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:

Terrestre Ambiental Landfill Gás Project
Version 8
23/07/2007

A.2. Description of the project activity:

The Terrestre Ambiental Landfill Gas Project's (hereinafter TALGP) aim is to capture and flare the landfill gas produced at CGR – Centro de Gerenciamento de Resíduos (Waste Management Center) Piaçaguera to avoid emissions of methane gas to the atmosphere. This landfill (class II-A and II-B[1]) is owned by Terrestre Ambiental Ltda. and located in Santos, State of São Paulo, Brazil.

Terrestre Ambiental Ltda is a society between Terracom Construções Ltda and ESTRE (Empresa de Saneamento e Tratamento de Resíduos S.A.).

ESTRE is presented in the main metropolitan centers of state of São Paulo (São Paulo metropolitan region, Campinas metropolitan region, and Santos region). With the goal of adequately dispose industrial and municipal waste produced in such regions, ESTRE has already implemented five landfills.

CGR Piaçaguera counts on the best management practices for such business. Modern engineering has been applied during design, leachate is collected and sent for treatment, and all the pertinent environmental variables are continuously monitored.

The landfill gas (biogas) is collected through a passive system, with no systematic and monitored flare. Therefore, an extra-incentive is needed for Terrestre to make additional investments and enhance its landfill gas collection rate and install appropriate facilities to properly flare the methane produced at the site.

Landfill gas generation will be guaranteed throughout TALGP's lifetime from various strategic aspects CGR Piaçaguera enjoys:

- CGR Piaçaguera is located in Baixada Santista Region, in the coast of the State of São Paulo, formed by 9 municipalities, which, in most cases, do not have feasible areas where landfills could be developed because the region is surrounded by the Serra do Mar State Park, an APP – Área de Preservação Permanente (Permanent Preserved Area). In fact, all of those municipalities are both facing problems regarding their rubbish dumps/landfills capacity or environmental demands by the environmental agency in the state of São Paulo (CETESB), requiring dumps' areas to be recovered and obliging the authorities to find proper destination to the waste generated.
- CGR Piaçaguera receives waste from the two main cities of the region (Santos and Cubatão), among from the private companies located in the region. Considering these clients, CGR Piaçaguera receives around 1,200 tonnes of waste daily.
- Studies conducted by ESTRE show that landfill development and operation is only feasible for

[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 solubilised in standard above the potable water.

waste disposition rates of at least 500 tonnes of waste per day. And moreover, there are no potential feasible areas for landfill development in the region, as the Serra do Mar State Park is protected by legislation.

TALGP will have a significant impact on sustainable development. First, while reducing methane emissions that would enhance climate change, it will also minimize the risk that any explosion occurs at the site – although CGR Piaçaguera's engineering and design specifically aims at avoiding this type of accidents. Second, given the fact that initiatives of this type are relatively new in Brazil, a significant technology transfer will be needed for the project's implementation and operation. Third, specialized operators will be needed for project operation, which means a positive impact on employment and capacity-building. The aforementioned elements concur in making the project extremely vital in the context of sustainable development.

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)	• Terrestre Ambiental Ltda (private entity) • 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.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

CGR Piaçaguera is located in Morro das Neves neighbourhood, Domênico Rangoni Highway, SP-055, km 75, CEP: 11100-000, Santos (SP), 23º 53' 34.670'' S and 46º 18' 58.653'' W.

A.4.1.1. Host Party(ies):

Brazil

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

São Paulo

A.4.1.3. City/Town/Community etc:

Santos

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

The Figure 1 shows the location of Santos.

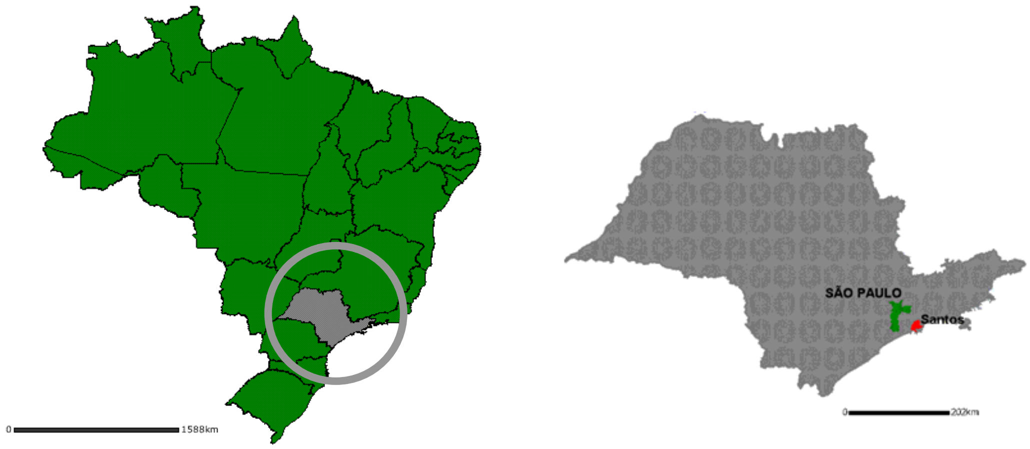

Figure 1. Santos and CGR Piaçaguera location

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

TALGP is designed as a sectoral scope 13 – waste handling and disposal – project.

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

The State of São Paulo environmental agency – CETESB (Companhia de Tecnologia de Saneamento Ambiental) – classifies the state's landfills according to technology used, management techniques and other criteria in its Landfill Quality Index (*IQR -- Índice de Qualidade de Aterros de Resíduos*). CGR Piaçaguera was qualified with an IQR of 9.6 (range 0 to 10) in CETESB's 2005 assessment of the state's landfills[2].

