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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

M'beubeuss Landfill Methane Recovery Project
Document Version Number 01
Document date: March 06

A.2. Description of the project activity:

The M'beubeuss Landfill Methane Recovery Project ("the Project Activity") will flare recovered methane as a result of the landfill's remediation and installation of biogas capture equipment. The M'beubeuss Landfill is owned by the city of Dakar, Senegal and is located 27 km to the west of Dakar, in the area of M'beubeuss, near to the village of Malika, occupying a part of the M'beubeuss salt lake which lies close to the coast between coastal dunes and desert dunes. It receives waste from the city of Dakar and its environs. Dakar has a population of circa. 1.82 million.

The landfill occupies the natural depression formed by the M'beubeuss Lake. Waste tipping commenced in 1968. Between 1970 and 1980, waste was tipped over an area of approximately 45 hectares; post-1980 the area was subsequently extended over a further 10 hectares to the east and west.

The site is roughly linear and covers a distance of approximately 3 km and has waste depth of between 3-15 metres. It is estimated that more than 3 million m^3 of waste has been deposited at the active site to date.

The landfill is operational and economic activities within the landfill continue. The implementation of the Project Activity will, therefore, be sensitive to the operation of the landfill and of the waste pickers who utilize the landfill for their own economic benefit.

In its present state, this extensive landfill area is subject to:

- burning of waste (open fires);
- a large surface area of waste is exposed, allowing oxygenating conditions and preventing the formation of gas;
- inconsistency in location of waste placement, e.g., recent waste may have been deposited on top of very old waste, rather than the waste in one place being all of a similar age;
- spreading of waste in thin layers rather than in small, deep cells; and
- unauthorised waste 'mining', i.e. removal of waste for use as 'compost'.

The objective of the Project Activity is to destroy methane emissions that would have otherwise been released into the atmosphere. By capturing the LFG, GhG emissions are reduced, local environmental impacts are mitigated, and the operational safety of the site is increased. The Project Activity consists of the remediation of the landfill and installation of a system to collect and flare the landfill gas, including:

- reshaping the land and accumulated residues;

- sealing the site with an industrial liner to facilitate the correct drainage of the biogas and contribute to the stability of the landfill as well as prevent methane from leaking out into the atmosphere; and
- installing drainage networks and flaring units to destroy methane gas.

This Project Activity assumes that a LFG to Energy ("LFGTE") module may be commissioned in the future to utilise the LFG that will be flared. The decision to invest in a LFGTE module will be made on the basis of an economic review of the module and whether a Power Purchase Agreement ("PPA") can be obtained. Consequently, it is assumed by the baseline calculation methodology that electricity is generated to account for this potential option. Whilst the primary activity of the Project Activity is flaring, the PDD is designed to account for a potential second investment phase to add on power generation (e.g., the monitoring methodology is prepared so that it recognises emissions from power generation, should they be produced).

Finally, the Project Activity will develop and implement a social programme that addresses the needs of the local waste picking community that will be affected by the landfill remediation. All social projects will be funded by a percentage of the proceeds generated by the sale of Certified Emission Reductions ("CERs"). The social programme will be designed to meet the needs of the local community with appropriate consultation including that of local NGOs.

CH_4 is 21 times more potent a GhG than CO_2. A major benefit of the project is the reduction of approximately 784,222 tCO_2 ("CO_2") equivalent ("CO_2e") will be achieved for the period 2008-2012 and 1,313,220 tCO_2e over a 10-year period.

The Project Activity will contribute to the sustainable development goals of Senegal. The Senegalese Designated National Authority ("the DNA") has developed a set of sustainability criteria approved by the Ministerial Decree creating the DNA "Arrete Portant Creation De L'Unite National Pour Le Mechanisme Pour Un Developpement Propre Du Senegal".

All CDM project activities in Senegal are required to meet the following criteria:

1. provide a sustainable contribution to the local environment;
2. contribute to reducing global impact on climate change;
3. contribute to inward investment that would not have occurred without the CDM;
4. contribute to the creation of real employment opportunities; and
5. account for the local populations in the development and implementation of the project.

Overall, the project will contribute to the sustainable development of Senegal and the local communities and meet the goals of the DNA since the project will:

- increase inward investment to Senegal for clean technology;
- introduce best practices for landfill management;
- improve the economic and social status of local stakeholders due to the remediation of the site and implementation of social activities and programmes;
- enhance the local environment, through the reduction of water pollution, reduced toxic air emissions and bad odours, and enhancement of the global environment, through the reduction of CH4 a significant GhG; and
- transfer state-of-the-art landfill management technology yet largely unknown in Senegal.

A.3. Project participants:

Names of Party Involved	Private and/or public project participants	Does the Party involved wish to be considered as project participant
Senegal	TBD	No
UK	Carbon Capital Markets Ltd	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The landfill is located in Malika, M'beubeuss, Senegal

A.4.1.1. Host Party(ies):

Senegal (the "Host Country")

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

M'beubeuss

A.4.1.3. City/Town/Community etc:

