculation of the emission factor for the most three recent years with available information, which are 2003, 2004 and 2005.

The Lambda factors were calculated in accordance with methodology requests. The table below presents such factors.

Year	Lambda
2003	0,7192

[11] *Acompanhamento Diário da Operação do Sistema Interligado Nacional*. ONS-CNOS, Centro Nacional de Operação do Sistema. Daily reports on the whole interconnected electricity system from Jan. 1, 2003 to Dec. 31, 2005.

2004	0,5330
2005	0,5572

Electricity generation for each year needs also to be taken into account. This information is provided in the table below.

Year	Electricity Load (MWh)
2003	76.935.819
2004	81.199.780
2005	85.818.478

Using therefore appropriate information for $F_{i,j,y}$ and $COEF_{i,j}$, OM emission factors for each year can be determined, as follows.

$$EF_{OM,simple\_adjusted,2003} = (1-\lambda_{2003}) \frac{\sum_{i,j} F_{i,j,2003}.COEF_{i,j}}{\sum_j GEN_{j,2003}} \therefore EF_{OM,simple\_adjusted,2003} = 0{,}1264 \text{ tCO}_2\text{/MWh}$$

$$EF_{OM,simple\_adjusted,2004} = (1-\lambda_{2004}) \frac{\sum_{i,j} F_{i,j,2004}.COEF_{i,j}}{\sum_j GEN_{j,2004}} \therefore EF_{OM,simple\_adjusted,2004} = 0{,}3289 \text{ tCO}_2\text{/MWh}$$

$$EF_{OM,simple\_adjusted,2005} = (1-\lambda_{2005}) \frac{\sum_{i,j} F_{i,j,2005}.COEF_{i,j}}{\sum_j GEN_{j,2005}} \therefore EF_{OM,simple\_adjusted,2005} = 0{,}2702 \text{ tCO}_2\text{/MWh}$$

Finally, to determine the baseline *ex-ante*, the full generation weighted-average among the three years is calculated, finally determining the $EF_{OM,simple\_adjusted}$.

$$EF_{OM,simple\_adjusted\ 2002\_2004} = \frac{EF_{OM,simple\_adjusted,2003} * \sum_j GEN_{j,2002} + EF_{OM,simple\_adjusted,2004} * \sum_j GEN_{j,2003} + EF_{OM,simple\_adjusted,2005} * \sum_j GEN_{j,2004}}{\sum_j GEN_{j,2003} + \sum_j GEN_{j,2004} \sum_j GEN_{j,2005}} = 0{,}1044$$

According to the methodology used, a Build Margin emission factor also needs to be determined.

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y}.COEF_{i,m}}{\sum_m GEN_{m,y}}$$

Electricity generation in this case means 20% of total generation in the most recent year (2005), as the 5 most recent plants built generate less than such 20%. If 20% falls on part capacity of a plant, that plant is fully included in the calculation. Calculating such factor one reaches:

$$EF_{BM,2005} = 0{,}0491 \text{ tCO}_2\text{/MWh}$$

Finally, the electricity baseline emission factor is calculated through a weighted-average formula, considering both the OM and the BM, being the weights 50% and 50% by default. That gives:

$$EF_{electricity,2003-2005} = 0{,}5 * 0{,}1044 + 0{,}5 * 0{,}0491 = 0{,}0767 \text{ tCO}_2\text{/MWh}$$

The Brazilian electricity system has been historically divided into two subsystems: the North-Northeast (N-NE) and the South-Southeast-Midwest (S-SE-CO). This is due mainly to the historical evolution of the physical system, which was naturally developed nearby the biggest consuming centers of the country.

The natural evolution of both systems is increasingly showing that integration is bound to happen in the future. In 1998, the Brazilian government was announcing the first leg of the interconnection line between S-SE-CO and N-NE. With investments of around US$700 million, the connection had the main purpose, in the government's view, at least, to help solve energy imbalances in the country: the S-SE-CO region could supply the N-NE in case it was necessary and vice-versa.

