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:

El Panul – EcoMethane Landfill Gas Project
Document Version Number 9 (version 09 incorporates corrections requested at EB 49)
Date completed 18/09/2009

A.2. Description of the project activity:

The El Panul – EcoMethane Landfill Gas (hereafter, the "Project") developed by Biogas Technology Ltd. (hereafter referred to as the "Project Developer") is a landfill gas (LFG) collection and flaring project in the city of Coquimbo, Chile, hereafter referred to as the "Host Country".

The "El Panul" Landfill was opened in 1981, and nearly 2 million tonnes of municipal solid waste from the cities of Coquimbo, La Serena, and Paihuano have been deposited at the site since then. The landfill consists of two main areas, a closed dumpsite and an engineered sanitary landfill (which recently started operation). The older segment of the site started as an open dump, was later operated as a controlled dumpsite, and was finally closed by the end of 2005. The new sanitary landfill area started operations in 2006, currently receives about 350 tonnes of municipal waste daily, and will be operational until 2014. The landfill includes a leachate collection system, a lined leachate basin, and a passive venting system to partially collect and flare the LFG.

The objective of the Project is to replace the existing ineffective passive venting system with an active gas collection system so as to destroy the LFG, thus minimising gaseous emissions and improving overall landfill operation. Indeed, the landfill gas was previously released to the atmosphere, or partially burnt via low efficiency combustion passive flaring systems. This scenario, which is the baseline scenario, results in important methane release into the atmosphere. The project activity, by collecting and destroying efficiently the landfill gas via a proper flaring system, results in considerable methane emission reduction.

The project involves investment in a highly efficient gas collection system and a flaring equipment.

The Project is being developed through EcoMethane, an unincorporated joint venture dedicated to financing, constructing, and operating projects that capture and make productive use of methane emissions from landfills. EcoMethane brings together investors, technology providers, engineers, and consultants to capitalise on the opportunities offered by the emerging market in greenhouse gas (GHG) emissions, particularly those related to activities that reduce emissions of methane to the atmosphere. EcoMethane works exclusively with Biogas Technology Ltd. (Biogas) for the financing, construction, and operation of LFG projects worldwide, and with EcoSecurities Group PLC (EcoSecurities) for the development of these projects under the Clean Development Mechanism of the Kyoto Protocol. Biogas has designed, installed, and operated LFG collection systems on more than 100 landfill. EcoSecurities is a leading CDM/JI project development company.

The Project will have numerous positive social and environmental impacts:

- Properly collecting and destroying flammable LFG will reduce the risks associated with explosions in and around the landfill. This is particularly important as the LFG collection system will minimise

LFG migration to zones outside of the landfill boundaries. Such LFG migration poses dangers to the surrounding population and area.

- Destruction of the LFG will improve the local environment by reducing the odours and associated health risks from the noxious air pollution arising from the landfill.
- The Project will provide a model for managing LFG, a key element in improving landfill management practices in the Host Country.
- The Project will provide both short- and long-term employment opportunities for the local population. Local contractors and labourers will be required for construction, and long-term staff will be needed for operation and maintenance.

The Project helps the Host Country to fulfil its goals of promoting sustainable development. Specifically, the Project:

- Promotes the integration of environmental infrastructure, such as appropriate waste management and storage, as well as rehabilitation;
- Optimises the use of natural resources and avoids uncontrolled contamination;
- Increases employment opportunities in the area where the Project is located;
- Improves the overall management practices of the landfill.

A.3. Project participants:

Table 1.1: 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)**
Chile (host)	TASUI Norte Sur S.A. (private entity)	No
United Kingdom of Great Britain And Northern Ireland	Biogas Technology Ltd. (private entity)	No
United Kingdom of Great Britain and Northern Ireland	EcoSecurities Group PLC (private entity)	No
United Kingdom of Great Britain and Northern Ireland	EcoSecurities Carbon I Ltd. (private entity)	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 (country) involved may or may not have provided its approval. At the time requesting registration, the approval by the Party (ies) involved is required.

Further contact information of project participants is provided in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Republic of Chile (the "Host Country")

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

Region IV / Region of Coquimbo, Elqui Province

A.4.1.3. City/Town/Community etc:

Coquimbo

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

The Project will be located south of Coquimbo in the "Altas de Panul" region, 3 km east of the main road "Ruta 5 Norte" (Route 5 North), and 18 km from the city of La Serena.
Coordinates: 30° 01' 10'' S and 71° 21' 31'' E.
Photos 1.1 and 1.2 (below) illustrate the Project location[1].

Photo 1.1: Aerial view of the "El Panul" Landfill, Chile.

[1] www.googleearth.com

Photo 1.2: Aerial view (detail) of the "El Panul" Landfill, Chile.

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

According to Annex A of the Kyoto Protocol, this Project fits under Sectoral Category:

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 LFG collection system, an enclosed flare system, as illustrated in Diagram 1.3.

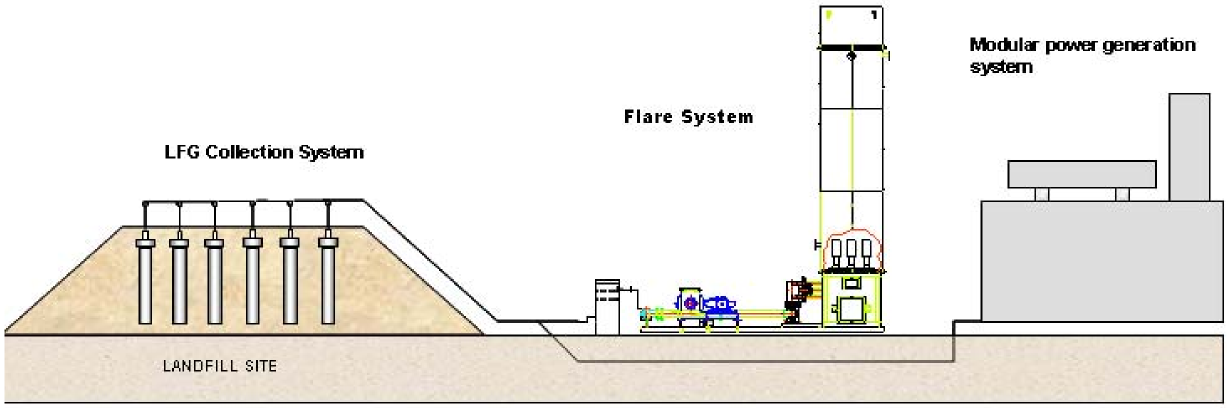

Diagram 1.3: Illustration of Project's main components

The Project Developer has over twenty years' experience in the design, installation, and operation of LFG collection and flaring systems. This is a proven technology for LFG combustion, and has been widely demonstrated as reliable and environmentally safe.

The technology used in the project activity to collect, flare, and utilise the LFG comes from the UK. The import and installation of the equipment in "El Panul" Landfill represents a transfer of technology.

Landfill Gas Collection System

The project activity involves the installation of an active LFG collection system using vertical gas wells drilled into the waste to extract the LFG. The gas collection pipe network consists of piping that connects groups of gas wells to manifolds. These manifolds are in turn connected to a main pipe and then to the main header pipe, which delivers the gas to the extraction plant and the flare. The system operates at pressure slightly lower than atmospheric, as blowers will draw the gas from the wells through the collection system and deliver it to the flare or the LFG power generation system.

Flare System

The project activity involves the installation of a modular enclosed gas flare consisting of piping, valves, blower, stack with proprietary burners, instrumentation, and control panel. The rated capacity for the flare is 2000 m^3/h,

For safety purposes, flare units are fitted with flame arresters that protect the blower and the field pipe work from burner flame flashback. At high temperatures, proprietary Biogas Technology Group designed burners ensure complete destruction of the combustible constituents found in LFG, in accordance with UK Environment Agency guidelines.

The average equipment life time (flare, etc.) is around fifteen years.

Prior to the project activity, the landfill had an ineffective passive venting system, where a small amount of the gas was partially combusted via the passive flaring systems, with very low combustion efficiency.

In the absence of the new gas collection system and flare installation, the landfill gas produced would have continued to be released (Baseline scenario); therefore emitting a significant amount of methane into the atmosphere. Thanks to the project, the LFG is captured and destroyed, resulting in methane emission reduction.

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

Table 1.2: Estimated emission reductions for the Project

Year	**Annual estimation of emission reductions in tCO_2e**
2009	18,485
2010	19,270
2011	20,050
2012	20,825
2013	21,595
2014	22,362
2015	21,230
2016	20,158
2017	19,141
2018	18,178
Total estimated reductions (tonnes of CO_2e)	201,294
Total number of crediting years	10 years
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	20,129

A.4.5. Public funding of the project activity:

The Project 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:

ACM0001 Version 8.1, adopted at EB39, “Consolidated baseline and monitoring methodology for landfill gas project activities” will be used.

ACM0001 refers to the following tools:

- “Tool for the demonstration and assessment of additionality” Version 05, adopted at EB39;
- “Tool to determine project emissions from flaring gases containing methane”, adopted at EB28;
- “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” Version 01, adopted at EB39;
- “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” Version 1, adopted at EB32;
- “Combined tool to identify the baseline scenario and demonstrate additionality” Version 02.1, adopted at EB28; and
- “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site” Version 2, adopted at EB 35
- “Tool to calculate the emission factor for an electricity system” Version 01.1, adopted at EB35

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

The Project activity is based on the methane collection and destruction (through flaring) of LFG, thus converting its methane content into CO_2, reducing its greenhouse gas effect.