Malika

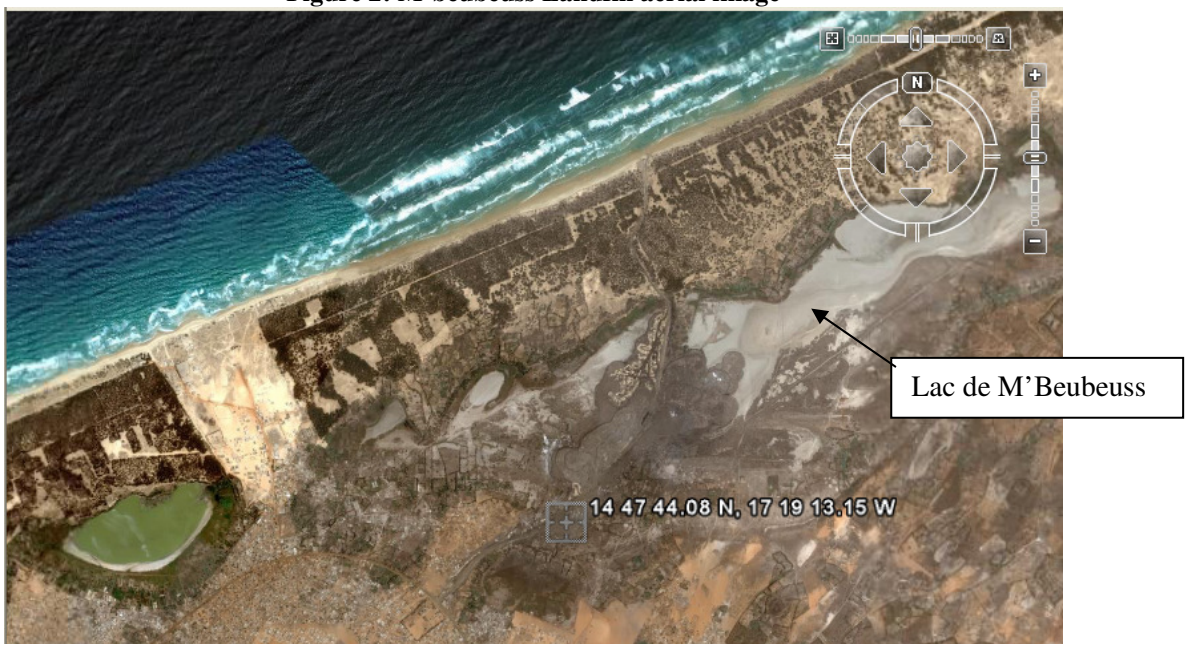
A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The M'beubeuss landfill is a solid, non-hazardous waste deposal facility located in Senegal. Figures below presents an aerial view of the area and landfill.

Figure 1 Dakar and M'Beubeuss

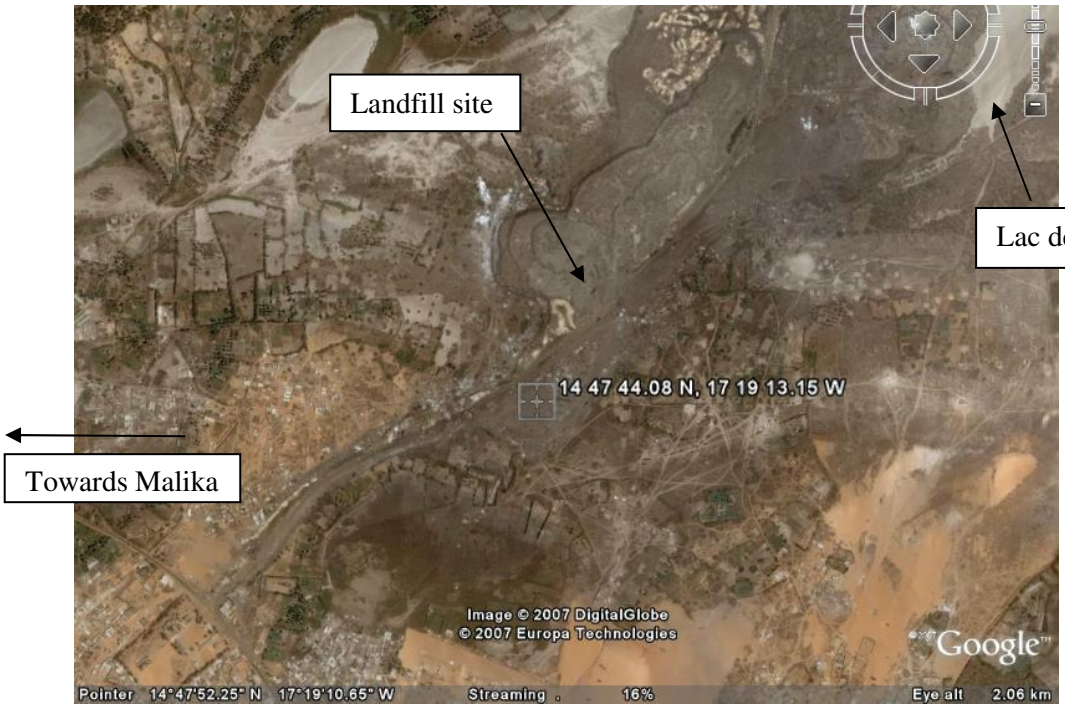
Source: Google Earth, 2007

Figure 2: M'beubeuss Landfill aerial image



Location: Area of M'Beubeuss
Source: Google Earth, 2007

Figure 3 Local Landfill Area



Location: M'Beubeuss Landfill Site
Source: Google Earth, 2007; Report by the Pesticide Action Network, 2005

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

Sectoral scope 13: Waste handling and disposal.

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

The Project Activity involves the installation of an active gas collection system, an efficient gas flaring plant, collection of leachates and improvement of the landfill covering system. In a second phase, electricity may be generated. Due to the possibility of power generation in the future, this PDD will present both flaring and power generation as possible project activities versus the baseline of release to atmosphere.

Note that the following refers to standard technology found in the industry. The final engineering design of this project (to be completed in the near future) will affect the final decisions on number, layout and manufacturer of the specific technology pieces.

The Project Activity will involve the implementation of the following:

(a) Remediation (leachates collection, landfill covering system)
(b) Landfill Gas Collection System
(c) Gas flaring
(d) Optional: Electricity generation

(a) **Remediation**

To support the collection and flaring of the landfill gas, as well as to mitigate current, adverse environmental impacts, the following remediation activities will be implemented:

- the landfill surface and slopes will be capped to prevent the ingress of water and to prevent the natural ventilation of the landfill gas;
- capping will comprise of either a thick layer of clay compacted to achieve the specified low permeability or a low permeability geomembrane This may facilitate the correct drainage of the landfill gas, prevent methane venting and contribute to the landfill stability; and
- a peripheral system of ducts will be installed in order to collect the wastewater which flows from the landfill. This will prevent leachates from reaching neighbouring agricultural lands and hence help minimize the environmental impact that now is occurring. The drainage system serves the additional function of acting as an anchor weight for the geo-membranes if used.

(b) Landfill Gas Collection System

Prior to the development and installation of a methane capture and recovery system, a feasibility study will be carried out including soil boring tests and pumping tests to determine landfill characteristics and quantity as well as quality and flow rate of the landfill gas. The final system will incorporate a network of vertical and horizontal collection pipes (laterals, subheaders, headers, etc.) to collect and conduct the landfill gas to the flare. The configuration of the gas collection wells will be sensitive to landfill characteristics determined in the design phase such as varying depths and slopes in the landfill.