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 and transportation pipeline network and a flaring system, as shown in Figure 2.

[2] CESTESB – Companhia de Tecnologia de Saneamento Ambiental. *Inventário Estadual de Resíduos Sólidos Domiciliares*, 2005.

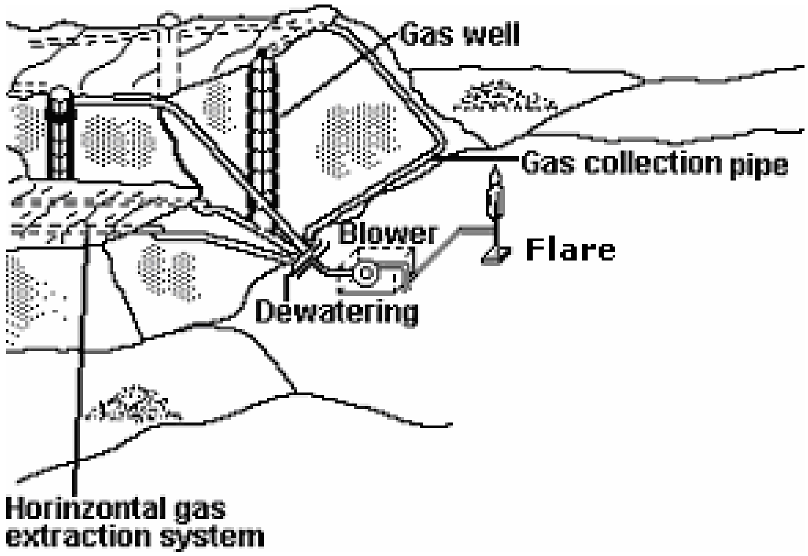

Figure 2. Schematic situation of a landfill with active gas recovery (Source: WILHELM, 1991[3])

Following concrete examples from other landfill gas projects in the world, the TALGP may 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 on Figure 3 and Figure 4.

Figure 3. Example of wellhead (source: Biogás Ambiental[4])

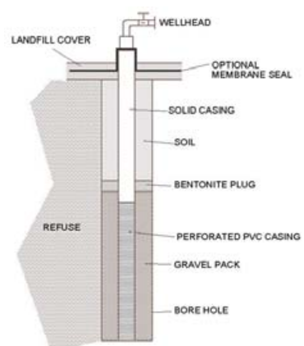

Figure 4. Internal detail of a well and wellhead

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

A common practice all over the world is to use PVC 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.

[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

[4] Biogás Ambiental; available at < http://www.biogas-ambiental.com.br/instalacaorede.htm>; accessed on Jan 31st, 2006.

The wellheads are connected to a collecting pipeline. This pipeline transports the landfill gas to the manifolds. The manifolds are equipment that can be connected with more than 10 wellheads and transfer the collected gas to the transmission pipeline.

Figure 5. Example of manifold, connected with the 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 with all manifolds around the landfill. In order to preserve the operation of the equipment, a dewatering system might be installed to remove the condensate.

Figure 6. Example of a transmission pipeline

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

Figure 7. Example of flares (source: Biogás Ambiental)

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, Terrestre 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. Technology transfer will hence occur from countries with strict environmental legislative requirements and environmentally sound technologies. Environmentally sound technologies are also needed for Terrestre to comply with its environmental guidelines.

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

Years	Annual estimation of emission reductions in tonnes of CO_2e
2007*	20,815
2008	105,479
2009	125,585
2010	113,559
2011	102,678
2012	92,832
2013	83,924
2014*	56,689
Total estimated reductions (tonnes of CO_2e)	**701,561**
Total Number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**100,222**

* 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:

With the implementation of the TALGP, methane that would be naturally released to the atmosphere in the baseline scenario will be captured through the use of a collecting and flaring system. Only a part of the methane is flared at the baseline due to safety and odour concerns.

As mentioned before, a complete collecting network pipeline and a flaring system will be installed in order to avoid the emission of methane to the atmosphere. Such a system ensures that methane will be captured, transported and flared under controlled conditions, in a way that it will be possible to measure the amount of methane flared on-site.

The description of formulae used to estimate emission reduction for the project activity is indicated B.6.1.

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 20% 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 of TALGP.

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

Since the TALGP will start its activities after the prompt-start date, the project participants will not benefit from the crediting period starting prior to 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

Since the project activity will not deliver commercial goods or services (i.e. electricity generation or thermal energy) and no other incentives will be obtained for the capturing and flaring of the methane, and taking into account that there is no legislation that obligates the landfill to destroy the methane, the landfill would continue with its core business (final disposal of solid waste) and the methane would continue to be released to the atmosphere, continuing the baseline scenario.

Presently, methane recovery is not mandatory for landfills in Brazil and the cost of capturing the methane and investing in electricity generation is not economically feasible as a baseline scenario. The fact of the majority of the waste in Brazil (83%) is disposal at sites which are not at the level of sanitary landfill.

According to CDM pipeline[5], in Brazil there are 6 CDM landfill projects with power generation. All the others (20 projects) consist in methane flaring only. It is possible to conclude that, even with the CERs revenue incentive, the power generation with landfill gas is not a common practice in Brazil.

One reason for the small quantity of landfill power generation is the lack of technical expertise in the country. As there was so far just little research on this subject in Brazil, the companies that decide to use this kind of technology, will preferably buy the equipments from companies based in US or EU, and train the work labor to operate the system.

