MONITORING REPORT

LANDFILL GAS EXTRACTION ON THE LANDFILL VILLA DOMINICO, BUENOS AIRES (ARGENTINA)

(CDM REGISTRATION REFERENCE NUMBER 0072)

MONITORING PERIOD:

OCTOBER 01, 2007 UP UNTIL AND INCLUDING FEBRUARY 29, 2008

FEBRUARY 13, 2009 VERSION 3

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1. INTRODUCTION

Van der Wiel implemented the 'Landfill gas extraction on the landfill Villa Dominico, Buenos Aires, Argentina' project (hereafter: the project activity), according the Project Design Document version 2, validated by Det Norske Veritas (DNV) under reference number 2005-0086 of July, 2005. The project was approved by the Argentinean DNA on June 22nd, 2005 and registered on the UNFCCC website on September 17th, 2005. The project is registered under reference number 0072.

2. OBJECTIVE

The purpose of this monitoring report is to quantify the volume of achieved greenhouse gas emission reductions (ERs) by means of the project. These reductions are expressed in tonnes CO_2-equivalents. The Designated Operational Entity (DOE) can certify these reductions as per the Kyoto Protocol and CDM Modalities Procedures requirements (Decision 17.CP7). The crediting period for this verification is from 01-10-2007 up until and including 29-02-2008.

3. GENERAL DESCRIPTION OF THE PROJECT

PURPOSE OF THE PROJECT

The purpose of the project is to capture and process biogas from the landfill site Villa Dominico, Buenos Aires, Argentina. The project aims to invest in a biogas collection system at the landfill site. Van der Wiel will use a proven technology, including a piping and well network, blowers and flaring system. The extracted landfill gas is converted into electricity, although the generated electricity is only for on site usage. Feeding electricity into the grid has not been taken into account for the proposed CDM project activity.

The project will result in greenhouse gas emission reductions result by combusting of the recovered methane contained in the landfill gas. It is estimated that the project will generate 5,300,000 ton CO_2 equivalent (CERs) within a 9 year period.

CONTRIBUTION OF THE PROJECT ACTIVITY TO SUSTAINABLE DEVELOPMENT

The long-term strategic objective of the project is to contribute to better waste management and to capture GHG-emissions from the landfill site Villa Dominico Landfill. In this way, emissions of other gases, such as H_2S, mercaptenes and other odorous compounds, are reduced, which leads to a cleaner environment in the surroundings of the landfill.

The project is implemented in an area characterized by poverty and social problems, including a high rate of unemployment and social instability. Residents from the surrounding the landfill area communities regularly demonstrate against the environmental pollution caused by the Villa Dominico landfill. Even after closure of the landfill, escape of the landfill gas to the atmosphere is not stopped. Only degasification of the landfill can improve the unwished local situation, guarantying:

- Abatement of methane emissions;

- Elimination of odorous gas emissions that affect the public health and quality of life. Bad odours can cause local health problems, negatively affect investment in the surrounding communities and lower property values and it's socio economic status;
- Reduction of explosion and fire risk.

The proposed project faces a number of market barriers of which the economic unattractiveness, lack of technical know-how, lack of availability of equipment is the most important. The implementation of this project will assist Argentina in demonstrating the practice of landfill gas recovery. Important elements are:

- Demonstrating the practice of landfill gas recovery in Argentina;
- Demonstrating how trading in emission reductions via the Kyoto mechanisms could assist in making the practice of landfill gas recovery economically viable;
    - Transferring the necessary technology and know-how to Argentina, including:
    - making available the required equipment for the landfill de-gasification (at this moment there are no providers of landfill gas recovery equipment in Argentina);
    - building of local know-how about the technology of LFG extraction through the involvement of Argentinean partners in the project;
    - additionally, building of local know-how about correct landfill site management after the closing time, i.e. covering systems, that contribute to reduction of the risk of waste slides at the site (covering of the landfill strongly accelerates the settlement of the waste);
    - carry over the technical knowledge about possibilities of the LFG gas utilisation methods, such as electrical power generation.

The Argentinean economy requires new investments from international sources. The landfill gas project brings several million euros for new investments from foreign sources into the country. It is also envisaged that the project will create a better environment for other future investments of similar nature.

The project increases economic activities in the region. The construction of the landfill gas plant will create new positions for both skilled and unskilled labour in the region. The purchase of materials and equipment from national sources will create better employment opportunities.