The number and spacing of the vertical extraction wells will be determined by the preliminary tests. The horizontal and drainage pipes will be designed to minimize accumulation of condensates due to temperature differentials between the interior and exterior of the landfill. The placement of a dewatering system, condensate management equipment and a blower system to aid collection will be considered in the final system.

(c) Gas Flaring Integrated booster and flare station

At least one high-temperature, high-efficiency, continuous flare will be used to combust the landfill gas. The flare(s) will be enclosed and will incorporate the necessary measurement equipment to monitor vital data points such as temperature, pressure, flow rate and gas composition. The flare will be appropriately sized and designed after the feasibility study.

(d) Electricity Generation

In the event that power generation is implemented in a second project stage, appropriate gas engines suitable for landfill gas would be installed. For example, the system could include internal combustion engines, a generator, transformer and LFG cleaning equipment (for hydrogen sulphide and other corrosive compounds). Provisions may also be made for the export of power not used on-site to the power grid.

In the meantime, a small fossil fuel (diesel) generator will be used on-site for power requirements for various components of the system such as blowers. Specifics of the size will be finalised as part of the design of the landfill collection system.

This Project Activity is the first of its kind to be implemented in Senegal. Open dumps are the standard type of landfill site with no sanitary landfills as yet established in the country. Additionally, there are no laws in effect that mandate collection/capture of landfill gas.

Component	Imported or locally manufactured	Standard
Wells	Locally manufactured	According to EU Standards
Gas collection system	Partly Locally manufactured and partly imported.	According to US or EU Standards (operational safety and environmental aspects).
Flaring system	Imported from EU or US	According to EU Standards
Gas engine and generator sets	Imported from EU or US	According to EU Standards
Monitoring and control systems	Imported from EU or US	According to EU Standards.

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

By direct flaring of the LFG generated at the site, the Project Activity is expected to generate 1,382,337 tonnes of emission reductions expressed as tonnes of CO_2e over the 10-year crediting period.

The table below indicates the annual expected amount of emission reductions generated over the entire project lifespan.

Year	CERS
2008	165,451
2009	162,079
2010	159,028
2011	156,267
2012	141,397
2013	127,941
2014	115,766
2015	104,749
2016	94,781
2017	85,761
Total Estimation of Emission reductions (CO_2e tons)	1,313,220
Crediting period (in years)	10
Annual Average of Emission reductions (CO_2e tons)	131,322

A.4.5. Public funding of the project activity:

The Project Activity will not receive any public funding from Parties included in Annex I of the UNFCCC.

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:

The baseline and monitoring methodology to be applied for the proposed project activity is the approved consolidated baseline methodology ACM0001, version 5, December 2006: ***"Consolidated baseline methodology for landfill gas project activities"*** and ***"Consolidated monitoring methodology for landfill gas project activities"***. For emissions reductions associated with electricity generation using LFG, this PDD also incorporates the small-scale CDM methodology AMS I.D Version 10, December 2006 ***"Grid connected renewable electricity generation"***. Please note that power generation is only being considered as a second investment phase to this Project Activity and will be determined based on a thorough economic evaluation and receiving an appropriate PPA.

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

The consolidated methodology ACM0001 is applicable to landfill gas project activities where the baseline scenario is the partial or total atmospheric release of LFG.

In the case of the Project Activity, the baseline scenario is the total atmospheric release of the gas, and the Project Activity is the flaring/destruction of captured gas; ACM0001 is, therefore, applicable to the Project Activity.

In the future, if a LFGTE unit is added to the Project Activity, emission reductions corresponding to the electricity generation component will be determined according to the latest version of AMS-1.D "Grid connected renewable electricity generation" of the simplified modalities and procedures for small-scale CDM project activities. In this case, the Project Activity would not be financially viable without CER revenues, since the financial return from LFG would be insufficient to recover project investments and operational costs.

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

	Source	Greenhouse Gas	Included/ Excluded	Justification
Baseline	Landfill waste gas	CO_2	Excluded	Not an emissions source
		CH_4	Included	Main emissions source
		N_2O	Excluded	Not an emissions source
Project Activity	Landfill waste gas	CO_2	Excluded	Not an emissions source
		CH_4	Included	Main emissions reduction source
		N_2O	Excluded	Not an emissions source
	Fossil Fuel use[1]	CO_2	Included	Secondary emissions source
		CH_4	Included	Secondary emissions source
		N_2O	Included	Secondary emissions source
	Grid electricity imported / exported[2]	CO_2	Included	Main emissions source
		CH_4	Excluded	Not an emissions source
		N2O	Excluded	Not an emissions source

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

According to methodology ACM0001, the baseline is the atmospheric release of the gas and the baseline methodology considers that "*some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odour concern*".

In the case of the Project Activity, the baseline scenario is the continued uncontrolled release of LFG to the atmosphere, which is what occurs at landfill sites throughout the Host Country.

In the case the Project Activity also includes LFGTE, the baseline scenario is the continued uncontrolled release of LFG to the atmosphere, which is what occurs at landfill sites throughout the Host Country.

The baseline scenario is set and additionality is demonstrated according to the following methodology: Tool for the demonstration and assessment of additionality (version 02).

Details concerning determination of the baseline scenario are described in the examination of additionality in section B.5. Accordingly, the following paragraphs give an outline description.

[1] In the event that there is no power grid transmission into the site, a stand-alone diesel engine will be used on-site.

[2] The Project Activity may in the future generate power. Should this occur it will be a net exporter of power. There may also be exceptional cases, where electricity is drawn from the power grid to electrify onsite components of the Project Activity. In this exceptional case the Project Activity will import electricity from the grid.

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

The following scenarios are examined:

- **Scenario 1**: Maintain the status quo. This scenario assumes that LFG is emitted into the atmosphere without conducting any management, collection or utilization on the landfill site and a Gas Engine Generator ("GEG") is not established.
- **Scenario 2**: LFG recovery project. This scenario assumes that LFG from the landfill site is recovered and combusted by flaring.
- **Scenario 3**: LFG recovery and electricity generation project. This scenario assumes that LFG from the landfill site is recovered and used to generate electricity.

Step 2 Investment Analysis
As a result of conducting investment analysis, it became clear that Scenario 1 is the only plausible baseline, as the other possible scenarios constitute an economically attractive course of action.