Another reason is the high investment costs estimated for biogas collection for power generation. If a project implements only the biogas collection and flaring system, the costs are estimated to be around € 775,000.00 for a similar project, as showed in Table 1 below:

Table 1. Estimated costs for a similar biogas collection and flare systems

Pipelines and wellheads	€ 124,300.00
Biogas plant (blowers, chillers, flares, manifolds and others)	€ 576,684.50
Facility building	€ 15,000.00
Engineering expenses	€ 66,469.00
Total estimated costs	€ 774,953.50

Effective methane recovery for electricity generation can be achieved at sanitary landfills, but only with significant investments. From our experience, the cost involved in the implementation of a power

[5] CDM Pipeline overview updated 1st April 2007, Capacity Development for the Clean Development Mechanism – CD4CDM, available at http://www.cd4cdm.org.

generation system (out of the needed biogas collection system) is estimated to be also around € 770,000.00[6] per MW of installed capacity.

In Table 2 below, it can be noted that the estimated costs involved in installing the collection system and a 3 MW power generation are very high and, as demonstrated above, such projects are only being pursued in conjunction with the support of CER revenues.

Table 2. Estimated costs for a similar biogas collection and power generation system

Power generation engine	€ 1,286,446.26
Electric panels	€ 283,445.09
Power transformers	€ 38,982.03
Sound attenuators	€ 30,050.04
Electromechanical installations	€ 458,455.51
Transport	€ 41,185.62
Insurance	€ 13,744.64
Emergency power generation group	€ 3,691.69
Filters	€ 158,108.74
Total Power Generation system 3MW Installed capacity	***€ 2,314,109.62***
Biogas collection and backup flare	€ 774,953.50
Total Power Generation + biogas collection and backup flare	***€ 3,089,063.12***

In addition, there is a lack of funding in Brazil. CNI[7] says that "…the bank loans are expensive; the payments are in short terms and not enough to supply the market. The capital market is not very developed, restricting the shares sells and others bonds directly to investors. And external financing, in the last years, has been oscillating in payment terms and costs, also being an unstable resource". Furthermore, to get the loans, companies underwent through lot of bureaucracy, and the whole process could last months.

As showed above, it is reasonable to conclude that the lack of technical expertise, the high investment costs and the lack of funding make the landfill power generation not a plausible scenario. Thus, the only plausible scenario is the continuation of the actual scenario (no active methane collection and flaring).

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

The alternative, which is to continue with the business as usual situation before the decision of implementing this CDM project activity is consistent with the applicable laws and regulations.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

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

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[6] Market data and Master Thesis – Diagnóstico técnico institucional da recuperação e uso energético do biogás gerado pela digestão anaeróbica de resíduos, João Wagner Silva Alves , São Paulo, 2000;

[7] Financiamento no Brasil – Desafio ao Crescimento, CNI – Confederação Nacional da Indústria, Brasilia, 2003.

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, the implementation of the project activity will have no other benefits than the CDM revenues.

As already mentioned before, there is a high investment cost related to biogas collection in Brazil. If a project implements only the biogas collection and flaring system, a rough cost estimate is around USD 1,000,000.00 (or about € 775,000.00) for a similar project, as shown in the table below:

Table 3. Estimated costs for similar biogas collection and flare systems

Pipelines and wellheads	€ 124,300.00
Biogas plant (blowers, chillers, flares, manifolds and others)	€ 576,684.50
Facility building	€ 15,000.00
Engineering expenses	€ 66,469.00
Total estimated costs	€ 774,953.50

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 8 shows the final destination of the waste per municipality, according to PNSB 2000.

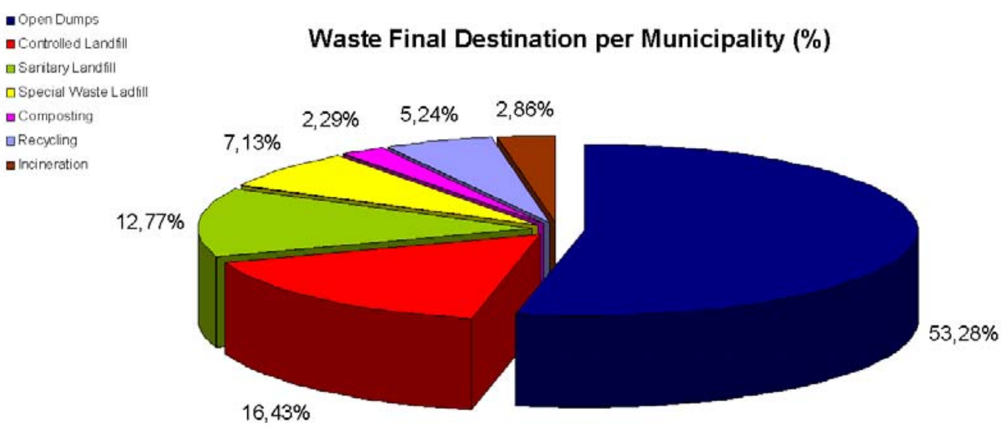


Figure 8. Waste Final Destination per Municipality in Brazil (Source: PNSB, 2000[8])

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.

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

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 reduce the economic and financial barriers to 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 text of the Tool for demonstration and assessment of additionality, published by the CDM-EB, will be experienced by the project: 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 biogas 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 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:

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

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 TALGP 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 TALGP does not have any contractual obligations to burn methane; so $MD_{reg, y}$ is calculated based on the "Adjustment Factor", a value estimated as 20% of total methane produced at the baseline that is flared due to odor and security concerns:

$$MD_{reg,y} = 0.2 \times \mathrm{MD}_{\mathrm{project, y}}$$

and

$$\mathrm{ER}_{\mathrm{y}} = 0.8 \times \mathrm{MD}_{\mathrm{project,y}} \times 21 - EL_{IMP} \times CEF_{electricity}$$

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:

$$MD_{project,y} = MD_{flared,y} \text{ and}$$

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

$MD_{flared, y}$ = 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 tCH_4/Nm^3CH_4, at 0ºC and 1.013 bar);
FE = flare efficiency (%);