Further problems in controlling and monitoring of the landfill gas extraction and utilization, and additional monitoring pollution of water, soil and air at the project landfill, are set up by the competent staff of the Supplier. Landfills managed under environmental regulations such as degassing, which is an important tool for the sustained development of neighbouring communities, are of the utmost importance.

4. Baseline Methodology

The used baseline methodology is AM0011: **"Landfill gas recovery with electricity generation and no capture of methane in the baseline scenario"**.

§4.1 Baseline Determination

In order to calculate the baseline emissions, an estimation of the potential landfill gas production has been performed. Van der Wiel Stortgas BV has developed a model to calculate landfill gas production. The quantity of methane projected to be generated during a given year is estimated using as a basis the First Order Decay model for landfill gas generation. The general formula of degradation used in this model depends on several parameters including age of waste, mass, waste composition (concentration in organic carbon) and waste temperature.

The model is driven by the input of the following key parameters:
(1) Total tonnage of disposed waste

(2) Organic carbon content means the total quantity of organic carbon contained in waste and is measured in kg/ton. The organic carbon content depends on the composition of waste. By using bibliographical data and measurements in laboratory column tests or in instrumented cells, the organic carbon content value can be evaluated for municipal solid waste on 150 kg / Mg wet component.

(3) Methane generation decay rate is specified as an exponential rate of decomposition of the landfill refuse. Its value determines the amount of methane, that is released in a given disposal area during a specified time.

- Methane content in the landfill gas is 50%
- Molecular weight CH_4: 16.03
- Gas density of CH_4 : 0.72 kg/ Nm^3.

(4) Temperature in the refuse is expressed in °C. Temperature has an impact on the biodegradable carbon converted to landfill gas. Temperatures generally observed in landfills range 36 ^{0}C.

(5) Parameters, that have been applied by calculations:

- Parameter of gasification speed: 0.035
- Calorific value of the landfill gas: 5 kW
- Gas density of CO_2 : 1.99 kg/ m^3
- Heating value of landfill gas: 18 MJ/m^3

(6) Extraction efficiency
The recoverable landfill gas depends on the effectiveness of the extraction system. The rate of landfill gas recoverable generally ranges between 50 and 90% of the total production. It was considered for this calculation that the extraction efficiency is 0 % during the filling period and 70% one year after the area is covered and equipped with an extraction system.

(7) Assessment and uncertainties
The main uncertainty in the proposed project is the prediction of future emission levels, LFG production levels and LFG extraction efficiency, which are depending on a large number of practical and

operational factors. However, the baseline emissions are in this case determined by measuring the real amount of extracted LFG, so this uncertainty does not affect the choice of the baseline scenario.

The quantity of methane projected to be generated during a given year is estimated using as a basis the First Order Decay model for landfill gas generation:

GHG = Collectable gas quantity m3/h x Hours per year x Methane content x Spec. mass x 21

GHG = GHG emissions [ton CO_2e/yr]
21= GWP of methane [ton CO_2e/ton methane]

The general formula of degradation used in this model depends on several parameters including age of waste, mass, waste composition (concentration in organic carbon) and waste temperature. At the moment the flaring of the biogas does not occur at the project landfill.

The actual quantity of methane emitted to the atmosphere is therefore equivalent with the quantity to be captured and flared.

- Decayable carbon in refuse 150 kg/ton
- Lag phase of methane production 0.7 year
- Half value for decomposing or organics 3.0-15.0 year
- Average landfill temperature 36 °C
- Landfill gas collection efficiency 70 %
- Methane content in landfill gas 50 %
- Molecular weight CH_4 16.03 --
- Gas density of CH_4 at STN 0.72 kg/ m^3
- Gas density of CO_2 at STN 1.99 kg/ m^3
- Heating value of landfill gas 18 MJ/m^3

5. MONITORING METHODOLOGY

§5.1 CALCULATION OF THE EMISSION REDUCTIONS OF THE PROJECT ACTIVITY

The methodology AM0011 states that the emission reductions achieved by the project are equal to:

$$ER = (MD_{project} - MD_{reg}) * GWP_{CH_4} + EG * CEF_{electricity}$$

Where: ER are the emission reductions; $MD_{project}$ is the amount of methane actually destroyed/combusted during the year; MD_{reg} is the methane that would have been destroyed/combusted during a year in the absence of the project activity; GWP_{CH4} is the approved global warming potential value for methane (considered 21 throughout Villa Dominico lifetime for the purpose of estimating emission reductions); EG is net quantity of electricity displaced; and $CEF_{electricity}$ is the CO_2 emissions intensity of the electricity displaced.