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): >>

There is no capture of LFG for use or destruction in Senegal. There are, in fact, no sanitary landfills in Senegal. Open dumps are the normal standard for landfills in Senegal. The Project Activity represents the first of its kind in this country.

The additionality tool is fully applied as follows:

Step	Title	Description
Step 0	Preliminary screening based on the starting date of the project activity	Since the project is not scheduled to start before December 31st 2005, this step can be skipped.
Step 1	**Identification of alternatives to the project activity consistent with current laws and regulations**	
Sub-step 1a	Define alternatives to the project activity	**Scenario 1: Maintain the status quo (current business as usual practice)** i.e. waste covering and passive LFG venting with no implementation of gas collecting systems. **Scenario 2: LFG recovery and flaring project**. This alternative represents the Project Activity. **Scenario 3: LFG recovery and electricity generation project**. This scenario assumes that LFG from the landfill site is recovered and used to generate electricity. This alternative represents a possible second development stage of the Project Activity.
Sub-step 1b	Enforcement with applicable laws and regulations	Scenario 2 and Scenario 3 do not contravene any laws or regulations of Senegal. The tool for the demonstration and assessment of additionality states that only laws that are enforced should be considered in the determination of the baseline scenario. Presently, common practice shows that existing landfills in the country do not capture and flare or utilise their landfill gas.
Step 2	Investment Analysis	According to the tool for the demonstration and assessment of additionality, one of three options must be applied for this step: (1) simple cost analysis (where no benefits other than CDM income exist for the project), (2) investment comparison analysis (where comparable alternatives to the project exist), or (3) benchmark analysis.
Sub-step 2a	Determine appropriate analysis method	Scenario 2, which represents the Project Activity, does not contain any income other than income from the sale of CERs. A simple cost analysis may be used. For Scenario 3, according to the methodology, if alternatives to the Project Activity do not include investments of comparable scale to the project, then Option III (Benchmark Analysis) must be used.

Step	Title	Description
Sub-step 2b Scenario 2	Apply Simple Cost Analysis	*Scenario 2*: Total investment of the LFG collection and flaring system is estimated to be more than €3 million. The LFG system will also incur additional expenses once it becomes operational (e.g., maintenance, management, administrative). In Scenario 2, no returns corresponding to the initial investment or on-going expenses are expected and, therefore, this scenario carries a negative net present value and no IRR. Therefore, without CERs, the project activity is not economically attractive and not a realistic baseline scenario.
Sub-step 2b: Scenario 3	Apply benchmark analysis	*Scenario 3:* In the case of Scenario 3, securing revenues from electricity generation would increase the IRR of the project activity, though not to an IRR high enough to warrant the investment. The likelihood of development of this project, as opposed to the continuation of current activities (i.e., no collection and combustion of landfill gas), will be determined by examining its IRR.
Sub-step 2c: Scenario 3	Calculation and comparison of financial indicators	The table below shows the financial analysis for the project activity. As shown, the project does not have any viable returns. **Table:** Financial results of the project in case of the Electrical Generation and without carbon finance. NPV uses 15% discount rate which is in line with commercial expectations. The electricity price is assumed to be 110 USD/MWh which is consistent with average prices in Dakar, Senegal. **Without Carbon Revenues** Net Present Value (€) -5,417,000 IRR (%) none Discount Rate (%) 15
Sub-step 2d: Option 3	Sensitivity analysis	A sensitivity analysis may be conducted by altering those parameters which were most likely to fluctuate over time: ▪ Increase in project revenue (price of electricity sold to the grid) ▪ Reduction in project capital on running costs. **Scenario** / **% Change** / **IRR (%)** / **NPV (€)** Original 0 none -5,417,000 Increase in Project Revenue 10 none -5,022,000 Reduction in project costs 10 none -4,538,000 Sensitivity analysis shows that the project does not have viable returns even when the revenue from power increases or the project costs decrease. Consequently, Scenario 3 cannot be considered as financially attractive.

Step	Title	Description
Step 3	Barrier Analysis	Step 3 can be skipped since Step 2 was implemented.
Step 4	Common Practice Analysis	*Applicable to Scenario 2 and Scenario 3* There are no other sanitary landfills in Senegal; all other landfills are open dumps. This will be the first project of its kind in the country whereby landfill gas is captured and destroyed (either through flaring or power generation).
Step 5	Impact of CDM Registration	The impact of CDM registration takes into consideration the economic value of CERs under the investment analysis of Scenario 2 and Scenario 3. As shown in Step 2 above, the project is unlikely to move forward without the additional financial support of the CDM. The Project Activity will produce a closed landfill site as opposed to the open dump, introduce best practice landfill management activities to the country and fund social projects for the local communities. *Scenario 2:* Assuming that CERs per tonne have a market value of €10 per tonne, the post-tax IRR is projected to be approximately 33.8%. *Scenario 3:* Assuming that CERs per tonne have a market value of €10 per tonne, and generate additional revenues from the sale of electricity to the grid (assuming a market value is 83 €/MWh), the post-tax IRR is projected to be approximately 15.8%. *Summary* The above analysis shows that Scenario 2 and Scenario 3 do not represent the baseline scenario. Since a PPA has yet to be secured, Scenario 2 has been chosen as the Project Activity. Scenario 1 is determined to represent the baseline scenario. It is through the projected estimates of aggregate emission reductions of 1,313,220 tCO_2e over 10 years, that the Project Activity will receive investment, and can therefore be said to be additional to the business-as-usual.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Step 1

The GhG emissions reduction achieved by the Project Activity:

$$ER_y = (MD_{project,\,y} - MD_{reg})*GWP_{CH4} + EL_y*CEF_{electricity,\,y} - ET_y * CEF_{thermal,\,y} \quad (1)$$

ER_y	GHG emissions reduction (in year y), in tonnes of CO_2 equivalents (tCO_2) as a result of project implementation
$MD_{project,\,y}$	The amount of methane that would have been destroyed/combusted during the year, in, tonnes of methane (tCH_4)
$MD_{reg,\,y}$	The amount of methane that would have been destroyed/combusted during the year in absence of the project, in, tonnes of methane (tCH_4)
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/CH_4.
EL_y	Net quantity of electricity exported during year y, in megawatt hours (MWh).
$CEF_{electricity,\,y}$	The CO_2 emissions intensity of the electricity displaced. In the Project, this is calculated according to AMS.I.D. version 10, as of 21 December 2006 *"The weighted average emissions (in kg CO_2e/kWh) of the current generation mix."*
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, in TJ. Should an on-site diesel engine be used to provide power, the emissions from the fossil fuel use will be accounted for in this term.
$CEF_{thermal,\,y}$	CO_2 emissions intensity of the fuel used to generate thermal / mechanical energy, in tCO_2e/TJ

According to ACM0001, no leakage is expected for such project activities.