The estimative 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:

$$ER_y = \left(0.8 \times LFG_{flared,y} \times w_{CH_4} \times D_{CH_4} \times FE \times 21\right) - EL_{IMP} \times CEF_{electricity}$$

GHG emissions by sources in the baseline were estimated using IPCC's guidelines[9]. In the case of TALGP, the derivative of first order decay model approach was used:

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

- $LFG_{flard, y}$ = landfill gas produced during year *T* (m^3_{LFG});
- *CE* = collection efficiency (%);
- *k* = decay constant (1/year);

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

- 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 (%)

Terrestre provided waste flow data from year 2003 to 2005 together with the estimative from 2006 to the end of the crediting period. The emission reductions estimative were calculated considering the landfill's closure year in 2009. It is important to note that the CGR Piaçaguera Environmental Impact Analysis considers the expansion of the landfill until 2010, but it has not been considered in the Operation License yet.

According with USEPA[10], 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% of collection efficiency was adopted for TALGP. So, $LFG_{flare,y}$ is equal to 65% of total landfill gas emitted to the atmosphere at the baseline:

In other words, the amount of Methane destroyed by the project activity is calculated as follows:

$$MD_{project,y} = 0.8 \times 0.65 \times \frac{k \times R_y \times L_0 \times \sum_{i=y}^{T} \sum_{j=y}^{i} \left[e^{-k(i-j)} \right]}{F} \times w_{CH_4} \times D_{CH_4} \times FE \times 21$$

or

$$MD_{project,y} = 0.52 \times \frac{k \times R_y \times L_0 \times \sum_{i=y}^{T} \sum_{j=y}^{i} \left[e^{-k(i-j)} \right]}{F} \times w_{CH_4} \times D_{CH_4} \times FE \times 21$$

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
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

[10] **USEPA**; *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook*; September 1996

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 São Paulo).
Any comment:	

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

Data / Parameter:	**EF**
Data unit:	tCO_2e/MWh
Description:	CO_2 emission of the grid
Source of data used:	ONS
Value applied:	0.2611
Justification of the choice of data or description of measurement methods and procedures actually	Calculated as weighted sum of the OM and BM emission factor, as explained in Annex 3. Required to determine CO_2 emissions from use of electricity to operate the project activity.

applied :	
Any comment:	

Data / Parameter:	**EF_{BM}**
Data unit:	tCO_2e/MWh
Description:	Build Margin
Source of data used:	ONS
Value applied:	0.0872
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated as explained in Annex 3. Required to determine CO2 emissions from use of electricity to operate the project activity.
Any comment:	

Data / Parameter:	**EF_{OM}**
Data unit:	tCO_2e/MWh
Description:	Operating Margin
Source of data used:	ONS
Value applied:	0.4349
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated as explained in Annex 3. Required to determine CO_2 emissions from use of electricity to operate the project activity.
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 20% 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:

$$ER_y = \left(0.8 \times CE \times \frac{k \times R_y \times L_0 \times \sum_{i=y}^{T} \sum_{j=y}^{i} \left[e^{-k(i-j)} \right]}{F} \times w_{CH_4} \times D_{CH_4} \times FE \times 21 \right) - EL_{IMP} \times CEF_{electricity}$$

The following data is applied to the formula:

Year of Opening	2003
Year of Closure	2009
Daily Waste Flow (t/day)	Variable
Collection Efficiency (%)	65%
Flare Efficiency (%)	90%
Blower consumption (MWh/year)	3,000
Emission Factor (tCO_2e/MWh)	0.2611
k (1/year)	0.1
L_0 ($m^3_{methane}/kg_{waste}$)	0.07

a) Baseline emissions:
Appling the derivative of the First Order Decay Model, the methane baseline estimative is:

Table 4. 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	4,439,895	2,219,948	**2021**	10,805,646	5,402,823
2004	8,262,127	4,131,063	**2022**	9,777,353	4,888,677
2005	12,975,901	6,487,951	**2023**	8,846,915	4,423,457
2006	17,836,082	8,918,041	**2024**	8,005,020	4,002,510
2007	23,859,722	11,929,861	**2025**	7,243,241	3,621,621
2008	30,168,023	15,084,011	**2026**	6,553,956	3,276,978
2009	35,876,009	17,938,004	**2027**	5,930,264	2,965,132
2010	32,461,955	16,230,978	**2028**	5,365,925	2,682,963
2011	29,372,792	14,686,396	**2029**	4,855,290	2,427,645
2012	26,577,601	13,288,801	**2030**	4,393,248	2,196,624
2013	24,048,408	12,024,204	**2031**	3,975,175	1,987,588
2014	21,759,899	10,879,950	**2032**	3,596,887	1,798,444
2015	19,689,171	9,844,586	**2033**	3,254,598	1,627,299
2016	17,815,499	8,907,749	**2034**	2,944,882	1,472,441
2017	16,120,130	8,060,065	**2035**	2,664,640	1,332,320
2018	14,586,097	7,293,048	**2036**	2,411,066	1,205,533
2019	13,198,046	6,599,023	**2037**	2,181,622	1,090,811
2020	11,942,086	5,971,043	**2038**	1,974,014	987,007

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 S-SE-CO Brazilian electric grid is equal to 0.2611 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 783 tCO_2e/year.

c) Leakage
According with ACM0001 – version 5, no Leakage emissions need to be considered for TALGP.