Nevertheless, even after the interconnection was established, technical papers continue to divide the Brazilian system in three (Bosi, 2000)[12]:

"… where the Brazilian Electricity System is divided into three separate subsystems:

- *(i) The South/Southeast/Midwest Interconnected System;*
- *(ii) The North/Northeast Interconnected System; and*
- *(iii) The Isolated Systems (which represent 300 locations that are electrically isolated from the interconnected systems)"*

Moreover, the ACM0002 version 6 suggests using the regional grid definition, in large countries with layered dispatch systems (e.g. state/provincial/regional/national), where DNA guidance is not available. A state/provincial grid definition may indeed in many cases be too narrow given significant electricity trade among states/provinces that might be affected, directly or indirectly, by a CDM project activity.

Finally, one has to take into account that even though the systems today are connected, the energy flow between N-NE and S-SE-CO is heavily limited by the transmission lines capacity. Therefore, only a fraction of the total energy generated in both subsystems is sent one way or another. It is natural that this fraction may change its direction and magnitude (up to the transmission line's capacity) depending on the hydrological patterns, climate and other uncontrolled factors. But it is not supposed to represent a significant amount of each subsystem's electricity demand.

The Brazilian electricity system nowadays comprises of around 101.3 GW of installed capacity, in a total of 1 482 electricity generation enterprises. From those, nearly 70% are hydropower plants, around 10% are natural gas-fired power plants, 4.5% are diesel and fuel oil plants, 3.2% are biomass sources (sugarcane bagasse, black liquor, wood, rice straw and LFG), 2% are nuclear plants, 1.4% are coal plants, and there are also 8.17 GW of installed capacity in neighboring countries (Argentina, Uruguay, Venezuela and Paraguay) that may dispatch electricity to the Brazilian grid[13]. This latter capacity is in fact comprised by mainly 5.65 GW of the Paraguayan part of *Itaipu Bi-national*, a hydropower plant operated by both Brazil and Paraguay, but whose energy almost entirely is sent to the Brazilian grid.

The approved methodology ACM0002 asks project proponents to account for "all generating sources serving the system". In that way, project proponents in Brazil should search for, and research, all power plants serving the Brazilian system.

However, information on such generating sources is not publicly available in Brazil. The national dispatch center, ONS – National System Operator – argues that dispatching information is strategic to the

[12] Bosi, M. *An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study*. International Energy Agency. Paris, 2000.
[13] www.aneel.gov.br

power agents and therefore cannot be made available. On the other hand, ANEEL, the electricity agency, provides information on power capacity and other legal matters on the electricity sector, but no dispatch information can be got through this entity.

In that regard, project proponents looked for a plausible solution in order to be able to calculate the emission factor in Brazil in the most accurate way. Since real dispatch data is necessary after all, the ONS was specifically contacted and the reason for data collection was explained. After several months of talks, plants' daily dispatch information was made available by ONS.

Project proponents, discussing the feasibility of using such data, concluded it was the most proper information to be considered when determining the emission factor for the Brazilian grid. According to ANEEL, in fact, ONS centralized dispatched plants accounted for 75 547 MW of installed capacity by 31/12/2004, out of the total 98 848.5 MW installed in Brazil by the same date[14], which includes capacity available in neighboring countries to export to Brazil and emergency plants, that are dispatched only during times of electricity constraints in the system. Such capacity in fact is constituted by plants with 30 MW installed capacity or above, connected to the system through 138 kV power lines, or at higher voltages. Therefore, even though the emission factor calculation is carried out without considering all generating sources serving the system, about 76.4% of the installed capacity serving Brazil is taken into account, which is a fair amount if one looks at the difficulty in getting dispatch information in Brazil. Moreover, the remaining 23.6% are plants that do not have their dispatch coordinated by ONS, since: either they operate based on power purchase agreements which are not under control of the dispatch authority; or they are located in non-interconnected systems to which ONS has no access. In that way, this portion is not likely to be affected by the CDM projects, and this is another reason for not taking them into account when determining the emission factor.

In an attempt to include all generating sources, project developers considered the option to research for available, but non-official data, to supply the existing gap. The solution found was the International Energy Agency database built when carrying out the study "Road-Testing Baselines for Greenhouse Gas Mitigation Projects in the Electric Power Sector", published in October 2002. Merging ONS data with the IEA data in a spreadsheet, project proponents have been able to consider all generating sources connected to the relevant grids in order to determine the emission factor. The emission factor calculated was found more conservative when considering ONS data only, as the table below shows the build margin in both cases.