The Project therefore fulfils the conditions of option a) of ACM0001 applicability criteria (i.e., captured LFG is simply flared), and is consequently considered the most appropriate methodology for the proposed project activity.

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

According to ACM0001 baseline methodology, the project boundary is the site of the project activity where the gas will be captured and destroyed.

The activities and emission sources considered within the project boundaries are listed in Table 1.3:

Table 1.3: Summary of gases and sources included in the project boundary.

	Source	Gas	Included?	Justification/Explanation
Baseline	Emission from decomposition of waste at the landfill site	CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	Yes	Electricity consumed from the grid in the baseline scenario.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emission from thermal energy generation	CO_2	No	No thermal energy generation is planned in the project activity.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	Applicable in case an on site fossil fuel generator is used as a back up.
		CH_4	No	Excluded for simplification. This emission source is assumed to be negligible.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.
	Emissions from on-site electricity use	CO_2	Yes	Important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be negligible.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.
	LFG destruction (flaring)	CO_2	No	The combustion products of, methane are CO_2 and H_2O. The CO2 released during the combustion process was originally fixed via biomass so that the life cycle CO2 emissions of LFG are zero.
		CH_4	Yes	As the Project uses a 90% default value for flare efficiency, the remaining 10% is accounted for as project emissions and are therefore deducted from the total emission reduction. Those emission will be

				taken into account for any value of the flare efficiency (ex ante default or ex post calculated value)

A full flow diagram of the project boundaries is presented in Figure 1.6. The flow diagram comprises all possible elements of the LFG collection system

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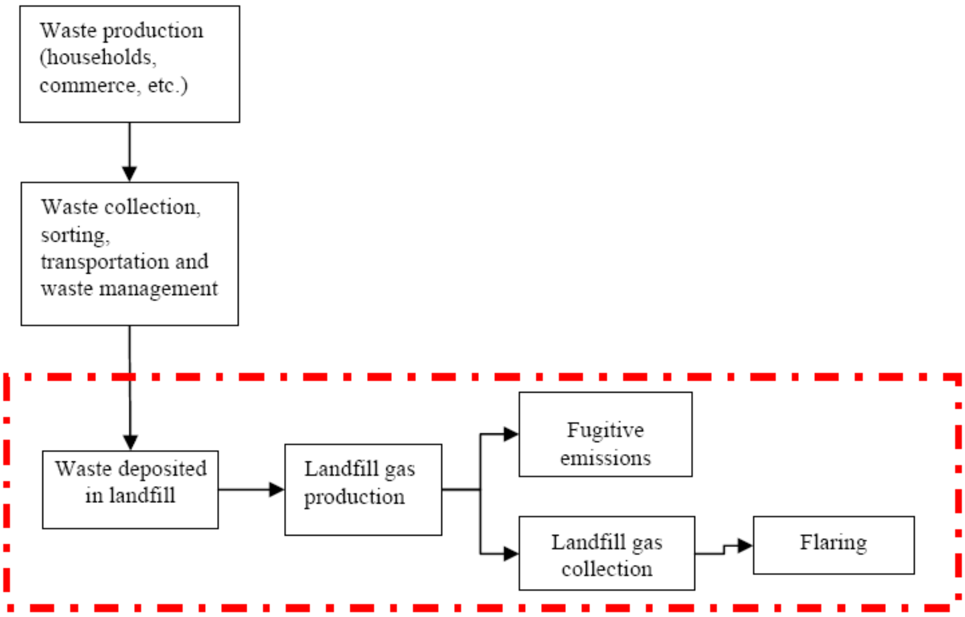

Figure 1.6: Flow chart of project boundary (red line indicates project boundary)

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

The baseline scenarios are identified and listed in section B.5.
The selected baseline scenario is:

- LFG2: Atmospheric release of landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.

The baseline scenario in this particular case is the partial collection and uncontrolled flaring of a fraction of the LFG generated at the site. This practice occurs at most existing landfills in the Host Country, although some of the landfills in the Host Country as yet do not have any type of venting system despite regulations calling for the controlled management of LFG.

In the particular case of the proposed project activity, the baseline scenario is defined according to the procedure detailed in the methodology ACM0001 v08.1. For detailed information on this assessment, please refer to Section B.5.

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 additionality):

The determination of project scenario additionality is performed using the methodological "Tool for the demonstration and assessment of additionality" Version 05, adopted at EB39, which follows the subsequent steps:

The project activity was conceived as a CDM activity and has considered carbon revenues since its conception. The Project Developer conducted the first site visit to the El Panul Landfill in early 2006. At the time, the Project Developer was in the process of evaluating offers from different CDM project developers and technology providers, and the purpose of the visit was to technically assess the site in order to prepare an offer for TASUI, including developing the Project under the CDM. Carbon revenues were considered in the decision to proceed with the project activity upon contract signature between the Project Developer (Biogas) and TASUI on August 2006.

The Project schedule is summarized in Table below (the evidences have been made available to and validated by the DOE):

Events	Date	Evidence Provided
CDM consideration	January/February 2006	Email conversations between EcoSecurities and Biogas about CDM opportunity , and first landfill site visit by Biogas
Project activity start date	2nd August 2006	Contract signed between Biogas and TASUI
Validation start date	22nd September 2006	First International Stakeholder Consultation
Host Nation LOA request	October 2006	First request for Non Annex I LOA
Construction start date	December 06	Flare being built by Biogas Ltd, in Sawtry (UK)
Shipping date	11th May 07	Flare shipped to Chile-Shipping invoice
EIA approved	December 07	Approval of the flaring project
Commissioning date	1st March 2008	Flare Operation start date-Commission certificate

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

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

According to ACM0001 Version 08, the alternatives for the disposal/treatment of the waste in the absence of the project activity, i.e. the scenario relevant for estimating baseline methane emissions, to be analysed should include, inter alia:

<u>LFG 1:</u> The project activity (i.e. capture of LFG and its flaring and/or its use) undertaken without being registered as a CDM project activity.

LFG 2: Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns. This represents the business as usual scenario.

LFG 3: Utilization of landfill gas for generation of electricity

For generation of electricity, an initial investment is needed to collect the biogas from the landfill. After that, a substantial additional investment is needed for gas treatment, electricity generation system and connection to the grid.
In Chile, where electricity prices are low (due to abundant and cheap hydro resources) the additional investment for electricity generation is not economically justified: the expected revenue from electricity sales does not cover the additional costs incurred (financing costs, operating costs, depreciation, etc.) in relation to electricity generation and grid connection. Also, the amount of landfill gas produced in El Panul landfill is too low to warrant any investment in power generation, as outlined by the monitored data provided from 2008 and validated by the DOE.

A financial analysis of this alternative has been done, based on the following input:

- The total investment: 1,353,000 US$ (1MW engine + Compound civil costs and electrical connection- estimated cost provided by Biogas Technology Group Ltd)
- Operation and maintenance cost: €0.023 per kWh (estimated cost by Biogas, consistent with project developer estimation in other registered PDDs in the same region)
- The electricity sale price: $0.058 per kWh
- Corporate Tax in Chile: 17%

For the assumptions stated above, the IRR for LFG electricity generation (without CDM revenue) is negative. Hence, investing in power generation is economically not attractive for the project developer.

Furthermore, it has to be noted that the electricity generation also adds considerable delays because of the mandatory in-depth technical studies and lengthy regulatory process involved. Overall, based on the sites poor gas production volumes, the hurdles of obtaining the necessary environmental approvals, and the negative IRR, it is clearly demonstrated that Alternative 3 is not a realistic and credible alternative and that's why this alternative is discarded.

Baseline alternatives for heat generation were not considered in this assessment; given isolation of the project site and the lack of local off-takers. The costs associated with developing a pipeline to supply offtakers further from the project site would be too high to justify an investment in thermal energy production. Furthermore, as the biogas is not pure methane, it requires purification before its use, which also involves significant cost. Therefore, alternatives for heat generation are not realistic and credible alternatives.

Outcome of sub-Steps 1a: identified realistic and credible alternative scenario(s) to the project activity
The identification of alternatives to the project activity identifies two realistic and credible alternative scenarios:

- LFG 1: The project activity (i.e. capture of LFG and its flaring and/or its use) undertaken without being registered as a CDM project activity.
- LFG 2: Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.

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

Alternative LFG 1, the proposed project activity, complies with all applicable laws and sectoral permits. Statute Number 19300 “Ley de Bases del Medio Ambiente” of March 9th, 1994, constitutes the relevant legal framework in the environmental sector.
Resolution Number 2444 “Normas Sanitarias Mínimas para la Operación de Basurales” July 31st,1980, and a draft for a new landfill regulation “RSS 189”, define responsibilities regarding waste management as well as the specifications for environmental protection including the selection, design, construction and operation, monitoring and closure of final disposal sites for municipal solid waste.
This comprehensive regulation calls for LFG control and management but does not define specific requirements regarding amounts of LFG that need to be captured, or technologies that should be used. In addition, this regulation had not come into force at the time of submitting the PDD to validation.
Alternative LFG 2, a continuation of the current situation, represents the business-as-usual practice for the Project Developer and most of the landfills in the Host Country.
Existing regulations do provide recommendations, but do not detail specific requirements regarding the construction of gas collection systems, or the techniques which shall be applied to collect, control, and monitor LFG.
Regulations notwithstanding, common practice demonstrates that existing landfills in the country do not adequately capture and utilise their LFG, as explained in Step 4 (below).