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*	196	21,011	0	20,815
2008	783	106,262	0	105,479
2009	783	126,368	0	125,585
2010	783	114,343	0	113,559
2011	783	103,461	0	102,678
2012	783	93,616	0	92,832
2013	783	84,707	0	83,924
2014*	585	57,274	0	56,689
TOTAL	**5,481**	**707,042**	**0**	**701,561**

*Note: 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 4).
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 TALGP'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 used:	Measurements of the temperature of the combustion chamber, according with 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 TALGP'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 TALGP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Data / Parameter:	**T**
Data unit:	^{o}C
Description:	Temperature of the LFG.
Source of data to be used:	Readings from the temperature-meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 ^{o}C
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 TALGP'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 TALGP's operators (the team, the organizational structure and the management structure will be defined after

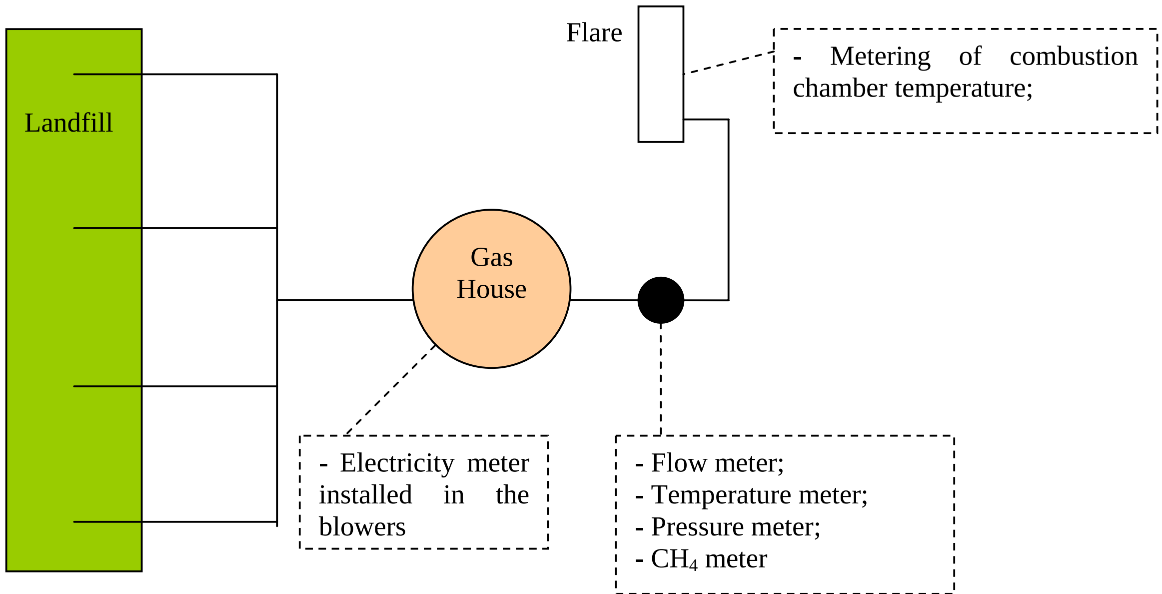
	the project's implementation).

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 section B.5	3,000 MWh/year
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 electricity 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 TALGP's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

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 TALGP.

- 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 TALGP'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 5) for such report will be filled in, with the metered data provided as background.

Table 5. Summary Worksheet

DAY	Total TALGP - Terrestre Ambiental Landfill Gas Project											
	LFG Collected (m3)	Temperature (°C)	Pressure (mbar)	LFG Collected (Nm3)	Methane (%)	Methane Collected (N.m³)	Temperature FLARE #1 (°C)	Hours of Operation FLARE #1	Temperature FLARE #2 (°C)	Hours of Operation FLARE #2	Flare Efficiency (%)	Methane Destroyed (Nm3)	Electricity Consumed from the Grid(MWh)
1/1/2007	84.000,0000	60,0000	36,0000	65.879,4700	52,2	34.389,0833					99,78%	34.313,4273	
2/1/2007				0,0000		0,0000						0,0000	
3/1/2007				0,0000		0,0000						0,0000	
4/1/2007				0,0000		0,0000						0,0000	
5/1/2007				0,0000		0,0000						0,0000	
6/1/2007				0,0000		0,0000						0,0000	
7/1/2007				0,0000		0,0000						0,0000	
8/1/2007				0,0000		0,0000						0,0000	
9/1/2007				0,0000		0,0000						0,0000	
10/1/2007				0,0000		0,0000						0,0000	
11/1/2007				0,0000		0,0000						0,0000	
12/1/2007				0,0000		0,0000						0,0000	
13/1/2007				0,0000		0,0000						0,0000	
14/1/2007				0,0000		0,0000						0,0000	
15/1/2007				0,0000		0,0000						0,0000	
16/1/2007				0,0000		0,0000						0,0000	
17/1/2007				0,0000		0,0000						0,0000	
18/1/2007				0,0000		0,0000						0,0000	
19/1/2007				0,0000		0,0000						0,0000	
20/1/2007				0,0000		0,0000						0,0000	
21/1/2007				0,0000		0,0000						0,0000	
22/1/2007				0,0000		0,0000						0,0000	
23/1/2007				0,0000		0,0000						0,0000	
24/1/2007				0,0000		0,0000						0,0000	
25/1/2007				0,0000		0,0000						0,0000	
26/1/2007				0,0000		0,0000						0,0000	
27/1/2007				0,0000		0,0000						0,0000	
28/1/2007				0,0000		0,0000						0,0000	
29/1/2007				0,0000		0,0000						0,0000	
30/1/2007				0,0000		0,0000						0,0000	
31/1/2007				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 20% (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 05/02/2007, by Econergy Brazil 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:

20/09/2007

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

The project participants confirm the start date of the crediting period will not commence prior to the date of the registration.