Step 2

The amount of methane that would have been destroyed/consumed in the absence of the Project Activity is as:

$$MD_{reg} = MD_{project,y} * AF \quad (2)$$

The Adjustment factor ("AF") is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirements to that of the collection and destruction system in the Project Activity. For this project, there are no regulatory or contractual requirements and the baseline scenario chosen above is that all landfill gas would be released into the atmosphere. Therefore, the AF applied to the Project Activity is 0% and MD_{reg} is = 0.

Step 3

The Project Activity does not include thermal energy generation from LFG, then the amount of methane that would have been destroyed / combusted during the year will be the addition of the following terms:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} \quad (3)$$

Both components of this equation are expressed separately in Step 4 and Step 7

Step 4

$MD_{flared,y}$ is the quantity of methane destroyed by flaring by the Project Activity. It is calculated as follows:

$$MD_{flared,y} = (LFG_{flared,y} * W_{CH4y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (4)$$

$LFG_{flare,y}$	The quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3)
W_{CH4}	The average methane fraction of the landfill gas as measured* during the year and expressed as a fraction (in m^3 CH_4 / m^3 LFG)
D_{CH4}	The methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)**
$PE_{flare,y}$	The project emissions from flaring of the residual gas stream in the year y (tCO_2)

(*) Methane fraction of the landfill gas to be measured on wet basis
(**) At standard temperature and pressure (101.325 kPa and 273.15 K) the density of methane is 0.0007168 tCH_4/m^3CH_4)

The Project Emissions (PE) will be determined following the procedure described in the "*Tool to determine project emissions from flaring gases containing Methane"* as shown in step 5.

Step 5

The Project Emissions from flaring of the Project Activity are calculating according to the following equation:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH_4}}{1000} \quad (5)$$

Variable	S.I. Unit	Description
$PE_{flare,y}$	tCO_2e	Project emissions from flaring of the residual gas stream in year y
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$\eta_{flare,h}$	-	Flare efficiency in hour h
GWP_{CH4}	tCO_2e/tCH_4	Global Warming Potential of methane valid for the commitment period

Step 6

The tool offers two options for enclosed flares. This Project Activity will use the 90% default efficiency factor with continuous monitoring of manufacturer's specifications (temperature and flow rate of residual gas at the inlet of the flare). If in any specific hour, any parameter is out of the limit of manufacturer's specifications, an efficiency of 50% will be used.

Step 7

$MD_{electricity}$ represents the quantity of methane destroyed for the generation of electricity in the Project Activity and is expressed by the following equation:

$$MD_{electricity,\ y} = LFG_{electricity,\ y} * W_{CH4y} * D_{CH4} \quad (7)$$

$LFG_{electricity\ y}$	Quantity of landfill gas used to generate electricity during a year measured in cubic meters (m^3)
W_{CH4y}	Average methane fraction of the LFG as measured during the year and expressed as a fraction ($m^3\ CH_4/m^3$ LFG)
D_{CH4}	Density of methane expressed in tonnes of methane (tCH_4/m^3 LFG)

Step 8

In the second phase of the project where excess power generation will be exported to the grid, the emissions reductions are claimed for displacing or avoiding energy from other sources net of any electricity imported.

$$EL_y = EL_{EX,\ LFG} - EL_{IMP} \quad (8)$$

$EL_{EX,LFG}$	Net quantity of electricity exported during year y, produced using landfill gas, in Megawatt hours.
EL_{IMP}	Net Incremental electricity imported, defined as difference of project imports less any imports less any imports of electricity in the baseline, to meet the requirements, in MWh

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

Data / Parameter:	GWP CH_4
Data unit:	t CO_2
Description:	Global Warming Factor ("GWP") value for CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	The IPCC approved is GWP is 21 tonnes of CO_2e/tonne of CH_4
Any comment:	

Data / Parameter:	AF
Data unit:	-
Description:	Adjustment Factor
Source of data used:	-
Value applied:	0.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	Changes in the law shall be monitored as a matter of procedure

Data / Parameter:	$CEF_{electricity}$
Data unit:	Tonnes of CO_2e/MWh
Description:	CO_2e emissions conversion factor for electricity
Source of data used:	
Value applied:	2.33
Justification of the choice of data or description of measurement methods and procedures actually applied :	Information provided through the International Energy Agency Statistics[3] on the CO_2 emissions from fuel combustion (4.11 Mt) calculated using IEA's energy balances and the Revised IPCC 1996 Guidelines and power generation from oil (1,764,000 MWh). Note that oil represents over 97% of fossil generation in Senegal.
Any comment:	This figure will be updated from year to year as data is made available

[3] http://www.iea.org/Textbase/country/n_country.asp?COUNTRY_CODE=SN&Submit=Submit

http://www.iea.org/Textbase/stats/electricitydata.asp?COUNTRY_CODE=SN

Data / Parameter:	η_{flare}
Data unit:	--
Description:	Efficiency of the flare combustion
Source of data used:	Default value from "Tool to Determine Project Emissions from Flaring Gases Containing Methane"
Value applied:	90%
Justification of the choice of data or description of measurement methods and procedures actually applied :	A default value for closed flares can be used under this Tool when substantiated with continuous measurements of the manufacturer's specifications (temperature and flow rate of residual gas at flare inlet). In any hour where these parameters fall out of specification, an efficiency value of 50% will be used
Any comment:	

Data / Parameter:	D_{CH4}
Data unit:	tCH_4/m^3 CH_4
Description:	Methane Density
Source of data used:	Revision to the approved consolidated monitoring methodology ACM0001 Version 5 "Consolidated monitoring methodology for landfill gas project activities
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since the value adopted in the approved consolidated methodology is used, the selected data are considered to be appropriate.
Any comment:	Changes in the approved methodology shall be checked for in monitoring.