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the “Tool for the demonstration and assessment of additionality” Version 05, if the CDM project activity and the alternatives identified in step 1 generate no financial or economic benefits other than CDM related income, then, Option I (Simple Cost Analysis) shall be used.
In this case, the most likely alternative to the project is simply to not install flaring equipment at the site, the business as usual scenario, and therefore the Simple cost analysis has been chosen.

Sub-step 2b: Option I - Simple Cost Analysis

The project costs over the crediting period and the project lifetime are listed in the table below:

Project Cost	**Crediting period (10years)**	**Project lifetime (15 years)**
*Investment (Capital Cost) in US $	$1,045,180	$1,045,180
**Operational and Maintenance Cost in US $	$1,637,380	$2,456,070
Total Investment and O&M Cost in US $	**$2,682,560**	**$3,501,250**

**So far, the investment costs are based on the flare construction, shipping and commissioning and some field work (around $721,000). The rest of the field work investment will happen once the project is registered.*
*** The total estimated O&M costs are based on real O&M cost that occurred in year2008 ($163,738*10 years)*

By investing in a landfill gas collection and flaring systems, the project would not generate any revenues in the absence of the CDM. Therefore, the project activity is not economically attractive and not a realistic baseline scenario. Since there are no revenues other than CDM revenues, the project is demonstrably additional.

The costs related to the baseline scenario are close to zero, as the landfill gas was simply released through the atmosphere, and this does not require any kind of investment. Prior the project activity, the landfill gas was sometimes burnt manually (open combustion) by on-site employee for safety reason (to avoid explosion). The costs involved in this process can be neglected comparing to the O&M costs involved in a proper gas collection system.

Thus, it has been clearly demonstrated that at least one alternative to the project (the business as usual) is less costly than the project activity, and we can now proceed to step (Step 4: Common Practice).

Step 4. Common Practice Analysis

Sub-step 4a: Analyse other activities similar to the proposed project activity

While the Chilean Ministry of Health is developing new national legislation for the landfill sector which will include detailed information for LFG management, current Chilean landfill regulations neither define how to capture LFG, nor give any specifications about amounts of LFG that need to be collected and utilised. As such, this legislation is still not legally binding as it is still at a draft stage.

To date there has been limited development of LFG projects in the Host Country. So far, only a few landfills in the Host Country have been designed to partially collect and flare generated LFG. Table 1.7 presents information regarding a representative sample of landfills in the Host Country.

As Table 1.7 illustrates, landfills in the Host Country either have: (1) a passive system for venting LFG only (no flaring); or (2) a passive system for venting and limited flaring of LFG. Since the publication of the landfill regulation draft, no new proper LFG collection and flaring or utilisation systems have been developed in the Host Country without considering carbon revenues.

Table 1.7: The Project control group

Landfill Name	Location	Waste Deposition Rate (tonnes/day)	Current Status
Viña del Mar	Viña del Mar	350	Passive venting and partial flaring
Boyeco	Temuco	260	Passive venting and partial flaring
Valdivia	Valdivia	235	Passive venting
Lagunitas	Puerto Montt	200	Passive venting and partial flaring
Limache	Limache	150	Passive venting
Carriel Norte	Concepción	unknown	Passive venting and partial flaring

All projects similar to the proposed project activity are being developed under the CDM, and can therefore not be considered as common practice.

Table 1.8: The similar projects in Chile, under the CDM:

Cosmito landfill gas project (Improvement of Gas Extraction System in Old Cosmito Dump)
Copiulemu landfill gas project (Center for the Storage and Transfer, Recovery and Control of Waste, Treatment and Disposal of Industrial and Household Waste)
El Molle – Landfill gas (LFG) capture project
Lepanto Landfill Gas Management Project
Santa Marta Landfill Gas (LFG) Capture Project.
Loma Los Colorados Landfill Gas Project Coronel landfill gas capture project

Sub-step 4b: Discuss any similar options that are occurring

Not applicable, as all similar projects in the Host Country are being developed in the context of the CDM.

B.6 Emission reductions:

B.6.1. Explanation of methodology choices:

Baseline emissions:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \qquad (1)$$

As the proposed project activity does not include either electricity or a thermal energy component, the equation[3] is simplified as per below:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} \qquad (1^*)$$

Where:

BE_y	tCO_2e	Baseline emissions in year *y*;
$MD_{project,y}$[4]	tCH_4	Methane destroyed/combusted by the project activity during year *y*;
$MD_{BL,y}$	tCH4	The amount of methane that would have been destroyed/combusted in year y in the absence of the project, due to regulatory and/or contractual requirements;
GWP_{CH4}	tCO2 e/tCH4	Global Warming Potential value for methane for the first commitment period;

1. Methane destroyed by the project activity ($MD_{project,y}$):

MDproject,y will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational. The methane destroyed by the project activity (MDproject,y) during a year is determined by monitoring the quantity of methane actually flared.

a) Ex post:

As the LFG is only feed to the flare, $MD_{project,y}$ *can be expressed as below:*

[3] All equations which are modified and/or simplified are marked with an asterisk "*".

$$MD_{project,y} = MD_{flared,y} \qquad (8^*)$$

Where:

$MD_{project,y}$:	tCH_4	Amount of methane that would have been destroyed during year *y*, in the project scenario;
$MD_{flared,y}$:	tCH_4	Quantity of methane destroyed by flaring during year *y*;

The quantity of methane destroyed by flaring is calculated using the following equation:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \qquad (9)$$

Where:

$MD_{flared,y}$:	tCH_4	Quantity of methane destroyed by flaring during year *y*;
$LFG_{flare,y}$:	Nm^3LFG	Quantity of landfill gas fed to the flare(s) during the year *y*;
$w_{CH4,y}$:	Nm^3CH_4/Nm^3LFG	Average methane fraction of the landfill gas as measured[5] during a year *y*;
D_{CH4}:	tCH_4/Nm^3CH_4	Methane density[6];
$PE_{flare,y}$:	tCO_2e	Project emissions from flaring of the residual gas stream in year *y* determined following the procedure described in the *"Tool to determine project emissions from flaring gases containing methane"*;
GWP_{CH4}:	tCO_2e/tCH_4	Global Warming Potential of methane valid for the first commitment period.

As the sum of quantities fed to the flare(s) must be compared annually with the total quantity of methane generated in order to adopt the lowest value of the two as $MD_{project,y}$, the following estimation must be carried out with the additional equation from the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*:

b) Ex-ante estimation of the amount of methane that would have been destroyed/combusted during year y ($MD_{project,y}$)

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4} \qquad (13)$$

$BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity during year y (tCO2e), calculated as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.

The tool estimates methane generation adjusted for, using an adjustment factor (f) to account for any landfill gas in the baseline that would have been captured and destroyed to comply with relevant regulations or contractual requirements, or to address safety and odour concerns. As this is already accounted for in ACM0001, "f" in the tool shall be assigned a value 0.

[5] Methane fraction of the landfill gas to be measured on a wet basis.
[6] At standard temperature and pressure (0 degrees Celsius and 1,013 bars), the density of methane is 0.0007168 t/m^3.

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1-e^{-k_j}\right)$$

Where:

Parameter	Unit	Default	Description
$BE_{CH4,SWDS},_y$	tCO_2e		Methane generation from the landfill in the absence of the project activity in year *y*;
φ	-	0.9	Model correction factor to account for uncertainties;
f	-	0	Fraction of methane captured at the SWDS[7] and flared, combusted, or used in another manner;
GWP_{CH4}	tCO_2e/tCH_4	21	Global Warming Potential of methane, valid for the relevant commitment period;
OX	-	0.1	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste);
F	volume fraction	0.5	Fraction of methane in the SWDS gas;
DOC_f	-	0.5	Fraction of degradable organic carbon that can decompose;
MCF	-	0.5	Methane correction factor;
$W_{j,x}$	tons		amount of organic waste type *j* prevented from disposal in the SWDS in year *x*;
DOC_j	weight fraction		Fraction of degradable organic carbon in the waste type *j*;
k_j	-	-	Decay rate for the waste type *j*;
j	-	-	Waste type category (index);
x	-	-	Year since the landfill started receiving waste, runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y);
y	-	-	Year for which methane emissions are calculated.

Above specified default values were taken from the **"***Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. Where the tool provides different values to choose from, the following choices were made:

- OX: 0.1 because the landfill is covered with a mix of soil and clay.
- MCF: 0.5. The El Panul landfill consist of two different areas, one previously operated as a dump with some passive vents, while the other area has a leachate collection system, a lined leachate basin and a passive venting and flaring system. As the landfill consists of two parts, none of the alternatives for the MCF listed in the Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site match the project precisely. As the dump had a depth of more than 5 metres, the alternatives "anaerobic managed solid waste disposal site" and "unmanaged-shallow solid waste disposal site" could clearly be ruled out.