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:

The possible environmental impacts are to be analyzed by the State Secretary of Environment (SMA – Secretaria de Estado do Meio Ambiente), through DAIA – Environment Impact Assessment Department (Departamento de Avaliação de Impacto Ambiental) and CETESB – State of São Paulo Environmental Agency (Companhia de Tecnologia de Saneamento Ambiental). Terrestre has all the pertinent licenses for CGR Piaçaguera, and will carry out the necessary process in order to obtain the Operation License for the flaring facility. From December-2002 to June-2004, the landfill received 2 temporary Operational Licenses, until the definitive Operational License from 21 June 2004.
There will be no transboundary impacts resulting from TALGP. All the relevant impacts occur within Brazilian borders and will be mitigated to comply with the environmental requirements for project's implementation.

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:

The CGR Piaçaguera is one of the few landfills that has an Environmental License from CETESB (license number 18000614, issued on June 21st 2004), showing Terrestre Ambiental is totally committed to environmental integrity in its practices.

There are no significant environmental impacts in TALGP. The necessary infra-structure to flare the gas and produce energy will not likely cause any significant impacts in the site.

Flaring gas, nevertheless, may cause gaseous emissions, such as volatile organic compounds and dioxins that have to be controlled. During the environmental licensing procedures, all the necessary measures will be taken to mitigate such impacts, as requested for issuance of the Operation License by the environmental agency.

SECTION E. Stakeholders' comments

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

As required by the Interministerial Commission 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 Terrestre 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 Santos – SP / *Municipal Administration of Santos – SP;*
- Secretaria Municipal do Meio Ambiente / *Municipal Secretariat of Environment;*
- Câmara dos Vereadores de Santos - SP / *Municipal Legislation Chamber;*
- Secretaria Estadual do Meio Ambiente / *Environmental Secretariat of São Paulo State;*
- CETESB / *State of São Paulo Environmental Agency;*
- Rotary Club de Santos;
- Ministério Público do Estado de São Paulo / *Public Ministry of São Paulo State;*
- Fórum Brasileiro de ONGs (FBOMS) / *Brazilian NGO Forum.*

E.2. Summary of the comments received:

A comment from *Fórum Brasileiro de ONGs* was received. According with the comment, the entity expresses gratitude for the correspondence dispatched by Terrestre. FBOMS also recognizes their role, as one of several institutions listed in the "Resolução nº1", created by CIMGC, that must invite for comments. They highlight their support in transparency mechanisms of analysis process and approval of CDM projects. They mention the importance of consulting local stakeholders for comments in order to improve of sustainability and the quality of projects collaborating with the implementation of international climate exchange regime. Futhermore, FBOMS affirms it is waiting for a Brazilian Federal Government manifestation, by means of CIMGC, about how the comments and analysis made by FBOMS integrants for CDM projects are considered into the final decision. Therefore, it emphasizes its interest in technical information evaluation, but a lack of more detailed analysis of the project does not mean their approval of the same.

It also suggests the application of sustainability criteria in order to evaluate the project's real impact on sustainable development.

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

Terrestre appreciated the comments from FBOMS. A letter was sent from Terrestre expressing its gratitude for the considerations about the TALGP and availability of providing any necessary additional information. Terrestre informed that they might study the adoption of a sustainability criteria certification, but recognizes that the CDM verification procedures already include the assessment of such criteria.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Project Participant -1:

Organization:	TERRESTRE AMBIENTAL LTDA.
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E-Mail:	estre@estre.com.br
URL:	www.estre.com.br
Represented by:	Alex Schlosser
Title:	
Salutation:	Mr.
Last Name:	SCHLOSSER
Middle Name:	-
First Name:	ALEX
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URL:	http://www.econergy.com.br
Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in TALGP.

Annex 3

BASELINE INFORMATION

Table 6. Baseline determination information

DATA	VALUE	UNIT	SOURCE
L_0 (methane potential generation)	0.07	m^3_{CH4}/kg_{waste}	USEPA
k (decay constant)	0.1	1/year	
Year of opening	2003		CGR Piaçaguera
Year of closure	2009		
R_x	Variable	t_{waste}	
EAF (Emission Adjustment Factor)	20	%	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 TALGP 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 Terrestre Ambiental from 2003 to 2009.

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 South-Southeast-Midwest 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.

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 validator (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	0.5312
2004	0.5055
2005	0.5130

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	288,933,290
2004	302,906,198
2005	314,533,592

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

$$EF_{OM,simple\_adjusted,2003} = (1-\lambda_{2003})\frac{\sum_{i,j} F_{i,j,2003}.COEF_{i,j}}{\sum_{j} GEN_{j,2003}} \therefore EF_{OM,simple\_adjusted,2003} = 0.4605 \text{ tCO}_2\text{/MWh}$$

$$EF_{OM,simple\_adjusted,2004} = (1-\lambda_{2004})\frac{\sum_{i,j} F_{i,j,2004}.COEF_{i,j}}{\sum_{j} GEN_{j,2004}} \therefore EF_{OM,simple\_adjusted,2004} = 0.4531 \text{ tCO}_2\text{/MWh}$$

$$EF_{OM,simple\_adjusted,2005} = (1-\lambda_{2005})\frac{\sum_{i,j} F_{i,j,2005}.COEF_{i,j}}{\sum_{j} GEN_{j,2005}} \therefore EF_{OM,simple\_adjusted,2005} = 0.3937 \text{ tCO}_2\text{/MWh}$$

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

$$EF_{OM,simple\_adjusted\,2003\_2005} = \frac{EF_{OM,simple\_adjusted,2003} * \sum_{j} GEN_{j,2003} + EF_{OM,simple\_adjusted,2004} * \sum_{j} GEN_{j,2004} + EF_{OM,simple\_adjusted,2005} * \sum_{j} GEN_{j,2005}}{\sum_{j} GEN_{j,2003} + \sum_{j} GEN_{j,2004} + \sum_{j} GEN_{j,2005}} = 0.4349$$

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:

$$EF_{BM,2005} = 0.0872 \text{ tCO}_2\text{/MWh}$$

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:

$$EF_{electricity,2003-2005} = 0.5*0.4349 + 0.5*0.0872 = 0.2611 \text{ tCO}_2\text{/MWh}$$

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 continues to demonstrate that integration will happen in the future. In 1998, the Brazilian government announced 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)[11]:

"… 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 biogas), 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[12]. 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 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.