Data / Parameter:	$CEF_{thermal}$
Data unit:	tCO_2e/TJ of fossil fuel
Description:	CO_2e emissions conversion factor for electricity in México
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 2 Energy
Value applied:	74.349 tonnes / TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on CO_2 factor of 74,100 kg/TJ; CH_4 factor of 3 kg/TJ; N_2O factor of 0.6 kg/TJ
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

TABLE: US EPA DECAY MODEL USED TO ESTIMATE EMISSION REDUCTIONS

FIRST-ORDER DECOMPOSITION RATE EQUATION:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where:

Q_{CH4} = annual methane generation in the year of the calculation (m^3/year)

i = 1-year time increment

n = (year of the calculation) - (initial year of waste acceptance)

j = 0.1-year time increment

k = methane generation rate ($year^{-1}$)

L_o = potential methane generation capacity (m^3/Mg)

M_i = mass of waste accepted in the i^{th} year (Mg)

t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year

The quantity of waste was based on data provided by the ministry. Results are summarized below.

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

The ex-ante estimation of baseline emissions are calculated based on the methodology in section B.6.3. Project emissions will be from landfill gas collection efficiency, flare combustion efficiency and use of a stationary combustion diesel engine for on-site power.

The ex-ante estimation of emission reductions shown below are, therefore, the baseline emissions discounted by using a 50% collection efficiency and 90% flare efficiency. The project emissions from the use of diesel are expected to be minor compared to the combusted landfill gas. These will be accounted for once the landfill gas collection system has been designed (e.g., power for the blowers, etc.). Project emissions from diesel use are represented by a 5% discount in the ex-ante forecast.

The ex-ante estimation of emission reductions as a consequence of the Project Activity is shown in the table below. Once the Project Activity is operating, these emissions reductions will be obtained through the measurement of actual parameters, in accordance with ACM0001 methodology version 5.

Year	CERs
2008	165,451
2009	162,079
2010	159,028
2011	156,267
2012	141,397
2013	127,941
2014	115,766
2015	104,749
2016	94,781
2017	85,761
Total	1,313,220

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**$LFG_{total,y}$**
Data unit:	m^3
Description:	Total amount of landfill gas captured
Source of data to be used:	On-line LFG Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	see section B.6.3
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a hour Data archive: electronic Length of archiving: during the crediting period plus two years post crediting period.
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. Low Uncertainly level of data
Any comment:	Monitoring ID Number 1

Data / Parameter:	**$LFG_{flare,y}$**
Data unit:	m^3
Description:	Amount of landfill gas flared
Source of data to be used:	On-line LFG flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	see section B.6.3
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a hour Data archive: electronic Length of archiving: during the crediting period plus two years post crediting period.
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. Low Uncertainly level of data
Any comment:	Monitoring ID Number 2

Data / Parameter:	**$LFG_{electricity,y}$**
Data unit:	m^3
Description:	Total amount of landfill gas combusted in power plant
Source of data to be used:	On-line LFG Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a month Data archive: electronic Length of archiving: during the crediting period plus two years post crediting period.
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. Low uncertainly level of data
Any comment:	Monitoring ID Number 3

Data / Parameter:	**$PE_{flare, y}$**
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream, determined according to Annex 13 "Tool to determine project emissions from flaring gases containing methane"
Source of data to be used:	i) Flow meter in the residual gas conducts a. Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h ii) Thermocouple Type N a. Measure the temperature of the exhaust gas stream in the flare ("TEX") (K)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$\eta_{flare} = 90\%$
Description of measurement methods and procedures to be applied:	Continuous monitoring of the methane destruction efficiency of the flare measured hourly. Data archive: electronic Length of archiving: during the crediting period plus two years post crediting period
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. The thermocouples will be replaced or calibrated every year. Medium Uncertainly level of data
Any comment:	If the temperature of the exhaust gas of the flare (T_{flare}) is below 500ºC during the hour h the flare efficiency value will be $\eta_{flare,h} = 0\%$ If the parameters fall outside manufacturer's specifications for any specific hour, a default of $\eta_{flare,h} = 50\%$. Manufacturer's specifications are detailed in Annex 3. Monitoring ID Number 4

Data / Parameter:	$W_{CH4,y}$
Data unit:	m^3 CH_4/m^3 LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	On-line LFG 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:	Measured continuously and recorded once a hour Data archive: Electronic
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. Low Uncertainly level of data
Any comment:	Monitoring ID Number 5

Data / Parameter:	**T**
Data unit:	ºC / K
Description:	Temperature of the landfill gas
Source of data to be used:	Thermometer Measured On line
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a hour Data archive: electronic
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured.
Any comment:	Monitoring ID Number 6 Note that the Esters flow meter will have an integrated pressure and temperature measurement to deliver the normalized m³/h

Data / Parameter:	**P**
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be used:	Pressure gauge Measured On line
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a hour Data archive: electronic
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured.
Any comment:	Monitoring ID Number 7 Note that the Esters flow meter will have an integrated pressure and temperature measurement to deliver the normalized m³/h