  As the dump had some passive flares, was covered with soil and had a primitive leachate system draining leachate from the dump, the alternative "semi-aerobic managed solid waste disposal sites" was deemed to better represent the landfill as a whole than "unmanaged solid waste

[7] Solid Waste Disposal Site, as defined in the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.

disposal sites – deep and/or with high water table" and therefore it is more appropriate to use MCF = 0.5 than MCF = 0.8.

- DOC_j: Values are chosen assuming that the waste is wet (there is no drying process prior to landfilling). Please find values for the different waste types listed in Section B.6.2.
- k_j: Values are chosen considering that the climate is Temperate (Mean Annual Temperature < 20ºC) and dry[8] (MAP/PET < 1).

2. Amount of methane that would have been destroyed/combusted in the absence of the Project due to regulatory and/or contractual requirements (**$MD_{BL,y}$**)

For the amount of methane destroyed in the baseline scenario, the following equation is used:

$$MD_{BL,y} = MD_{project,y} * AF \qquad (2)$$

Where:

$MD_{BL,y}$:	tCH_4	Amount of methane that would have been destroyed/combusted during year *y* in the absence of the project due to regulatory and/or contractual requirements;
$MD_{project,\,y}$:	tCH_4	Amount of methane that would have been destroyed/combusted during year *y* in the project scenario;
AF:	%	Adjustment factor expressed as a percentage.

The adjustment factor (AF) was set at 5% (fixed ex-ante value) for the proposed project activity, based on a thorough analysis[9] of the volume of methane calculated to have been destroyed by the site operator in the baseline scenario, taking 2007 as an illustrative year. The analysis relies on the following four steps:

1) **Calculation of methane generated by the site**. The first step of the analysis calculates the methane generated by the site as a whole, and is based on the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". In 2007, the site would have generated approximately 1,584 tonnes of methane, according to the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".

2) **Methane destroyed in the baseline**. The following step of the analysis involves calculating the volume of methane likely to be destroyed in the baseline scenario. This requires understanding a series of site-specific circumstances, including:

- Percentage of LFG vented through the passive system. The site operator has installed a simple passive venting system which consists of old oil drums with a stone backfill, but with no piping. This rudimentary system is useful for evacuating excess LFG from the site, but does not compare with fully engineered, properly installed and maintained systems, particularly because the latter will have active suction (i.e. negative pressure) which greatly expands the "area of influence" of each well. Industry experts estimate that passive, rudimentary venting systems of the type installed by the

[8] CNR-CIREN, Chile

[9] The table illustrating the calculations of the AF can be found in Annex 3.

operator of the El Panul Landfill are able to vent between one fifth and one fourth of the LFG that a properly engineered and managed system would.

To be conservative, we have assumed that the venting system in the baseline scenario is able to capture as much as one fourth (rather than one fifth) of the LFG that a properly designed, installed and maintained system would. Given that the Project Developer has estimated that a theoretical maximum LFG capture efficiency of 60% could be reached on site, on fourth of this value could be attained by the rudimentary systems in place, suggesting that up to 15% (60% / 4) of the LFG generated by the site is actually channeled to the passive vents in the baseline scenario. The following circumstances support the fact that a small percentage of the LFG, not greater than 15%, is actually channeled to the passive venting system installed by the operator:

- Because large volumes of the site are not influenced by the geomembrane seals, the LFG migrates through the slopes and the uncapped areas directly into the atmosphere, and much of the LFG is not therefore directed towards the passive venting system. As such, a significant fraction of the LFG is emitted to the atmosphere directly, without passing through the venting system.
- It is important to note that the number of wells and the spaces between them in the baseline scenario is not optimal; indeed, the project activity envisions the drilling of wells that will be much closer together than the matrix laid out in the baseline scenario.
- Because large parts of the landfill are located on a slope, the geometry of the site and the cells induces a high lateral migration of the LFG in the baseline scenario.

- Percentage of chimneys available for flaring. Not all of the existing passive vents are used as chimneys. The destruction of methane in the baseline principally took place in closed parts of the landfill, to avoid the risk of explosions in the operational part of the site. Approximately one fourth of the landfill is currently operational, suggesting that, at most, 75% of the landfill is closed and thus only the vents on that part of the site are theoretically available for flaring.

- Percentage of time the chimneys were actually lit. An important consideration is the fact that appropriate flaring equipment is not installed on the chimneys, and therefore they have to be lit manually. The chimneys are not always lit, and there is no systematic approach to maximizing the time that they are lit. Specifically, an employee goes out to light the chimneys only when the vast majority of them are not lit, suggesting that many of the chimneys are unlit for considerable periods of time. Site observations suggest the chimneys are lit approximately half of the time (50%), due to unstable flame conditions caused by windy conditions on the site, located close to the Pacific Ocean, and the variable flow and concentration of the LFG. To be conservative, we have chosen 67% (two out of three chimneys lit) as the variable to use in the analysis.

- Combustion efficiency of an open flame. The last factor to consider in estimating the volume of methane actually destroyed in the baseline is the combustion efficiency of an open flame. Taking into account that open flames tend to have combustion efficiencies ranging from 20 to 25% (due to variable gas flows and unstable flame conditions), we have selected 30% combustion efficiency as a conservative variable to use in the analysis.

- Methane destroyed in the Baseline. Considering the conservative assumptions made, and multiplying each percentage by the total methane generated by the site in 2007, the total volume of methane destroyed in the baseline is equivalent to 35.6 tonnes/year.

3) **Methane destroyed by the project activity**. The third part of the analysis involves calculating the methane to be destroyed by the project activity, which involves the following variables:

- Collection efficiency. The collection efficiency reflects the fraction of total LFG generated by the site that will actually be captured by the system to be installed. The Project Developer has estimated the collection efficiency to be 60%.

- Flare Efficiency. This figure reflects the flare efficiency that will be used to calculate the volume of CERs generated. It is a default value based on the "Tool to determine project emissions from flaring gases containing methane" approved by the Methodologies Panel; and

- Methane destroyed by the Project is obtained by multiplying the collection efficiency and flare efficiency explained above by the total methane generated by the site in 2007. The analysis indicates that the Project would have destroyed 855 tones of methane in 2007.

4) **Adjustment Factor (AF)**. This figure is calculated by dividing the methane destroyed in the Baseline by the methane destroyed in the Project. The resulting AF is 4.17%. In order to add another element of conservativeness to our AF, we have chosen the fixed value 5%, which is greater than the 4.17% that is calculated using already conservative figures.

This value is based on the fact that regulatory requirements do not specify amounts of gas for collection, destruction, or utilisation, and the fact that in practice, minimal amounts of LFG are actually flared.

Project emissions:

1. Project emissions from flaring:

. According to the “*Tool to determine project emissions from flaring gases containing methane*”, in case of enclosed flares, the default value for the flare efficiency, should be:
• 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 °C for more than 20 minutes during the hour h .
• 50%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer’s specifications on proper operation of the flare are not met at any point in time during the hour h.
• 90%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h and the manufacturer’s specifications on proper operation of the flare are met continuously during the hour h.

Project emissions from flaring will therefore be calculated and monitored according to the procedures described in the “*Tool to determine project emissions from flaring gases containing methane*”, using the 90% default value[10] as the methane destruction efficiency of the flare, assuming that the temperature in the exhaust gas of the flare (Tflare) is above 500 °C.

[10] A 90% default value will be used for the project activity as long as the equipment for continuous measurement of the methane destruction efficiency of the flare is not installed. At the moment of submitting the PDD, only a continuous monitoring of the parameter T_{flare} is contemplated. If and when the equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the actual flare efficiency will be monitored continuously *ex-post*, and the default value will no longer be used. Details of the additional parameters to be monitored in the event of using continuous monitoring of the flare efficiency are described in Annex 4. Additional equations will be based on the “*Tool to determine project emissions from flaring gases containing methane*”.

According to the description in the *“Tool to determine project emissions from flaring gases containing methane”,* the project emissions from flaring gases are calculated as follows:

$$PE_{flare,y} = \sum_{i=1}^{8760} TM_{RG,h} \times (1-\eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$$

Where:

$PE_{flare,y}$	tCO_2e	Project emissions from flaring of the residual gas stream in a year *y*;
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in hour *h*;
$\eta_{flare,\ h}$	-	Flare efficiency in hour *h;*

The mass flow rate of methane in the residual gas is calculated as follows:

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

Where:

$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in hour *h*;
$FV_{RG,h}$	Nm^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h;*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h*;
$\rho_{CH4,n}$	kg/Nm^3	Density of methane at normal conditions (0.7168).

2. Project emissions from electricity consumption:

$PE_y = PE_{EC,y} + PE_{FC,y}$ (16)

As there is no thermal energy component for this project activity, the simplified equation will be used:

$$PE_y = PE_{EC,y} \qquad (16^*)$$

Where:

PE_y	tCO_2/yr	Project emissions in year *y*;
$PE_{EC,y}$	tCO_2/yr	Emission from consumption of electricity in the project case. The project emissions from electricity consumption, $PE_{EC,y}$, will be calculated using the latest version of the *“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”*.