IEA/ONS Merged Data Build Margin (tCO_2/MWh)	**ONS Data Build Margin (tCO_2/MWh)**
0,205	0,0491

Therefore, considering all the rationale explained, project developers decided for the database considering ONS information only, as it was capable of properly addressing the issue of determining the emission factor and doing it in the most conservative way.

The fossil fueled plants efficiencies were also taken from the IEA paper. This was done considering the lack of more detailed information on such efficiencies from public, reliable and credible sources.

From the mentioned reference:

> *"The fossil fuel conversion efficiency (%) for the thermal power plants was calculated based on the installed capacity of each plant and the electricity actually produced. For most of the fossil fuel*

[14] www.aneel.gov.br/arquivos/PDF/Resumo_Gráficos_mai_2005.pdf

power plants under construction, a constant value of 30% was used as an estimate for their fossil fuel conversion efficiencies. This assumption was based on data available in the literature and based on the observation of the actual situation of those kinds of plants currently in operation in Brazil. The only 2 natural gas plants in combined cycle (totaling 648 MW) were assumed to have a higher efficiency rate, i.e. 45%."

Therefore only data for plants under construction in 2005 (with operation start in 2003, 2004 and 2005) was estimated. All others efficiencies were calculated. To the best of our knowledge there was no retrofit/modernization of the older fossil-fuelled power plants in the analyzed period (2003 to 2005). For that reason project participants find the application of such numbers to be not only reasonable but the best available option.

The aggregated hourly dispatch data got from ONS was used to determine the lambda factor for each of the years with data available (2003, 2004 and 2005). The Low-cost/Must-run generation was determined as the total generation minus fossil-fuelled thermal plants generation, this one determined through daily dispatch data provided by ONS.

On the following pages, a summary of the analysis is provided. The Table 5 shows the summarized conclusions of the analysis of the emission factor calculation and Figures 10, 11 and 12 present the load duration curves for the N-NE subsystem. Finally, the Figure 13 shows the estimated generation of methane in the baseline scenario and the methane captured and fired.

Table 5. Summary of the emission factor calculation

Emission Factor for the Brazilian North-Northeast Interconnected grid					
Baseline (including imports)	EF_{OM} [tCO2/MWh]	Load [MWh]	LCMR [MWh]	Imports [MWh]
2003	0,1264	76.935.819	75.994.843	7.632.626
2004	0,3289	81.199.780	78.248.786	3.826.422
2005	0,2702	85.818.478	83.269.838	4.790.635
	Total (2003-2005) =	243.954.076	237.513.467	16.249.684
	$EF_{OM, simple-adjusted}$ [tCO2/MWh]	$EF_{BM,2005}$	Lambda	
	0,1044	0,0491	λ_{2003}	
	Weights	Default weights	0,7192	
	w_{OM} = 0,50	w_{OM} = 0,5	λ_{2004}	
	w_{BM} = 0,50	w_{BM} = 0,5	0,5330	
	EF_y [tCO2/MWh]	Default EF_{OM} [tCO2/MWh]	λ_{2005}	
	0,0767	0,0767	0,5572	