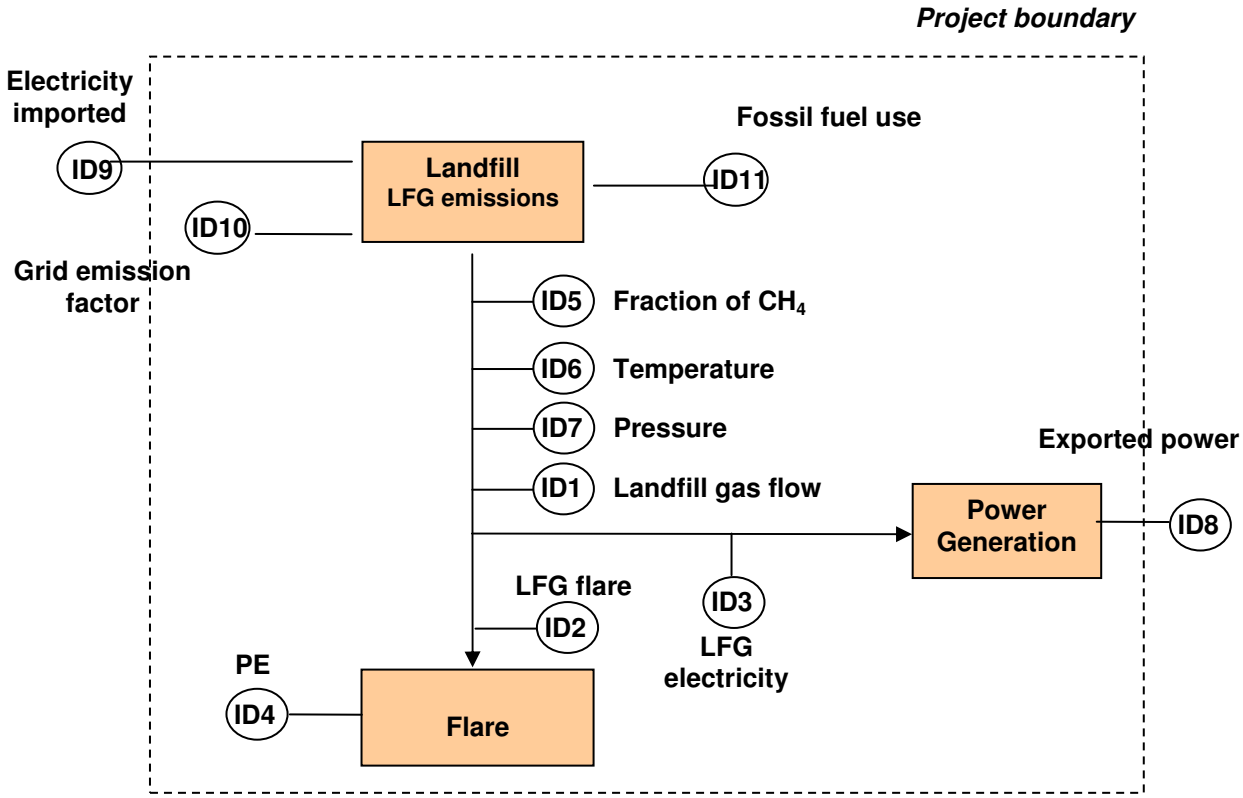
Data / Parameter:	**$EL_{EX, LFG}$**
Data unit:	MWh
Description:	Total amount of electricity exported out of the project boundary
Source of data to be used:	Electricity meter Measured on site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a month Data archive: electronic
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured.
Any comment:	Monitoring ID Number 8

Data / Parameter:	EL_{IMP}
Data unit:	MWh
Description:	Total quantity of electricity imported to meet the requirements of the Project Activity
Source of data to be used:	Electricity meter Measured on site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured continuously and recorded once a month Data archive: electronic
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured.
Any comment:	Monitoring ID Number 9

Data / Parameter:	$CEF_{ELECTRICITY}$
Data unit:	tCO_2/MWh
Description:	CO_2 emission intensity of the electricity and/or other energy carriers in the previous parameter.
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2.33
Description of measurement methods and procedures to be applied:	Data archive: electronic
QA/QC procedures to be applied:	
Any comment:	Monitoring ID Number 10

Data / Parameter:	EL_y
Data unit:	TJ of fuel
Description:	Energy of fuel combusted to provide on-site power
Source of data to be used:	Purchase records for volume of fuel and fuel calorific value
Value of data applied for the purpose of calculating expected emission reductions in section B.5	see note in section B.5;
Description of measurement methods and procedures to be applied:	Data archive: electronic Purchase record quantities
QA/QC procedures to be applied:	
Any comment:	Monitoring ID Number 11

The diagram below represents graphically how data parameter relates to each other:



B.7.2 Description of the monitoring plan:

The monitoring plan will be the responsibility of the site manager and undertaken by site staff responsible for the maintenance and care of the landfill gas collection system and flaring unit. The plan will include:

- routine reminders for site staff;
- QA/QC procedures;
- service forms;
- corrective action plans;
- maintenance plans; and
- monitoring schedules.

Measurements will be taken using state-of-the-art technology such as continuous flow meters.

The site manager will ensure the measurements are recorded and calibration/maintenance actions are performed per schedule, review the results of the measurements, ensure proper records are kept and transmit data for archiving.

Carbon Capital Markets Ltd will perform quality assurance on the data and ensure archiving of the data for the specified period (crediting period plus two years).

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)

March 2007

Carbon Capital Markets Ltd
Carbon Logistics
Level 3, 15 Berkeley Street
London, W1J 8DY
United Kingdom

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:

October 31, 2007

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

12 years

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:

C.2.1.2.	Length of the first crediting period:

C.2.2.	Fixed crediting period:

A ten-year fixed crediting period will be used for this project.

C.2.2.1.	Starting date:

October 31, 2007

C.2.2.2.	Length:

10 (ten) years

SECTION D. Environmental impacts

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

The Project Activity will collect and flare landfill gas which is currently released to the atmosphere, thereby reducing harmful global and local environmental effects. Apart from contributing to global warming and stratospheric ozone layer depletion, LFG emissions pose serious health and safety problems to the local environment, affecting the neighbouring population and causing damage to crops, plants and to the local fauna.

The Project Activity has a number of positive environmental impacts stemming from the covering and remediation of the landfill and the capture and destruction of the landfill gas including:

- improvement of odour nuisances;
- reduce ground-level ozone creation;
- prevention of open landfill site fires;
- improvement on visual impact of area;
- reduction of wild scavengers, rodents and insects in area;
- reduction of waste spread through wind and climate conditions;
- prevention of toxic and carcinogenic effects on humans.

Despite the numerous positive effects of the Project Activity, the following adverse impacts may be cause for concern and shall, therefore, be considered:

- Risks from collection, pumping and treatment of LFG (such as risk of fire from installation of flaring equipment) will be properly controlled through various equipment safety precautions (temperature and air intake control equipment, alarms, safety valves, automatic shutdown, etc) that are incorporated into the capture and flaring equipment. As well, a preventative maintenance plan for on-site equipment will be put in place to ensure the equipment continues to work according to manufacturer's specifications. Lastly, personnel working near the equipment will be provided with appropriate training for personal safety as well as proper equipment maintenance and operation.
- Noise and vibration caused by LFG collection equipment will not affect the neighbouring village of Malika since it is located at a suitable distance to the site. However, some individuals live in close proximity to the landfill site. The equipment will incorporate enclosed acoustic housings for sound reduction as much as possible.
- Air pollution resulting from combustion of LFG, such as SO_2, NO_X, VOC, CO, is possible; however, these emissions are expected to be minimal because the Project Activity includes a high-temperature, high efficiency combustion system congruent with EU standards. The majority of these emissions will be destroyed and the remainder will be minimal and significantly less harmful than the continued uncontrolled release of LFG.