Case A1: Electricity consumption from the grid is applicable to the project activity, using the following formula:

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1 + TDL_y)$$

Where:

Parameter	**Unit**	**Default or estimated value**	**Description**
$PE_{EC,y}$	tCO_2/yr		Project emissions from electricity consumption by the project activity in year *y*;
$EC_{PJ,y}$	MWh	263[11]	Quantity of electricity consumed by the project activity in year *y*;
$EF_{grid,y}$	tCO_2/MWh	0.523	Emission factor for the grid in year *y*;
TDL_y	-	20%	Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site.

The default value for TDL_y was used, since recent, accurate, and reliable data about grid-related transmission and distribution losses within the Host Country were not available at the time of PDD submission.

$EF_{grid,y}$ is calculated ex-ante, according to the "Tool for calculation of emission factor for electricity systems".

Of the four methods to calculate Operating Margin, option b) the Simple Adjusted OM, was chosen as the most appropriate for the small scale electricity generation by the project activity, since low-cost must-run resources constitute more than 50% of total grid generation, and detailed data to apply Option c) the Dispatch Data Analysis was not publicly available at the time of PDD submission.

The Combined Margin emission factor**,** $EF_{grid,CM,y}$, is the evenly weighted average of the Operating Margin emission factor ($EF_{grid,OMy}$) and the Build Margin emission factor ($EF_{grid,BMy}$):

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

where:

$EF_{grid,OMy}$ is the operating margin carbon emission factor, expressed in tCO_2/MWh

$EF_{grid,BMy}$ is the build margin carbon emission factor, expressed in tCO_2/MWh and the weights ω_{OM} and ω_{BM} are by default each 0.5.

Since the Project is using ex-ante emission reductions calculations, a 3-year data vintage is used, based on the most recent statistics available at the time of PDD submission. The source of the data is the CDEC-SIC and the National Energy Council, CNE.

The simple-adjusted Operating Margin (OM) emission factor ($EF_{grid,OM-adj,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO2/MWh), where the power sources are separated into low-operating cost and must-run power plants (*k*) and other power sources (*j*). A three-year average, based on the most recent fuel consumption statistics available at the time of PDD submission, is used.

[11] For estimated Project average annual electricity consumption, please refer to Annex 3.

$$EF_{grid,OM\text{-}adj,y} = (1-\lambda_y)\times\frac{\sum_{i,j} FC_{i,j,y}\cdot NCV_{i,y}\cdot EF_{CO2,i,y}}{\sum_j EG_{j,y}} + \lambda_y\times\frac{\sum_{i,k} FC_{i,k,y}\cdot NCV_{i,y}\cdot EF_{CO2,i,y}}{\sum_k EG_{k,y}}$$

Where:

$FC_{i,j,y}$ is the amount of fuel *i* (in mass or volume units) consumed by power source *j* in year *y*;
j is the set of plants delivering electricity to the grid, not including low-cost or must-run plants and carbon financed plants;
k represents the low cost/must run power sources;
$NCV_{i,y}$ is the net calorific value of fossil fuel type i in year y (GJ/mass or volume unit);
$EF\ CO_{2,i,,y}$ is the CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ);
$EG_{j,y}$ is the electricity (MWh) delivered to the grid by source *j*;
$FC_{i,k,y,}$, and $EG_{k,y}$ are analogous to the variables described above for plants *k*;
λ_y is the calculated number of hours for which low cost/must run sources are on margin divided by 8,760 (the number of hours per year)

$$\lambda_y = \frac{number\_of\_hours\_per\_year\_low\cos t/must-run\_sources\_are\_on\_m\arg in}{8760 hours\_per\_year} \quad (3)$$

The simple-adjusted OM emission factor of the grid is then calculated as 0.6319 tCO_2e /MWh

The build margin emissions factor (EF grid,BM_y) is the generation-weighted average emission factor (tCO_2e/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y}\times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

where:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y}\cdot NCV_{i,y}\cdot EF_{CO2,i,y}}{EG_{m,y}}$$

$EF_{EL,m,y}$: CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$FC_{i,m,y}$: Amount of fossil fuel type i consumed by power unit m in year y (mass or volume units)
$NCV_{i,y}$: Net calorific value of fossil fuel type i in year y (GJ/mass or volume unit);
$EF_{CO2,i,y}$: CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
$EG_{m,y}$: Net electricity generated and delivered to the grid by power plant / unit m in year y (MWh)
m : Power units included in the build margin
y: Most recent historical year for which power generation data is available

The BM average emission factor of the grid is therefore calculated as 0.4144 tCO2e /MWh.

Data and assumptions are from the following sources:

Baseline Emission Factor of the SIC grid (tCO_2/MWh)

No.	Elements	Value	Data Source
A	Operating Margin Emission Factor	0.6319	CDEC-SIC and the National Energy Council, CNE (2005-2007)
B	Build Margin Emission Factor	0.4144	CDEC-SIC and the National Energy Council, CNE (2007)
C	Combined Emission Factor (C=0.5A+0.5B)	0.5230	N/A

More details of OM&BM calculation can be found in Annex 3

Also, in the event that a diesel generator is used as a back up of the Grid for electricity consumption, the following equation from the *Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* (Option B2) will apply:

PE EC, y= ECPJ,y *1.3 tCO2 /MWh**Leakage emissions:**

No leakage effects need to be accounted for under this methodology.

Emission reductions:

The following formula was modified in order to clearly differentiate between project emissions from flaring ($PE_{flare,y}$) and electricity consumption ($PE_{EC,y}$). Project emissions from flaring are already included in the calculation of $MD_{flare.y}$ (equation (9) of meth ACM0001), and therefore in $MD_{project}$ and BE_y. Hence, they have not to be deducted once more in the overall emission reduction calculation, in equation (17*).

$$ER_y = BE_y - PE_{EC,y} \qquad (17^*)$$

Where:

ER_y tCO_2e/yr Emission reductions in year *y*;
BE_y tCO_2e/yr Baseline emissions in year *y*;
$PE_{EC,y}$ tCO_2e/yr Project emissions from electricity consumption in year *y*.

All *ex-ante* calculations to obtain the emission reduction from the project activity are listed in Section B.6.

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

Data / Parameter:	**Regulatory requirements relating to landfill gas projects**
Data unit:	-
Description:	Regulatory requirements relating to landfill gas projects
Source of data used:	National legislation and mandatory regulations
Value applied:	Will be reflected in the AF.
Justification of the choice of data or	Further information can be found in section.B6.1, and Annex 3.

description of measurement methods and procedures actually applied:	
Any comment:	

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of methane
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied:	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	

Data / Parameter:	**D_{CH4}**
Data unit:	tCH_4/m^3CH_4
Description:	Methane Density
Source of data used:	
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied:	At standard temperature and pressure (0 degrees Celsius and 1,013 bars), the density of methane is 0.0007168 t/m^3.
Any comment:	

Data / Parameter:	**$BE_{CH4,SWDS,y}$**
Data unit:	tCO_2e
Description:	Methane generation from the landfill in the absence of the project activity at year *y*
Source of data used :	Calculated as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.
Any comment:	Used for *ex-ante* estimation of the amount of methane that would have been destroyed/combusted during the year.

<table>
<tr><td>Data / Parameter:</td><td>DOCj</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Fraction of degradable organic carbon (by weight) in the waste type j.</td></tr>
<tr><td>Source of data used:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Value applied:</td><td>The following values for the different waste types j are applied:
<table>
<tr><th>Waste type j</th><th>DOC_j
(% wet waste)</th></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied:</td><td>In accordance with “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”, Version 02.</td></tr>
<tr><td>Any comments</td><td>The values applied are for wet waste.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>k_j</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type j.</td></tr>
<tr><td>Source of data used:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value applied:</td><td>The following values for the different waste types j are applied:
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th colspan="2">Boreal and Temperate (MAT≤20°C)</th></tr>
<tr><th>Dry (MAP/PET <1)</th><th>Wet (MAP/PET >1)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td><td>0.185</td></tr>
</table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied:</td><td>In accordance with “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”, Version 02.</td></tr>
<tr><td>Any comments</td><td>The values applied are for Temperate (MAT< 20°C) and dry (MAP/PET < 1) conditions. (CNR-CIREN, Chile)</td></tr>
</table>

Data / Parameter:	**E_{DS}**
Data unit:	%
Description:	Efficiency of the degassing system which will be installed in the project activity
Source of data used:	Project Developer
Value applied:	60
Justification of the choice of data or description of measurement methods and procedures actually applied:	The collection efficiency value considers the physical conditions of the landfill (properly managed with lining), as well as the capping material (a mix of clay and sand). 60% is a reasonable factor to differentiate between LFG generated (from the pure application of the methodology) and LFG collected. This collection efficiency takes into account losses of gas through the gas collection system.
Any comments	

Data / Parameter:	**$EF_{grid,y}$**
Data unit:	tCO_2/MWh
Description:	Emission factor for the grid in year *y*
Source of data used:	
Value applied:	0.5230
Justification of the choice of data or description of measurement methods and procedures actually applied:	Calculated as per the *"Tool to calculate the emission factor for an electricity system"*, based on fuel consumption and electricity generation data for plants connected to the grid, provided by CDEC-SIC. Detailed information can be found in Annex 3.
Any comment:	.