[11] Bosi, M. *An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study*. International Energy Agency. Paris, 2000.

[12] www.aneel.gov.br

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[13], 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	0.0872

Therefore, considering all the rationale explained, the project developers selected to use 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 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

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

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 received from ONS was used to determine the lambda factor for each of the years with available data (2003, 2004 and 2005). The Low-cost/Must-run generation was determined as the total generation minus the generation from fossil-fuelled thermal plants generation, this one determined through daily dispatch data provided by ONS. All this information has been provided to the validators, and extensively discussed with them, in order to make all points crystal clear.

On the following pages, a summary of the analysis is provided. The Table 7 shows the summarized conclusions of the analysis of the emission factor calculation and Figures 14, 15 and 16 present the load duration curves for the S-SE-CO subsystem. Finally, the Figure 17 shows the estimated generation of methane in the baseline scenario and the methane captured and fired.

Table 7. Summary of the emission factor calculation

Emission factors for the Brazilian South-Southeast-Midwest interconnected grid

Baseline (including imports)	EF_{OM} [tCO2/MWh]	Load [MWh]	LCMR [MWh]	Imports [MWh]
2003	0.9823	288,933,290	274,670,644	459,586
2004	0.9163	302,906,198	284,748,295	1,468,275
2005	0.8086	314,533,592	296,690,687	3,535,252
	Total (2003-2005) =	906,373,081	856,109,626	5,463,113
	$EF_{OM,\ simple\text{-}adjusted}$ [tCO2/MWh]	$EF_{BM,2005}$	Lambda	
	0.4349	0.0872	λ_{2003}	
	Weights	Default weights	0.5312	
	w_{OM} = 0.50	w_{OM} = 0.5	λ_{2004}	
	w_{BM} = 0.50	w_{BM} = 0.5	0.5055	
	EF_y [tCO2/MWh]	Default EF_y [tCO2/MWh]	λ_{2005}	
	0.2611	0.2611	0.5130	