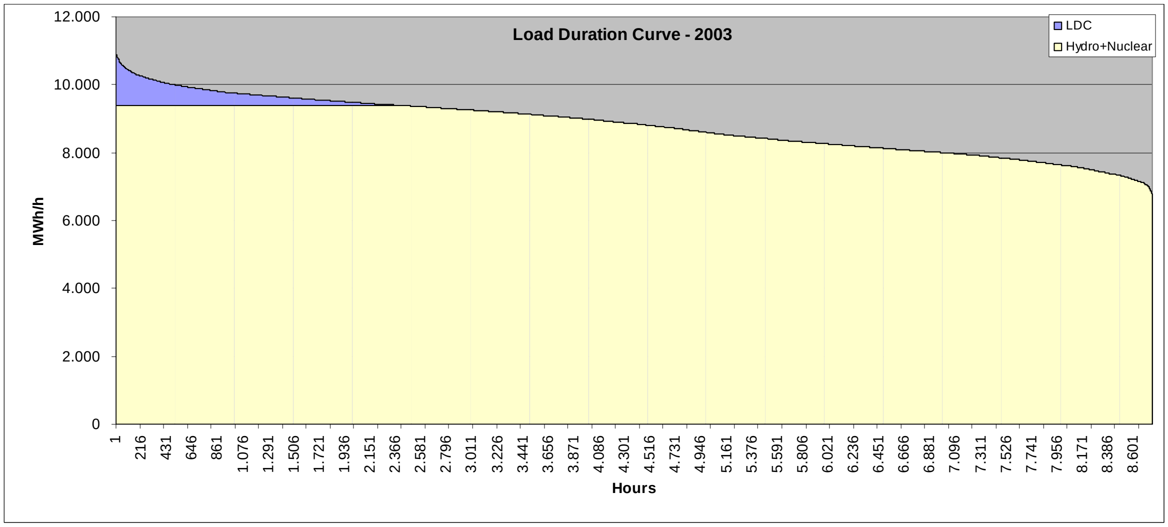

Figure 15. Load duration curve for the N-NE system, 2003

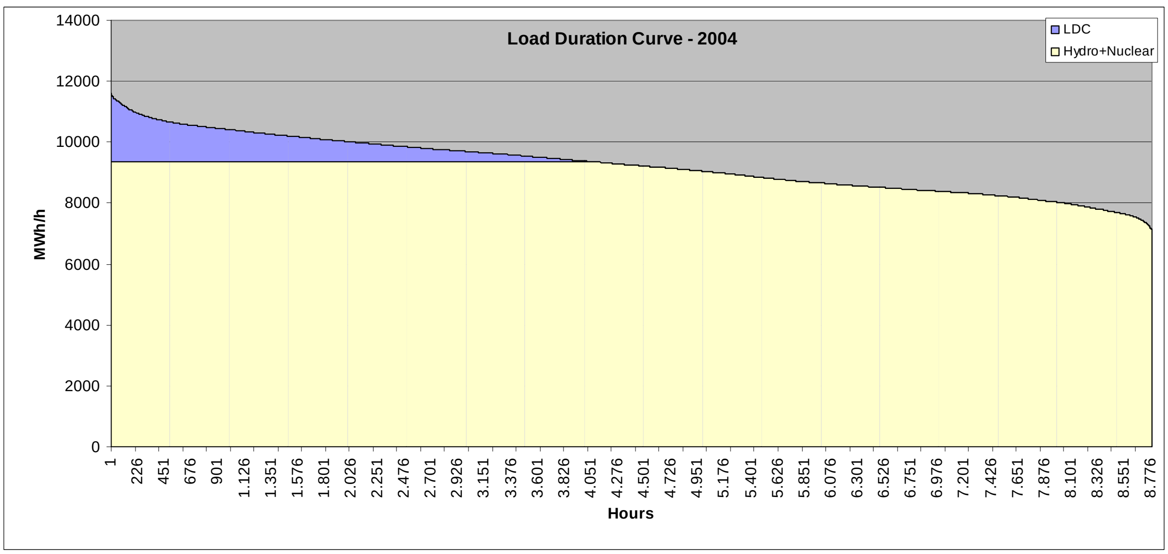

Figure 16. Load duration curve for the N-NE system, 2004

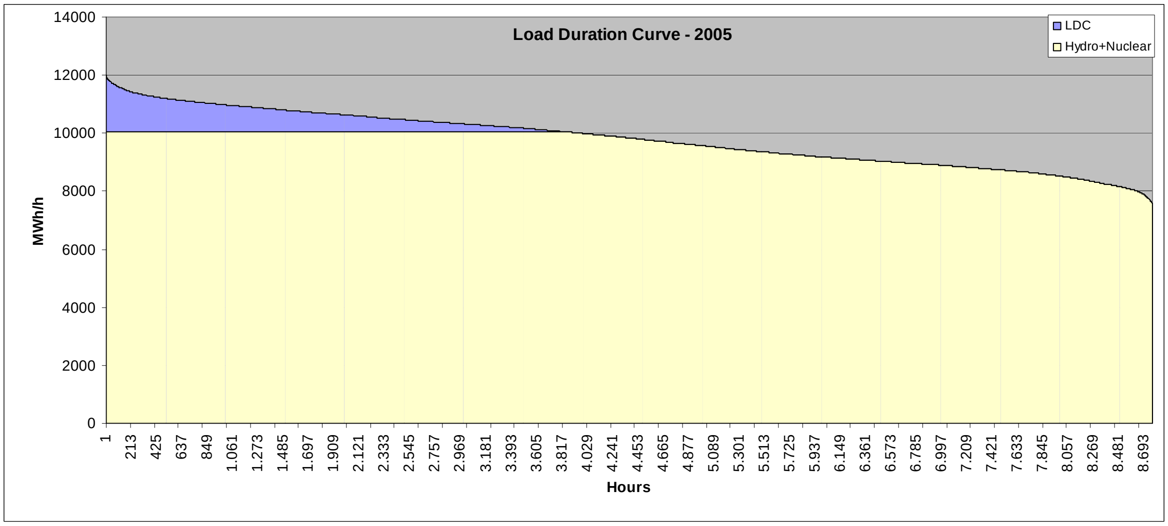

Figure 17. Load duration curve for the N-NE system, 2005

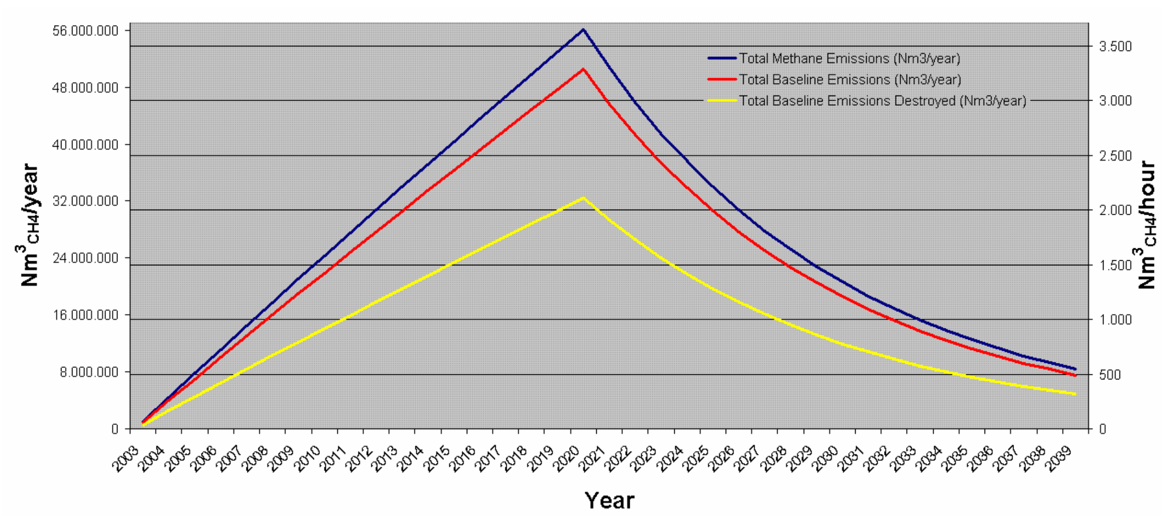

Figure 18. Baseline Emission and Emission Reductions from João Pessoa Landfill

Annex 4

MONITORING INFORMATION

The calculation of emission reductions will be made using the following table:

A	The lowest value between "Total LFG collected" and "LFG sent to flares"	m^3
B	Methane content on LFG	$\%_{methane}$
C	Pressure of the LFG	bar
D	Temperature of the LFG	K
E = $B \times \frac{C \times A}{D} \times \frac{273}{1.013} \times 0.0007168$	Methane collected	$t_{methane}$
F	Flare Efficiency	%
G = E . F	Total methane destroyed	$t_{methane}$
H = G . 21	Total CO_2e destroyed	tCO_2e
I = H . 0.1	Total CO_2e destroyed in the baseline	tCO_2e
J = H – I	CO_2e destroyed by PROBIOGAS-JP	tCO_2e
K	Total electricity imported	MWh
L	Emission factor of the grid which PROBIOGAS-JP is connected	tCO_2e/MWh
M = K . L	Emissions due to the import of electricity	tCO_2e
N = J – M	Emissions reductions due to PROBIOGAS-JP	tCO_2e

The calibration procedures will be made according with the fabricant's information.

As the project has not been implemented, no management structure and no procedures were identified. By the time of the project's implementation, all structures, authorities and procedures will be described and available to the Verification Team.

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