Data / Parameter:	**$\eta_{flare,h}$**
Data unit:	%
Description:	Flare efficiency in the hour *h*
Source of data used:	*"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:	Ex ante default value as per *"Tool to determine project emissions from flaring gases containing methane".* *(Please see Footnote (10))*
Any comment:	As and when the entire equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the actual flare efficiency will be monitored continuously *ex-post,* and the default value will no longer be used. For further details, please refer to Section B.6.3.

B.6.3. Ex-ante calculation of emission reductions:

Baseline emission

$$BE_y = (MD_{project,\ y} - MD_{BL,\ y}) * GWP_{CH4} \quad (1*)$$

1. $MD_{project,\ y}$

a) Estimated amount of methane destroyed by the project activity - Sum of quantities fed to the flare(s) :

$$MD_{project,y} = MD_{flared,y} \qquad (8*)$$

Table 1[12]:

	$MD_{flared,y}$ (tCH_4)	**$MD_{project,y}$ (tCH_4)**
2009	935	935
2010	974	974
2011	1,013	1,013
2012	1,052	1,052
2013	1,091	1,091
2014	1,129	1,129
2015	1,072	1,072
2016	1,019	1,019
2017	968	968
2018	919	919
Total	10,173	10,173

Where the quantity of methane destroyed by flaring was calculated using the following equation:

$$MD_{flared,\ y} = (LFG_{flare,\ y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,\ y} / GWP_{CH4}) \qquad (9)$$

Table 2:

	$LFG_{flare,\ y}$ (m^3)	$PE_{flare,\ y}$ (tCO_2)	$MD_{flared,\ y}$ (tCH_4)

[12] The values for $MD_{flare,y}$ and $MD_{electricity,y}$ in Table 1 are derived from the FOD model (tCO_2e transformed into LFG flow in Nm^3/hr) as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*

2009	2,898,140	2,181	935
2010	3,020,122	2,273	974
2011	3,141,316	2,364	1,013
2012	3,261,767	2,455	1,052
2013	3,381,515	2,545	1,091
2014	3,500,599	2,635	1,129
2015	3,324,799	2,502	1,072
2016	3,158,158	2,377	1,019
2017	3,000,184	2,258	968
2018	2,850,411	2,145	919
Total	31,537,010	23,736	10,173
Default values: $w_{CH4,y}$ = 50%; D_{CH4} = 0.0007168 tCH4/m3CH4; GWP_{CH4} = 21			

b) <u>*Ex-ante estimation of the amount of methane that will be destroyed/combusted during the year*</u> ($MD_{project,y}$)

$$MD_{project,y} = BE_{CH4,\ SWDS,y}/GWP_{CH4} \quad (13)$$

Table 4:

	$BE_{CH4,\ SWDS,\ y}$ (tCO_2)	**$MD_{project,\ y}$** (t CH_4)
2009	21,813	1,039
2010	22,731	1,082
2011	23,643	1,126
2012	24,549	1,169
2013	25,451	1,212
2014	26,347	1,255
2015	25,024	1,192
2016	23,770	1,132
2017	22,581	1,075
2018	21,453	1,022
Total	237,360	11,303
Default values: $w_{CH4,y}$ = 50%; D_{CH4} = 0.0007168 tCH4/m3CH4; EDS: Degassing efficiency :60%		

In this Table, the values of BECH4, SWDS, y are taking into account the collection efficiency (60%).

The comparison of $MD_{project,y}$ from Table 1 and Table 4 show, that $MD_{project,y}$ from Table 1 gives lower values, as it includes the project emissions from flaring. $MD_{project,y}$ values from Table 1 will be adopted for the *ex-ante* estimations.
The methane actually destroyed by the project activity is determined *ex-post* by monitoring the quantity of methane flared and/or used to generate electricity.

2. $MD_{BL,y}$

For the amount of methane destroyed in the baseline scenario, we use the following equation:

$$MD_{BL,\ y} = MD_{project,\ y} * AF$$

The adjustment factor (AF) was set at 5%.

Table 5:

MD project (tCH_4)	**MD BL, y (tCH_4)**

2009	935	47
2010	974	49
2011	1,013	51
2012	1,052	53
2013	1,091	55
2014	1,129	56
2015	1,072	54
2016	1,019	51
2017	968	48
2018	919	46
Total	10,173	509

Project emissions:

1. Project emissions from flaring:

$$PE_{flare,y} = \sum_{i=1}^{8760} TM_{RG,h} \times (1-\eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$$

with:

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

Table 7:

	$FV_{RG, h}$ (Nm3/h)	**$TM_{RG, h}$ ((Kg/h))**	**$PE_{flare, y}$ (t CO2)**
2009	331	119	2,181
2010	345	124	2,273
2011	359	129	2,364
2012	372	133	2,455
2013	386	138	2,545
2014	400	143	2,635
2015	380	136	2,502
2016	361	129	2,377
2017	342	123	2,258
2018	325	117	2,145
Total	3,600	1,290	23,736
Default values: $fv_{CH4, RG, h}$ = 50%; $\rho_{CH4, n}$ = 0.7168 tCH4/m3CH4; $\eta_{flare, h}$ = 90%; GWP_{CH4} = 21			

These project emissions are already included in the calculation of $MD_{project,\ y}$ (equation (8*)), and thus in BE_y. Hence, they need not be deducted again in the overall emission reduction calculation in equation (17*).

2. Project emissions from electricity consumption

$$PE_y = PE_{EC,y} \qquad (16^*)$$

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1 + TDL_y)$$

$$PE_{EC,y} = EC_{PJ,y} * 0.5230 * (1 + 0.20) = PE_y$$ [13]

Table 8:

	$EC_{PJ,\ y}$ (MWh)	$PE_{EC,\ y}$ (tCO_2e)
2009	263	165
2010	263	165
2011	263	165
2012	263	165
2013	263	165
2014	263	165
2015	263	165
2016	263	165
2017	263	165
2018	263	165
Total	2,628	1,649

Emission reduction

The greenhouse gas emission reductions achieved by the project activity during a given year *y* (ER_y) are calculated using a modified equation (based on the formula above), since Project Emissions from flaring ($PE_{flare,\ y}$) also need to be deducted:

$$ER_y = BE_y - PE_{EC,\ y} \qquad (17^*)$$

Table 9:

	BE_y ($tC0_2e$)	$PE_{EC,\ y}$ (tCO_2e)	ER_y (tCO_2e)
2009	18,650	165	18,485
2010	19,435	165	19,270
2011	20,215	165	20,050

[13] Using default values as defined in the *"Tool to calculate the emission factor for an electricity system"*.

2012	20,990	165	20,825
2013	21,760	165	21,595
2014	22,527	165	22,362
2015	21,395	165	21,230
2016	20,323	165	20,158
2017	19,306	165	19,141
2018	18,343	165	18,178
Total	202,943	1,649	201,294

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

Table 10: Total Emission Reductions over the first crediting period (taking into account three months in 2008 and nine months in 2018), so as to have precisely a ten-year crediting period.

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
2009	165	18,650	0	18,485
2010	165	19,435	0	19,270
2011	165	20,215	0	20,050
2012	165	20,990	0	20,825
2013	165	21,760	0	21,595
2014	165	22,527	0	22,362
2015	165	21,395	0	21,230
2016	165	20,323	0	20,158
2017	165	19,306	0	19,141
2018	165	18,343	0	18,178
Total (tonnes of CO2e)	1,649	202,943	0	201,294

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:	Nm^3
Description:	Total amount of landfill gas captured at Normal Temperature and Pressure
Source of data to be used:	Project Developer (telemetry monitoring data and/or back-up data)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,153,701 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Data will be measured with a flow meter and monitored continuously by the Project Developer. The flow meter will be maintained and calibrated periodically in line with the manufacturer (officially accredited entity) requirements .This will ensure that the accuracy of the measurement instrument is maintained. The accuracy will be ±1.5 % of reading plus ±0.5 % of full scale. Monitoring data and/or back-up data will be gathered regularly on site and aggregated monthly by the Project Developer.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	The flow meter will express gas flow in normalized cubic meters, therefore no separate monitoring of pressure (P) and temperature (T) of LFG is necessary to determine density. **$LFG_{total,y}$** will equal **$LFG_{flared,y}$** in case the project does not generate electricity, and no separate flow meter will be installed.

Data / Parameter:	**$LFG_{flared,y}$**
Data unit:	Nm^3
Description:	Amount of LFG flared at Normal Temperature and Pressure
Source of data to be used:	Project Developer (telemetry monitoring data and/or back-up data)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,153,701 (Annual average over the first crediting period)

Description of measurement methods and procedures to be applied:	Data will be measured with a flow meter and monitored continuously by the Project Developer. The flow meter will be maintained and calibrated periodically in line with the manufacturer (officially accredited entity) requirements. This will ensure that the accuracy of the measurement instrument is maintained. The accuracy will be ±1.5 % of reading plus ±0.5 % of full scale. Monitoring data and/or back-up data will be gathered regularly on site and aggregated monthly by the Project Developer.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	The flow meter will express gas flow in normalized cubic meters, therefore no separate monitoring of pressure (P) and temperature (T) of LFG is necessary to determine density. $\mathbf{LFG_{flared,y}}$ is considered to be equivalent to the variable $FV_{RG,h}$ (volumetric flow rate of the residual gas) as described in the "*Tool to determine project emissions from flaring gases containing methane*" to determine the project emissions from the flaring process. Furthermore, $\mathbf{LFG_{flared,y}}$ will equal $\mathbf{LFG_{total,y}}$ in case the project does not generate electricity.