Considering there is no regulatory or contractual requirement determining MD_{reg}, an adjustment factor of 0% is used in Villa Dominico case:

$$MD_{reg} = MD_{project} * 0$$

Moving on:

$$MD_{project} = MD_{flared} + MD_{electricity} .$$

$$MD_{flared} = LFG_{flare} * w_{CH_4} * D_{CH_4} * FE .$$

In this case, MD_{flared} is the quantity of methane destroyed by flaring (tCH_4), LFG_{flare} is the quantity of landfill gas flared during a year measured in normal cubic meters (Nm^3), w_{CH4} is the daily methane fraction of the landfill gas expressed as a fraction CH_4 volume per LFG volume, FE is the flare efficiency (the fraction of the methane destroyed) and D_{CH4} is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4), measured at STP. This value is in fact 0.0007168 tCH_4/Nm^3CH_4.

$$MD_{electricity} = LFG_{electricity} * w_{CH_4} * D_{CH_4}$$

Where $MD_{electricity}$ is the quantity of methane destroyed by generation of electricity and $LFG_{electricity}$ is the quantity of landfill gas fed into electricity generator. No extra reductions for electricity replacement are claimed.

§5.2 MONITORING PLAN

This description contains a validated monitoring system to determine the reduction of the greenhouse effect.

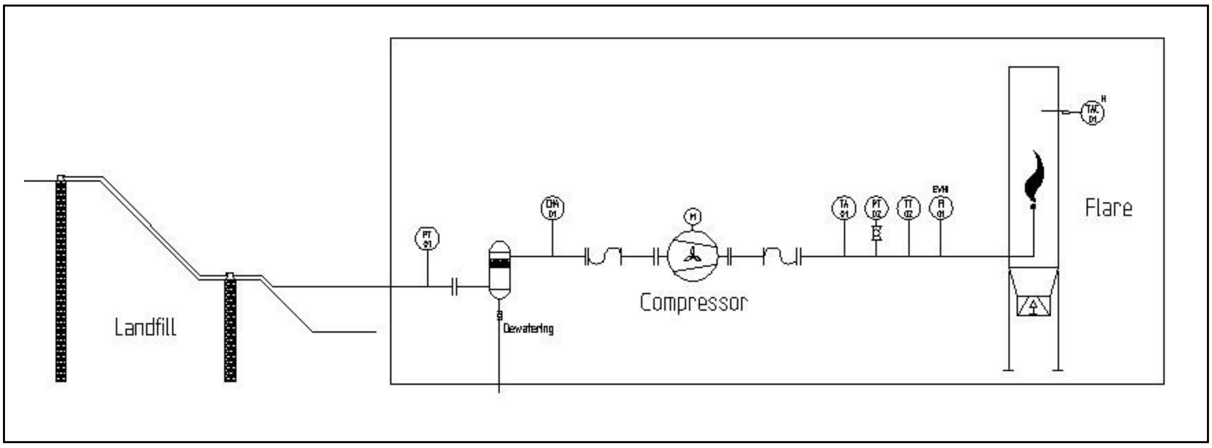
In our case the greenhouse will be reduced by burning LFG (landfill gas) by means of a degassing installation. The degassing installation will be provided with a monitoring system to quantify the reduction of greenhousing. The payment for the reduction of the greenhousing will be according this quantification.

Besides the description of the monitoring system also the reliability of the data and the resistance against data manipulation will be described.

PROCESS

A landfill generates LFG. By means of the degassing installation the LFG will be extracted from the landfill and will be burnt. The blower creates a vacuum in the gaswells, constructed on the landfill, and transports it to the flare. The flow scheme is enclosed in appendix A.

The generation of energy by LFG Generators is optional. Therefore, at this moment, there are no generators installed due to economic reasons. Because of that all the energy used for the plant is provided by the local Electricity Companies.



The purpose of the degassing installation is to burn the methane (CH_4) of the LFG. This will result in a reduction of the greenhouse effect. Methane is a greenhouse gas and has very big impact on the greenhousing (21 times more than CO_2).

MONITORING AND LOGGING SYSTEM

The just described parameters, gas quality Q [Nm^3], methane content M [Vol.% CH_4] , electricity consumption E [kW.h], and Grid Emission Factor, will be monitored and logged. Additional also other parameters will be monitored and logged for indicating purposes. The table below shows all the parameters.