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 Project Activity results in positive environmental impacts. Of the possible adverse impacts, these are minimized by the use of appropriate technology, procedures and area characteristics.

- To minimise noise pollution that may be generated by the Project Activity acoustic housing will be used where appropriate.
- Safety training and equipment will be provided to the personnel who will be working in close proximity to the flare and capture system.
- Since the M'Beubeuss landfill site will remain active for a number of years maximum consideration will be made for the safety aspects of this Project Activity. Specifically, preventative measures will be taken to ensure that flares and associated equipment will be secure, tamper proof and separated from local peoples.

According to Senegalese regulations, an Environmental Impact Assessment is not required for the implementation of LFG collection and flaring systems in open dumps. The Project Activity meets all regulatory requirements at municipal, state and national level in the Host country.

SECTION E. Stakeholders' comments

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

The stakeholder consultation was held on 28th February 2007 at the Sofitel Hotel in Dakar, approximately 15 kms from the Project Activity site.

Forty individual invitations were sent to relevant stakeholders. In addition, the stakeholder consultation information was circulated among the press who attended on the day. At least four articles reporting on the information presented during the consultation were published in local media.

Thirty-five participants joined the stakeholder consultation, including representatives of the Ministry for Environment, Ministry of Energy, The Climate Change Group, Ecopole, a local NGO affiliated with the waste pickers of the M'Beubeuss landfill site and the leading representative of the waste pickers (a full list of participants has been provided to the DOE).

Questions on the Project Activity and related social and environmental impacts were received for two hours following the presentation.

E.2. Summary of the comments received:

Material comments of consideration for the project activity were as follows.

- *Power generation*: Many interested stakeholders, government and non-government commented on the desirability of power generation. The feasibility of power generation will be dependent on the quality of the gas present and whether a power purchase agreement can be secured. As both of these criteria will be determined in the future, this PDD has made provisions for power generation from landfill gas. Should power generation become possible, it will be already included as a project activity.

- *Impact on current landfill operations*: As there is a large amount of manual labour occurring on the landfill (waste-picking, etc.), there was concern that the implementation of the Project Activity would impede or stop current activities. The Project Activity will be implemented in phases rather than transforming the entire landfill all at once. As well, the Project Activity will concentrate on the older portions of the landfill where waste-picking activities have already ceased; therefore, there should be minimal disruption to current activities.

- *Project lifespan*: Issue arose concerning how long the Project Activity would continue should the landfill remain open longer than anticipated. The technology for this project should be more than adequate to cover an extended period of operation especially as the climate is fairly dry and not conducive to humid conditions that could interfere with the machinery.

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

No negative comments were received. None of the comments received necessitated a change to the PDD approach.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

	Landgem results					
	Methane Emitted[1]	CO_2e[2]	Captured[3]	Flared[4]	Minus project emissions from diesel[5]	CERs
	tonnes/yr					
2008	18,430	387,020	193,510	174,159	165,451	165,451
2009	18,054	379,132	189,566	170,610	162,079	162,079
2010	17,714	371,995	185,998	167,398	159,028	159,028
2011	17,407	365,538	182,769	164,492	156,267	156,267
2012	15,750	330,752	165,376	148,838	141,397	141,397
2013	14,251	299,277	149,638	134,675	127,941	127,941
2014	12,895	270,797	135,398	121,859	115,766	115,766
2015	11,668	245,027	122,514	110,262	104,749	104,749
2016	10,558	221,710	110,855	99,769	94,781	94,781
2017	9,553	200,611	100,306	90,275	85,761	85,761
10-year sum	146,279	3,071,860	1,535,930	1,382,337	1,313,220	1,313,220

1) based on Landgem input assumptions below and methodology in section B.6.3
2) using a GWP of 21
3) assuming a 60% capture efficiency
4) assuming a 90% flare efficiency
5) diesel use represented by a 5% discount

Landgem constants:

k = 0.1
Lo = 120

Annex 4

MONITORING INFORMATION

The Monitoring plan covers procedures for the systematic surveillance of the CDM Project Activity's performance by measuring and recording performance-related indicators relevant to the project or activity. The Plan includes:

- **Routine Reminders for site staff:** All site staff will be issued with a reminder list to guide them through their daily, weekly and monthly routine. In addition, archived data will be checked to ensure it is being appropriately maintained.

- **Corrective Actions:** There will be quality assurance measures to handle and correct nonconformities in the implementation of the Project or this Monitoring Plan. In case such nonconformities are observed:
    - An analysis of the nonconformity and its causes will be carried out,
    - Appropriate corrective actions to eliminate the non-conformity and its causes will be identified, and
    - The implementation of corrective actions will be reported.

- **Service Sheets:** Service sheets will be used to ensure all aspects of the monitoring are completed and recorded. These sheets will serve as a procedural reminder and record of the monitoring that is required for the CDM project activity.

- **Calibration of measurement equipment:** Calibration of measurement equipment will be defined and scheduled by the technology provider.

- **Operational Manual**: All the information about monitoring procedures and quality assurance measures will be included in an Operational Manual. The Operational Manual will include procedures for training, capacity building, proper handling and maintenance of equipment, emergency plans.

There will be a team that will cover all aspects of the monitoring. The team members will be responsible for collecting, reviewing, recording and archiving the data. There will be a manager who will quality check the team's work ensuring that the monitoring is performed correctly and on time. The monitoring tools that will be available to the team and the manager include:

- Operational Manual (see above) including procedures on what is to be monitored, frequency of the monitoring, equipment to be used, maintenance required on instrumentation, corrective actions, etc.
- This Project Design Document
- UNFCCC baseline and monitoring methodology (ACM0001 and ACM0002)
- Service sheets (see above)
- Spreadsheets

The spreadsheets will serve as a registry of the all data collected by the different measuring equipments distributed all over the facilities. They will also be used to quantify ERs achieved by the projects activity during specific time periods through the use of auxiliary equations.

For the purposes of QA/QC and archiving data will be transmitted electronically to Carbon Capital Markets Ltd on a weekly basis as well as a reporting of any anomalies, equipment failures or any other causes of data loss. A final data quality check of the information will be made before an archived copy is created.