Data / Parameter:	$\mathbf{PE_{flare,y}}$
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,374 (Annual average over the first crediting period)
Description of measurement methods and procedures to be applied:	Calculated as per the *"Tool to determine project emissions from flaring gases containing Methane"*.
QA/QC procedures to be applied:	As per the *"Tool to determine project emissions from flaring gases containing Methane"*.
Any comment:	

Data / Parameter:	$\mathbf{w_{CH4}}$
Data unit:	% (m^3CH_4 / m^3LFG)
Description:	Methane fraction in the landfill gas
Source of data to be used:	Project Developer (telemetry monitoring data and/or back-up data)
Value of data applied for the purpose of calculating expected emission reductions in	50

section B.5	
Description of measurement methods and procedures to be applied:	Methane content will be measured continuously with a fixed gas analyser and regularly with a portable gas analyser by the Project Developer. The gas analysers will be maintained and calibrated regularly in line with the manufacturer's requirements. The Methane fraction of the landfill gas will be measured according to the methodology requirement.
QA/QC procedures to be applied:	Calibration is carried out using a standard certified gas. The analysers will be subject to a regular maintenance and calibration according to manufacturer's recommendation to ensure accuracy. A zero check is performed.
Any comment:	Used to determine the methane concentration in the captured landfill gas. In accordance with the *"Tool to determine project emissions from flaring gases containing methane"*, only the methane content of the landfill gas is measured and the remaining part is considered as N_2. Furthermore, $\mathbf{w_{CH4}}$ is considered to be equivalent to the variable $fv_{CH4,h}$ (Volumetric fraction of the component CH_4 in the landfill gas in hour *h*) as described in the "*Tool to determine project emissions from flaring gases containing methane*".

Data / Parameter:	$\mathbf{T_{flare}}$
Data unit:	˚C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Project Developer (telemetry monitoring data and/or back-up data)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	The temperature in the exhaust gas will be measured with a type N thermocouple and continuously monitored as described in the "*Tool to determine project emissions from flaring gases containing methane*".
QA/QC procedures to be applied:	The thermocouple will be replaced or calibrated every year.
Any comment:	Required to determine adequate operation of the flare

Data / Parameter:	$\mathbf{EC_{PJ,y}}$
Data unit:	MWh
Description:	Onsite consumption of electricity provided by the grid and/or captive power plant(s) and attributable to the project activity during year *y*
Source of data to be used:	Electricity meter
Value of data applied for the purpose of	263 (*ex-ante* estimate from Project Developer)

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Electricity will be measured continuously with an electricity meter. Data will be aggregated at least annually as stated in the **“***Tool to calculate project emissions from electricity consumption”*.
QA/QC procedures to be applied:	Electricity meter will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier to ensure accuracy.
Any comment:	Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity.

Data / Parameter:	**TDLy**
Data unit:	%
Description:	Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site.
Source of data to be used:	Default value as per *“Tool to calculate baseline, project and/ or leakage emissions from electricity consumption”*, as recent, accurate and reliable data was not publicly available within the Host Country at the time of PDD submission.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20
Description of measurement methods and procedures to be applied:	N/A
QA/QC procedures to be applied:	N/A
Any comment:	The 20% default value will only be used if no accurate and reliable data is obtained during the crediting period. As soon as data for average technical transmission and distribution losses is obtained, the default value will be replaced by the real value.

B.7.2. Description of the monitoring plan:

The monitoring plan details the actions necessary to record all relevant variables and factors as per methodology ACM0001 (Version 8, adopted at EB36), and detailed in section B.7.1. All relevant data will be archived electronically and in written form, and regularly backed up. Moreover, it will be kept for the full crediting period, plus two years after the end of the crediting period or the last issuance of CERs for this project activity (whichever occurs later).

Project staff will be trained regularly in order to satisfactorily fulfil their monitoring obligations. The authority and responsibility for project management, monitoring, measurement, and reporting will be agreed upon and formalized between the project participants. Detailed procedures for calibration of monitoring equipment, maintenance of monitoring equipment and installations, and for records handling will be established. Further information on the delegation of responsibilities can be found in Annex 4.

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):

Date of completion: November 23rd, 2007

Person/entity determining the baseline:

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Detailed baseline and monitoring information are found in Annexes 3 and 4

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/08/2006 (Date when the contract between TASUI and Biogas was signed)

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

Approximately 15 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:

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

The crediting period will start on 15/06/2009, or on the date of registration of the CDM project activity, whichever is later.

C.2.2.2. Length:

10 years

SECTION D. Environmental Impacts

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

The Project will actively collect and combust LFG, thereby improving overall landfill management and reducing adverse global and local environmental effects of uncontrolled release of LFG. While the main global environmental concern over gaseous emissions of methane is the fact that it is a potent greenhouse gas contributing to global warming, emissions of LFG can also have significant health and safety implications at the local level. For example:

- Risk of explosions and/or fires either within the landfill or outside its boundaries, although the majority of LFG emissions are quickly diluted in the atmosphere;

- Asphyxiation and/or toxic effects to humans from concentrated emissions of LFG;

- Local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation due to over 150 trace components contained in LFG.

Through both the installation of a well-designed LFG collection and a destruction/utilisation system and its proper operation, LFG will be captured and combusted in a controlled way, thereby eliminating safety risks to the surrounding community, reducing the risks of toxic effects on the local community and the local environment, and reducing the emissions of a potent greenhouse gas.
It is worth noting that the Project Developer will install flares which comply with stringent UK emission standards, thereby minimising the environmental impact from this particular source, and suggesting that these emissions are significantly less harmful than the continued uncontrolled release of LFG. The Project will significantly reduce odour and greenhouse gas emissions.

In a previously conducted environmental impact study for a Latin-American landfill, where the LFG collection and destruction/combustion system described in section A.4.3 was installed as a component of the closure and rehabilitation plan, it was clearly stated that the construction of the LFG collection system and the monitoring of the LFG constitutes a favourable environmental impact because it minimises the negative effects of the LFG and therefore the risks of the landfill. Furthermore the study declares that this presents a global and permanent impact of high magnitude and importance[14].

Thus, the Project activity can be referred to as environmentally ameliorative, and the installation of the LFG collection and combustion system is part of a broader effort by the landfill operator to continue to improve waste management practices.

Nevertheless, a Declaration of Environmental Impact was carried out in accordance with regulatory requirements, given that the Regional Commission of Environment needs to be informed of any kind of construction or modification made at the existing landfill in accordance with the Resolution of the Environmental Qualification (RCA), Article 17.
The Declaration of Environmental Impact presents information regarding the collection and combustion of the generated LFG, the respective impacts on the global and local environments, as well as detailed technical information on the equipment which will be used for the proposed project activity. The Declaration of Environmental Impact has been submitted in July 2007 and approved in December 2007. It will be available to the DOE upon request.

An Environmental Impact Study for the landfill operation has been completed in accordance with the current regulations of the Host Country. It was made available to the DOE

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:

Not applicable.

SECTION E. Stakeholders' comments:

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

The stakeholder consultation took place on September 7th, 2006 in Coquimbo and was well attended. The event allowed stakeholders to understand the basic concepts related to climate change, its consequences and the aims of the Kyoto Protocol, as well as the most important features of the El Panul – EcoMethane Landfill Gas Project undertaken by the Project Developer.

The event was properly announced in national and local newspapers "El Día" and "Las últimas noticias" respectively. Specifically, people from local authorities, a local university, local media, and members of the community participated in the event, which lasted approximately 2 hours. Most of the participants represented local communities. All participants were registered appropriately in the Project Developer's files.

[14] SIGEA (2006). Manifestación de Impacto Ambiental "Clausura y Ampliación del Relleno Sanitario de Ecatepec de Morelos, Estado de México" page 129, lines 13-15. (Environmental Impact Assessment "Closure and expansion of the Ecatepec de Morelos, State of Mexico")

The stakeholder consultation included a brief description of the Project and its benefits by the project proponent, as well as presentations by the Project Developer covering the following topics: Climate change; how this Project is mitigating climate change through the Clean Development Mechanism of the Kyoto Protocol; the technical details of the Project; and a session aimed at addressing questions posed by the stakeholders.

E.2. Summary of comments received:

To date no formal comments have been received from stakeholders. However, during the public consultation stakeholders raised various questions regarding the project activity specifically, as well as LFG capture at dump sites and landfills in general.
Further factual issues about risk management in LFG projects were raised. The Project Developer explained applied risk preventative procedures, and all concerns/questions were answered to the complete satisfaction of the audience.
The stakeholder consultation was videotaped and will be made available to the Validating DOE on request.

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

No formal comments were submitted by any of the stakeholders regarding this Project. Several stakeholders had questions about specific aspects of the Project and/or the future management of the landfill, and these were addressed at the meeting. Overall, the stakeholder consultation was a positive event with stakeholders being informed about the project activities.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This Project will not receive any public funding.