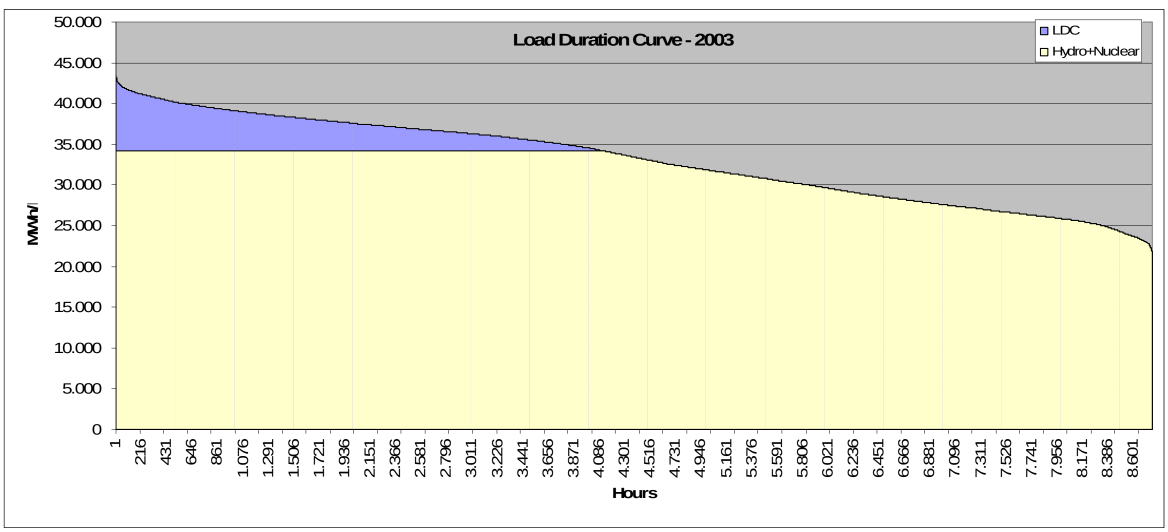

Figure 14. Load duration curve for the S-SE-CO subsystem, 2003

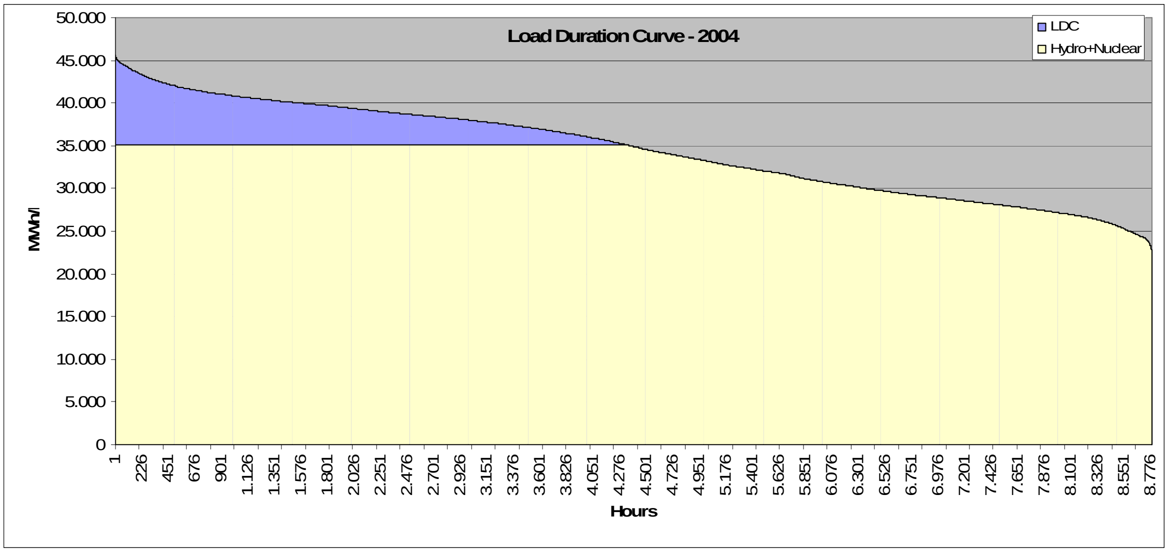

Figure 15. Load duration curve for the S-SE-CO subsystem, 2004

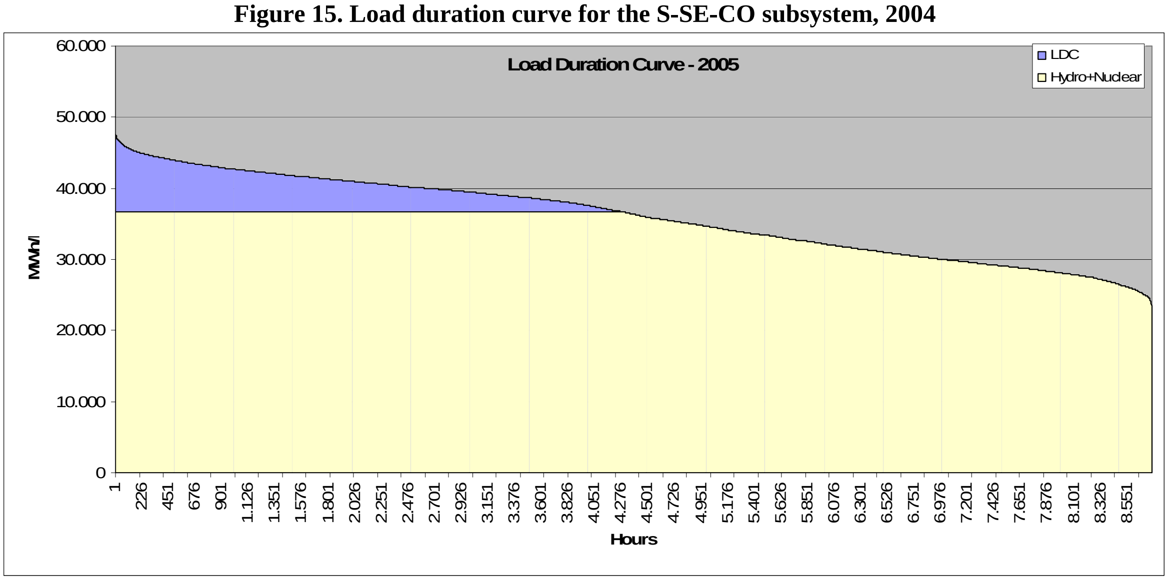

Figure 16. Load duration curve for the S-SE-CO subsystem, 2005

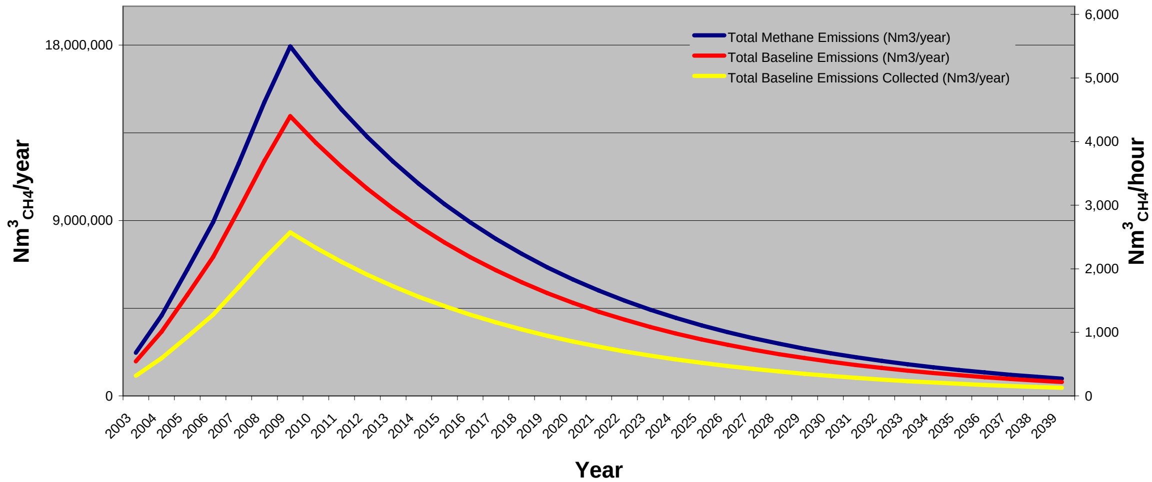

Figure 17. Baseline Emission and Emission Reductions from Terrestre Ambiental Landfill

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 TALGP	tCO_2e
K	Total electricity imported	MWh
L	Emission factor of the grid which TALGP is connected	tCO_2e/MWh
M = K . L	Emissions due to the import of electricity	tCO_2e
N = J – M	Emissions reductions due to TALGP	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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