Parameter	Code	Unit	Purpose
Quantity LFG	Q	Nm^3	Determine $CO_{2;eq}$
Hourly gas quantity	Q_{mom}	Nm^3/h	Indicating
Methane content	M	Vol.% CH_4	Determine $CO_{2;eq}$
Electricity consumption	E	kW.h	Determine $CO_{2;eq}$
Pressure suction side	-	mbar	Indicating
Burning temperature	-	°C	
Temperature LFG discharge side	-	°C	
Operating hours blower	-	h	Cross checking, indicating
Pressure discharge side	-	mbar	
Operating hours flare	-	h	
Operating hours CHP (if applied)	-	h	
Operating hours analyzing system	-	h	
$CO_{2;eq}$	-	ton $CO_{2;eq}$	Payment

Every hour all process parameters will be sampled and stored in the data-logger of the degassing installation. Once a day the data will be transferred to the monitoring station. The monitoring station is a PC containing a

- modem for connection with the data-logger of the degassing installation;
- visualization system of the process for operating purposes;
- database to store the received process data and
- system to provide alarm signals to the operators.

The monitoring system is located at Van der Wiel Stortgas BV. Appendix B and C shows the monitoring system and database.

RELIABILITY OF DATA

As explained the parameters

- LFG quantity [Nm^3],
- electrical power consumption [kW.h],
- methane content [Vol.%]
- Grid Emission Factor

are the most important parameters because the amount of payment depends on these parameters. This section describes how these 4 parameters will be monitored safely and resistant against data manipulation.

<u>LFG quantity</u>

Flow meter

The LFG quantity will be measured by means of a flow meter (appendix E). The flow meter is a counter which counts every passed m^3 LFG. Further the influence of pressure and temperature on the gas quantity will be corrected by means of an electronic volume corrector (appendix E). The display of the flow meter shows the counted and corrected gas quantity. The flow meter is secured by means of a seal so the displayed value on the flow meter is true and protected against manipulation. The counted gas quantity will be provided to the data-logger of the degassing installation.

Logging

As described the LFG quantity will be logged (once per hour) and transferred (once per day) to the database of the monitoring system.

Calibration

According the specifications of the flow meter, every 4 years the flow meter has to be calibrated.

The flow meter was calibrated on 27/02/2008 by “TGS Laboratorio de Caudal” . During period calibration, the Plant was out of service. Meanwhile we have no operation at all except regular maintenance procedure

Electrical power consumption

kWh meter

The electrical power consumption will be measured by means of a kWh-meter. The kWh meter is a counter and counts every consumed kWh. The display of the kWh meter shows the quantity of electrical power consumption. This quantity is true and cannot be manipulated because the kWh meter is sealed. The kWh meter also provides the signal "quantity electrical power consumption" to the data-logger of the degassing installation.

Logging

The logging procedure of the electrical power consumption is the same as the logging procedure of the LFG quantity. Once an hour the electrical power consumption will be sampled and stored in the data logger of the installation and transferred once a day to the monitoring system. This fixed and true quantity will also be a (manually) input of the database (appendix C). To prove the logging procedure and database are correct, the read electrical power consumption has to be higher than the earlier logged electrical power consumption and lower than the later logged electrical power consumption. This procedure is also mentioned on the monitoring scheme of Appendix D.

Methane content

Methane analyzer

The methane content of the LFG will be measured by means of the methane analyzer Binos 100. The Binos 100 measures the LFG on-line. The accuracy of the Binos 100 is ± 2,0 Vol.% CH_4. The only condition for this accuracy is to calibrate according the calibration protocol of the Binos 100.

Logging

Once an hour the methane content will be sampled and stored in the data logger of the installation. Once a day these data will be transferred to the monitoring system. Also the calibration moments will be an input of the database so the accuracy of the Binos 100 is secured.

Check

The condition of correct logged CH_4-values is the calibration of the Binos 100 according the calibration protocol. In the calibration protocol 3 main issues are important for correct calibration:

1. The calibration frequency has to be correct.
2. The quality of the calibration gas has to be according the standard.
3. The calibration procedure, carried out by the operator, has to be correct.

During calibration the LFG will not be sampled because calibration gas streams through the Binos 100 in stead of LFG. To calculate the $CO_{2;eq}$ during calibration the average CH_4-content of the last 7 days will be used.

The calibration gases will be purchased from certified gas suppliers. All in gas bottles stored calibration gases will be provided with a quality certificate. The quality certificate indicates the quality of calibration gas is according the standard. Appendix H contains examples of these certificates.