Annex 3

BASELINE INFORMATION

LANDFILL CALCULATION PARAMETERS		
Parameter	Units	**El Panul**
	Landfill data	
Year landfill started operation		1990
Waste in place at beginning of Project	tonnes	appr. 2,000,000
Density of waste	tonnes/m^3	0.8
Area of site (cell #1)	ha	34
Average daily waste rate	tonnes/day	350
Date gas collection project starts		February 6th, 2008
	Operational data	
Gas collection efficiency[15]	%	60
Ex-ante default flare efficiency	%	90
	General data	
Methane content of landfill gas	%	50
GWP CH_4	tCO_2 / tCH_4	21
Density of Methane	tCH_4/m^3	0.0007168
	Baseline data	
Proportion of methane flared in Baseline (AF)	%	5

Carbon Emission factors of the Electricity Grid "SIC"

Operating Margin of the SIC Electricity Grid using the "Simple Adjusted OM option"	**2005**	**2006**	**2007**
Electricity Generation (MWh)	12,065,387	11,697,837	19,058,939
CO_2 Emissions (tonnes)	6,778,486	7,459,804	13,235,203
Operating Margin (tCO_2 / MWh)	0.5618	0.6377	0.6944
Load (MWh)	37,743,115	40,087,815	41,686,385
Lambda	0.0023	0.0058	0.0000
Simple Adjusted Operating Margin (tCO_2e / MWh)	**0.6319**		

Table: Data used to calculate the build margin emissions factor for the electricity component of the project.

Build Margin of the SIC Electricity Grid using the "ex-ante option"	**2007**
Electricity Generation (MWh)	9,399,463
CO2 Emissions (tonnes)	3,892,165
Build Margin (tCO_2 / MWh)	0.4141

Carbon Emission Factor 2005 - 2007	**tCO_2 / MWh**
Simple Adjusted Operating Margin 2005-2007	0.6319
Average Build Margin 2007	0.4141
Carbon Emission Factor	**0.5320**

Source: Comisión Nacional de Energía (CNE). Electricidad/Infrastructura - Capacidad Instalada de generación, SIC 2007. http://www.cne.cl/estadisticas/nacionales/electricidad/f_precio.html

Calculation of the Adjustment Factor (AF):

Table 1: Adjustment Factor: El Panul - EcoMethane LFG Project	
Parameter	**El Panul Landfill**
(1) Calculation of methane generated by the site in 2007	
Total LFG generated at site (Nm^3/hour)	**504**
Total LFG generated at site (Nm^3/year)	4,419,380
Volumetric fraction of methane in LFG	50%
Density of CH_4 (t/m^3) @ NTP	0.0007168
Total methane generated at the site (tonnes, in 2007)	**1,584**
(2) Methane destroyed in the Baseline	
Percentage of LFG vented through the Passive System	15%
Percentage of chimneys available for flaring	75%
Percentage of time the chimneys were actually lit	67%
Combustion efficiency of an open flame	30%
Methane destroyed in the Baseline (tonnes, in 2007)	**35.6**
(3) Methane destroyed by the Project Activity	
Collection efficiency	60%
Flare Efficiency	90%
Methane destroyed by the Project (tonnes, in 2007)	**855**
(4) Adjustment Factor (AF)	
Adjustment Factor calculated	**4.17%**
Adjustment Factor used by the Project Activity	**5.00%**

Input data for the electricity generation component of the project activity

Input data	
PROJECT DATA	
Date Project starts operating (year)	**2008**
Estimated on-line availability of equipment (%)	**91**
Operating period (h/yr)	**8,000**
BASELINE DATA	
Country	**Chile**
CEF country (tCO2e/MWh)	**0.5230**
Crediting period (years)	**10**
FINANCIAL PARAMETERS	
Income tax (%)	**17.0**
Discount rate (%)	**12.0**
Depreciation (%)	**10.0**
Price of carbon (US$ / tCO2)	**9.00**

CER calculation

Formula used

$$BE_y = \left(MD_{project,y} - MD_{BL,y}\right) * GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y}$$

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4}$$ or $$MD_{project,y} = MD_{flared,y}$$

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

Baseline emission BE y

ACM001 vers 08 & Tool methane avoidance	Units	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Baseline emission BE CH4,SWDS,y	tCO_2e	21,813	22,731	23,643	24,549	25,451	26,347	25,024	23,770	22,581	21,453
MD project,y= BE/GWP CH4	tCH4	**1,039**	**1,082**	**1,126**	**1,169**	**1,212**	**1,255**	**1,192**	**1,132**	**1,075**	**1,022**
LFG volume collected per year	m3/year	2,898,140	3,020,122	3,141,316	3,261,767	3,381,515	3,500,599	3,324,799	3,158,158	3,000,184	2,850,411
Total LFG volume to be flared	m3/year	2,898,140	3,020,122	3,141,316	3,261,767	3,381,515	3,500,599	3,324,799	3,158,158	3,000,184	2,850,411
Methane mass flow rate in the residual gas	kg / h	119	124	129	133	138	143	136	129	123	117
Project Emissions from flaring	tCO2e	2,181	2,273	2,364	2,455	2,545	2,635	2,502	2,377	2,258	2,145
Methane destroyed by the flare	tCH4	935	974	1,013	1,052	1,091	1,129	1,072	1,019	968	919
MD project,y = MD flared	**tCH4**	**935**	**974**	**1,013**	**1,052**	**1,091**	**1,129**	**1,072**	**1,019**	**968**	**919**
Baseline Emission Reductions	tCH4	47	49	51	53	55	56	54	51	48	46
Emission reductions from methane destruction											
(MD project,y - MD reg,y)* GWP CH4	tCO_2e	18,650	19,435	20,215	20,990	21,760	22,527	21,395	20,323	19,306	18,343

$$PE_y = PE_{EC,y}$$ **and** $$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1 + TDL_y)$$

Project emission PE y

ACM001 vers08 & Tool to calculate project emissions fr	Units	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Electricity consumption	MWh/year	263	263	263	263	263	263	263	263	263	263
Project emissions	tCO2e	165	165	165	165	165	165	165	165	165	165

$$ER_y = BE_y - PE_y$$

Emission reduction ER y

ACM0001 vers08	Units	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Emission reduction	tCO2e	18,485	19,270	20,050	20,825	21,595	22,362	21,230	20,158	19,141	18,178

Total cummulative CERs through 2012	78,629
Cummulative CERs 10years	201,294
Average CER flow annually 1st crediting period	20,545

Annexe 4

MONITORING INFORMATION

Table: CDM Monitoring System Procedures

Procedure / Training	Description	Scope
CDM Staff training	This training outlines the necessary steps to ensure that staff adequately collects and archives complete and accurate data required for CDM monitoring.	This training should be received by the staff on site prior to performing monitoring duties for the CDM project.
CDM data and record keeping arrangements / day-to-day record handling	This procedure provides details of the on-site data gathering and record keeping arrangements. The arrangements ensure that all relevant data and records are retained within the quality control system. Data and records will be stored and archived according to this procedure.	All data and records should be managed following this procedure. Staff are responsible for ensuring that the retained data and/or records are dealt with according to this procedure.
CDM data quality control and quality assurance	Data and records will be checked prior to being stored and archived. Data from the Project will be checked to identify possible errors or omissions. All records will be checked for completeness on a regular basis.	Staff are responsible for ensuring the collection and archiving of complete and accurate data and records.
Internal audits	This procedure will outline the process of internal audits, where the performance of the project will be assessed. It will also provide details on the follow-up of forward actions arising after third party verification.	This procedure should be followed by all CDM staff involved in internal audits.
Equipment failure	This procedure details the process for identifying and fixing any failure of the equipment	This procedure will be established by the project developer in the site fault report.

Equipment calibration	This procedure details calibration schedules and subsequent steps in order to comply with manufacturer's recommendations and assure high levels of accuracy..	The calibration of the equipment will be conducted by a suitable company as per relevant standards. The Project Developer is responsible for organising calibration and ensuring that records are retained.

The above procedures will be documented as part of the monitoring support materials. The procedures may be consolidated into a single document (e.g. a Monitoring Manual) for CDM monitoring rather than separate procedures.

Data/Parameters to monitor in case of using continuous monitoring of the flare efficiency

As and when the entire equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the flare efficiency will be monitored continuously *ex-post*, and the default value will no longer be used. According to the *"Tool to determine project emissions from flaring gases containing methane",* the following additional parameters will be monitored to determine flare efficiency:

Data / Parameter:	$\mathbf{t_{O2,h}}$
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Source of data to be used:	Project Developer
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:	Volumetric fraction of O_2 will be measured continuously via in situ analyzers. The sample is taken with a high temperature probe and will be conducted through filtration and conditioning system to ensure optimized functioning of the analyzer. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height).
QA/QC procedures to be applied:	The analysers will be subject to regular maintenance and calibration according to manufacturer's recommendation to ensure accuracy. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	

Data / Parameter:	$\mathbf{fv_{CH4,FG,h}}$

Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h*
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Concentration of CH_4 in the exhaust gas will be measured continuously via in situ analyzers The sample is taken with a high temperature probe and will be conducted through filtration and conditioning system to ensure dry basis and optimized functioning of the analyzer. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height).
QA/QC procedures to be applied:	The analysers will be subject to regular maintenance and calibration according to manufacturer's recommendation to ensure accuracy. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	Measurements will be undertaken in ppmv. This will be converted in accordance with the Tool.