To prove the calibration procedure will be carried out correctly, the skilled operator demonstrates this procedure to the authorized validator at the installation. The operators are well trained and possess the necessary certificates.

At the end of the yearly visit to the installation the authorized validator writes the CH_4-content of that moment on an official document[1]. Additional the frequency of calibration and the correct demonstration of calibration will be written down on this official document. The validator signs this document and sends it to the CDM EB.

Grid Emission Factor

To establish the Grid Emission Factor we take, the most recently, value which is, or was, emitted by the Secretary of Energy of the Republica Argentina or the Secretaria de Medio Ambiente y Desarrollo Sustentable , as they are the National Organism, in Argentina, for emitting this parameter. Once a year, we check if there are any, possible, changes which are presented by these organism. If there are no changes in those values, we will take the last mentioned and used value of that parameter.

Once a year the Grid Emission Factor will be stored in the data logger of the Degassing installation.

OPERATION

This section contains a strategy when a failure occurs at the degassing installation. Also actions to limit the consequences as much as possible are mentioned.

No electrical power

When no electrical power is available the blower of the degassing installation cannot operate. So no LFG-stream is available. The flow-meter detects no LFG-stream and no $CO_{2;eq}$ will be counted. No special actions are possible to avoid this.

Failure flow meter

To limit the time of operating with no flow signal in case of failure, the flow meter will be exchanged by a spare flow meter as soon as possible. Despite this quick exchange the degassing installation operates a short time without flow signal and $CO_{2;eq}$ values. To determine the flow during this time span the average flow of the last 7 days will be used and so it is possible to calculate the reduced $CO_{2;eq}$. Remark: The chance of a failure of the flow meter is very small.

[1] *This CH_4-content will be read from the display of the Binos 100 after the correct calibration procedure of the operator so this value is surely correct. This CH_4-value will also be an input of the database and has to be in the range of the earlier logged CH_4-values.*

Failure kWh meter

To limit the time of operating with no kWh meter in case of failure, this kWh meter will be exchanged by a spare kWh meter as soon as possible. Despite this quick exchange the degassing installation operates a short time without measuring the electrical power consumption. To determine the consumed electrical power consumption during this time span the average electrical power consumption of the last 7 days will be used. Remark: The chance of a failure of the kWh meter is very small.

Failure methane analyzer (Binos 100)

To limit the time of operating with no methane analyzer in case of failure, this analyzer will be exchanged with a spare analyzer as soon as possible. Despite this quick exchange the degassing installation operates a short time without CH_4-signal. To determine the CH_4-content during this time span the average CH_4-content of the last 7 days will be used.

Failure of the flowcomputer Model FC2000 due to "out of calibration range error"

The calibration limit of the landfill gas temperature transmitter is adjusted between 0 and 50°C. When the gas temperature leaves this range the "Main Totals" list stops registering. An alarm signal will be send out to the operator of the plant. The registering of the m³/h and Nm³/h will always be guaranteed by the "Alarm Totals" register of the flow computer model FC2000. From 01/06/06, the "Alarm Totals" are registered every day by the local operator of Van der Wiel Argentina S.A.

Remark: this procedure was not in the PDD, but added later on.

Appendix A,B,C,D,E,F,G,H,I and J are available on request.

6. BACKGROUND ON ACTUAL CER-VOLUMES

The calculation of CERs can be done by subtracting the first display value (01-10-2007 = 197,591 TCO2eq) from the last one (29-02-2008 =221,706 TCO2eq). Due to electricity failure, missing data transfers through CARs and maintenance, the total volume was conservatively corrected from 24, 115 t CO2e to 21,843 t CO2e as presented in Chapter 7.

Efficiency measurements were performed on 19/12/2007. The combustion efficiency (FE) is > 99,99 %.

7. CER VOLUME REQUIRED

The total volume of CO_2 avoided based on the monitoring sheets (chapter 8), is 21,843 tCO_2e. This is without an adjustment for the use of electricity. In total 34,930 kWh's are used to keep the plant in operation. This amount should be multiplied by the Se-factor. The Se-factor (CEF-factor) is determined to be **0.47 Ton – CO_2e/mW**[2]. Therefore, the total CER volume claimed for this verification is:

Total volume of avoided CO_2 in t CO_2e	21,843
Total CO_2 emissions for use of electricity	- 16
CERs claimed	**21,827**

8. MONITORING SHEETS

See Attached Excel document.

[2] "Calculo del factor de Emisión de CO2 de la Red Argentina de Energía Eléctrica", Secretaria de Energía, Junio 2007